Attachment A – Sound Level Analysis for the Rugby Wind Repower Project

Jacobs

Memorandum

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Subject	**Sound Level Analysis for the Rugby Wind Repower Project**
Attention	Manuela Elizondo/Avangrid Renewables, LLC
From	Mark Bastasch, P.E. (OR), INCE Bd. Cert./Jacobs Engineering Group Inc.
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Rugby Wind, LLC (Rugby Wind), a wholly owned subsidiary of Avangrid Renewables, LLC, operates the Rugby wind farm (Facility) in Pierce County, North Dakota. The Facility began commercial operations in 2009 and has a nameplate capacity of 149.1 megawatts (MW). Facility components include 71 Suzlon S88 wind turbines with a capacity of 2.1 MW each, access roads, buried and overhead electrical collection lines, an electrical substation, an operations and maintenance building, a meteorological tower, and an aircraft detection lighting system. Additionally, a 9.5-mile-long, 230-kilovolt transmission line runs from the Rugby Wind Farm Substation to the existing Rugby Substation.

Rugby Wind proposes to retrofit the Facility for the purpose of improving wind turbine efficiency, increasing energy output, and prolonging the useful life of the wind farm. The retrofitting process is known as "repowering." The repower scope includes replacing the turbine nacelles and its interior elements, adding an adapter section to the tower and increasing the hub height up to 84.8 meters, replacing the rotor (hub and blades) and increasing the rotor diameter up to 120 meters, replacing generators from 2.1 MW to 2.2 MW, and reinforcing turbine foundations and associated collector lines, as needed. Rugby Wind proposes no changes to turbine locations, point of interconnection output capacity, or other existing components such as the generation-tie line and collector substation, at this time. Temporary ground disturbance is primarily limited to existing facilities such as turbine pads, electrical collection line easements, access roads, and a laydown yard.

1. Summary of Proposed Repower and Sound Level Analysis Results

Rugby Wind proposes to repower up to all 71, 2.1-MW, Suzlon S88 turbines with 2.1-MW to 2.2-MW turbines. The nameplate capacity would increase from 149.1 MW up to 156.2 MW. This technical memorandum provides a sound level analysis for the repowered Facility. The turbine type considered in this analysis was Vestas V120 with Serrated Trailing Edge (STE) blades.

Figure 1 (attached) shows the Facility's predicted sound pressure levels based on the analysis of the turbine type described in this memorandum, as well as the residences identified by Rugby Wind. Predicted sound levels do not exceed 50 dBA at the nearest residences. The predicted sound level of 45 dBA is exceeded within 100 feet of eight participating and one nonparticipating occupied residence. Rugby Wind anticipates obtaining waivers, maintaining the existing Suzlon turbines, or operating turbines at a lower electrical and sound output mode in order to reduce the sound level to less than 45 dBA within 100 feet of occupied residences. Thus, the Facility will be in compliance with the noise standards adopted by the Pierce County Board of County Commissioners and the North Dakota Public Service Commission (ND PSC), respectively.

2. Regulatory Requirements

Pierce County granted a conditional use permit (CUP; CUP 2005-001 – Rugby Wind Farm) to Rugby Wind on July 12, 2005, and an updated CUP on September 3, 2008, prior to construction. Pierce County's Zoning Ordinance Article 2 Section 10(3) states that "*Noise shall be limited to a maximum level of 50 dBA at the nearest property line.*" The Facility's CUP granted an exception allowing the 50 dBA threshold to be assessed at the residence rather than the property line. The County confirmed no additional zoning permits are required for these repowering efforts.

Rugby received a Certificate of Site Compatibility (Certificate) from ND PSC on October 3, 2005, in Case No. PU-05-47. The Certificate was reissued on August 27, 2008, and the final layout was approved by ND PSC on May 22, 2009. Rugby Wind began operations in December 2009. In 2019, ND PSC established a new sound criterion of 45 dBA within 100 feet of an inhabited residence or a community building unless the owner has signed a waiver [ND PSC Chapter 69-06-08-01(4) Energy Conversion Facility Siting Criteria (PU-19-290)]. Rugby Wind anticipates complying with this requirement by obtaining the necessary waivers, maintaining existing turbines, or operating turbines at a lower electrical and sound output mode.

3. Acoustical Modeling Method and Results

Standard acoustical engineering methods were used in the analysis to document the predicted sound level at existing nonparticipating residences as well as participating residences. The sound power levels representing the standard performance of the wind turbines are assigned based on International Electrotechnical Commission (IEC) Standard 61400-11 (IEC 2012) data supplied by the manufacturers to Rugby Wind. The stated maximum turbine sound power level for the Vestas V120 STE is 107.6 decibels on an A-weighted scale (dBA). The substation transformer specifications are expected to require a National Electrical Manufacturers Association sound rating of 74 dBA, resulting in a sound power level of 94 dBA. Using these sound power levels as a basis, the model calculates the sound pressure level that would occur after losses from distance, air absorption, ground effects, and screening are considered.

It is useful to understand the difference between a sound pressure level (or noise level) and a sound power level. A sound power level (commonly abbreviated as PWL or L_w) is analogous to the wattage of a light bulb; it is a measure of the acoustical energy emitted by the source and is, therefore, independent of distance. A sound pressure level (commonly abbreviated as SPL or L_p) is analogous to the brightness or intensity of light experienced at a specific distance from a source and is measured directly with a sound level meter. Sound pressure levels always should be specified with a location or distance from the noise source.

Sound power level data are used in acoustic models to predict sound pressure levels. This is because sound power levels consider the size of the acoustical source and account for the total acoustical energy emitted by the source. For example, the sound pressure level 15 feet from a small radio and a large orchestra may be the same, but the sound power level of the orchestra will be much larger because it emits sound over a larger area. Similarly, 2-horsepower (hp) and 2,000-hp pumps can both achieve 85 dBA at 3 feet (a common specification), but the 2,000-hp pump will have significantly larger sound power level. Consequently, the sound from the 2,000-hp pump will travel farther. A sound power level can be determined from a sound pressure level if the distance from and dimensions of the source are known, and this is accounted for in the IEC 61400-11 standard for wind turbines. Sound power levels always will be greater than sound pressure levels and sound power levels should never be compared to sound pressure levels. The sound power level of commercially available modern wind turbines typically will vary between 100 and 110 dBA depending on make, model, and windspeed. This will result in a sound pressure

level of about 55 to 65 dBA at 130 feet from the turbine. These levels are well below the sound pressure level where hearing protection is considered (85 dBA).

The commercial software used to prepare the acoustical model is CadnaA by DataKustik GmbH, Version 2023 (DataKustik 2023). The sound propagation factors used in the acoustical model have been adopted from International Organization for Standardization 9613-2 (ISO 9613-2), *Acoustics—Sound Attenuation During Propagation Outdoors Part 2: General Method of Calculation* (ISO 1996). The ISO 9613-2 parameters used in this assessment are a receptor height of 4 meters and mixed ground (G = 0.5, where G may vary between 0 for acoustically hard or reflective surface and 1 for acoustically absorptive surface), with all turbines operating at their stated sound power level plus 2 dBA. These modeling parameters are consistent with the parameters established in the 2022 ACP/ANSI standard on modeling of wind turbines (ANSI 2022). Multiple bodies of water of varying sizes are situated within the Facility area. These waterbodies were imported into the acoustical model based on features characterized as lakes, ponds, marshes, or swamps in the NHDPlus High Resolution geospatial dataset (USGS 2023). Each waterbody was modeled as a fully reflective ground coefficient (G = 0). Sound contours were developed based on a 5-foot grid spacing incorporating the waterbodies as depicted on Figure 1.

The turbines were evaluated with the sound emitted at hub height (84.8 meters). Atmospheric absorption for conditions of 10 degrees Celsius and 70 percent relative humidity (conditions that favor propagation) was computed in accordance with ISO 9613-1, *Acoustics—Sound Attenuation During Propagation Outdoors, Part 1: Calculation of the Absorption of Sound by the Atmosphere* (ISO 1993). Coordinates of the sound sources and occupied residences included in this assessment have been provided by Rugby Wind. Sound sources and modeled sound power levels for each scenario are included in Table 1. Residence locations and resulting sound pressure levels are presented in Table 2.

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Height (m)	Coordinates	
			X (m)	Y (m)
A2	109.6	84.8	423645	5377150
A3	109.6	84.8	423910	5377216
A4	109.6	84.8	424329	5377057
A5	109.6	84.8	424563	5377190
A6	109.6	84.8	424994	5377084
A7	109.6	84.8	425433	5376948
A8	109.6	84.8	428471	5376484
B1	109.6	84.8	429034	5375884
B2	109.6	84.8	429252	5376109
B3	109.6	84.8	429657	5376158
B4	109.6	84.8	430024	5376181
B5	109.6	84.8	428972	5375500
C1	109.6	84.8	430982	5375718
C2	109.6	84.8	431276	5375873
C3	109.6	84.8	431719	5375959

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Height (m)	Coordinates	
			X (m)	Y (m)
C4	109.6	84.8	432176	5376028
D1	109.6	84.8	430523	5374844
D2	109.6	84.8	430868	5374838
D3	109.6	84.8	431193	5374935
D4	109.6	84.8	431651	5374996
E1	109.6	84.8	423615	5374761
E2	109.6	84.8	424058	5374768
E3	109.6	84.8	424073	5375125
E4	109.6	84.8	424515	5375069
E5	109.6	84.8	424767	5375181
F1	109.6	84.8	424713	5373432
F2	109.6	84.8	424924	5373593
F3	109.6	84.8	425466	5373611
G1	109.6	84.8	424768	5372777
G2	109.6	84.8	425429	5372749
G3	109.6	84.8	425948	5372738
G4	109.6	84.8	426825	5372766
G5	109.6	84.8	427051	5372908
G6	109.6	84.8	427269	5373064
G7	109.6	84.8	427500	5373255
H1	109.6	84.8	430182	5373530
H2	109.6	84.8	430534	5373608
J1	109.6	84.8	431677	5372648
J2	109.6	84.8	431461	5372487
J3	109.6	84.8	431248	5372322
J4	109.6	84.8	430933	5372293
K1	109.6	84.8	432407	5372990
K2	109.6	84.8	432573	5372467
K3	109.6	84.8	432405	5372219
L1	109.6	84.8	432619	5373627
L2	109.6	84.8	432303	5374200
L3	109.6	84.8	432879	5374220
M1	109.6	84.8	433259	5372899

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Height (m)	Coordinates	
			X (m)	Y (m)
M2	109.6	84.8	433420	5373184
M3	109.6	84.8	433938	5372625
M4	109.6	84.8	434180	5372914
M5	109.6	84.8	434328	5373194
M6	109.6	84.8	434338	5373764
M7	109.6	84.8	434340	5374150
N1	109.6	84.8	430250	5370380
N2	109.6	84.8	430508	5370416
P1	109.6	84.8	432162	5369802
P2	109.6	84.8	432452	5369979
Q1	109.6	84.8	428730	5369235
Q2	109.6	84.8	428859	5369569
Q3	109.6	84.8	429136	5369642
Q4	109.6	84.8	429595	5369621
R1	109.6	84.8	431880	5368792
R2	109.6	84.8	432142	5368856
R3	109.6	84.8	432383	5369032
R4	109.6	84.8	432614	5369180
S1	109.6	84.8	432931	5367819
S2	109.6	84.8	433135	5368068
S3	109.6	84.8	434029	5368017
S4	109.6	84.8	434142	5367203
S5	109.6	84.8	433994	5366981
Transformer	94	4	428582	5370839

Notes:
dBA = decibel (A-weighted scale)
ID = identifier
m = meter(s)

Table 2. Modeled Residence Locations and Sound Pressure Levels

Residence Status[a]	Residence ID	Coordinates		Sound Pressure Level (dBA)	Distance to 45 dBA Contour (ft)
		X (m)	Y (m)		
Participating	REC10	427444	5372591	49	Within 100 ft of 45 dBA
Participating	REC13	429213	5370074	49	Within 100 ft of 45 dBA
Participating	REC18	432920	5367309	47	Within 100 ft of 45 dBA
Nonparticipating	REC04	425106	5377692	47	Within 100 ft of 45 dBA
Participating	REC19	433357	5367173	47	Within 100 ft of 45 dBA
Participating	REC34	423800	5375837	46	Within 100 ft of 45 dBA
Participating	REC14	431323	5368466	45	Within 100 ft of 45 dBA
Participating	REC33	423661	5376293	45	Within 100 ft of 45 dBA
Participating	REC39	423186	5375339	45	Within 100 ft of 45 dBA
Nonparticipating	REC15	432989	5371214	44	450
Participating	REC07	425672	5375293	44	700
Participating	REC08	433360	5375223	43	>1,000
Participating	REC35	423578	5373574	43	>1,000
Participating	REC44	426194	5376303	42	>1,000
Nonparticipating	REC12	426634	5371313	40	>1,000
Nonparticipating	REC06	428370	5377614	40	>1,000
Nonparticipating	REC59	422487	5375868	39	>1,000
Participating	REC23	435372	5374993	39	>1,000
Participating	REC11	425699	5370908	38	>1,000
Participating	REC20	433138	5365907	38	>1,000
Nonparticipating	REC38	423222	5372146	38	>1,000
Nonparticipating	REC58	422113	5375952	38	>1,000
Nonparticipating	REC30	434641	5365645	37	>1,000
Nonparticipating	REC16	431215	5366507	37	>1,000
Nonparticipating	REC57	421887	5374243	37	>1,000
Nonparticipating	REC25	436397	5372533	36	>1,000
Nonparticipating	REC55	422545	5372689	36	>1,000
Participating	REC60	429848	5366794	35	>1,000
Nonparticipating	REC36	423463	5371000	35	>1,000
Participating	REC27	436154	5368809	35	>1,000
Nonparticipating	REC56	421745	5373378	35	>1,000
Nonparticipating	REC05	427876	5379003	35	>1,000
Participating	REC17	426580	5368203	34	>1,000

Table 2. Modeled Residence Locations and Sound Pressure Levels

Residence Status[a]	Residence ID	Coordinates		Sound Pressure Level (dBA)	Distance to 45 dBA Contour (ft)
		X (m)	Y (m)		
Nonparticipating	REC37	424736	5369835	34	>1,000
Nonparticipating	REC63	437098	5372305	34	>1,000
Nonparticipating	REC03	425070	5379856	34	>1,000
Nonparticipating	REC47	422614	5371019	33	>1,000
Nonparticipating	REC28	436117	5365894	33	>1,000
Nonparticipating	REC02	425012	5380574	32	>1,000
Nonparticipating	REC01	423459	5380440	31	>1,000
Nonparticipating	REC48	421813	5370887	31	>1,000
Nonparticipating	REC52	437832	5375630	31	>1,000
Nonparticipating	REC50	432868	5363892	30	>1,000
Nonparticipating	REC22	428923	5364470	29	>1,000
Nonparticipating	REC62	434301	5363345	29	>1,000
Nonparticipating	REC49	421929	5369060	29	>1,000
Nonparticipating	REC61	429637	5363884	29	>1,000
Nonparticipating	REC31	436215	5363795	28	>1,000
Nonparticipating	REC51	437078	5364423	28	>1,000
Nonparticipating	REC29	437713	5365035	28	>1,000
Nonparticipating	REC41	424801	5366011	28	>1,000
Nonparticipating	REC32	433061	5362491	27	>1,000
Nonparticipating	REC40	422998	5367053	27	>1,000
Nonparticipating	REC21	427132	5363714	26	>1,000
Nonparticipating	REC42	423349	5365751	26	>1,000
Nonparticipating	REC43	423335	5364105	24	>1,000
Nonparticipating	REC46	422508	5364580	24	>1,000

[a] For purposes of this memorandum, a participating landowner is a landowner that has signed a wind option, easement agreement, or waiver with Rugby Wind, LLC.

4. Conclusions

As indicated in Table 2, the highest predicted level is 49 dBA at the nearest occupied residences. The predicted sound level of 45 dBA is exceeded within 100 feet of eight participating and one nonparticipating occupied residence. Rugby Wind anticipates obtaining waivers, maintaining the existing Suzlon turbines, or operating turbines at a lower electrical and sound output mode in order to reduce the sound level to less than 45 dBA within 100 feet of occupied residences. Thus, the Facility will be in compliance with the noise standards adopted by the Pierce County Board of County Commissioners and the ND PSC, respectively.

5. References

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Figure

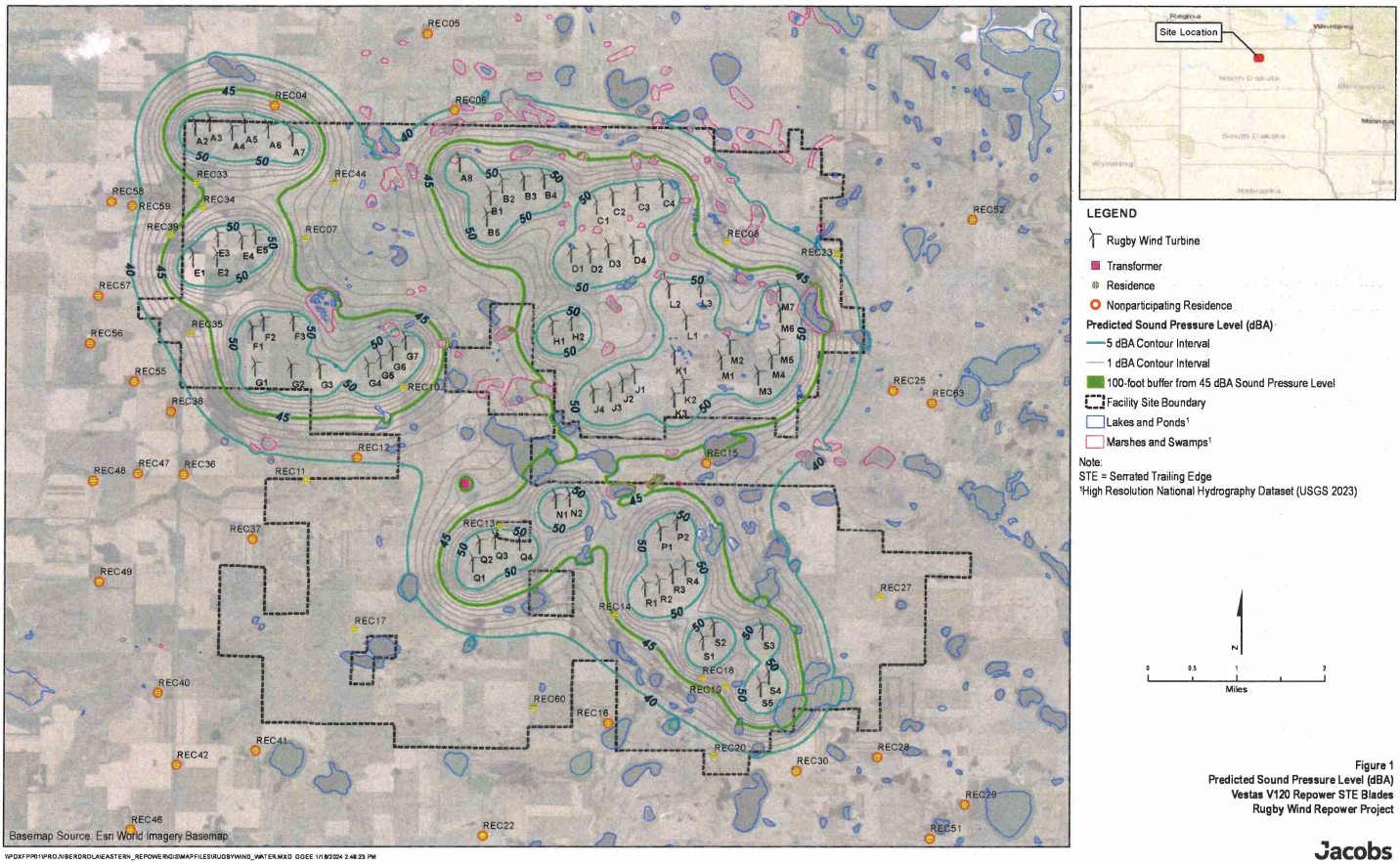

Figure 1
Predicted Sound Pressure Level (dBA)
Vestas V120 Repower STE Blades
Rugby Wind Repower Project

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