Appendix N

Sound Modeling

Memorandum

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Subject	**Tatanka Ridge Wind Project Sound Modeling**
Attention	Jesse Bermel/Avangrid Renewables, LLC
From	Mark Bastasch/Jacobs Engineering Group, Inc.
Date	April 29, 2019

This technical memorandum provides the predicted sound levels for the Tatanka Ridge Wind Project (Project) proposed by Tatanka Ridge Wind, LLC (Tatanka Ridge) a subsidiary of Avangrid Renewables, LLC (Avangrid Renewables). This analysis is based on 62 wind turbine locations (55 primary locations and 7 potential alternate locations) and a substation transformer. Figure 1 (attached) presents the Project's proposed wind turbine layout and the predicted sound level based on the analysis described herein, as well as the residences that have been identified by Avangrid Renewables. Deuel County's zoning ordinance establishes a sound limit to 45 dBA at non-participating residents. An acoustical model of the predicted Project sound levels results in levels of 44 dBA at existing non-participating residences, which complies with the Deuel County sound requirements not to exceed 45 dBA at non-participating residences. These results are based on 62 turbine locations, while the Project is committed to building only 55 turbines. The Tatanka Ridge Wind Project is committed to designing and operating the Project in compliance with the Deuel County noise standard.

1. Regulatory Requirements and Modeling Methods

Deuel County's Zoning Ordinance Section 1215.03(13)(a) states that "*Noise level shall not exceed 45 dBA average A-Weighted Sound pressure at the perimeter of existing residences, for non-participating residences.*" Standard acoustical engineering methods were used in the analysis to document the predicted sound level at existing non-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 (2012) data supplied by the manufacturer, General Electric (GE), to Avangrid Renewables. The stated maximum turbine sound power levels for the GE116 Low Noise Trailing Edge (LNTE) is 106 decibels A-weighted scale (dBA). Similarly, the sound power level of the GE127 LNTE is 108.5 dBA. The sound power levels used for modeling the turbines was increased by 2 dBA in this assessment. The substation transformer specifications are expected to require a National Electrical Manufacturers Association sound rating of 76 dBA, resulting in a sound power level of 96 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 is 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 Cadna/A by DataKustik GmbH, Version 2019 (build: 169.4915). 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* (1996). Cadna/A as well as ISO 9613-2 have been used by researchers and regulatory bodies throughout the world in similar wind turbine sound evaluations. The ISO 9613-2 method is based on an omnidirectional downwind condition. That is, the sound prediction algorithms assume every point at which sound level is calculated is downwind of all noise-emitting equipment simultaneously. In essence, the prediction assumes each receiver or prediction point is a “black hole” and the wind is blowing from each turbine and into this black hole. While this is physically impossible, the ISO 9613-2 model has been widely and successfully used to develop acoustical models for wind energy as well as other facilities. Numerous agencies and regulatory bodies rely on properly conducted ISO 9613-2 modeling. 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 hard and 1 for acoustically absorptive ground) with all turbines operating at their maximum rated sound power level plus 2 dBA.

The turbines were evaluated with the sound being emitted at hub height (90 meters for the GE116 and 88.6 meters for the GE127). 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 residences included in this assessment have been provided by Avangrid Renewables and are included in Tables 1 and 2, respectively.

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Source Spectrum	Height (m)	Coordinates	
				X (m)	Y (m)
A1	110.5	GE127LNTE+2	88.6	690799	4939136
A2	110.5	GE127LNTE+2	88.6	691407	4939152
B1	110.5	GE127LNTE+2	88.6	690097	4940133
B2	110.5	GE127LNTE+2	88.6	691218	4940385
B3	110.5	GE127LNTE+2	88.6	691615	4940639
C5	110.5	GE127LNTE+2	88.6	689357	4940791
E1	108	GE116LNTE+2	90	684544	4942375
E2	108	GE116LNTE+2	90	685022	4942384
E3	108	GE116LNTE+2	90	685724	4942474
E4	110.5	GE127LNTE+2	88.6	686854	4941987

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Source Spectrum	Height (m)	Coordinates	
				X (m)	Y (m)
E5	110.5	GE127LNTE+2	88.6	687711	4942510
E6	110.5	GE127LNTE+2	88.6	688223	4942843
F1	110.5	GE127LNTE+2	88.6	687280	4943515
F2	110.5	GE127LNTE+2	88.6	688033	4944395
F4	110.5	GE127LNTE+2	88.6	689608	4943698
G1	108	GE116LNTE+2	90	684078	4943490
G2	108	GE116LNTE+2	90	684583	4943517
G3	108	GE116LNTE+2	90	685040	4943455
H1	110.5	GE127LNTE+2	88.6	681030	4944127
H2	110.5	GE127LNTE+2	88.6	681471	4944211
H3	110.5	GE127LNTE+2	88.6	681931	4944224
H4	110.5	GE127LNTE+2	88.6	682427	4943501
H5	110.5	GE127LNTE+2	88.6	682765	4943922
I2	110.5	GE127LNTE+2	88.6	682410	4945098
I3	110.5	GE127LNTE+2	88.6	683048	4944921
I4	110.5	GE127LNTE+2	88.6	683432	4944956
I5	110.5	GE127LNTE+2	88.6	685151	4945281
J1	110.5	GE127LNTE+2	88.6	684023	4945449
J2	110.5	GE127LNTE+2	88.6	684389	4945846
K0	110.5	GE127LNTE+2	88.6	676230	4943117
K1	110.5	GE127LNTE+2	88.6	676670	4943472
K2	110.5	GE127LNTE+2	88.6	677108	4943724
K3	110.5	GE127LNTE+2	88.6	677637	4943727
K4	110.5	GE127LNTE+2	88.6	678278	4943221
K5	110.5	GE127LNTE+2	88.6	678736	4943263
K6	110.5	GE127LNTE+2	88.6	679281	4943157
K7	110.5	GE127LNTE+2	88.6	679879	4943079
K8	110.5	GE127LNTE+2	88.6	680365	4943168
L1	110.5	GE127LNTE+2	88.6	675295	4946281
L10	110.5	GE127LNTE+2	88.6	679680	4944655
L11	110.5	GE127LNTE+2	88.6	680314	4944999
L2	110.5	GE127LNTE+2	88.6	676183	4946247
L3	110.5	GE127LNTE+2	88.6	676798	4946277
L4	110.5	GE127LNTE+2	88.6	677113	4946511
L5	110.5	GE127LNTE+2	88.6	677560	4945484
L6	110.5	GE127LNTE+2	88.6	678208	4945420
L7	110.5	GE127LNTE+2	88.6	678716	4945435
L8	110.5	GE127LNTE+2	88.6	679174	4945757

Table 1. Modeled Sound Sources

Source ID	Sound Power Level (dBA)	Source Spectrum	Height (m)	Coordinates	
				X (m)	Y (m)
L9	110.5	GE127LNTE+2	88.6	679657	4946274
O3	110.5	GE127LNTE+2	88.6	683641	4940587
O4	110.5	GE127LNTE+2	88.6	682854	4940037
O5	110.5	GE127LNTE+2	88.6	683275	4939446
P1	110.5	GE127LNTE+2	88.6	680174	4941593
P3	110.5	GE127LNTE+2	88.6	680988	4942323
P4	110.5	GE127LNTE+2	88.6	681515	4942260
P5	110.5	GE127LNTE+2	88.6	681693	4941514
P6	110.5	GE127LNTE+2	88.6	682544	4941503
P7	110.5	GE127LNTE+2	88.6	682938	4942691
P8	110.5	GE127LNTE+2	88.6	683589	4941798
S5	110.5	GE127LNTE+2	88.6	676976	4948113
S6	110.5	GE127LNTE+2	88.6	677460	4948073
S8	110.5	GE127LNTE+2	88.6	677815	4948173
Transformer	96	Transformer	4	692269	4939331

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

Table 2. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)	Height (m)	Coordinates	
				X (m)	Y (m)
Participating	H155	49	4	678585	4942822
Participating	H81	49	4	678919	4943688
Participating	H76	49	4	680833	4942902
Participating	H89	49	4	679515	4945123
Participating	H75	48	4	681840	4942678
Participating	H74	48	4	683780	4942251
Participating	H72	48	4	682934	4941994
Participating	H156	48	4	676014	4943529
Participating	H158	47	4	678182	4946033
Participating	H77	47	4	681688	4942911
Participating	H86	47	4	684161	4944755
Participating	H43	46	4	683463	4939028
Participating	H145	46	4	676613	4947704
Participating	H163	46	4	675547	4946765

Table 2. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)	Height (m)	Coordinates	
				X (m)	Y (m)
Participating	H147	46	4	677166	4948738
Participating	H160	46	4	675633	4946794
Participating	H71	45	4	686229	4941921
Participating	H58	45	4	682263	4940123
Participating	H80	45	4	688300	4943646
Participating	H161	45	4	676584	4947413
Participating	H146	45	4	676373	4947953
Participating	H63	45	4	680616	4941080
Participating	H117	45	4	678375	4948421
Participating	H159	45	4	675799	4945577
Participating	H164	44	4	688863	4943158
Nonparticipating	H83	44	4	685334	4944133
Participating	H53	44	4	689381	4939944
Nonparticipating	H137	44	4	674779	4945951
Participating	H85	44	4	687326	4944518
Participating	H50	44	4	684050	4939765
Nonparticipating	H78	43	4	689062	4942941
Nonparticipating	H45	43	4	682524	4939180
Participating	H66	43	4	691388	4941342
Nonparticipating	H93	43	4	682055	4945939
Nonparticipating	H64	43	4	684540	4941185
Nonparticipating	H98	43	4	682904	4946155
Participating	H60	43	4	688637	4940736
Participating	H36	43	4	690696	4938383
Nonparticipating	H157	43	4	675808	4944069
Participating	H68	43	4	685385	4941463
Nonparticipating	H144	42	4	676071	4947608
Participating	H67	42	4	688636	4941413
Nonparticipating	H162	42	4	678852	4947413
Participating	H65	41	4	679189	4941266
Participating	H101	41	4	683599	4946691
Nonparticipating	H102	41	4	684074	4946851
Nonparticipating	H87	41	4	688741	4944987
Participating	H62	41	4	687368	4941026
Nonparticipating	H69	41	4	690352	4941587
Nonparticipating	H88	40	4	687136	4945116
Nonparticipating	H54	40	4	688658	4939959
Nonparticipating	H104	40	4	680692	4947086

Table 2. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)	Height (m)	Coordinates	
				X (m)	Y (m)
Nonparticipating	H55	40	4	681031	4940013
Participating	H40	40	4	692283	4938611
Nonparticipating	H33	39	4	691948	4938171
Nonparticipating	H154	39	4	675757	4941934
Nonparticipating	H132	38	4	674929	4944253
Nonparticipating	H25	38	4	690715	4937792
Nonparticipating	H59	38	4	686562	4940149
Participating	H52	38	4	687955	4939871
Nonparticipating	H105	37	4	684957	4947425
Nonparticipating	H108	37	4	681028	4947822
Nonparticipating	H106	37	4	684194	4947619
Nonparticipating	H152	37	4	676826	4941169
Nonparticipating	H133	37	4	674171	4945237
Participating	H28	37	4	683448	4937988
Nonparticipating	H116	37	4	677958	4949878
Participating	H26	37	4	682715	4937976
Nonparticipating	H49	37	4	686281	4939710
Nonparticipating	H92	37	4	688489	4945892
Nonparticipating	H95	37	4	687770	4946076
Nonparticipating	H109	36	4	683484	4947898
Nonparticipating	H141	36	4	674202	4947455
Participating	H23	36	4	691912	4937732
Nonparticipating	H142	36	4	674195	4947534
Nonparticipating	H38	36	4	688821	4938498
Nonparticipating	H153	36	4	675873	4941177
Participating	H24	36	4	692163	4937775
Participating	H46	36	4	687223	4939256
Nonparticipating	H41	36	4	685817	4938898
Nonparticipating	H37	36	4	685209	4938467
Nonparticipating	H96	35	4	688841	4946145
Participating	H150	35	4	678221	4939683
Nonparticipating	H34	35	4	688367	4938286
Nonparticipating	H151	35	4	677418	4939868
Participating	H128	35	4	678716	4939141
Nonparticipating	H17	35	4	684084	4937488
Nonparticipating	H130	35	4	675574	4940786
Participating	H20	34	4	681578	4937615
Nonparticipating	H30	34	4	680611	4938073

Table 2. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)	Height (m)	Coordinates	
				X (m)	Y (m)
Nonparticipating	H14	34	4	690508	4937083
Nonparticipating	H136	34	4	673228	4946679
Nonparticipating	H32	34	4	686745	4938142
Nonparticipating	H94	34	4	690052	4945991
Nonparticipating	H99	34	4	689630	4946277
Nonparticipating	H134	34	4	673086	4945901
Nonparticipating	H18	34	4	688764	4937521
Nonparticipating	H138	34	4	673333	4947545
Nonparticipating	H135	34	4	672956	4945917
Participating	H119	33	4	680671	4937573
Nonparticipating	H121	33	4	679979	4937635
Participating	H9	33	4	682277	4936774
Participating	H118	33	4	681391	4936894
Nonparticipating	H124	33	4	679249	4937641
Participating	H114	32	4	682887	4936492
Nonparticipating	H129	32	4	677481	4938248
Participating	H122	32	4	680705	4936501
Nonparticipating	H123	31	4	679220	4936990
Nonparticipating	H126	31	4	677489	4937617
Nonparticipating	H139	31	4	672465	4948293
Nonparticipating	H140	31	4	672468	4948419
Nonparticipating	H125	30	4	677541	4936351

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

2. Results

As indicated in Table 2, the highest predicted level at nonparticipating residence is 44 dBA, consistent with the Deuel County requirement of 45 dBA average A-weighted sound pressure level at existing nonparticipating dwellings.[1] While Deuel County has not established a sound limit for participating residences, the highest predicted level at a participant is 49 dBA. These results are based on 62 turbines which is 7 more than the Projects stated maximum buildout of 55 locations. As turbine technology continues to evolve, Tatanka Ridge intends to obtain multiple bids for the Project and evaluate multiple technologies. The final turbine locations will be selected based on a subset of the 62 locations identified in this analysis.

The ISO 9613-2 method and acoustical model provide a standardized assessment of predicted sound levels at residences. The results may vary depending on a number of factors, including timescale, metric

[1] Attachment A presents predicted results based on other common modeling parameters. These results also predict the project will comply with the applicable standard of 45 dBA at non-participating dwellings.

and method of evaluation. The Tatanka Ridge Wind Project is committed to designing and operating the Project in compliance with the Deuel County noise standard.

3. Construction Noise

Typical construction equipment noise levels have been published in the Federal Highway Administration (FHWA) Roadway Construction Noise Model User's Guide (FHWA, 2006). The User's Guide provides one of the most recent and comprehensive assessment of noise levels from construction equipment. Table 3 provides typical sound levels and usage factors for general construction equipment and activities consistent with the FHWA Roadway Construction Noise Model. The acoustical usage factor does not equate to the percentage of time the equipment is in use, but rather the percentage of time that it is operated at its highest sound emission level. For example, a back hoe may be used and energized during the entire shift, but on average, it is expected to operate at its highest sound level 40 percent of the time.

Table 3. Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor (%)	Specified Sound Level 50 feet (dBA)	Actual Measured Sound Level 50 feet (dBA)
All Other Equipment Greater than 5 Horsepower	50	85	N/A
Auger Drill Rig	20	85	84
Backhoe	40	80	78
Bar Bender	20	80	N/A
Blasting	N/A	94	N/A
Boring Jack Power Unit	50	80	83
Chain Saw	20	85	84
Clam Shovel (dropping)	20	93	87
Compactor (ground)	20	80	83
Compressor (air)	40	80	78
Concrete Batch Plant	15	83	N/A
Concrete Mixer Truck	40	85	79
Concrete Pump Truck	20	82	81
Concrete Saw	20	90	90
Crane	16	85	81
Dozer	40	85	82
Drill Rig Truck	20	84	79
Drum Mixer	50	80	80
Dump Truck	40	84	76
Excavator	40	85	81
Flat Bed Truck	40	84	74
Front End Loader	40	80	79
Generator	50	82	81
Generator (less than 25 kilovolt-amperes, VMS signs)	50	70	73
Gradall	40	85	83
Grader	40	85	N/A
Grapple (on backhoe)	40	85	87
Horizontal Boring Hydraulic Jack	25	80	82
Hydra Break Ram	10	90	N/A
Impact Pile Driver	20	95	101
Jackhammer	20	85	89
Man Lift	20	85	75

Table 3. Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor (%)	Specified Sound Level 50 feet (dBA)	Actual Measured Sound Level 50 feet (dBA)
Mounted Impact Hammer (hoe ram)	20	90	90
Pavement Scarafier	20	85	90
Paver	50	85	77
Pickup Truck	40	55	75
Pneumatic Tools	50	85	85
Pumps	50	77	81
Refrigerator Unit	100	82	73
Rivet Buster/chipping gun	20	85	79
Rock Drill	20	85	81
Roller	20	85	80
Sand Blasting (single nozzle)	20	85	96
Scraper	40	85	84
Shears (on backhoe)	40	85	96
Slurry Plant	100	78	78
Slurry Trenching Machine	50	82	80
Soil Mix Drill Rig	50	80	N/A
Tractor	40	84	N/A
Vacuum Excavator (vac-truck)	40	85	85
Vacuum Street Sweeper	10	80	82
Ventilation Fan	100	85	79
Vibrating Hopper	50	85	87
Vibratory Concrete Mixer	20	80	80
Vibratory Pile Driver	20	95	101
Warning Horn	5	85	83
Welder/Torch	40	73	74

Source: FHWA, 2006.
N/A = not applicable

Review of the typical construction equipment noise levels in Table 3 indicates that the loudest equipment generally emits noise in the range of 80 to 90 dBA at 50 feet, with usage factors of 40 to 50 percent. The types and numbers of construction equipment near any specific receptor location will vary over time. While construction is a dynamic activity, the sound level at any specific location is dominated by the closest and loudest equipment and the following assumptions were used to modeling construction noise:

- One piece of equipment generating a reference noise level of 85 dBA (at 50-foot distance with a 40 percent usage factor) located at the new turbine or road.
- Two pieces of equipment generating reference 85-dBA noise levels located 50 feet farther away from new turbine or road (100 feet distance with a 40 percent usage factor).
- Two additional pieces of equipment generating reference 85-dBA noise levels located 100 feet farther away new turbine or road (200 feet distance with a 40 percent usage factor).

Table 4 presents construction equipment noise levels at various distances based on this scenario. This scenario is anticipated to be conservative given only distance loss are accounted for and the reductions afforded by ground absorption or other factors have not been considered in these results.

Table 4. Typical Construction Equipment Noise Levels Versus Distance

Distance from Construction Activity (feet)	Average Sound Level (dBA)
100	79
200	74
400	69
800	63
1,600	58
3,200	52

Notes:
See text narrative preceding this table for the parameters of this noise modeling scenario.

4. Conclusions

An acoustical model of the predicted Project sound levels results in levels below 45 dBA at existing non-participating residence, consistent with the Deuel County sound requirements. These results are based on 62 turbine locations, while the Project is committed to building only 55 turbines.

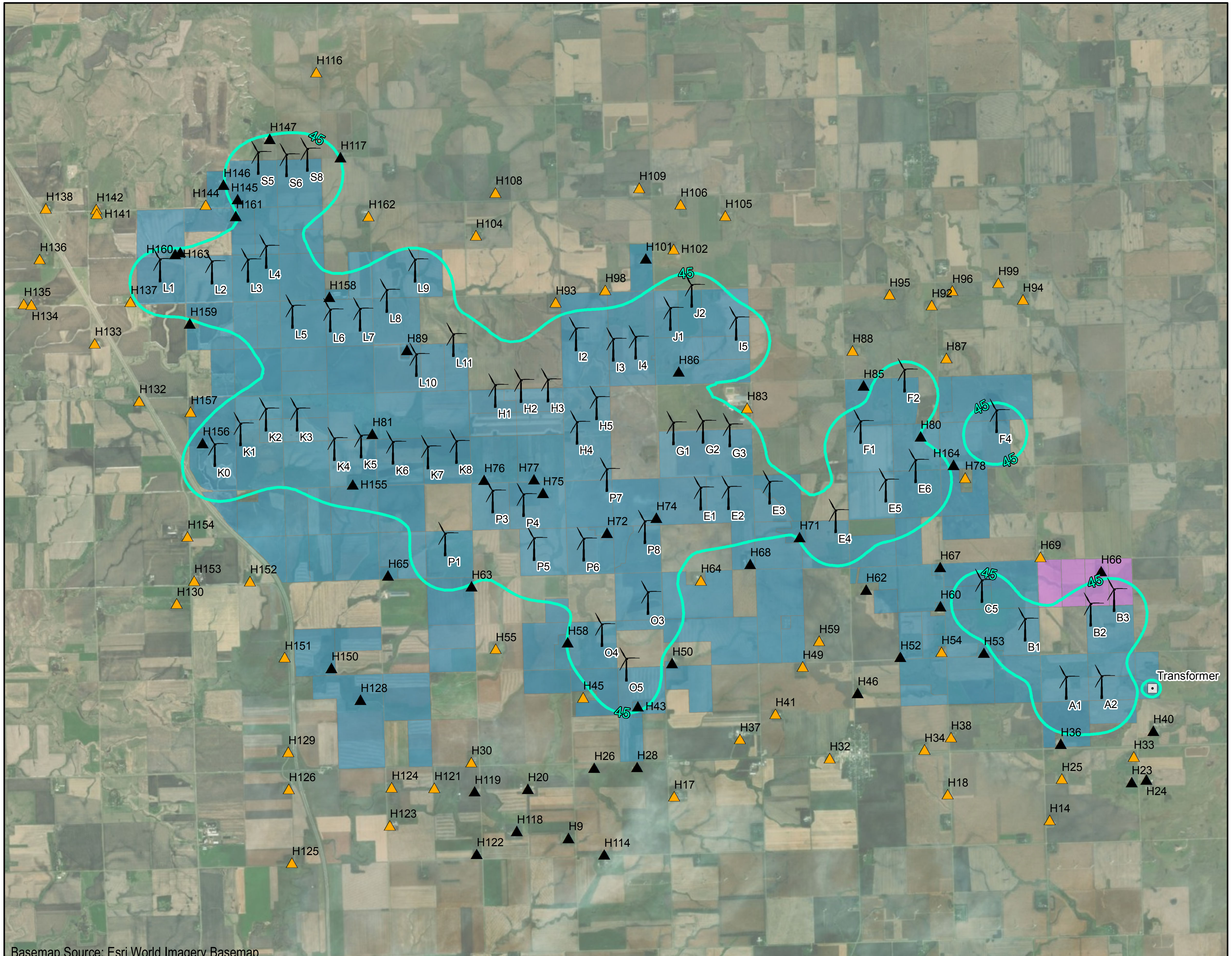
5. References

International Electrotechnical Commission (IEC). 2012. IEC 61400-11. Wind turbines - Part 11: Acoustic noise measurement techniques.

International Organization for Standardization (ISO) 1993. ISO 9613-1, Acoustics—Sound Attenuation During Propagation Outdoors. Part 1: Calculation of the Absorption of Sound by the Atmosphere. Geneva, Switzerland.

International Organization for Standardization (ISO). 1996. ISO 9613-2, Acoustics—Sound Attenuation During Propagation Outdoors. Part 2: General Method of Calculation. Geneva, Switzerland.

Figure



LEGEND

Turbine Location

Transformer

Predicted Sound Pressure Level (dBA)

45

Occupied Residence (Participating Status)

Participating

Nonparticipating

Property Agreement Status

Signed

Negotiating Transmission Line Easement

N

0 0.25 0.5 0.75 1 2

Miles

Figure 1
Predicted Sound Pressure Levels (dBA)
Scenario: Mixed
Tatanka Ridge Wind Project

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JACOBS

Appendix A

Comparisons of Modeling Methods

As discussed in Section 1, this analysis is based on ISO 9613-2 modeling parameters of mixed ground (G=0.5), receiver height of 4 meters and includes a +2 dBA adjustment to the turbine sound power level. Table A1, below, re-presents these under the "Mixed Ground Scenario" heading. Results are also presented for a "Hard Ground Scenario" which utilizes a hard ground factor (G=0, presuming concrete or pavement) and does not use an increased turbine sound power level. As shown below, the results between these two scenarios is similar. A document prepared for the National Association of Regulatory Utility Commissioners (NARUC)[2] identified modeling parameters of mixed ground condition (G=0.5), a receptor height of 1.5 meters and does not use an increased turbine sound power level. The results for the NARUC modeling parameters are presented in Table A1. As shown in Table A1, the mixed and hard ground scenarios result in higher or more conservative predictions than the NARUC scenario.

Table A1. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)		
		Mixed Ground Scenario (Figure 1)	Hard Ground Scenario (Figure A-1)	NARUC Scenario (Figure A-2)
Participating	H155	49	49	47
Participating	H81	49	49	46
Participating	H76	49	49	46
Participating	H89	49	49	46
Participating	H75	48	48	45
Participating	H74	48	48	45
Participating	H72	48	48	45
Participating	H156	48	47	45
Participating	H158	47	47	45
Participating	H77	47	47	44
Participating	H86	47	47	44
Participating	H43	46	46	44
Participating	H145	46	46	43
Participating	H163	46	46	43
Participating	H147	46	46	43
Participating	H160	46	45	43
Participating	H71	45	45	42
Participating	H58	45	45	42
Participating	H80	45	45	42
Participating	H161	45	45	42
Participating	H146	45	45	42
Participating	H63	45	45	42
Participating	H117	45	45	42
Participating	H159	45	44	42
Participating	H164	44	44	41
Nonparticipating	H83	44	44	41

[2] National Association of Regulatory Utility Commissioners (NARUC). 2011. Assessing Sound Emissions from Proposed Wind Farms & Measuring the Performance of Completed Projects. NARUC Grants & Research. The National Association of Regulatory Utility Commissioners. A report for the Minnesota PUC, Funded by the U.S. Department of Energy.

Table A1. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)		
		Mixed Ground Scenario (Figure 1)	Hard Ground Scenario (Figure A-1)	NARUC Scenario (Figure A-2)
Participating	H53	44	44	41
Nonparticipating	H137	44	44	41
Participating	H85	44	44	41
Participating	H50	44	43	41
Nonparticipating	H78	43	43	40
Nonparticipating	H45	43	43	40
Participating	H66	43	43	40
Nonparticipating	H93	43	43	40
Nonparticipating	H64	43	43	40
Nonparticipating	H98	43	43	40
Participating	H60	43	43	40
Participating	H36	43	43	40
Nonparticipating	H157	43	43	40
Participating	H68	43	43	39
Nonparticipating	H144	42	42	39
Participating	H67	42	42	39
Nonparticipating	H162	42	42	39
Participating	H65	41	41	38
Participating	H101	41	41	38
Nonparticipating	H102	41	41	38
Nonparticipating	H87	41	41	38
Participating	H62	41	41	38
Nonparticipating	H69	41	40	38
Nonparticipating	H88	40	40	37
Nonparticipating	H54	40	40	37
Nonparticipating	H104	40	40	37
Nonparticipating	H55	40	40	37
Participating	H40	40	40	37
Nonparticipating	H33	39	39	36
Nonparticipating	H154	39	39	36
Nonparticipating	H132	38	38	35
Nonparticipating	H25	38	38	35
Nonparticipating	H59	38	38	34
Participating	H52	38	38	35
Nonparticipating	H105	37	38	34
Nonparticipating	H108	37	38	34
Nonparticipating	H106	37	37	34
Nonparticipating	H152	37	37	34

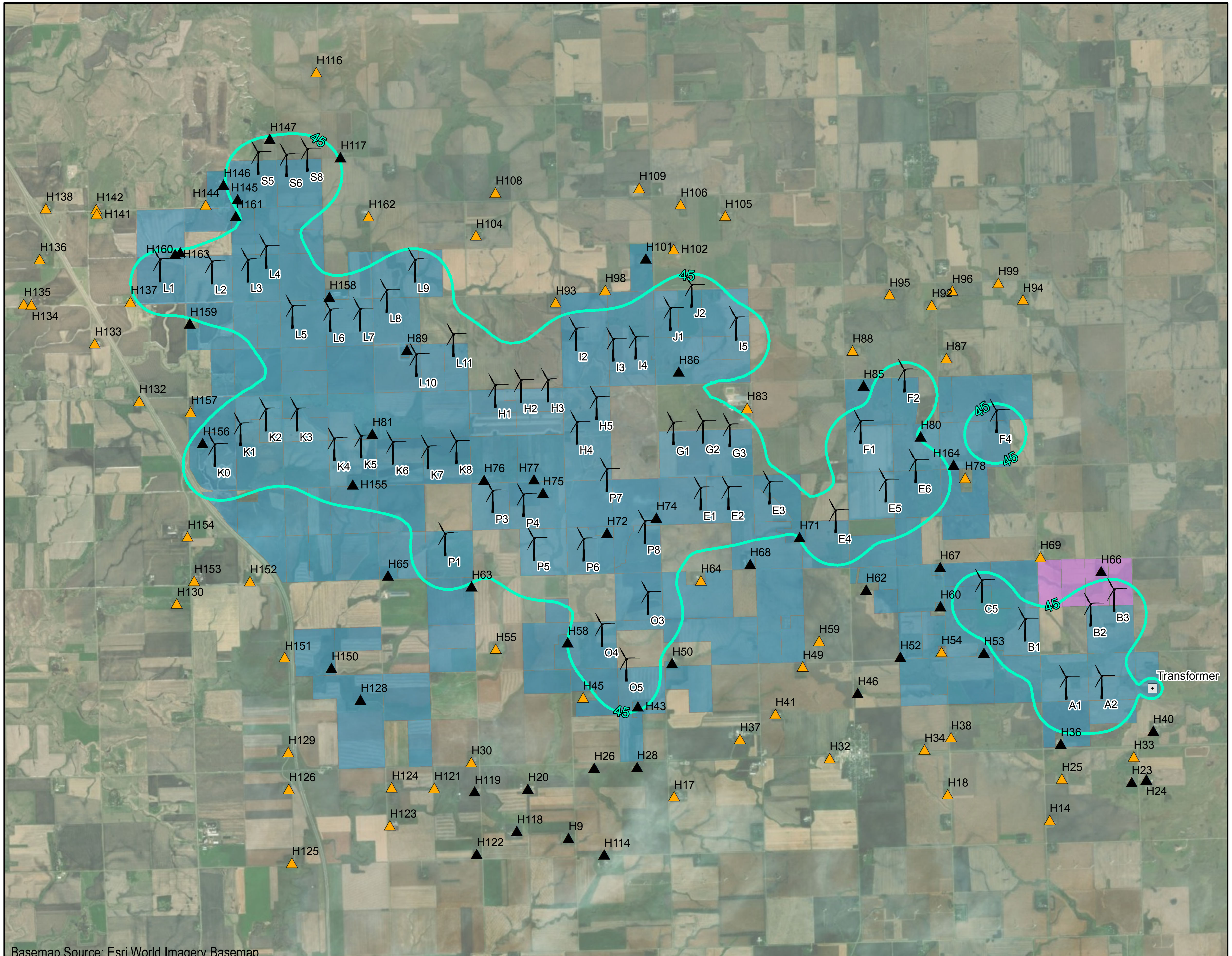
Table A1. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)		
		Mixed Ground Scenario (Figure 1)	Hard Ground Scenario (Figure A-1)	NARUC Scenario (Figure A-2)
Nonparticipating	H133	37	37	34
Participating	H28	37	37	34
Nonparticipating	H116	37	37	34
Participating	H26	37	37	34
Nonparticipating	H49	37	37	34
Nonparticipating	H92	37	37	34
Nonparticipating	H95	37	37	34
Nonparticipating	H109	36	37	33
Nonparticipating	H141	36	37	33
Participating	H23	36	37	33
Nonparticipating	H142	36	36	33
Nonparticipating	H38	36	36	33
Nonparticipating	H153	36	36	33
Participating	H24	36	36	33
Participating	H46	36	36	33
Nonparticipating	H41	36	36	33
Nonparticipating	H37	36	36	33
Nonparticipating	H96	35	36	32
Participating	H150	35	36	32
Nonparticipating	H34	35	35	32
Nonparticipating	H151	35	35	32
Participating	H128	35	35	32
Nonparticipating	H17	35	35	32
Nonparticipating	H130	35	35	32
Participating	H20	34	35	31
Nonparticipating	H30	34	35	32
Nonparticipating	H14	34	34	31
Nonparticipating	H136	34	34	31
Nonparticipating	H32	34	34	31
Nonparticipating	H94	34	34	31
Nonparticipating	H99	34	34	31
Nonparticipating	H134	34	34	31
Nonparticipating	H18	34	34	31
Nonparticipating	H138	34	34	31
Nonparticipating	H135	34	34	31
Participating	H119	33	34	31
Nonparticipating	H121	33	33	30
Participating	H9	33	33	30

Table A1. Modeled Receiver Locations

Receiver Status	Receiver ID	Sound Pressure Level (dBA)		
		Mixed Ground Scenario (Figure 1)	Hard Ground Scenario (Figure A-1)	NARUC Scenario (Figure A-2)
Participating	H118	33	33	30
Nonparticipating	H124	33	33	30
Participating	H114	32	33	30
Nonparticipating	H129	32	33	29
Participating	H122	32	32	29
Nonparticipating	H123	31	32	29
Nonparticipating	H126	31	32	29
Nonparticipating	H139	31	31	28
Nonparticipating	H140	31	31	28
Nonparticipating	H125	30	30	27

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



LEGEND

Turbine Location

Transformer

Predicted Sound Pressure Level (dBA)

45

Occupied Residence (Participating Status)

Participating

Nonparticipating

Property Agreement Status

Signed

Negotiating Transmission Line Easement

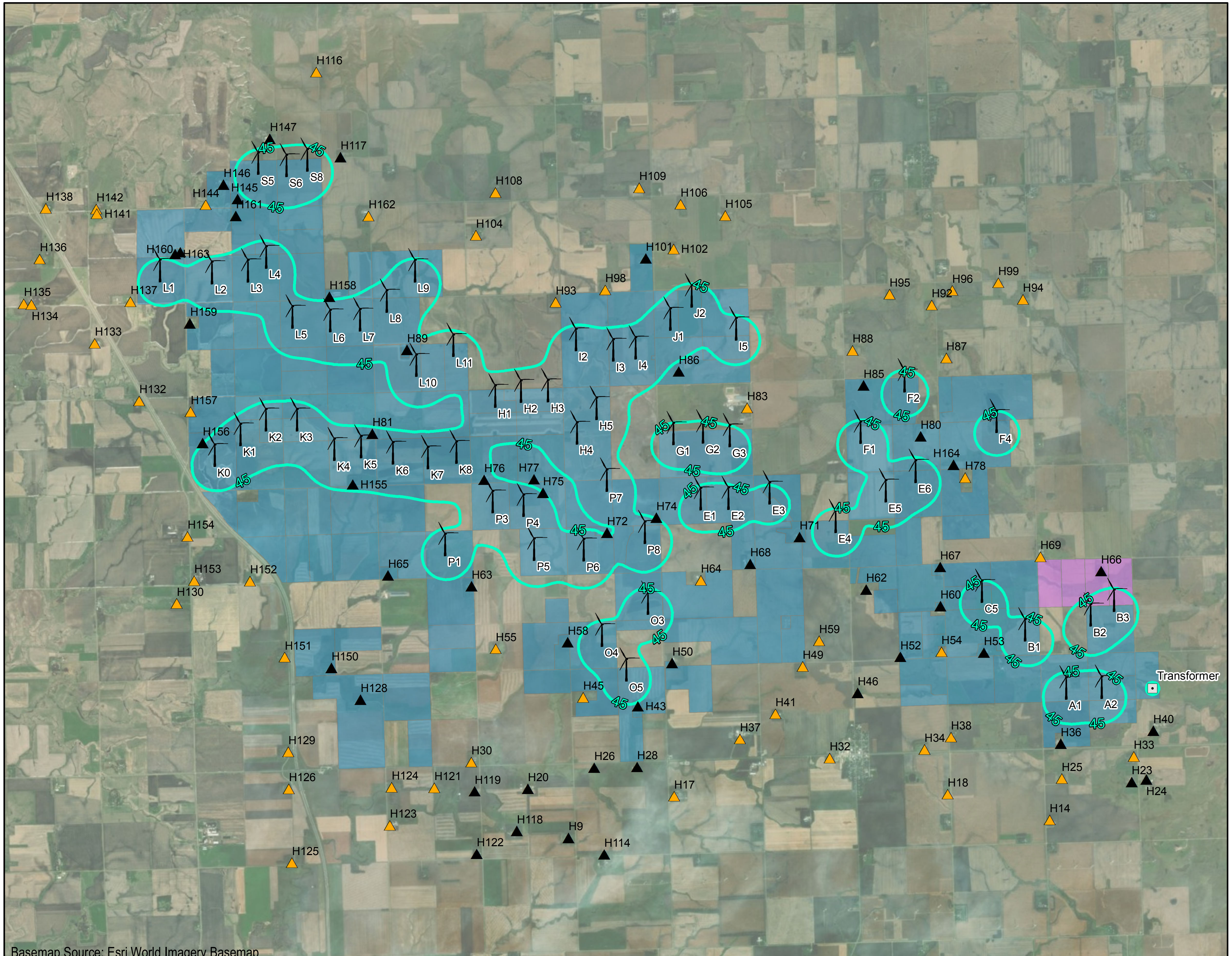
N

0 0.25 0.5 0.75 1 2

Miles

Figure A-1
Predicted Sound Pressure Levels (dBA)
Scenario: Hard Ground
Tatanka Ridge Wind Project

JACOBS



LEGEND

Turbine Location

Transformer

Predicted Sound Pressure Level (dBA)

45

Occupied Residence (Participating Status)

Participating

Nonparticipating

Property Agreement Status

Signed

Negotiating Transmission Line Easement

N

0 0.25 0.5 0.75 1 2

Miles

Figure A-2
Predicted Sound Pressure Levels (dBA)
Scenario: NARUC
Tatanka Ridge Wind Project

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