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May 11, 2021

Ms. Lisa Linowes  
The WindAction Group  
286 Parker Hill Road  
Lyman, NH 03585

Re: Complaint Response Noise Survey 3/18-4/9, 2021  
Antrim Wind Facility, Antrim, NH

Per your request, I respectfully submit this Complaint Response technical report summarizing Antrim Wind noise monitoring and post-analysis for a survey from March 18 to April 9, 2021.

### INTRODUCTORY SUMMARY

Framework: The New Hampshire SEC Rules for Noise Testing and Compliance are complaint-driven. Shortly after Antrim Wind began operation, neighbors east and west of the facility have complained repeatedly about excessive noise from Antrim Wind.

Survey: An outdoor noise monitor was installed near the Berwick home in Antrim, NH from March 18 to April 9, 2021. During the survey the Berwicks reported a number of intrusive wind turbine noise events to Rand Acoustics. For the purposes of this report, two complaints were investigated with dates/times at 3/24/21 12:16 AM and 3/31/21 3:14 AM.

Findings: Post-survey analysis with audio recordings and data review confirmed that intrusive noise present during the two complaints was from Antrim Wind turbines. **Antrim Wind noise levels at the Berwick home exceeded the NH SEC 40-dBA noise limit by 13 dBA, and exceeded Epsilon's predicted "Worst Case Sound Level" of 35.7 dBA by 17 dBA.**

### REGULATIONS

By NH SEC Rules, Leq-0.125-second noise levels shall not exceed 40 dBA at night and measurements during field sound surveys investigating noise complaints shall be taken at 1/8-second intervals using Fast response and Leq metrics:

*NH Site 301.14(f)(2)a: With respect to sound standards, the A-weighted equivalent<sup>1</sup> sound levels produced by the applicant's energy facility during operations shall not exceed the greater of 45 dBA or 5 dBA above background levels, measured at the L-90 sound level, between the hours of 8:00 a.m. and 8:00 p.m. each day, and the greater of 40 dBA or 5 dBA above background levels, measured at the L-90 sound level, at all other times during each day, as measured using microphone placement at least 7.5 meters from any surface where reflections may influence measured sound pressure levels, on property that is used in whole or in part for permanent or temporary residential purposes, at a location*

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1) Equivalent (Leq) sound level measurements are defined with 0.125-second intervals in NH Site 301.18(e)(6): "All sound measurements during post-construction monitoring shall be taken at 0.125-second intervals measuring both fast response and Leq metrics".

*between the nearest building on the property used for such purposes and the closest wind turbine, and the measurements shall be performed at night with winds above 4.5 meters per second at hub height and less than 3 meters per second at ground level; and*

*NH Site 301.18(e)(6): All sound measurements during post-construction monitoring shall be taken at 0.125-second intervals measuring both fast response and Leq metrics; and*

*NH Site 301.18(i): Validation of noise complaints submitted to the committee shall require field sound surveys, except as determined by the administrator to be unwarranted, which field studies shall be conducted under the same meteorological conditions as occurred at the time of the alleged exceedance that is the subject of the complaint.*

## METHODOLOGY

Noise measurements were acquired using recommended survey methods which are consistent with ANSI S12.9 and requirements in the NH Site 301.18(a)(4) Sound Study Methodology, sections of which are listed below:

*Sound measurements shall be omitted when the wind velocity is greater than 4 meters per second at the microphone position, when there is rain, or with temperatures below instrumentation minima; and,*

*a. Microphones shall be placed 1 to 2 meters above ground level, and at least 7.5 meters from any reflective surface; and*

*b. A windscreen of the type recommended by the monitoring instrument's manufacturer must be used for all data collection;*

*c. Microphones should be field-calibrated before and after measurements; and*

*d. An anemometer shall be located within close proximity to each microphone.*

and, to review data with high quality audio, and remove transient noises if needed,

*(a)(2) Long-term unattended monitoring shall be conducted in accordance with the standard of ANSI S12.9-1992 2013 Part 2, available as noted in Appendix B, provided that audio recordings are taken in order to clearly identify and remove transient noises from the data, with frequencies above 1250 hertz 1/3 octave band to be filtered out of the data;*

Noise monitoring during this complaint response survey represents the meteorological conditions for noise complaints, because the measurements were conducted at the times of complaints.

Facility noise levels were acquired at 1/10-second intervals which is consistent with and exceeds the 1/8-second interval requirements of the NH SEC Rules for Noise Testing and Compliance. Measurements using longer averaging than 1/8-second (examples, 1-second, 10-second, 10-minute, 1-hour) fail to track the Fast response as the ear hears (complaints).

Digital audio 24-bit, 12KHz .wav recordings were acquired and stored on an hourly basis during the survey. The recordings provided high audio quality for noise source identification.

Because of high recording quality, trained listening to recordings in post analysis functioned effectively as a workable equivalent to attended listening. Audio recordings were reviewed against sound metered data to ensure noise levels reported herein were due to wind turbines and not other transient sounds in the environment. ANSI S12.100 ANS-weighting was employed to remove intermittent transient noise, consistent with 301.18(a)(2). The NH SEC Rules do not support removing any of the sound data for the noise source under test. The data herein are presented without other processing, filtering, or averaging.

### SURVEY SETUP AND INSTRUMENTATION

The Berwick home was visited by the author during the afternoon on 3/18/21. The weather was light rain. The Berwicks were home during the visit and agreed to the noise survey. Locations selected for instrumentation were similar to those used in a 2020 survey [2].

The survey was conducted from approximately 3/18/21 3 PM to 4/9/21 3 PM. A Type 1 sound level meter system with microphone (NM) was installed in the yard approximately 40 feet (12 meters) diagonal to and southwest of the Berwick home, in the clear yard area away from trees (NM location lat/long 43.070043°, -71.994664°). Per NH Site rules, the distance from microphone to the home exceeded the minimum requirements of 7.5 meters, and the microphone location was between the home and turbine locations. The microphone was installed at a height of 1.5 meters, consistent with NH Site rules.

The NM system was comprised of a Svantek SV 277 PRO Outdoor Monitor System (SV 977: sn 46468) with Type 1 Environmental Microphone System with manufacturer's environmental windscreen and bird-spikes, powered via internal battery and charging power from the Berwick home with the permission of the Berwicks.

The NM system was operated under current calibration traceable to NIST standards. Calibration was checked before and after the survey with a Svantek Acoustic Calibrator (SV33A: sn 46144) operating within its calibration period. The external calibration pre- and post-survey was within 0.5 dB.

The system was set up to acquire hourly files starting on the hour, storing linear and Fast Response LAeq (A-weighted), LAI (Impulse), and LCEq (C-weighted) sound levels 10 times per second; meeting and exceeding the 0.125-second interval and weighting requirements of the NH SEC Rules.

Audio recordings were acquired by the meter synchronous to the sound level data, in 60-minute files recorded at 12KHz with 24-bit depth and stored to the meter's internal storage card in WAV format (.wav) files. The digital PCM (.wav) file format is recommended by

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2 A letter report dated 9/3/2020 and submitted to the NH SEC on September 23, 2020, "Antrim Wind Sound Monitoring Report by Rand Acoustics, LLC", [https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02\\_2020-09-23\\_sound\\_monitoring\\_rpt.pdf](https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02_2020-09-23_sound_monitoring_rpt.pdf).

ANSI S1.13 [3]. Audio recordings were reviewed during post analysis.

A datalogging wind speed anemometer (WM) was installed near the survey microphone to evaluate wind speeds at microphone during post analysis. The anemometer was installed near the microphone, and at the same height to document wind speeds at microphone height for assessing possible wind-on-microphone conditions during post-analysis. The WM wind speed logger was a Madgetech Wind101A cup anemometer (sn N66334) set up to record average wind speed in 10-second periods per ANSI S12.18. The Madgetech was configured to start automatically on 3/18/21 and was stopped and downloaded on 4/9/21.

Survey instrumentation locations are shown in Figures 1 and 2 below.



Figure 1. Meter microphone (NM) and anemometer (WM) locations.

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3 Compressed MP3 ".mp3" audio files are not recommended by ANSI S1.13. MP3 data loss during compression is significant. For an original PCM encoding of 44.1KHz, MP3 compression bitrates of 128, 160 and 192 kbit/s represent compression ratios of roughly 11:1, 9:1 and 7:1. MP3 compression results in poor quality which does not meet ANSI S1.13 guidelines, and is unreliable for analyzing and filtering environmental sounds.

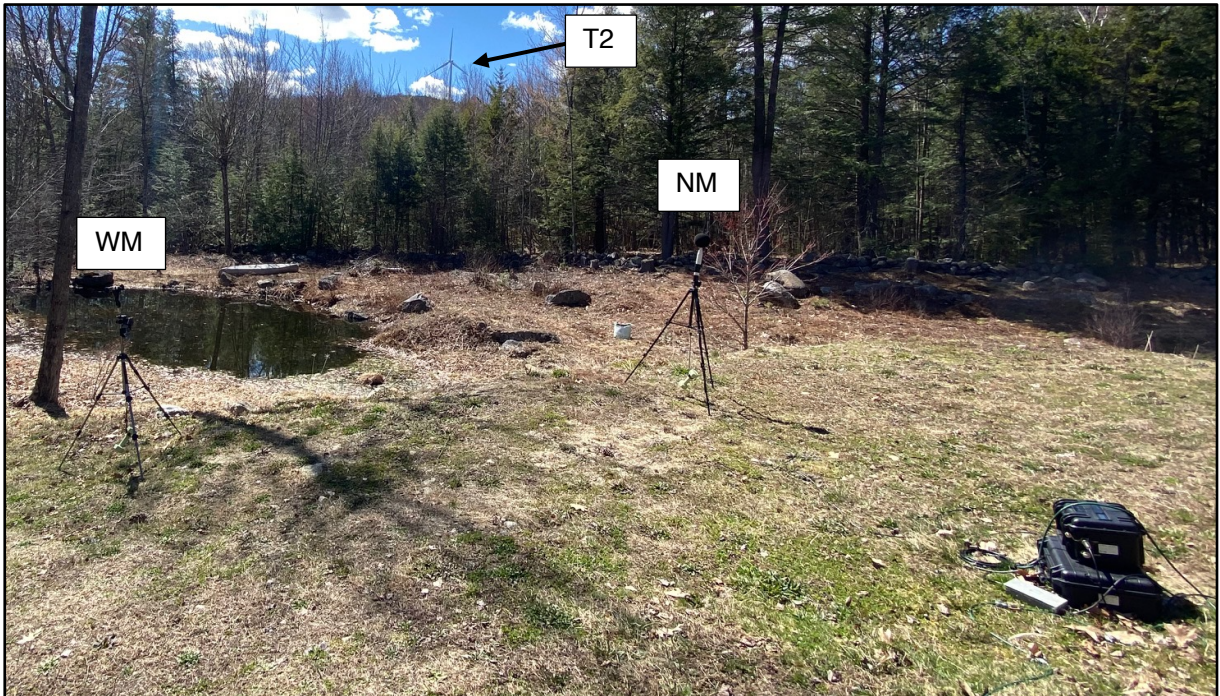


Figure 2. Looking West from outside the Berwick house. Left to right, anemometer WM, and NM meter microphone. Turbine T2 is visible direct line-of-sight on Tuttle Hill in top right portion of photograph. The T3 nacelle is just above ridgeline. T1 is beyond the NM behind trees to right.

## FACILITY OVERVIEW

The Antrim Wind facility consists of nine Siemens SWT-3.2-113 Direct Drive turbines, each with a nameplate generating capacity of 3.2 MW. The turbines run approximately two miles along the Tuttle Hill ridgeline toward nearby Willard Mountain as shown on Figure 3.

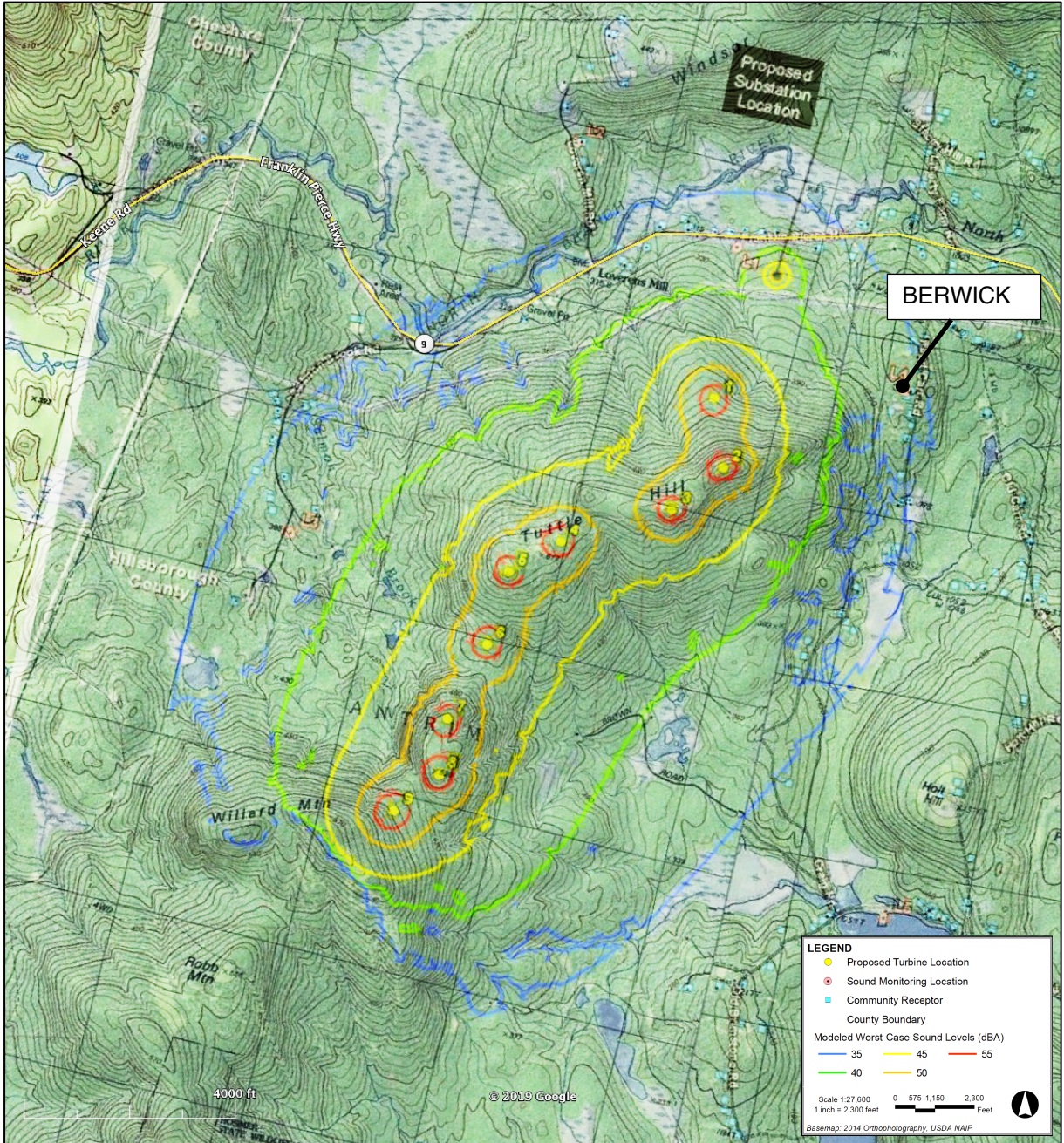


Figure 3. Turbine locations with 2016 predicted "Worst-Case" noise levels (yellow, 45 dBA; green, 40 dBA; blue, 35 dBA). This survey's location NM is at 74 Reed Carr Road (BERWICK).

Excluding turbine blades, 8 of the turbines are 92.5 meters tall (303.5 feet) and 1 turbine is 79.5 meters tall (260.9 feet). Including turbine blades, 8 of the turbines are 488.8 feet tall and turbine 9 is 446.2 feet tall.

The Tuttle Hill ridgeline elevation ranges between 1760 and 1830 feet, a rise of 610 to 680 feet above the valley floor. The three nearest turbines to the Berwick property, T1, T2, and T3 are line-of-sight and respectively approximately 3670, 3800, and 5000 feet from the Berwick home. Turbine T1 is visible and audible through trees. Turbine T2 (see Figure 2 of this report) has a total elevation to blade tip of approximately 1000 feet above the Berwick home. The T3 hub and blades are visible above the tree line.

The "Worst Case Sound Level" at the Berwick property home was predicted by Epsilon Associates in 2016 to be 35.7 dBA "under worst-case operational conditions" [4].

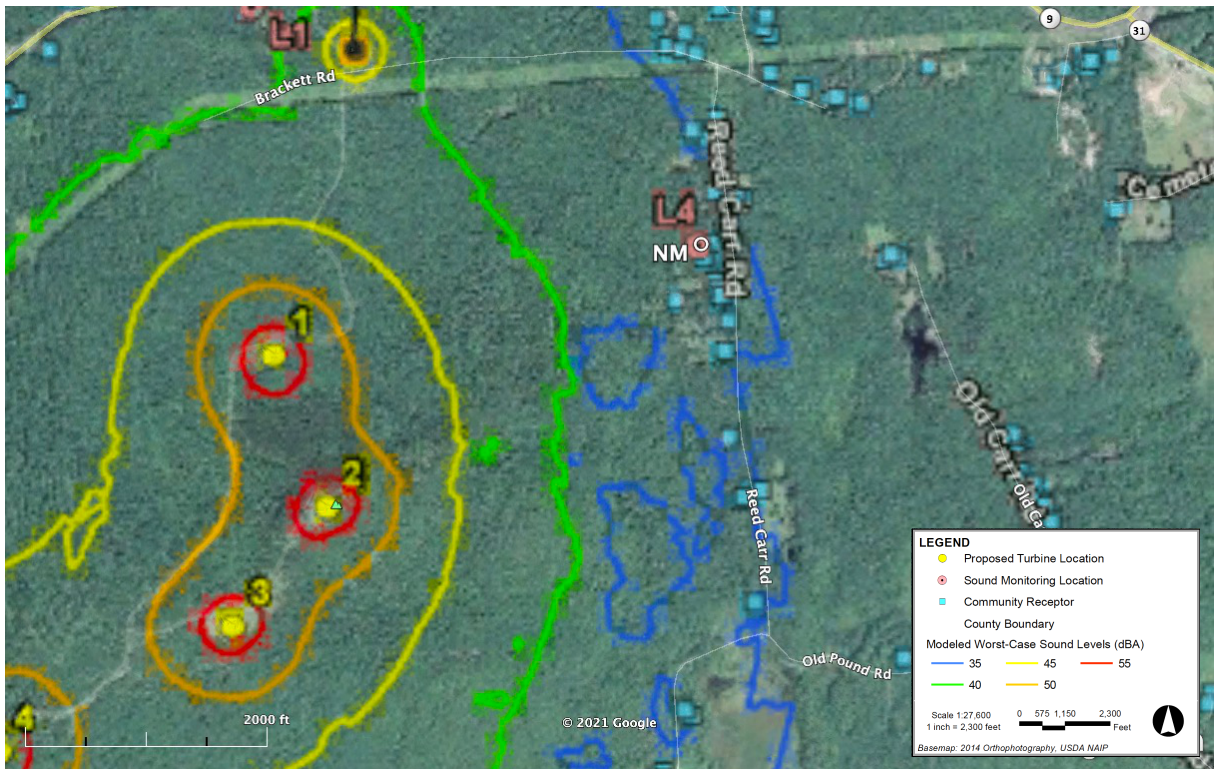


Figure 4. "Worst Case Sound Levels" predicted in 2016 by Epsilon Associates. The predicted worst case (highest) noise level at the Berwick home, 35.7 dBA, is similar to those predicted by Epsilon Associates at other nearby homes on Reed Carr Road; approximately 35-37 dBA.

## COMPLAINT NOISE ANALYSIS

### **COMPLAINT 3/24/21 12:16 AM: "Quite loud", "Modulating"**

Sound data and audio occurring at the time of the Berwick noise complaint were reviewed from the NM meter records. The Antrim Wind turbines dominated the acoustic environment with pronounced low frequency whooshing-thumping fluctuations. No other significant intrusive noises were heard.

For the hour from Midnight to 1AM, there was little to no wind at the NM microphone level, and no wind-induced noise in the microphone recording. The local temperature was 35-40F and humidity 71-89% [5].

Figure 5 below shows the entire hour from 12 to 1 AM. At the complaint time 12:16 AM, turbine noise levels exceeded 40 dBA (red marker). Numerous wind turbine noise fluctuations exceeded 40 dBA. Wind turbine fluctuating noise levels measured up to 50 dBA (blue marker), 14 dBA louder than the "Worst Case Sound Level" of 35.7 dBA predicted by Epsilon Associates in 2016, and up to 10 dBA over the NH SEC noise limit of 40 dBA.

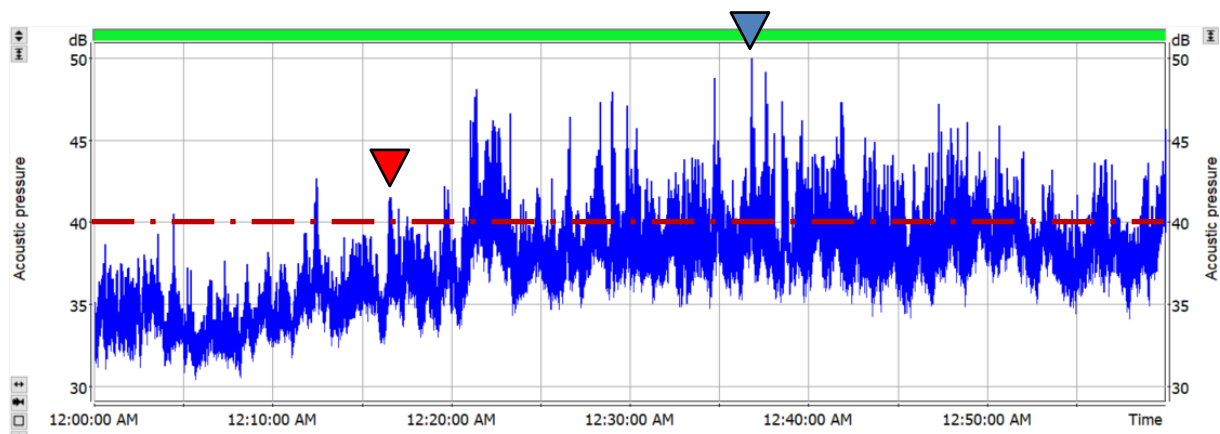


Figure 5. Noise levels 3/24/21 12-1 AM, Leq-0.1second. Turbines dominated the acoustical environment. The NH shall-not-exceed 40-dBA night noise limit is shown in red. The green band shows the time portion of the 1-hour record displayed (full hour). At the complaint time 12:16 AM, turbine noise levels exceeded 40 dBA (red marker). Numerous wind turbine noise fluctuations exceeded 40 dBA. Wind turbine noise levels measured up to 50 dBA (blue marker).

Figure 6 below shows a 2-minute segment from 12:36 to 12:38 when wind turbine noise reached 50 dBA (blue marker). Repetitive wind turbine amplitude fluctuations are clearly visible in the two-minute record. Trained listening to the audio recording confirmed the segment is dominated by wind turbine noise.

5 <https://www.wunderground.com/dashboard/pws/KNHANTRI9/table/2021-03-24/2021-03-24/daily> accessed May 4, 2021.



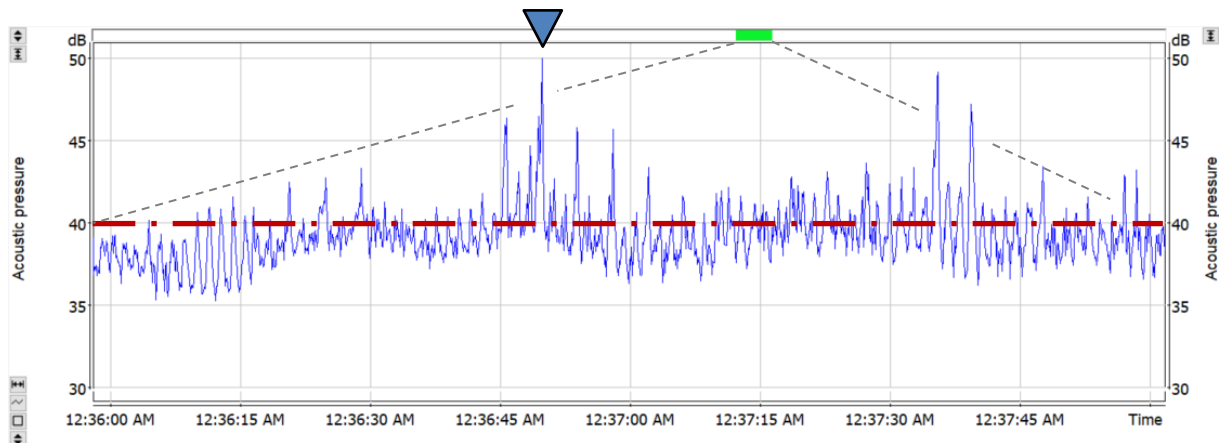


Figure 6. Noise levels 3/24/21 12:36-12:38 AM. Blade pass modulations visible with depths of 4 to 11 dB. Noise levels repeatedly exceeded 40 dBA and measured up to 45 to 50 dBA, 5 to 10 dBA above the facility noise limit. The green band shows the time portion of the 1-hour record displayed (12:36-12:38 AM).

**COMPLAINT 3/31/21 3:14 AM: "Maybe woke up", "Definitely bothering me", "Making it hard for me to go back to sleep"**

Sound data and audio recording acquired at the time of the Berwick noise complaint were reviewed from the NM meter records. The Antrim Wind turbines dominated the acoustic environment with pronounced low-frequency whooshing-thumping fluctuations. ANSI S12.100 ANS-weighting was employed to remove high-frequency transient noises. No other significant intrusive noises were heard.

For the hour from 3-4 AM, there was very low wind (slight to none) at the NM microphone level, and no wind-induced noise in the microphone recording. The local temperature was 43F and humidity 73-75% [6].

The complaint time was 3:14 AM, but the complaint included "maybe woke up" and "making it hard for me to go back to sleep". This suggested awakening prior to 3:14 AM, and prompted review of the record earlier in the hour. Prominent wind turbine noise fluctuations were found just after 3 AM, as shown below. Figures 7 and 8 below show the time-series record with ANSI S12.100 ANS-weighting applied to remove transient high frequency noise. The charts show 3:00-3:01 AM and 3:14-3:15 AM, respectively.

Figure 7 shows fluctuating turbine-only noise levels. As a hypothesis, those levels might have been associated with awakening prior to the 3:14 complaint time.

6 <https://www.wunderground.com/dashboard/pws/KNHANTRI9/table/2021-03-31/2021-03-31/daily> accessed May 4, 2021

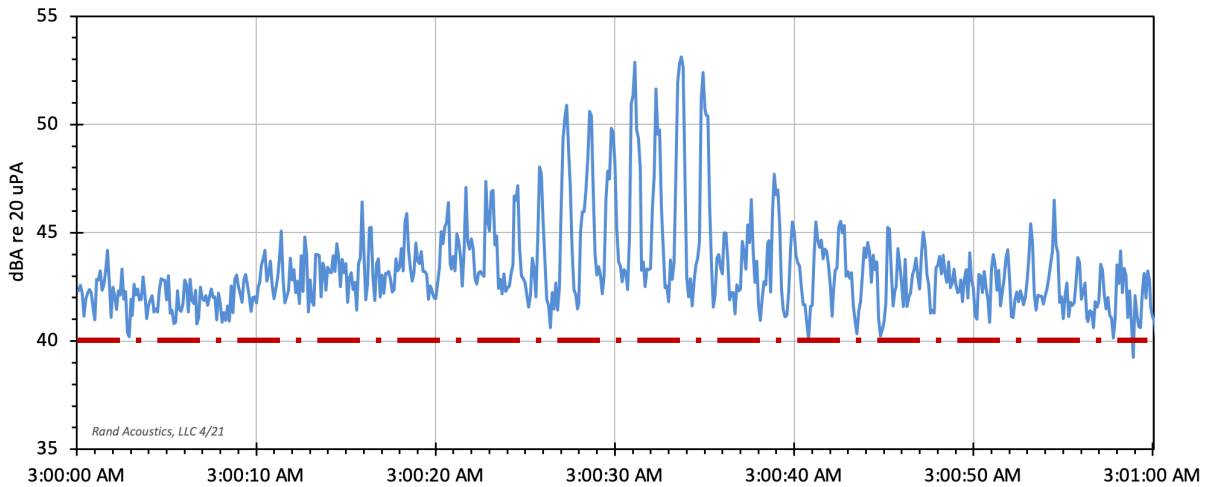


Figure 7. Noise levels 3/31/21 3:00-3:01 AM, Leq-0.1second, ANS-weighting. Blade pass modulations visible with depths of 4 to 11 dB. Several turbine noise fluctuations reached 50 to 53 dBA.

Figure 8 shows fluctuating turbine-only noise levels exceeding 40 dBA at the complaint time with report of being bothered and the noise making it hard to go back to sleep.

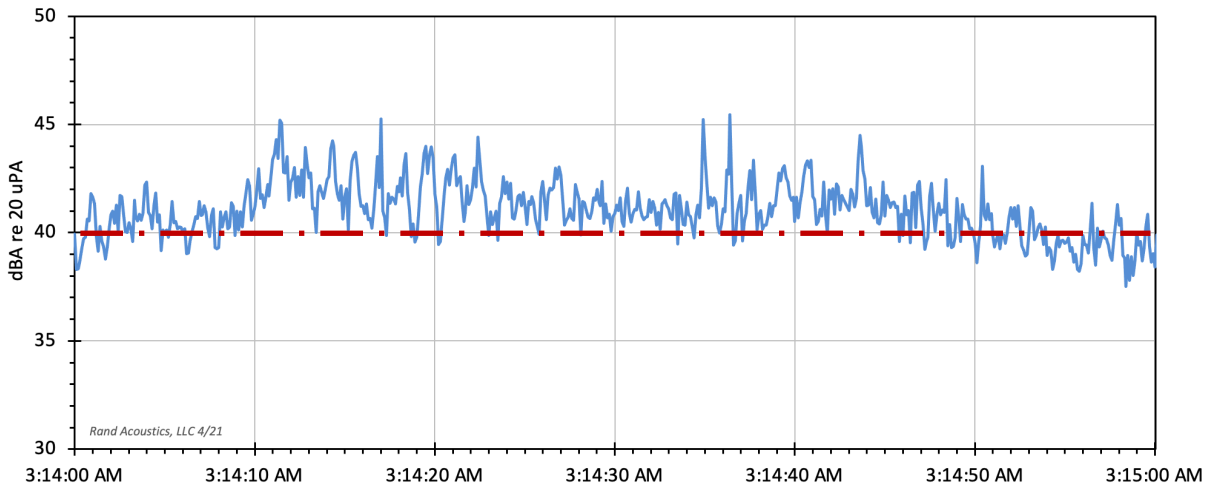


Figure 8. Noise levels 3/31/21 3:14-3:15 AM, Leq-0.1second, ANS-weighting. Several turbine fluctuations reached 45 dBA.

Wind turbine fluctuating noise levels measured up to 45 to 53 dBA, 5 to 13 dB louder than the NH SEC noise limit of 40 dBA.

### WIND SPEED AT MICROPHONE

Wind speeds at microphone level measured by the WM anemometer were less than 3 m/s (7 mph), as required for noise surveys by NH SEC rules, during the complaint times of 3/24/21 12:16 AM and 3/31/21 3:14 AM.

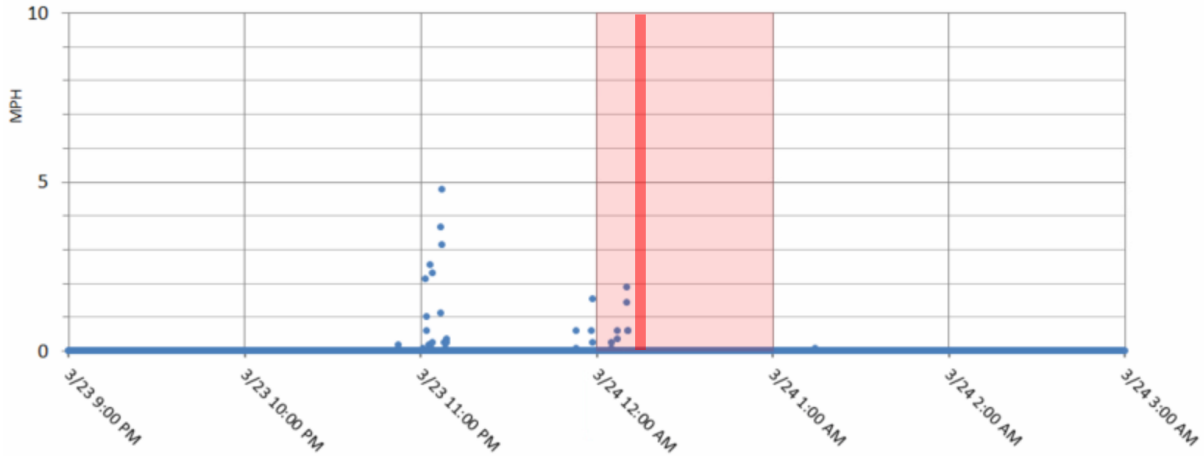


Figure 9. Wind speeds at microphone with complaint times shown for 3/24/21.

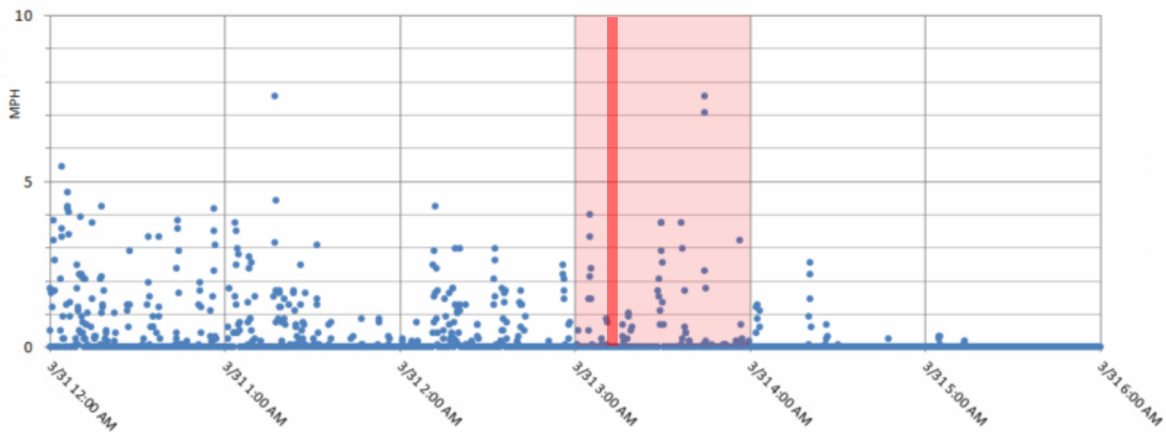


Figure 10. Wind speeds at microphone with complaint times shown for 3/31/21.

Ground-level wind speeds at the Berwick home were light or non-existent during the complaint times. The wind speed data are consistent with observations that the Antrim Wind turbines dominated the acoustic environment at the time of complaints and "wind in trees" sounds were not significant contributors to the measured sound levels.

### ANTRIM WIND TURBINES NOT "STEADY"

ANSI S12.9 Part 3 states, "*For the sound to be essentially steady, the difference between the maximum sound pressure level and the minimum sound pressure level measured during the 5-min observation period shall be less than or equal to 3 dB.*" Whereas this survey measured repetitive fluctuations of 4 dB to 11 dB. Result: Antrim Wind turbines aren't "steady".

### BEST PRACTICES REQUIRE AN ADEQUATE MARGIN OF SAFETY

From years of work in power generation noise control, accepted practice includes assuring that a proposed facility will comply with regulatory requirements with an adequate margin of safety.

This survey documented excessive noise levels that confirm: An adequate margin of safety is absent from the noise control design of the Antrim Wind facility. Antrim Wind noise levels exceed facility noise limits by as much as 13 dBA.

At this time no reliable noise control option is known to exist that provides a 13 dBA noise reduction for the wind turbine technology used by Antrim Wind, except shutdown.

### ETHICS

Rand Acoustics is an independent professional noise control consulting firm. Rand Acoustics applies no bias regarding the sound source technology under test when investigating for regulatory noise compliance and noise impact assessment.

As a neutral party, my background is in power generation noise control, community noise impact assessment, and designing power, industrial and commercial facilities to meet regulations and protect health and welfare. I worked for Stone & Webster for ten years in the Noise and Vibration Group and have designed or reviewed noise controls for most utility-scale power technologies and a number of commercial technologies. If someone levels the charge "anti-wind", by the same logic they'd have to charge "anti-coal", "anti-oil", "anti-nuclear", "anti-gas", "anti-transformer", "anti-secondary-treatment-plant", "anti-backup-generator", "anti-restaurant", "anti-hospital", and "anti-concert-hall".

Recommendations and professional cautions by Rand Acoustics are carefully developed from years of power generation experience, noise complaint investigations, and noise surveys. Professional services and opinions have proved useful for utilities, commercial clients, the military, regulators and communities alike.

## CONCLUSIONS

1. This complaint response noise survey investigated two complaint times at the Berwick home during March 18 to April 9, 2021. Antrim Wind noise levels reached 45 to 53 dBA, 6 to 13 dB over the shall-not-exceed 40-dBA noise limit.
2. Antrim Wind turbine noise dominated the acoustic environment at the complaint times with repetitive 1/10-second LAeq fluctuations exceeding 40 dBA numerous times.
3. Antrim Wind turbine noise was confirmed as not "steady". Fluctuations of 4 to 11 dB breach the 3-dB limit for steady sound specified in ANSI S12.9 Part 3.
4. Epsilon Associates' "Predicted Worst Case Sound Level" at the Berwick home was 35.7 dBA. Measured wind turbine noise levels reached 53 dBA, exceeding Epsilon "worst case" noise level predictions by 17 dB.
5. The Berwick location is considered representative of the nearest residents to the east and northeast of the wind farm along Reed Carr Road and Craig Road. It appears certain that similar noise limit exceedances occur in properties adjacent to the Berwick property.
6. Complaints investigated during the noise survey occurred at night. Sensitive home activities such as sleeping and restoration in quiet occur primarily between 8 pm and 8 am (night). Night-time noise monitoring can make best use of investigative resources.
7. Complaint times provided an efficient basis for assessing intrusive noise. Noise survey results confirmed that excessive noise can be documented using recorded, unattended monitoring when analysis is based on neighbor complaints.
8. Valley topographic isolation below ridge, with winds hundreds of feet aloft moving through turbine blade envelopes, can result in low or no winds at the valley home, with Antrim Wind turbine noise illuminating and dominating the valley acoustic environment.

Much appreciation is extended to the Berwicks for hosting the survey at their home.

Thank you for your consideration of this report. If you have any questions, please contact me.

Respectfully Submitted,



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Robert W. Rand, ASA, INCE (Member Emeritus)