HANKARD ENVIRONMENTAL
ACOUSTICS AND VIBRATION CONSULTING

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Re: Review of Proposed Noise-Related Changes to the Champaign County Wind Turbine Ordinance

Mr. Mallernee,

Per your request, I reviewed the proposed noise-related changes to the Champaign County Zoning Ordinance. A summary of the most important issues is provided below. Additional information follows which provides a more in-depth review of the issues involved.

The Champaign County Zoning Board of Appeals (ZBA) gathered public input and provided recommendations limiting noise levels to 39 dBA (audible) and 80 dB (infrasound) at the property line to "better protect Champaign County residents." Audible noise levels have been and continue to be safely regulated by the rules of the Illinois Pollution Control Board (IPCB). The IPCB rules limit noise from wind projects to approximately 46 dBA[1], which is in line with recommendations from the World Health Organization (WHO), other health-based studies, and on the low end of the range of limits used by virtually all states and counties in the U.S. The proposed limit of 39 dBA is based on the opinion of a handful of consultants who have only *theorized* that such a limit is necessary. These theories have not been borne out in reality with over 3,000 turbines safely operating in Illinois and 70,000 nationwide. Understand that this low limit completely prohibits the development of wind turbines in the Midwest and is lower than existing ambient noise levels due to the wind blowing through trees.

The ZBA also raised concerns of infrasound (very low frequency sound). For decades it has been *postulated* and *theorized* by a handful of mostly non-medical individuals that infrasound from wind turbines *might* be harmful to human health. This has been disproven by numerous studies conducted by government health-based agencies the world over. It has been tested and verified that infrasound produced by wind turbines is not audible to humans in any way, shape, or form. The proposed limit of 80 dB is unnecessary and provides no demonstrated benefit to the public.

The ZBA also recommended that the 39 dBA and 80 dB limits be enforced at the edge of a property, not at the residence itself. This is unnecessary and inappropriate. The IPCB rules are comprehensive in their protection from noise impacts through the distinction of limits based on land use, with more stringent limits in place for noise emitted to a residence and more stringent limits yet for nighttime versus daytime. This is appropriate given that nighttime activities, such as sleeping, require a greater degree of protection. Developers of wind turbine projects understand this and design projects to meet the residential, nighttime noise limits at every residence.

Additional Information Regarding the Adequacy of the IPCB Noise Limits

The IPCB noise level limits are some of the most comprehensive and restrictive limits in the country. The have safely governed all forms of noise sources in the state, including the thousands of wind turbines that have been operating for 20 years. The noise limits take into account residential land use, nighttime activities (e.g., sleeping), and frequency content in that they limit low frequency noise as well as more typical "audible noise." The information the ZBA heard to the contrary was provided by a handful of non-medical consultants and their opinions stand in stark contrast to what medical experts and agencies have published. Specifically:

1. The IPCB limits noise using a different metric than other states, counties, and townships in the U.S. The IPCB specifies limits to individual frequency bands (dB), whereas almost all other regulations and standards utilize what is called the overall A-weighted level (dBA). Based on the frequency spectra of wind turbine noise, the IPCB effectively limits noise from wind turbines to 46 dBA.

2. The World Health Organization has long recommended a limit of 45 dBA for the protection of human health at night[2,3,4]. In 2018 the WHO studied noise from wind turbines specifically. They found no evidence for health impacts, some evidence for annoyance, and recommend a limit of 45 dBA. Note that this limit is expressed as the annual average of the 24-hour average day-evening-night level, which equates to a loudest-hour turbine noise level of 45 dBA. The IPCB limit is in line with these recommendations.

3. First published in 2016, the Health Canada[5] study is, to date, the most rigorous study of the potential effects of noise from wind turbines on human health. It studied 1,200 people living near wind farms in Canada and collected both subjective (surveys) and objective (e.g., cortisol levels and sleep parameters) data from participants. It concluded that, up to 46 dBA (the loudest level they studied), they too found no evidence of health impacts and some evidence of annoyance. Again, the IPCB limits are in line with these findings.

4. At a state-level in the U.S. the range of limits is 45 to 55 dBA, including Wisconsin (45 dBA), Colorado (50 dBA), Illinois (46 dBA), Minnesota utility commission (47 to 50 dBA), New York utility commission (45 dBA), South Dakota utility commission (45 dBA), and Maryland (55 dBA). The IPCB limits are on the low end of this range and therefore very much in line with what is being done nationally.

5. Hankard Environmental has conducted approximately 50 noise impact analyses for projects regulated at the county or township level in the U.S. In our experience, the limits at the local level overwhelmingly range from 45 to 55 dBA. There are some localities with higher limits, but this is moot as wind turbines do not produce noise levels in excess of approximately 50 dBA at residences based on our measurement of noise at more than 60 locations. Where limits of less than 40 dBA have been enacted, this too is moot, as no utility-scale wind development can or has been developed in the Midwest. The IPCB limits are on the very low end of this range.

Despite this conclusive information, opponents of wind energy projects have routinely asserted that the IPCB noise limits are not sufficient to protect public health and well-being. The following lists examples of the rationale for lower limits that has been presented by a few consultants who are not medical experts. The examples have a common thread, in that they consist of *theories* associated with decades-old studies, many of which are unrelated to wind turbines. These theories have remained the same for 10 to 20 years now, all the while ignoring the results of the health-based studies noted above. With over 70,000 wind turbines now operating in the U.S. it is becoming clearer that these theories have not, and are not coming to pass.

- ANSI S12.9 Parts 4 and 5[6,7] can be used to establish limits for certain land uses, such as residential. The standard will yield limits in the 30 to 35 dBA range if each adjustment in the standard is taken to its fullest. For example, the standard's starting point of 55 dBA can be lowered by 10 dBA for "quiet rural areas." Wind turbine projects are indeed sited in rural areas, but they produce full acoustic emissions only when it is windy which is when it is not quiet, and turbines are off during calm, quiet nights. The ANSI limit can be lowered by another 5 dBA for sources of noise that are new to a community. Wind turbines may be new in some cases, but their sound is similar to a fan or plane. Only by taking the full adjustment in both of these cases, which is an overreaching theory, does one arrive at a recommendation of 39 dBA. A more balanced interpretation of the ANSI guidelines leads to a limit of 45 dBA, which as noted above is that used by many counties and states.
- It has long been established in the acoustics profession that the impact of noise from a new source is dependent on how loud it is relative to existing noise levels. If the source is 10 dBA or more louder than existing levels it is generally considered potentially intrusive. On calm, quiet rural nights it can be very quiet (down to 20 dBA). But these are the very nights wind turbines are *off* and nearly silent. Turbines generate their maximum noise on windy nights, those nights where it is noisy due to the rustling of trees and crops. Wind blowing through trees generally produces noise levels ranging from 35 to 55 dBA. For a project permitted at 45 dBA, it could at times be 10 dBA louder than existing levels and at times be 10 dBA quieter (in other words not audible). Comparing wind turbine noise levels of 45 dBA to ambient levels of, for example 20 dBA, is misleading and inaccurate.
- In 2018 the WHO published a conditional recommendation of 45 dBA. This limit is specified using a metric called the annual-average day-evening-night level ("L_{den}" or "DNL," dBA). Consultants for wind turbine opponents have falsely asserted that wind turbine noise levels need to be limited to 35 dBA at night to meet this recommendation. They arrive at this conclusion through the 10 dBA "penalty" applied to nighttime noise levels in the calculation of the L_{den}, falsely assuming that turbines produce full acoustic emissions 24 hours a day, 365 days a year. Turbines operate fully only about 30% of the time, and not all of that occurs at night. Furthermore, there are many days and nights in a year when the turbines do not operate at all, or when atmospheric conditions do not favor noise propagation. When all of this is taken into account, limiting noise levels to 45 dBA (one-hour average of full operation) will meet the WHO 2018 conditional recommendation of an annual average L_{den} of 45 dBA[8].
- Relying on data published by the U.S. EPA in 1974, coupled with research published in Europe in 2008, and with a few adjustments of their own, a few acoustical consultants have testified that wind projects permitted with a maximum level of 45 dBA will result in "strong appeals to stop noise" and "vigorous community reaction." It is agreed that there have been

complaints about noise from wind turbine projects, and in some cases legal action. The same can be said about noise from many industrial facilities, airports, roadways, rail lines, and agricultural operations. Wind turbines are not unique in this regard. However, instead of reviewing and combining decades-old research on non-turbine sources with decade-old studies of turbine noise in Europe, it is preferable, and more realistic, to review a study conducted recently in the U.S. dealing directly with turbine noise and its annoyance[9]. This study of attitudes of people living near wind turbine projects throughout the U.S. shows that, when asked, ~25% of the respondents living with noise levels of up to 45 dBA reported being "highly annoyed." But it needs to be noted that only 25% of those living close to the turbines even responded to the survey. This is a very low response rate and indicative of a lack of concern. Thus, only ~6% of the population living very near the turbines could be considered highly annoyed based on this study (25% of 25%). In the field of environmental acoustics, a value of "10% highly annoyed" has long been used as a maximum value when designing power generation and other industrial facilities. The Haac study acknowledges that there is a degree of annoyance associated with wind turbine projects, but the level of annoyance is within expected bounds.

Additional Information Regarding Infrasound

The ZBA recommends a limit on infrasound from wind turbines of 80 dB. It is imperative to understand that humans routinely experience infrasound, it is produced by sources such as the wind, ocean waves, and home heating systems. When riding in a car, tractor, or plane a person experiences far higher levels of infrasound than those produced by wind turbines. However, none of these sources, nor wind turbines, produce enough infrasound for humans to detect, either through our ears or through other means such as vibration. In fact, the levels of infrasound produced by wind turbines are *significantly* below the threshold of hearing in humans at these very low frequencies. As detailed below, studies by numerous health-based organizations have repeatedly demonstrated that infrasound from wind turbines is not harmful to humans. Therefore, no limit is needed or warranted.

Infrasound from wind turbines has been measured at and inside homes by researchers in the U.S. and internationally, most notably by the Federal State of Baden-Wuerttemberg in Germany, Walker, et al. in the U.S., and Tachibana in Japan. Small peaks of acoustic energy are produced from about 1 Hz to 5 Hz and are the result of the blades passing the tower, but the levels are 50 dB below the threshold of human hearing.

In 2022, Liebich, et al.[10] produced the largest polysomnography study of the potential interaction between wind-turbines noise (WTN) and sleep. Their controlled, repeated-measures, laboratory study of 68 adults was conducted in a pin-drop quiet laboratory of 19 dBA background noise, with wind turbine noise exposures of 25 dBA in four different exposure conditions over four nights. The study did not demonstrate differences in participants' primary outcome of sleep efficiency. The importance of their study is that the wind turbine noise level was substantially higher than the background noise, and yet their primary outcome of sleep efficiency was undisrupted.

In 2021 Maijala, et al.[11] published the results of a study in the Journal of the Acoustical Society of America involving people who had complained of health impacts from wind turbines. Samples of turbine noise, including infrasound, were played in a test chamber for these people while certain tasks were performed and physical symptoms monitored. A control group who had not complained about turbines was also included. The concluding statement reads: "In the conditions used in the current study, infrasound did not contribute to the detection, annoyance, or physiological reactions to wind turbine sound." In other words, nobody, not even those who had complained of health impacts, could tell that infrasound was even there.

Wind energy opponents have for at least a decade theorized that perhaps there is something about infrasound that makes it different from other sources such that it could impact humans more directly or via a pathway not fully understood. In contrast to these theories, the following is a sample of what leading researchers and governments across the world have concluded based on their research into wind turbine infrasound impact to humans:

> Japan Ministry of the Environment study[12]: "Super-low frequency range components of wind turbine noise [20 Hz or lower] are at imperceptible levels. **Therefore, wind turbine noise is not an issue caused by super-low frequency range**."
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> French Government (ANSES) measurement study[13] at three wind farms concluded: "The results of these campaigns confirm that wind turbines are sources of infrasound and low sound frequencies, but no exceedance of the audibility thresholds in the areas of infrasound and low frequencies up to 50 Hz has been found." The study also noted "**all the experimental and epidemiological data available today do not show any health effects related to exposure to noise from wind turbines,** other than noise-related annoyance."
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> Health Canada's 2015 Community Noise and Health Study[14] is the largest-yet epidemiological study conducted to address community health concerns in relation to wind turbines. It concluded the following regarding infrasound: "Within the normal hearing frequency range, sounds have to be at a very low level to be non-audible, and at those levels would not contribute to any type of known hearing dysfunction. For low-frequency signals, including infrasound, activation of the vestibular system is possible if the signal levels are at high intensity. For both normal subjects and even for individuals with certain medical conditions that result in lowered vestibular activation thresholds (e.g., Tullio syndrome, superior canal dehiscence, perilymphatic fistula, or enlarged vestibular aqueduct), wind turbine signals are unlikely to reach the activation threshold. **It is therefore unlikely that wind turbine noise could directly cause any symptoms associated with vestibular dysfunction, such as vertigo, dizziness, vision problems, or nausea."**
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> The Australian Medical Association[15] evaluated the health impact relative to wind turbines and released a position statement: "The available Australian and international evidence **does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects** on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."

A 2016 German study[16], which spanned two years and examined six wind turbines by different manufacturers with different sizes and covering a power range from 1.8 to 3.2 MW, concludes that "Infrasound is caused by a large number of different natural and technical sources. It is an everyday part of our environment that can be found everywhere. Wind turbines make no considerable contribution to it. **The infrasound levels generated by them lie clearly below the limits of human perception. There is no scientifically proven evidence of adverse effects in this level range."**

Conclusion

It is my hope that the information provided in this letter demonstrates that:

1. The current IPCB noise level limits have been and continue to be adequate to protect public health based on the published findings of the most significant studies conducted by government and public agencies.

2. Infrasound from wind turbines has never been demonstrated to be audible by or harmful to humans.

3. The recommended noise limit of 39 dBA is based on the opinions of a few non-medical consultants that have long *theorized* that such a limit is necessary.

References

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Please let me know if you have any questions regarding the above or would like additional information.

Sincerely,

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Full Member of INCE and ASA