LANCASTER COUNTY

Print Form

Planning Department Application Request Form

Planning Department / 555 S 10th St, Ste 213 / Lincoln, NE 68508
Phone 402-441-7491 / Fax 402-441-6377
plan@lincoln.ne.gov

Date 9/21/18

	Application Type	Subtype	Category	Office Use Only: File #	Office Use Only: PC Final Action
+ -	Text Amendment	Zoning Ordinance		18011	☐

Project Name BLUE PRAIRIE WIND, LLC

Address/General Location 700 UNIVERSE BLVD JUNO BEACH, FL 33408

Legal Description Countywide
(Attach legal if necessary.)

Parcel ID Number(s) (PID)

Number of Acres N/A Number of lots being platted N/A *(Not outlots)* App # Being Amended N/A

THE FOLLOWING INFORMATION IS NECESSARY TO HAVE A COMPLETE APPLICATION:

1. **LETTER** stating purpose of application. This statement should include information concerning the reason for the request(s), any associated applications, projects or other information related to the application. This letter should include a list of waivers associated with an application and justifications for those waivers. If no waivers are requested state "no waivers are requested."
2. **FEE** (View Fee Schedule) Note: Make checks payable to Lancaster County.
3. **SITE PLAN** The site plan shall be submitted electronically using e-plan. (View instructions on eplan submittal)

NOTE: See Forms & Fees section of Planning Department website for checklists with specific requirements for each type of project.

*** This application may be returned as incomplete if all requested information is not provided. ***

The County reserves the right to ask for additional information to process this application.

Property Owner Name Phone

Address Email

City State Nebraska Zip

Applicant Name BLUE PRAIRIE WIND, LLC Phone (561) 691-7122

Address 700 UNIVERSE BLVD Email

City JUNO BEACH State Florida Zip 33408

Contact Name *DAVID KUHN* Phone (561) 691-7122

Address 700 UNIVERSE BLVD *Email* *david.kuhn@nexteraenergy.com*

City JUNO BEACH State Florida Zip 33408

ProjectDox Contact Kimberly Dickey *ProjectDox Email* Kimberly.Dickey@NEE.com

Applicant Signature:

* Property Owner Signature:

** NOTE: If application is for a special permit and the applicant is not the owner of the property, the property owner must sign the application or the applicant must attach written permission of the owner authorizing the applicant to sign on behalf of the owner. By signing this application request form or granting the applicant permission to sign on the owner's behalf, the owner hereby grants all authorized city/county personnel to access the property for purposes of review of this application.*

Blue Prairie Wind, LLC

September 24, 2018

Lancaster County Planning Department
555 South Tenth Street
Lincoln, Nebraska 68508

RE: Application for Text Amendment

Lancaster County Planning and Zoning Board:

Enclosed is a proposed text amendment to Lancaster County Zoning Regulations Chapter 13.048 that modifies: 1) setbacks to a non-participating property line, and 2) a noise limit for landowners who choose to participate in a wind energy project. These changes are designed to provide needed flexibility for citizens seeking to invest in wind energy development while protecting disinterested third parties from disturbance. In addition, these proposed changes would align Lancaster County more closely with surrounding counties, thus making Lancaster County competitive for wind energy development, without sacrificing any of the protections that Lancaster County citizens currently enjoy under the regulations the County Commission adopted in 2015. We look forward to the opportunity to review the details of this proposal at your earliest convenience.

~~Warmest Regards,~~

David Kuhn
Project Manager
Renewable Development

Proposed text amendments to Lancaster County Zoning Regulations:

13.048(A)(g).

2. For a non-participating lot, the setback shall be ~~2~~ **1.1** times the turbine height measured to the property line, or 3 ½ times the turbine height, measured to the closest exterior wall of the dwelling unit, whichever is greater, but at a minimum ~~1,000~~ **1,475** feet to the ~~property line~~ **closest exterior wall of a dwelling unit**.

13.048(A)(i). Noise: No CWECS or combination of CWECS turbine(s) shall be located as to cause an exceedance of the following as measured at the closest exterior wall of any dwelling located on the property. If a turbine violates a noise standard on a dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use. For ~~both participating and~~ nonparticipating properties:

1. From the hours of 7 am to 10 pm:
i. Forty (40) dBA maximum 10 minute Leq or;
ii. Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 15 hour period.

2. From the hours of 10 pm to 7 am:
i. Thirty-seven (37) dBA maximum 10 minute Leq or;
ii. Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 9 hour period.

For participating properties:
1. Fifty (50) dBA maximum 10 minute Leq for all hours of the day and night.

OLLSON
Environmental Health Management

September 21, 2018

Proposed Noise Levels at Participating Landowners Dwelling in a Commercial Wind Energy Conversion System (CWECS) in Lancaster County, Nebraska

Over the past decade there has been considerable research conducted around the world evaluating health concerns of those living in proximity to wind turbines. This independent research by university professors, consultants and government medical agencies has taken place in many different countries on a variety of models of turbines that have been in communities for numerous years. Based on scientific principles, and the collective findings of over 80 scientific articles, there is scientific justification to allow CWECS project participating landowners to have a noise limit of fifty (50) dBA maximum 10 minute Leq level at the exterior wall of their dwellings. This limit will enable proper siting of wind turbines on participating land while still ensuring the protection of public health, safety and welfare of participating residents.

This report examines the key issues surrounding sound levels at participating landowner's homes and provides scientific support for allowing the standard to be increased, while still ensuring the protection of their health.

1 Proposed Noise Levels at Participating Landowner Dwellings in Lancaster County, NE

The Lancaster Board of County Commissioners adopted Resolution No. R-15-0061 on November 10th, 2015. This resolution resulted in the adoption of Section 13.048, Commercial Wind Energy Conversion Systems, that revised the special permit conditions for wind turbine projects regarding decommissioning, shadow flicker, impact on environmental resources and view corridors, setbacks, noise, noise studies and other conditions.

The focus of this report is on Subsection (i), which states:

> *(i) Noise: No CWECS or combination of CWECS turbine(s) shall be located as to cause an exceedance of the following as measured at the closest exterior wall of any dwelling located on the property. If a turbine violates a noise standard on a dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use. For both participating and nonparticipating properties:*
>
> *(1) From the hours of 7 am to 10 pm:*
>
> - *Forty (40) dBA maximum 10 minute Leq or;*
> - *Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 15 hour period.*
>
> *(2) From the hours of 10 pm to 7 am:*
>
> - *Thirty-seven (37) dBA maximum 10 minute Leq or;*
> - *Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 9 hour period.*

Additionally, Subsection (j) provides details on pre-construction noise study to be completed:

(j) *A professional pre-construction noise study shall be conducted which includes all property within one mile of a tower support base. The protocol and methodology for such studies shall be submitted to the Lincoln-Lancaster County Health Department for review and approval. Such studies shall include noise modeling for all four seasons and include typical and worst case scenarios for noise propagation. The complete results and full study report shall be submitted to the Lincoln-Lancaster County Health Department for review.*

Subsection (j) is appropriate to ensure the protection of both participating and non-participating landowners. However, Subsection (i) should not be equally applied to participating and non-participating landowners. The amended Lancaster County ordinance is amongst the most restrictive sound levels in the Midwest for participating landowners.

Participating and non-participating landowners should be considered separately. In fact, there are numerous examples in the Lancaster County Section 13.048 where this is already the case. For example, the provisions for shadow flicker apply only to non-participating dwellings. In addition, setback distances from wind turbines to dwellings are more restrictive for non-participants than for participating landowners. Allowing a greater setback for non-participating landowners is consistent with general zoning principles for energy facilities and should equally apply to the noise requirements in the ordinance.

It is recommended that the Board of Commissioners should consider changing the language for participating land owners to:

Fifty (50) dBA maximum 10 minute Leq for all hours of the day.

The following sections provide the scientific basis for allowing for up to 50 dBA sound level at participating dwellings. OEHM has not provided any comment on the sound levels for nonparticipating landowners as it is my understanding that NEER intends to design their wind project to comply with these requirements.

2 Other Nebraska and State Jurisdiction Sound Levels

OEHM respects that each jurisdiction has the right to set noise limits that they believe to be appropriate to protect the public health and safety of their citizens. It is understood that a considerable amount of time was spent by the County Health Department and others aiding in developing the amendment to the CWECS siting guidelines. For this very reason OEHM has not commented on the appropriateness of the 37 dBA nighttime and 40 dBA daytime for protecting and reducing annoyance for non-participating landowners. However, there are many jurisdictions that allow participating landowners to voluntarily have different sound levels than their non-participating neighbors.

2.1 Nebraska Experience

By 2017 there were almost 800 wind turbines in Nebraska with an installed wind capacity of 1500 MW across the state and an additional 862 MW of wind projects under construction. In Nebraska there is no overarching state regulation on the sound level at homes resulting from wind turbines. However, numerous counties in Nebraska allow for a 50 dBA or greater noise limit at participating (and even non-participating) dwellings. NEER currently operates two wind farms in Nebraska – Cottonwood Wind (2017, 40 turbine, 90 MW) in Webster County and Steel Flats (2013, 44 turbine, 75 MW) in Gage County.

Webster County Zoning Regulations Section 609.E.G.3. provides the following for sound levels:

> *SOUND LEVEL: The utility grid WECS sound levels shall not exceed fifty-five (55) decibels using the A scale (dBA), as measured at any occupied building or noise sensitive receptor within the project boundary and on non-leased lands with the project boundary and on lands within one-half mile of the project boundary. In the event audible noise from the operation of the WCES contains a pure steady tone, the maximum sound level shall be reduced by five (5) dBA. The applicant shall provide modeling and analysis that will confirm that the utility grid WECS project will not exceed the maximum permitted sound pressure levels. Modeling and analysis shall conform to IEC 61400 and ISO 9613.*

Gage County Zoning Regulations Article 6.6 (updated March 2016) Section 6.70 provides the following for noise:

6.70 Noise

> *A. No CWECS shall exceed 60 dBA 10 minute Leq at the nearest structure occupied by humans. In the event of periods of severe weather, as defined by the United States Weather Service, a CWECS may exceed 60 dBA. Except that a participating landowner may waive a noise limitation by written agreement, which shall be submitted at the time of the application.*
>
> *1. No CWECS shall exceed 45 dBA during the day time and 40 dBA at night (night hours are 10:00 pm to 7:00 am) at the nearest residence of a non-participating property; or*
>
> > *a. Five (5) dBA maximum 10 minute Leq allowed above ambient noise level.*
> >
> > *b. In the event of periods of severe weather, as defined by the United States Weather Service, a CWECS may exceed 60 dBA.*
>
> *2. A non-participating landowner can waive a noise requirement by written agreement. A written waiver shall be submitted at the time of the application. Such an agreement must be filed with the Register of Deeds and proof of that filing shall be provided to the Gage County Planning & Zoning Administrator prior to approval of the permit.*

The NEER projects in both of these counties were designed such that the maximum sound level at participating residents does not exceed 50 dBA. It is OEHM's understanding that NEER has an excellent working relationship with their participating landowners and has not received any complaints about the noise levels associated with the wind turbines.

The Gage County Zoning Ordinance provides similar language to what is being proposed by OEHM to Lancaster County for consideration. Specifically they also have a lower noise level for non-participating landowners and allow participating landowners a greater noise at the nearest occupied dwelling. Therefore, this precedent has already been established in Nebraska and it has been proven to work.

2.2 Oregon Administrative Rule 340-035-0035 Noise Control Regulations for Industry and Commerce

There are a number of jurisdictions, both at the county and state level, that allow for higher noise levels at participating homes than those for non-participants. Oregon provides the best example of a comparable rule to Gage County, NE and that being requested by NEER for Lancaster County. The following is an excerpt from the rules governing noise levels from wind turbines at participating and non-participating:

> *(iii) For noise levels generated or caused by a wind energy facility:*

(I) The increase in ambient statistical noise levels is based on an assumed background L50 ambient noise level of 26 dBA or the actual ambient background level. The person owning the wind energy facility may conduct measurements to determine the actual ambient L10 and L50 background level.

(II) The "actual ambient background level" is the measured noise level at the appropriate measurement point as specified in subsection (3)(b) of this rule using generally accepted noise engineering measurement practices. Background noise measurements shall be obtained at the appropriate measurement point, synchronized with wind speed measurements of hub height conditions at the nearest wind turbine location. "Actual ambient background level" does not include noise generated or caused by the wind energy facility.

(III) The noise levels from a wind energy facility may increase the ambient statistical noise levels L10 and L50 by more than 10 dBA (but not above the limits specified in Table 8 [50 dBA]), if the person who owns the noise sensitive property executes a legally effective easement or real covenant that benefits the property on which the wind energy facility is located. The easement or covenant must authorize the wind energy facility to increase the ambient statistical noise levels, L10 or L50 on the sensitive property by more than 10 dBA at the appropriate measurement point.

The Orgeon metric of L50 is the same as the Leq being used by Lancaster County. Essentially what the language says, and is done in practice, is that non-participating homes can not experience more than 36 dBA at the exterior of their homes (similar to the 37 dBA in Lancaster County at nighttime), while participating landowners with waiver may experience up to 50 dBA of noise at the exterior of their homes both during the day and at night. This practice was put in place to reduce the level of annoyance for non-participating landowners, while recognizing that those who economically benefit from the projects will unlikely be annoyed by the sound. According to a health impact assessment (HIA) completed by the Oregon Health Authority (2013):

> *"Further, landowners who waive Oregon's ambient degradation standard may perceive and respond differently (potentially more favorably) to the new noise levels, particularly if they benefit from the facility or have good relations with the developer."*

3 Health Research on Living in Proximity to Wind Turbines

Wind-based energy production has been identified as a clean and renewable resource that does not produce any known emissions or harmful wastes. As a result, wind power has become the fastest growing source of new electric power generation, with several countries achieving high levels of wind power capacity.

Over 80 studies have been published worldwide to examine the relationship between wind turbines and possible human health effects. Based on the findings and scientific merit of these studies they have led health and medical authorities to conclude that when sited properly (i.e., based on distance and/or noise guidelines and setbacks), wind turbines are not causally related to adverse effects.

This report serves to provide the scientific basis that allowing a different noise level at participating dwellings will still ensure the protection of their health and safety. The focus is on:

- Audible noise
- Low frequency noise and infrasound
- Annoyance

The past decade of rapid increase in wind power development in North America has been coupled with some who believe that wind turbines should be set miles back from residences, at very low noise levels, or else it will result in public health impacts. However, the weight of scientific evidence does not hold this to be true. The following section provides an overview of the most up to date peer-reviewed published evidence that provides the rationale that 50 dBA is protective of health, especially for participating landowners.

3.1 Peer-Reviewed Health Literature for Consideration

The Health Canada Wind Turbine Noise and Health Study – The Most Comprehensive Study 2012-2014

This study is the most comprehensive study of its kind to date and its results will be referenced a number of times in this report. The following provides a high-level overview of the study design. This study was initiated in 2012 and was a partnership between Health Canada and Statistics Canada to understand the potential impacts of wind turbine noise on health and wellbeing of communities in Southern Ontario and Prince Edward Island (PEI). A total of 1238 households participated in the study, with an almost 80% response rate of all households within 10 km (6 mi) of projects investigated, making it the largest and most comprehensive study ever undertaken around the world. Households were located as close as 250 m (820 ft) and out to 10 km (6 mi) from operational wind turbines. Their reported high response rate included 1238 randomly selected participants (606 males, 632 females) between the ages of 18-79 years old. In addition, the study included both self-reported and physical/objective measures of health in participants. The sound modeling conducted in relation to this study indicated wind turbine noise (WTN) as high as 46 dBA outside of people's homes. This does not mean that issues arise at levels of greater than 46 dBA, rather it is just the high end of sound that was predicted in this study. Note that modeling wind turbine noise is typically more conservative in the United States and would result in 46 dBA being modeled typically as 47-49 dBA at the exterior of the homes.

In 2014, Health Canada released a Summary of their findings on their website (Health Canada, 2014).

http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php

Health Canada chose to release the summary of their findings to make the information available to the scientific community and the public in a timely manner. Subsequently, they have released eight (8) peer-reviewed scientific publications with their results.

Health Canada's public brochure contains the following statement:

> *The Wind Turbine Noise and Health Study is a landmark study and the most comprehensive of its kind. Both the methodology used and the results are significant contributions to the global knowledge base and examples of innovative; leading edge research.*

At the time that Lancaster County was reviewing the amendments in 2015 only a summary of the Health Canada findings was available on their website. Since 2016, Health Canada has published a number of their findings in scientific peer-reviewed journals. This provides considerably more information than what was available in 2015. Scientific papers with the first author "Michaud" that are provided below are those resulting from the Health Canada study.

3.2 Sleep and Audible Sound (Noise)

The critical effect from a health perspective in setting any sound source standard is to ensure that it is protective of sleep. Quality of sleep and sleep perception can be challenging to establish causation through self-reported surveys alone.

In 2006, the Institute of Medicine of the National Academies released the book "*Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*" (IOM, 2006). At that time they reported that*: "It is estimated that 50 to 70 million Americans suffer from a chronic disorder of sleep and wakefulness, hindering daily functioning and adversely affecting health."* In 2006 the population of the United States was 298 million, resulting in an approximately 23% of Americans with sleep disorders. This needs to be considered within any review of the sleep literature with respect to wind turbines.

Michaud et al., 2016. Effects of Wind Turbine Noise on Self-Reported and Objective Measures of Sleep. Sleep, Vol. 39, No. 1 (Health Canada)

The journal Sleep is a highly respected scientific publication in this area of research. This is reflected in its five-year Impact Factor score of 5.8. The paper presents the peer-reviewed published findings of the Health Canada study (2014) of wind turbine noise on sleep. The sample size was the entire 1,238 participants from the overall study for self-reported sleep quality over 30 days using the Pittsburgh Sleep Quality Index (PSQI) and additional questions assessing the prevalence of diagnosed sleep disorders and the magnitude of sleep disturbance over the previous year. For the first time for wind turbine sound and objective measures for sleep latency, sleep efficiency, total sleep time, rate of awakening bouts, and wake duration after sleep were recorded using the wrist worn Actiwatch2® for 654 participants, over a total of 3,772 sleep nights.

It is the largest and most comprehensive of its kind ever undertaken for wind turbine noise.

Table 1 in Michaud et al. (2016), provides an overview of the self-reported sleep magnitude and contribution of disturbance. They reported, "*The prevalence of reported sleep disturbance was unrelated to wind turbine noise levels.*"

From the conclusions of the paper:

> *However, in the current study it was demonstrated that the factors that influence sleep quality (e.g. age, body mass index, caffeine, health conditions) were related to one or more self-reported and objective measures of sleep. This demonstrated sensitivity, together with the observation that there was consistency between multiple measures of self-reported sleep disturbance and among some of the self reported and actigraphy measures, lends strength to the robustness of the conclusion that WTN levels up to 46 dB(A) [at homes as close as 820 ft] had no statistically significant effect on any measure of sleep quality.*

This is a critical study given the breadth of the study, the number of participants and consistency with past credible, peer-reviewed studies on whether living in proximity to wind turbines impacts sleep.. In addition, this study did not distinguish between participating and non-participating landowners. Therefore, there was no affect on sleep whether one was participating or not.

The Health Canada findings are consistent with credible previously published peer-reviewed literature in the field. In addition, given the variability in how Health Canada conducted wind turbine noise modeling and standard practice in the United States, the equivalent level in the US would be ~48-49 dBA at the exterior of homes.

Bakker et al. 2012. Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress. Science of The Total Environment, Volume 425, 15 May 2012, Pages 42-51

The most compelling research into wind sound awakenings, prior to the Health Canada Study (2014), was conducted by Bakker et al. (2012). This research reported the number or percentage of awakenings with those non-participating residents living in proximity to wind turbines in a rural setting. This is because participating landowners did not report any sleep disturbance from living near wind turbines. Table 7 from the Bakker paper shows that more people in rural environments are awakened by people/animal sound and traffic/mechanical sounds, than by the proximate wind turbines. In this study, people living in close proximity to wind turbines reported being awoken more by people/animal noise (11.7%) and rural traffic/mechanical noise (12.5%), than by turbine noise (6.0%). Sound levels in this study were as high as 54 dBA.

Table 7
Sound sources of sleep disturbance in rural and urban area types, only respondents who did not benefit economically from wind turbines.

Sound source of sleep disturbance	Rural		Urban		Total	
	n	%	n	%	n	%
Not disturbed	196	69.8	288	64.9	484	66.8
Disturbed by people/ animals	33	11.7	64	14.4	97	13.4
Disturbed by traffic/ mechanical sounds	35	12.5	75	16.9	110	15.2
Disturbed by wind turbines	17	6.0	17	3.8	34	4.7
Total	281	100	444	100	725	100

The Health Canada study provides the following comment linking the two studies (Michaud et al., 2016):

> *"Study results [Health Canada] concur with those of Bakker et al. (2012), with outdoor WTN levels up to 54 dB(A), wherein it was concluded that there was no association between the levels of WTN and sleep disturbance when noise annoyance was taken into account".*

Again, the Bakker study was only for those non-participating landowners, given that participating landowners did not express concern about sleep disturbance at levels as high as 54 dBA at the exterior of their homes. So even at levels of >50 dBA people were less disturbed by wind turbine noise than other common rural sources of noise.

Jalali et al. 2016. Before–after field study of effects of wind turbine noise on polysomnographic sleep parameters. Noise Health; 18:194-205.

The first study to be published on before-after operation effect of wind turbine noise on objectively measured sleep was conducted in 16 participants living within 2 km to a five-wind turbine project in Ontario, Canada. For the first time authors used portable polysomnography (PSG), which is a comprehensive system that objectively monitors people's sleep in their homes.

The authors concluded:

> *The result of this study based on advanced sleep recording methodology together with extensive noise measurements in an ecologically valid setting cautiously suggests that there are no major changes in the sleep of participants who host new industrial WTs in their community.*

Note in this case 'participants' refer to the community as a whole and not only those being paid to host wind turbines. These findings are consistent with the previous reported studies that wind turbines did not disturb their sleep.

Conclusion on Wind Turbine Noise and Sleep

The recent published findings reveal that there is no association between exterior wind turbine sound levels and impact on sleep for residences as close as 820 ft and sound levels at 50 dBA. Therefore, allowing up to a maximum of 50 dBA at exterior of participating landowners dwellings is sufficient to protect residents and should not affect their sleep.

3.3 Low Frequency Noise (LFN) and Infrasound

Infrasound is a term used to describe sounds that are produced at frequencies too low to be heard by the human ear at frequencies of 0 to 20 Hz, at common everyday levels. It is typically measured and reported on the G-weighted scale (dBG). Low frequency noise (LFN), at frequencies between 20 to 200 Hz, can be audible. It is measured and reported on the C-weighted scale (dBC) to account for higher-level measurements and peak sound pressure levels. The A-weighted scale (dBA), covers the audible range 20 Hz to 20 kHz and is similar to the response of the human ear at lower levels.

Over the past couple of years some have speculated that wind turbine infrasound and LFN could potentially cause health impacts or sleep disturbance. The mere presence of measured LFN and infrasound does not indicate a potential threat to health or an inability for people to sleep. The fact that one can measure infrasound and LFN from wind turbines at either the exterior or interior of a home does mean that it is at a level that poses a potential health threat.

Although wind turbines are a source of LFN and infrasound during operation, these sound pressure levels are not unique to wind turbines. Common natural sources of infrasound and LFN and infrasound include ocean waves, thunder, and even the wind itself. Other sources include road traffic, refrigerators, air conditioners, machinery, and airplanes.

Berger, et al. 2014. Health-based Audible Noise Guidelines Account for Infrasound and Low Frequency Noise Produced by Wind Turbines" Frontiers in Public Health

Given the growing attention being paid to this issue, an international team of acousticians and health scientists published a peer-reviewed article to investigate whether typical audible noise-based guidelines (dBA) for wind turbines account for the protection of human health given the levels of infrasound and LFN typically produced by wind turbines. The analysis showed that indoor infrasound levels were below auditory threshold levels while LFN levels at generally accepted setback distances were similar to background LFN levels.

From the abstract of Berger et al., 2015:

> *Over-all, the available data from this and other studies suggest that health-based audible noise wind turbine siting guidelines provide an effective means to evaluate, monitor, and protect potential receptors from audible noise as well as Infrasound and Low Frequency Noise.*

Simply put, the 50 dBA noise level at participating dwelling will ensure that levels of LFN and infrasound will also not impact health.

Ministry for the Environment, Climate and Energy of the Federal State of Bade Wuerttemberg in Germany. 2016. Low-frequency noise including infrasound from wind turbines and other sources.

The objective of the research was to collect field measurement of infrasound and low-frequency noise around six different turbines by different manufacturers from 1.8 to 3.2 MW. Measurements were taken at 150 m (492 feet), 300 m (984 feet) and 700 m (2296 feet) from wind turbines.

Measurements of other common sources of infrasound and low frequency noise were also collected for comparative purposes.

Figure 1 (from MECE, 2016) provides detail on the range of infrasound and low frequency noise measured at 300 m (984 feet). It can be seen that the levels of infrasound from wind turbines were similar to that of just the wind in an open field, while there was a slight increase in low frequency sound. The levels were considerably lower than either being in the interior of a car, near roadside traffic or in a home with oil heating. All infrasound levels (< 20 Hz) were below the perception threshold and international standards.

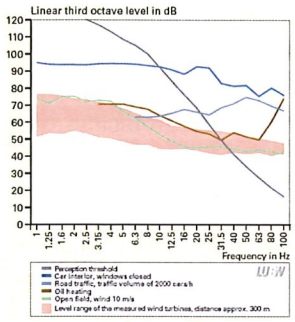


Figure 1. Measurements of infrasound and low frequency noise 300 m from wind turbines compared to other sources. [from MECE, 2016].

Overall, they concluded:

> *"Infrasound and low-frequency noise are an everyday part of our technical and natural environment. Compared with other technical and natural sources, the level of infrasound caused by wind turbines is low. Already at a distance of 150 m, it is well below the human limits of perception. Accordingly, it is even lower at the usual distances from residential areas. Effects on health caused by infrasound below the perception thresholds have not been scientifically proven. Together with the health authorities, we in Baden-Württemberg have come to the conclusion that adverse effects relating to infrasound from wind turbines cannot be expected on the basis of the evidence at hand.*
>
> *The measurement results of wind turbines also show no acoustic abnormalities for the frequency range of audible sound. Wind turbines can thus be assessed like other installations according to the specifications of the TA Lärm (noise prevention regulations).*
>
> *It can be concluded that, given the respective compliance with legal and professional technical requirements for planning and approval, harmful effects of noise from wind turbines cannot be deduced."*

Conclusion on Low Frequency Noise and Infrasound

Wind turbine sound standards are set using audible dBA levels and approved based on modeling. The levels of low frequency noise or infrasound from wind turbines are quite simply too low to cause health effects. Therefore, Lancaster County allowing an audible sound level at 50 dBA at participating landowners dwellings will ensure that infrasound and low frequency noise also do not pose a health threat.

3.4 Other Potential Health Concerns Living in Proximity to Wind Turbines

Much of the peer-reviewed literature on living in proximity to wind turbines has been focused on sleep and annoyance. This section is focused on the literature investigating both self-reported and physical measures of health for those living around wind turbines. Given that the extensive

nature of the literature it is not possible to summarize it all in this document. Rather, preference has been given to key references and those most recent or extensive.

There are numerous peer-reviewed studies that have explicitly examined the relationship between levels of wind turbine noise and various self-reported indicators of human health and well-being (e.g., Health Canada 2014 and associated publications; Bakker et al. 2012; Janssen et al. 2011; Pedersen 2011; Pedersen and Persson Waye 2004; 2007). These studies have researched a wide range of wind turbine models, manufacturers, heights and noise levels. They were conducted over several years, in some cases over 10 years, after wind turbines became operational.

It is important to understand that from a health perspective it is not the height of the turbines, or the noise output at their hub, that is the important. Rather, it is the resulting sound level at people's homes that is critical to ensure the protection of public health. Simply put, whether a developer selects a 500-foot wind turbine, or smaller model, the requirement to meet the 50 dB sound level at participating landowner homes would remain the same.

In general, peer reviewed studies do not support a correlation between wind turbine noise exposure and any other response other than some annoyance (McCunney et al., 2014). For example, various studies based on the results of two surveys performed in Sweden and one in the Netherlands (1755 respondents overall), found that no measured variable (e.g., self-reported evaluations of high blood pressure, cardiovascular disease, tinnitus, headache, sleep interruption, diabetes, tiredness, and reports of feeling tense, stressed, or irritable) other than annoyance was directly related to wind turbine noise for all three datasets (Pedersen, 2011).

Michaud et al. 2016a. Exposure to wind turbine noise: Perceptual responses and reported health effects. (Health Canada)

This paper provides the results of Health Canada's investigation into perceptual responses (annoyance and quality of life) and those of self-reported health effects by participants. Only the self-reported health effects results are discussed here. Health Canada developed a final questionnaire (Michaud, 2013) that consistent of socio-demographics, modules on community noise and annoyance, self-reported health effects, lifestyle behaviours, and prevalent chronic illness.

Health Canada reported that:

> *"The results from the current study did not show any statistically significant increase in the self-reported prevalence of chronic pain, asthma, arthritis, high blood pressure, bronchitis, emphysema, chronic obstructive pulmonary disease (COPD), diabetes, heart disease, migraines/headaches, dizziness, or tinnitus in relation to WTN exposure up to 46 dBA [at homes as close as 820 ft]. In other words, individuals with these conditions were equally distributed among WTN exposure categories."*

This resulted in the overall conclusion of the paper that:

> *"Beyond annoyance, results do not support an association between exposure to WTN up to 46 dBA [at homes as close as 820 ft] and the evaluated health-related endpoints."*

Michaud et al. 2016c. Self-reported and measured stress related responses associated with exposure to wind turbine noise (Health Canada)

This is the only study reported in the literature that in addition to collecting self-reported measures of stress, includes biophysical and chemical objective measurements of health associated with living in proximity to wind turbines. Of the 1238 study participants 1077 (87%) agreed to have blood pressure measurements, 917 of 1043 (87.9%) participants with hair consented to sampling for cortisol analysis and all completed questionnaires.

In the Concluding Remarks the authors report:

> *The results provide no evidence that self-reported or objectively measured stress reactions are significantly influenced by exposure to increasing levels of WTN up to 46 dB [at homes as close as 820 ft]. There is an added level of confidence in the findings as this is the first study to date to investigate the potential stress impacts associated with WTN exposure using a combination of self-reported and objectively measured endpoints.*

Therefore, wind turbine noise annoyance should not be considered a health impact and the level of annoyance falls within levels that we accept in our daily lives.

Conclusions on Other Potential Health Effects of Living Near Wind Turbines

The Health Canada study clearly demonstrated that there were no measurable changes in either people's perceived health status or that of the objective measures of health and the distance and sound level that they experience from wind turbines. This is consistent with the credible peer-reviewed scientific studies published to date.

3.5 Annoyance from Living in Proximity to Wind Turbines

The reported correlation between wind turbine noise and annoyance is not unexpected. Noise-related annoyance has been extensively linked to a variety of common noise sources such as rail, road, and air traffic (Berglund and Lindvall 1995; Laszlo et al. 2012; WHO Europe 2011).

Dr. Robert McCunney of Massachusetts Institute of Technology (MIT) and colleagues concluded the following on annoyance in their 2014 review paper:

> *Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.*

This finding is supported by numerous papers published in the field that indicate that the reported annoyance levels of those living in proximity to wind turbines is more related to the subjective factors of visual cue, economic benefit and attitude towards the project.

Much of the annoyance literature is focused on those non-participating residents living in proximity to wind turbines. However, there are a number of studies that support the notion that participating landowners that are paid to host wind turbines on their properties do not find the sound or the visual aspects of wind turbines annoying.

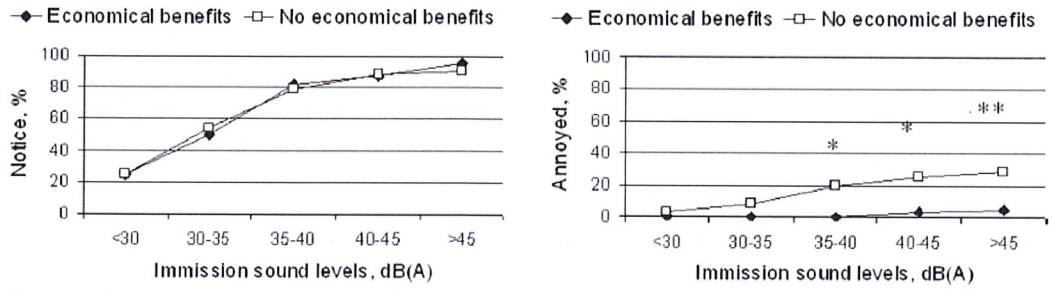
The following provides some examples that demonstrate that participating landowners do not report annoyance with living often much closer to wind turbines than non-participating neighbors.

Pederson et al. 2009. Response to noise from modern wind farms in The Netherlands. J. Acoust. Soc. Am., Vol. 126, No. 2, August 2009

Pederson and her colleagues provided some of the earliest evidence that participating landowners do not report annoyance with having the turbines, including sound levels as high as 50 dBA at their homes. The authors state:

As was expected, people benefiting economically from a noise source are less likely to be annoyed by it, though to the best of the authors' knowledge this has not previously been demonstrated as clearly as in this study.

This is clearly demonstrated in the graphs below. Those that economically benefit (participating landowners) notice the sound from wind turbines in the same way their non-participating neighbors do (Graph A). However, they report little to no annoyance at all from the noise, even at levels of >45 dBA.



A B

Bakker et al. 2012. Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress. Science of The Total Environment, Volume 425, 15 May 2012, Pages 42-51

Table 3 and 4 of the Bakker (2012) study that shows the clear difference between annoyance levels between participating and non-participating landowners. Although a very small percentage of participating landowners (1%) were very annoyed with outdoor noise levels, none (0%) were either rather or very annoyed with sound in the interior of their home. Again this is consistent with the evidence that participating landowners living in close proximity are also not experiencing sleep issues.

Table 3
Response to outdoor wind turbine sound among economically benefitting and non-benefitting respondents.

	Response											
	Do not notice		Notice, not annoyed		Slightly annoyed		Rather annoyed		Very annoyed		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
No economical benefit	255	44	184	31	78	13	41	7	28	5	586	100
Economical benefit	15	15	68	69	13	13	2	2	1	1	99	100

Table 4
Response to indoor wind turbine sound among economically benefitting and non-benefitting respondents.

	Response											
	Do not notice		Notice, not annoyed		Slightly annoyed		Rather annoyed		Very annoyed		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
No economical benefit	394	68	98	17	46	8	21	4	20	4	579	100
Economical benefit	53	54	39	39	7	7	0	0	0	0	99	100

Michaud et al. 2016b. Personal and situational variables associated with wind turbine noise annoyance. (Health Canada)

This paper is a continuance of the work reported in Michaud et al. (2016a). They found that similar to previous studies wind turbine annoyance is not based solely on sound levels but that

there are numerous visual and social factors that contribute to reported annoyance levels in relation to living in proximity to wind turbines.

They concluded (Michaud et al., 2016b):

> *"Variables associated with WTN annoyance included, but were not limited to, other wind turbine-related annoyances, personal benefit, noise sensitivity, physical safety concerns, property ownership, and province."*

Overall, annoyance levels associated with wind turbine sound are low and consistent with other levels of noise related annoyance. Regardless of the presence of some annoyance, the previous Health Canada research (Michaud et al. 2016a), demonstrated there was no association between self-reported health conditions and sound levels. It also demonstrates that "personal benefit" or participating landowners results in decreased annoyance with wind turbine noise.

Summary of Annoyance and Participating Landowners

Participating landowners that are paid to host wind turbines on their properties have not reported undue annoyance with the sound levels being requested by NEER of 50 dBA. The economic benefit and desire to participate in the project commonly results in a positive attitude towards hosting the turbines and the sound they make.

4 Conclusions

In summary, over the past decade there has been considerable research conducted around the world evaluating health concerns of those living in proximity to wind turbines. This independent research by university professors, consultants and government medical agencies has taken place in many different countries on a variety of models of turbines that have been in communities for numerous years. Based on scientific principles, and the collective findings of over 80 scientific articles, there is scientific justification to allow CWECS project participating landowners to have a noise limit of fifty (50) dBA maximum 10 minute Leq level at the exterior wall of their dwellings.

This limit will enable proper siting of wind turbines on participating land while still ensuring the protection of public health, safety and welfare of participating residents.

Sincerely,

OLLSON ENVIRONMENTAL HEALTH MANAGEMENT

Christopher Ollson, PhD
Senior Environmental Health Scientist

References

Bakker RH, Pedersen E, van den Berg GP, Stewart RE, Lok W, Bouma J. Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress. *Sci Total Environ* (2012) **425**:42–51.

Berger R.G., Ashtiani P., **Ollson C.A.**, Whitfield Aslund M., McCallum L.C., Leventhall G., Knopper L.D. 2015. *Health-based audible noise guidelines account for infrasound and low frequency noise produced by Wind Turbines.* Front Public Health. Vol 3, Art. 31

Berglund B, Lindvall T. (Eds.) *Community Noise*. Center for Sensory Research, Stockholm University and Karolinska Institute (1995).

Gage County Zoning Regulations Article 6.6 Section 6.70

Health Canada. Wind Turbine Noise and Health. The Government of Canada. 2014. Available online: http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php

Institute of Medicine (IOM). 2006. *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*

Jalali et al. 2016. Before–after field study of effects of wind turbine noise on polysomnographic sleep parameters. Noise Health; 18:194-205.

Janssen SA, Vos H, Pedersen E. A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources. *J Acoust Soc Am* (2011) **130**:3746-53.

Knopper, L.D., **Ollson, C.A.,** McCallum, L.C., Aslund, M.L., Berger, R.G, Souweine, K., and McDaniel, M. 2014. *Wind turbines and Human Health*. Front. Public Health, Vol. 2, Art. 63

Knopper, L.D. and **Ollson, C.A.** 2011. *Health Effects and Wind Turbines: A Review of the Literature.* Environmental Health. 10:78. Open Access. Highly Accessed.

Lancaster County 1979 Zoning Resolution Section 13.048

Laszlo HE, McRobie ES, Stansfeld SA, Hansell AL. Annoyance and other reaction measures to changes in noise exposure - A review. *Sci Total Environ* (2012) **435**:551-562.

McCallum, L.C., Whitfield Aslund, M.L., Knopper, L.D., Ferguson, G.L., **Ollson, C.A.** 2014. *Measuring electromagnetic fields (EMF) around wind turbines in Canada: is there a human health concern?* Environmental Health 13(9), doi:10.1186/1476-069X-13-9.

McCunney, R.J., Mundt, K.A., Colby, D., Dobie, R., Kaliski, K., Blais, M. 2014. Wind Turbines and Health A Critical Review of the Scientific Literature. JOEM Volume 56, Number 11

Michaud DS, Feder K, Keith SE, Voicescu SA, Marro L, Than J, Guay M, Denning A, Murray BJ, Weiss SK, Villeneuve PJ, van den Berg F, Bower T. 2016. Effects of Wind Turbine Noise on Self-Reported and Objective Measures of Sleep. Sleep. 2016 Jan 1;39(1):97-109. doi: 10.5665/sleep.5326.

Michaud DS, Feder K, Keith SE, Voicescu SA, Marro L, Than J, Guay M, Denning A, McGuire D, Bower T, Lavigne E, Murray BJ, Weiss SK, van den Berg F. 2016a. Exposure to wind turbine noise: Perceptual responses and reported health effects. J Acoust Soc Am. 2016 Mar;139(3):1443-54.

Michaud DS, Keith SE, Feder K, Voicescu SA, Marro L, Than J, Guay M, Bower T, Denning A, Lavigne E, Whelan C, Janssen SA, Leroux T, van den Berg F. 2016b. Personal and situational variables associated with wind turbine noise annoyance. J Acoust Soc Am. 2016 Mar;139(3):1455-66.

Michaud DS, Feder K, Keith SE, Voicescu SA, Marro L, Than J, Guay M, Denning A, Bower T, Villeneuve PJ, Russell E, Koren G, van den Berg F. 2016c. Self-reported and measured stress related responses associated with exposure to wind turbine noise. J Acoust Soc Am. 2016 Mar;139(3):1467-79.

Michaud DS, Keith SE, McMurchy D. Noise annoyance in Canada. *Noise Health* (2005) **7**:39-47.

Ministry for the Environment, Climate and Energy of the Federal State of Bade Wuerttemberg in Germany. 2016. Low-frequency noise including infrasound from wind turbines and other sources.

Ollson, C.A., Knopper L.D. McCallum, L.C., Aslund-Whitfield, M.L. 2013. *Are the findings of 'Effects of industrial wind turbine noise on sleep and health' supported?* Noise & Health 15:63, 148-150.

Oregon Administrative Rule 340-035-0035 Noise Control Regulations for Industry and Commerce

Pedersen E. 2009. Health aspects associated with wind turbine noise-Results from three field studies. *Noise Control Eng J* (2011) **59**:47-53.

Pedersen E, Persson Waye K. Perception and annoyance due to wind turbine noise – a dose–response relationship. *J Acoust Soc Am* (2004) **116**:3460-70.

Pedersen E, Persson Waye K. Wind turbine noise, annoyance and self-reported health and well-being in different living environments. *Occup Environ Med* (2007) **64**:480-6.

Webster County Zoning Regulations Section 609.E.G.3

Whitfield Aslund, M.L., **Ollson, C.A.,** Knopper, L.D. 2013. *Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada.* Energy Policy. 62, 44-50

WHO (World Health Organization), Regional Office for Europe. *Burden of disease from environmental noise: Quantification of healthy life years lost in Europe*. WHO Regional Office for Europe, Copenhagen, Denmark (2011).

OLLSON
Environmental Health Management

CHRISTOPHER OLLSON, PH.D., QP_{RA}

Owner and
Senior Environmental Health Scientist

37 Hepworth Cres
Ancaster, Ontario
Canada, L9K 0C4
(416) 456-1388
Christopher.ollson@gmail.com

Dr. Ollson is Owner and Senior Environmental Health Scientist at Ollson Environmental Health Management (OEHM). He has 20 years of international consulting experience in environmental health sciences and toxicology. Dr. Ollson has worked across the United States and is well versed in Federal and State environmental legislation. His Canadian experience spans from coast-to-coast-to-coast, having worked in all Provinces and Territories. Throughout his career, Chris has led some of North America's most high profile and controversial multi-disciplinary environmental health assessments.

Dr. Ollson is considered an expert in environmental health issues related to the energy sector. He has led risk assessments and provided risk communication support for wind turbine, solar, hydroelectric, energy-from-waste / waste-to-energy facilities, wind turbine projects, natural gas fired stations, oil sands environmental assessments, refineries, pipelines, and coal power plants. Dr. Ollson has conducted extensive research in potential health and environmental issues surrounding wind turbine facilities and has published numerous peer-reviewed articles and government white papers on the topic.

Chris has spent countless hours in community and stakeholder consultation on behalf of clients. Through proper risk communication they became part of the decision-making process on issues surrounding atmospheric, soil and water contaminant issues. Specific to the wind and solar sector Dr. Ollson has spent 1000s of hours in public consultation, stakeholder engagement, meetings with public health staff and local councils.

Dr. Ollson has testified at more than a dozen environmental review tribunals, commissions, hearings and court proceedings with respect to potential health concerns in living in proximity to wind turbines. With six peer-reviewed scientific journal articles, numerous invited conference presentations and invited university lectures he is considered one of the foremost experts in North America on renewable energy health issues. In recognition of these accomplishments he was the co-recipient of the 2015 Canadian Wind Energy Association R.J. Templin Award. The R.J. Templin Award recognizes an individual or organization that has undertaken scientific, technical, engineering or policy research and development work that has produced results that have served to significantly advance the wind energy industry in Canada.

In addition to his consulting practice, Dr. Ollson maintains an active research program through his Adjunct Assistant Professor appointment at the University of Toronto Scarborough. He teaches graduate level courses in Environmental Risk Assessment and has co-supervised a number of graduate students and Post-Doctoral Fellows. Dr. Ollson's primary research interests are in potential health issues related to the renewable energy sector, waste-to-energy sector and the emerging field of Health Impact Assessment of major projects.

EDUCATION

2003	Ph.D., Environmental Science (Specialization in Risk Assessment), Royal Military College of Canada
2000	M.Sc., Environmental Science, Royal Military College of Canada
1995	B.Sc., (Honours), Biology, Queen's University.
QP_{RA}	Qualified Person for Risk Assessment as defined by the Environmental Protection Act of Ontario (Brownfields Legislation)

AREAS OF SCIENTIFIC EXPERTISE

- Health Impact Assessment
- Environmental Health
- Air Quality Assessment
- Human Health Risk Assessment
- Major Infrastructure Health Assessment
- Energy Sector

EMPLOYMENT HISTORY

2015 – Present	**Ollson Environmental Health Management** Senior Environmental Health Scientist
2011-2015	Intrinsik Environmental Sciences Inc. Mississauga, Ontario Vice President, Strategic Development Senior Environmental Health Scientist
2002 – 2011	Stantec Consulting Ltd (formerly Jacques Whitford Limited) Practice Leader, Environmental Health Sciences
1997 - 2002	Royal Military College of Canada, Environmental Sciences Group (ESG) Senior Environmental Scientist / Risk Assessor
1990 – 2002	Naval Reserves, Department of National Defence Maritime Surface (MARS) Officer, Lt(N) Ret'd

PROFESSIONAL AFFILIATIONS

- Full Member of the International Association for Impact Assessment (IAIA)
- Full Member of the Society of Practitioners of Health Impact Assessment (SOPHIA)

ACADEMIC EXPERIENCE

2013 – PRESENT **University of Toronto Scarborough, Department of Physical and Environmental Sciences**
Adjunct Professor

2011 – PRESENT
University of Toronto, School of the Environment
Graduate Course Lecturer

2013 - 2016
University of Toronto Scarborough, Member Campus Governing Council, Vice-Chair of the Academic Affairs Committee

2009-2011 **University of Toronto, Scarborough**
Adjunct Lecturer, Physical & Environmental Sciences,

2004 - PRESENT **Royal Military College of Canada**
Adjunct Assistant Professor

AWARDS

Co-recipient of the 2015 Canadian Wind Energy Association R.J. Templin Award. *First awarded in 1985, the R.J. Templin Award recognizes an individual or organization that has undertaken scientific, technical, engineering or policy research and development work that has produced results that have served to significantly advance the wind energy industry in Canada.*

Wind Turbine Peer Reviewed Scientific Publications

Primary Research

Berger, R.G., Ashtiani, P., **Ollson, C.A.**, Whitfield Aslund, M. McCallum, L.C., Leventhall, G. and Knopper, L.D. 2015 Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines. Front. Public Health 3:31. Citations: 8

McCallum, L., Whitfield Aslund, M., Knopper, L.D., Ferguson, G.M. and **Ollson, C.A.** 2014. An investigation of wind energy and health: quantifying electromagnetic fields around wind turbines in Canada. *Environmental Health* 2014, **13**:9. Citations: 7

Whitfield Aslund, M.L., **Ollson, C.A.,** Knopper, L.D. 2013. Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada. Energy Policy 62, 44-50. Citations: 4

Systematic Literature Reviews

Knopper, L.D., **Ollson, C.A**., McCallum, L.C., Aslund, M.L., Berger, R.G, Souweine, K., and McDaniel, M. 2014. Wind turbines and Human Health. Front. Public Health, 19 June 2014. Citations: 22

Knopper, L.D. and **Ollson, C.A.** 2011. Health Effects and Wind Turbines: A Review of the Literature. Environmental Health. 10:78. Open Access. Highly Accessed. Citations: 86

Published Critique

Ollson, C.A., Knopper L.D. McCallum, L.C., Aslund-Whitfield, M.L. 2013. Are the findings of 'Effects of industrial wind turbine noise on sleep and health' supported? Noise & Health 15:63, 148-150. Citations: 5

Hearings, Tribunals and Court Proceedings on Wind Turbines and Associated Transmission Lines

In the following proceedings I testified and formally qualified as an expert in wind turbines and human health

Ontario Environmental Review Tribunals – Appeal of Company Renewable Energy Approvals

Erickson v. MOE 2011	Suncor
Monture v. MOE [GREP] 2012;	Samsung
Moseley v. MOE 2014;	Capstone
Lambton County v. MOE 2015	Suncor
EOCA v MOE 2015	ProWind

Queen's Bench of Saskatchewan in McKinnon v. Martin (2010 – also referred to as the Red Lily case)

Alberta Utilities Commission (AUC) Proceeding No. 22563, Halkirk 2 Wind Project (November 2017)

Alberta Utilities Commission (AUC) Proceeding No. 3329, Grizzly Bear Creek Wind Project (March 2016)

Alberta Utilities Commission (AUC) Proceeding No. 1955, Bull Creek Wind Project (October 2013)

North Dakota Public Services Commission 2015

Brady Wind Energy Center	NextEra
Brady II Wind Energy Center	NextEra
Oliver III Wind Energy Center	NextEra

Clinton County Planning and Zoning Commission, MO, County Ordinance Changes (2016)

Chowan County and Perquimins County Board of Commissioners hearings for the Timbermill Wind Project (2016)

Court Proceedings Unrelated to Wind Turbine Projects

John Chart vs. Town of Parma. W.D.N.Y Civil Action No. 6:10-CV-06179, Deposed 2013.

Lockridge and Plain v. Ministry of the Environment and Suncor Energy Products Ltd., 528/10, Ontario Superior Court of Justice, Deposed 2012

Appearances before Government Bodies

North Dakota State Senate and Representative Natural Resources Committee. Study on Wind Energy Conversion Facilities. December 2017.

Indiana State Senate Energy Committee Meeting on Wind Turbine Siting. October 2017.

North Dakota State Senate Energy and Natural Resources Committee. Senate Bill 2313. Exclusion Areas for Wind Energy Conversion Facilities. February 2017.

Vermont Public Services Board. Proposed Rule on Sound from Wind Generation Facilities. December 2016.

Example Appearances before US County Planning & Zoning Commissions and County Boards

Redfield Town Board, New York, Mad River Wind Farm, 2017

Parshville Town Board, New York, North Ridge Wind Farm, 2017

Grant and Dickinson County Planning and Zoning Commissions, Iowa, Upland Prairie Wind Farm, 2017

Codington and Grant County Planning Commissions, Dakota Range Wind, South Dakota, 2017

Deuel County Zoning Board, South Dakota, Crown Ridge Wind Project, 2017

Rush County Board of Zoning Appeals, Indiana, West Forks Wind Project, 2016

Hettinger County Planning and Zoning Commission and County Commission, North Dakota, Brady II Wind Energy Center, 2016

Kingman County Planning and Zoning Commission, Kansas, Kingman Wind Energy Center, 2016

Pratt County Planning and Zoning Commission, Kansas, Ninnescah Wind Energy Center, 2016

Stark County Planning and Zoning Commission and County Commission, North Dakota, Dickinson Wind Energy Center, 2015, 2016

Stark County Planning and Zoning Commission and County Commission, North Dakota, Brady Wind Energy Center, 2015, 2016

Colfax Township Board, Dekalb County, Missouri, Osborn Wind Energy Center, 2016

WashingtonTownship Planning Board, Dekalb County, Missouri, Osborn Wind Energy Center, 2016

Niagara County Board of Health, New York, Lightstation Wind Energy Center, 2015

El Paso Planning Commission and County Commission, Colorado, Golden West Energy Center, 2015

Stony Creek Town Commission, New York, Proposed InvEnergy project, working for the Town Commission, 2011

Wind Project Developers- Worked as Project Health Consultant of Record (Alphabetical)

- APEX, Algonquin Power, Avangrid, BluEarth, Boralex, Capital Power, Capstone, EDF, EDPR, InvEnergy, Longyung Power, NextERA, Niagara Region Wind Corporation, Northland Power, Pattern Energy, Prowind, RES, Samsung, South Canoe Wind, Sprott, Suncor, Veresen, Vermont Public Services Department, WPD

Wind Turbine Conference Proceedings

Whitfield Aslund, M.L., Berger, R.G.; Ashtiani, P.; **Ollson, C.A**.; McCallum L.C.; Leventhall, G.; Knopper, L.D. 2015. Health-based audible noise guidelines account for infrasound and low frequency noise produced by wind turbines. *Proceedings of the 6th International Conference on Wind Turbine Noise, April 2015, Glasgow, Scotland.*

Whitfield Aslund, M.L., Ollson, C.A., Knopper, L.D. 2013. 'Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada', submitted for publication in *Proceedings of the 5th International Conference on Wind Turbine Noise, Denver Colorado 28-30 August 2013*

Knopper, L.D., Whitfield Aslund, M.L., McCallum, L.C., Ollson, C.A. 2013. 'Wind turbine noise: What has the Science Told Us?', submitted for publication in *Proceedings of the 5th International Conference on Wind Turbine Noise, Denver Colorado 28-30 August 2013*

Conference Presentations on Wind Turbines and Health

Ollson, C.A., 2015. Effective Communication Strategies for Addressing Health Concerns. CanWEA annual conference.

Ollson, C.A. 2014. Responding to Health Concerns. CanWEA annual conference.

Ollson, C.A. 2014 Wind Turbines – Do They Cause Health Impacts? CPANs Air & Waste Management Association. Edmonton, Alberta

Ollson, C.A., McCallum, L.C., Whitfield Aslund, M.L., Knopper, L.D. 2014. Social Licence to Operate – Lessons From Canadian Wind Industry. International Association of Impact Assessment (IAIA) International Conference 2014. Chile.

Whitfield Aslund, M.L., **Ollson, C.A.,** Knopper, L.D. 2013. 'Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada', Wind Turbine Noise 2013, Denver, August 2013.

Ollson, C.A. ; Knopper, L.D., Whitfield Aslund, M.L., McCallum, L.C., 2013. 'Wind turbine noise: What has the Science Told Us?', Wind Turbine Noise 2013, Denver, August 2013.

Ollson, C.A., 2013 Health Effects and Renewable Energy: An Overview of the Issues. Association of Power Producers of Ontario Toronto, 2013

Ollson, C.A. and Knopper, L.D. Health Effects and Wind Turbines: A Review of the Issues. CANWEA Communications Summit , Vancouver, October, 2011

Additional Peer-Reviewed Scientific Publications

McCallum, LC, **Ollson, CA**, Stefanovic, IL. 2017. An adaptable Health Impact Assessment (HIA) framework for assessing health within Environmental Assessment (EA): Canadian Context, International Application. Impact Assessment and Project Appraisal. In Press.

McCallum, LC, **Ollson, CA**, Stefanovic, IL. 2016. Prioritizing Health: A Systematic Approach to Scoping Determinants in Health Impact Assessment. Frontiers in Public Health. Aug 22;4:170

McCallum, LC, **Ollson, CA**, Stefanovic, IL. 2016. Development of a Health Impact Assessment Screening Tool: A Value Versus Investment Approach. Journal of Environmental Assessment Policy and Management Vol. 18, No. 2

McAuley, C., Dersch, A., Kates, L. N., Sowan, D. R. and **Ollson, C. A.** 2016. Improving Risk Assessment Calculations for Traditional Foods Through Collaborative Research with First Nations Communities. Risk Analysis. Dec; 36(12):2195-2207

McAuley, C., Dersch, A., Kates, L. N., Sowan, D. R., Koppe, R and **Ollson, C. A.** 2016. Assessment of Exposure to Chlorinated Organics through the Ingestion of Moose Meat for a Canadian First Nation Community. Frontiers in Environmental Science. November 2016: Vol 4: Article 78

McCallum LC, Souweine K, McDaniel M, Koppe B, McFarland C, Butler K**, Ollson CA**. Health Impact Assessment of an oil drilling project in California. Int J Occup Med Environ Health. 2016;29(2):229-53.

McCallum, L.C., **Ollson, C.A.** and Stefanovic I.L. 2015. Advancing the practice of health impact assessment in Canada: obstacles and opportunities. Environmental Impact Assessment Review. Volume 55, November 2015, Pages 98–109

Ollson, C.A., Knopper, L.D., Whitfield Aslund, M., Jayasinghe, R. 2014. Site specific risk assessment of an energy-from-waste thermal treatment facility in Durham Region, Ontario, Canada. Part A: Human health risk assessment. Science of the Total Environment 466-467: 345-356.

Ollson, C.A., Knopper, L.D., Whitfield Aslund, M., Dan, T. 2014. Site specific risk assessment of an energy-from-waste/ thermal treatment facility in Durham Region, Ontario, Canada. Part B: Ecological risk assessment. Science of the Total Environment 466-467: 242-252.

Johnson KE, Knopper LD, Schneider DC, **Ollson CA**, Reimer KJ. 2009. Effects of local point source polychlorinated biphenyl (PCB) contamination on bone mineral density in deer mice (Peromyscus maniculatus). Sci Total Environ. 2009 Sep 1; 407(18):5050-5. Epub 2009 Jul 5

Ollson, C.A., Koch, I., Smith, P.; Knopper, L.D., Hough, C., Reimer, K, J. 2009. Addressing arsenic bioaccessibility in ecological risk assessment: A novel approach to avoid overestimating risk. Environmental Toxicology and Chemistry 28(3): 668-675.

Knopper, L.D., Smith, G.K., **Ollson, C.A.**, Stephenson, M. 2009. Use of Body Mass Scaling of Dose in Ecological Risk Assessments In Ecotoxicological Research Developments. Nova Publishers, pp. 23-29.

Gregor, D., Stow, J., Kennedy, D., Reimer, K., **Ollson, C**. 2003. Local Sources of Contaminants in the

Canadian Arctic. Canadian Arctic Contaminants Assessment Report /I(CACAR /I) Physical Environment 157-183

Reimer, K.J., **Ollson, C.A**., Koch, I. 2002. An Approach for Characterizing Arsenic Sources and Risks at Contaminated Sites: The Consequences of 60 Years of Gold Mining in Yellowknife, NWT, Canada. 2003. Metals in the Environment. American Chemical Society.

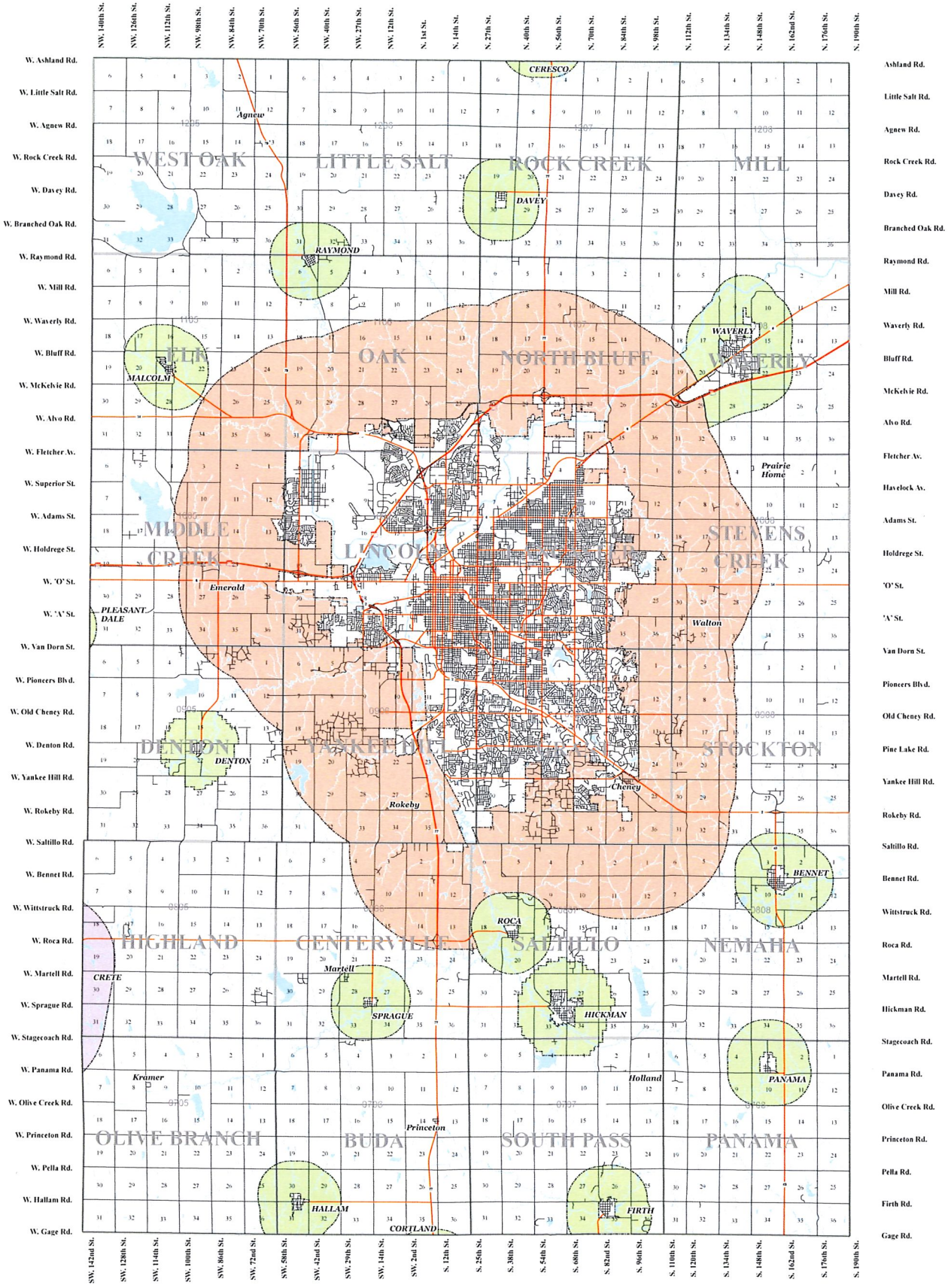
Koch, I., Hough, C., Mousseau, S., Mir, K., Rutter, A., **Ollson, C.,** Lee, E., Andrewes, P., Granhchino, S,, Cullen, B., Reimer, K. 2002. Canadian Journal of Analytical Sciences And Spectroscopy 47(4):109-118.

Koch, I., **Ollson, C.A**., Potten, J., and Reimer, K.J. 2002. Arsenic in Vegetables: An Evaluation of Risk from the Consumption of Produce from Residential and Mine Gardens in Yellowknife, Northwest Territories, Canada. I. in Annual Reviews in Food and Nutrition: Toxic and Pathological Aspects, Taylor & Francis, London.

Koch, I., Wang, L., **Ollson, C.A.,** Cullen, W.R., Reimer, K. J. 2000. The Predominance of Inorganic Arsenic Species in Plants from Yellowknife, Northwest Territories, Canada. Environmental Science and Technology 34:22 26.

Ollson, C. A. 2003. Arsenic Risk Assessments: The Importance of Bioavailability. PhD Thesis, Royal Military College of Canada.

Ollson, C. A. 1999. Arsenic Contamination of the Terrestrial and Freshwater Environment Impacted by Gold Mining Operations, Yellowknife, NWT. M,Sc, Thesis, Royal Military College of Canada.



ZONING JURISDICTIONS IN LANCASTER COUNTY

One Mile Jurisdiction of Incorporated Villages

Two Mile Jurisdiction of Crete

Three Mile Jurisdiction of Lincoln

Lancaster County Jurisdiction

0 0.5 1 2 3 Miles

LINCOLN-LANCASTER COUNTY PLANNING DEPARTMENT

f:\lts\gis\plots\mxds\ZoningJurisdictionsInLancasterCounty.mxd

December 19, 2017