

WIND TURBINE SITING IN MINNESOTA



10/19/2017

A Report for the Legislative Energy Commission

- Many Minnesotans report sleep deprivation, migraine headache, vertigo and ringing in the ears after large wind turbines are installed near their homes. Some have left their homes.
- MN Department of Health identified low frequency noise as the most likely cause and confirms that the health of some Minnesotans is being harmed by wind turbines.
- Setback distance between a turbine and a home is based on wind turbine noise. State agencies concur that they understand so little about wind turbine noise they cannot even enter into rulemaking on wind turbine noise.
- Minnesotans who are harmed have no recourse.
- European countries more experienced with wind turbines than Minnesota have setbacks that are 10 times the height of the turbine to the blade tip at its highest point (5000 feet for large modern wind turbines).

Wind Turbine Siting in Minnesota

A REPORT FOR THE LEGISLATIVE ENERGY COMMISSION

Wind Turbine Installations in Minnesota – Background

Earlier commercial wind turbines were installed in the 1990s in SW Minnesota in an area referred to as the “Buffalo Ridge.” The average number of homes per section (one square mile) ranges from zero to two in most of this part of Minnesota. These turbines were mostly .5 MW to .75 MW total capacity. The permits were evaluated and issued by the Minnesota Environmental Quality Board (EQB). The contents and requirements for those permits were developed by EQB staff in consultation with the wind industry as to what the industry believed were best practices. One of the major early wind developers upon whom EQB staff relied was Enron.

When the 2007 legislature passed Minnesota’s 25 X 25 renewable energy standard, they also moved the wind site permitting process to the Department of Commerce and the Public Utilities Commission (PUC) which are connected by statute. EQB staff responsible for the earlier collaboration with the wind industry in the 1990s was transferred to work in the Department of Commerce in what is now referred to as “Energy Environmental Review and Analysis” (EERA). The head of EERA is appointed by the Commissioner of Commerce. The Commissioners of the PUC are appointed by the Governor.

Minnesota’s renewable energy standard, also called a “renewable portfolio standard”, mandates 25% renewable electricity “retail sales” by the year 2025. Wind is specifically

mandated for most of the 25%. The goals are considered to have been reached by utilities acquiring and turning in “Renewable Energy Credits” (RECs) to the Midwest Renewable Energy Trading System. RECS can be bought, sold, banked, and traded.

Minnesota law exempts wind from almost all laws governing electrical generators. These exemptions include State Constitutional limitations on the maximum lease length allowed for production agricultural land and statutes governing consumer need, cost/rates, minimum number of megawatts (MW) produced per acre and control of agricultural production lands by foreign corporations.

Bill Grant is Deputy Commissioner of Commerce and head of the EERA staff that assist wind developers with their certificate of need and siting applications. Mr. Grant was previously the head of Izaak Walton League and helped design the State’s 2007 renewable energy mandate. When asked why wind is exempt from the law, Mr. Grant stated that the design goal was to install as much wind as possible as quickly as possible to obtain as much of the federal money as possible (Production Tax Credit (PTC)).

Former Senator Ellen Anderson (an author of the 2007 renewable law, former PUC Chair and former Special Energy Advisor to Governor Mark Dayton) and Bill Grant publically confirmed that there were no scientific studies performed, cited, or used as a basis in the creation of Minnesota’s renewable energy law. (November 27, 2012; EQB public forum on energy, Rochester, MN)

No science was used to inform the decisions and laws affecting wind energy in Minnesota.

MN Statute allows counties to assume permitting and siting of wind projects 25MW total capacity or less. The Legislature required the PUC to provide the counties guidance. The PUC issued the *Order Establishing General Wind Permit Standards* January 2008. The Order appears to be based on the practices brought to the PUC from the EQB. The PUC has never issued an order or adopted Rules for siting wind projects of over 25MW total capacity. Almost all wind capacity in Minnesota is in projects over 25MW.



Site Permit – Setback distance from homes is based on “noise” even though the State knows so little about turbine noise they cannot enter into rulemaking on the topic.

The PUC stated multiple times that wind projects are sited on a “case-by-case basis”; however, Commerce provides standardized guidance to wind developers as to what is required. Every wind project site permit contains the requirement that the “project must meet Minnesota noise standards, Minnesota Rules Chapter 7030, at all receivers.” A “receiver” is a home, business, church or school – places where people are. Audible noise standard M.R. 7030 is the sole site permit “standard” governing the setback distance between a turbine and a home.

https://mn.gov/commerce/energyfacilities/documents/LWECS_APP_Guide_AUG2010.pdf

M.R. 7030 is also called the “State Noise Standard.” This is written, interpreted and administered by the Minnesota Pollution Control Agency (MPCA) since noise is a form of pollution. MPCA enforces noise standards at facilities for which it has issued an air permit – this does not include wind turbines. There are specific noise rules for roads and highways, vehicles, snowmobiles, boats, airplanes, mining, and gun clubs in *A Guide to Noise Control in Minnesota* <https://www.pca.state.mn.us/sites/default/files/p-gen6-01.pdf>

The MPCA has stated the following about applying M.R. 7030 to wind turbines:

- Not a low frequency noise standard. (2/1/2010; DOC ID 201510-114767-01)
- “Does not measure the [low frequency] noise that is of concern [in *Public Health Impacts of Wind Turbines*].” (2/1/2010; DOC ID 201510-114767-01)
- “We don't have a noise standard that's designed to work for turbines.” (9/22/2011; Commissioner Paul Aasen; DOC ID 201510-114768-03)
- “[The MPCA noise testing] protocol doesn't fit well for turbines.” (9/22/2011; Commissioner Paul Aasen; DOC ID 201510-114768-03)
- “Should not be used for wind turbines.” (2/25/2016; DOC ID 20163-119078-01)
- “The PUC should develop a siting standard that does not involve noise measurement at all since noise standards are difficult to develop, difficult to measure and difficult to administer.” (2/25/2016; DOC ID 20163-119078-01)

Wind Turbine Siting in Minnesota

- “After consulting with colleagues at the Minnesota Departments of Health and Commerce, I have concluded that the current understanding of wind turbine noise and its potential effects is insufficient to support rule making at this time.”
(9/12/2016; Commissioner John Linc-Stine; DOC ID 20169-124844-01)

The result of the PUC using M.R. 7030 – a noise standard that should not be used for wind turbine noise and which cannot be accurately measured in wind speeds above 11 mph – is 400- to 500-foot turbines sited less than 1000 feet from Minnesotans’ homes. A thousand feet does nothing to address known audible and low frequency noise problems associated with large industrial-scale wind turbines. Minnesota does not even require a setback as long as the turbine safety evacuation zone that wind turbine manufacturers require for their own employees.



Minnesotans' homes are inside the turbine Safety Evacuation Zone

Vestas, which was the largest wind turbine manufacturer on the planet for decades, and sometimes lobbies at the Minnesota legislature, said this in their various safety manuals:

- During normal operations “Do not stay within a radius of 400m (1300 ft) from the turbine unless it is necessary.”
- In case of “runaway operations,” run upwind and evacuate the area within at least 500 meters (1640 ft) <https://patch.com/massachusetts/falmouth/vestas-confidential-health-safety-instruction-manual-falmouth-ma-wind-farm-0>

Blade tip speeds on these large operating turbines can reach over 160 mph. Vestas has recorded debris traveling 1600 feet from a tower during what turbine manufacturer General Electric (GE) calls “uncontrolled operation” and “component liberation.” (PUC Docket 08-1233) During icing conditions, ice can fall or be flung from turbine blades.

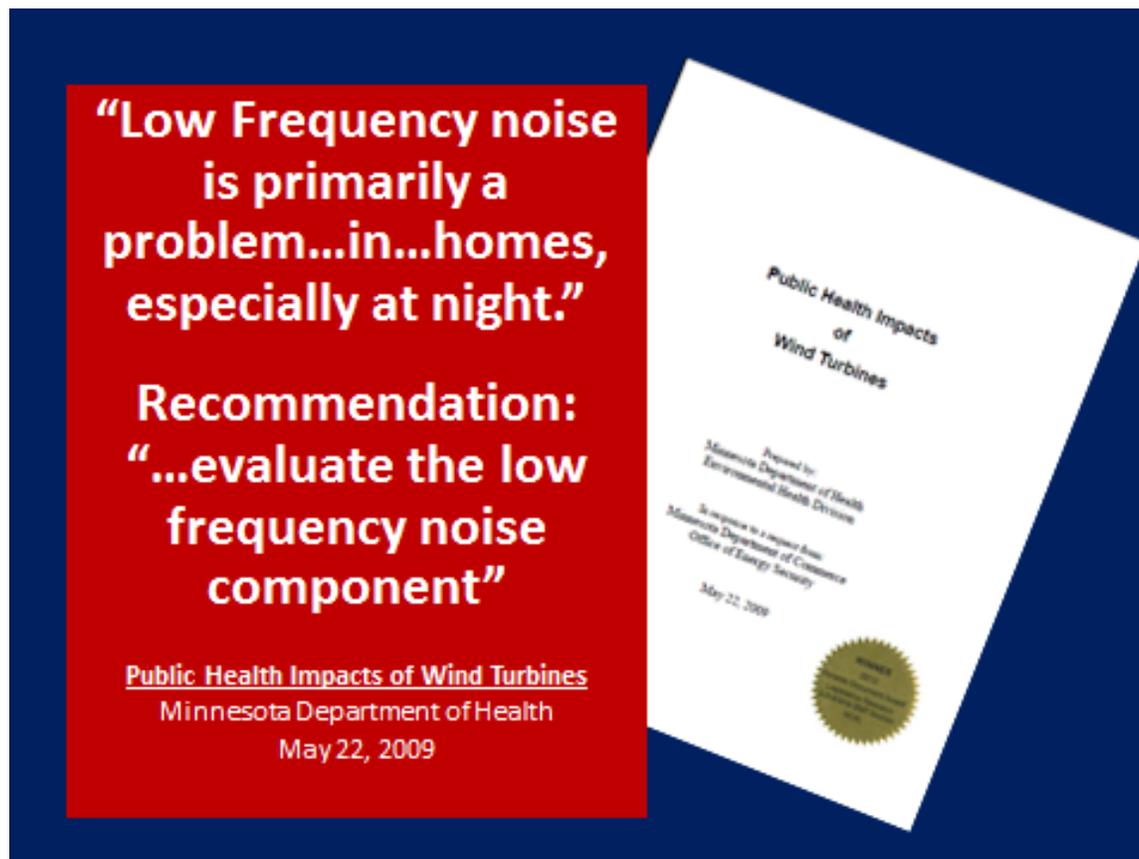
The PUC permits these wind turbines to be built 1000 feet from a home and 250 from public roadways.



What studies does the PUC have in front of it and how did they respond?

Minnesota citizens pressed the PUC, Commerce, Department of Health (MDH) and the Pollution Control Agency (MPCA) since at least 2008 (just after passage of Minnesota's renewable energy law mandating wind) to address the negative health effects of wind turbines. The first result was MDH's award-winning White Paper *Public Health Impacts of Wind Turbines*. This is a literature review. There was no original research performed in Minnesota. (5/22/2009)

<http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf>



On February 1, 2010 the PUC held a public hearing on *Public Health Impacts of Wind Turbines*. All five PUC Commissions agreed that low frequency noise (LFN) was a problem and committed the PUC to addressing the issue in all future wind site permits. The PUC established a continuous open docket on the topic (PUC docket 09-845). The PUC also requested legislative action then, and multiple times since then, during proceedings on multiple wind siting dockets. There is not, and has never been, LFN/infrasound

evaluation in site permits issued by the PUC despite their commitment of February 1, 2010 and the PUC's specific commitments in the Bent Tree (PUC Docket 08-573) and Pleasant Valley (PUC Docket 09-1197) wind projects.

The Minnesota Department of Health stated the following about wind turbine noise:

- "...low frequency noise is a problem that may affect some people in their homes, especially at night." (*Public Health Impacts of Wind Turbines*)
- "The most common complaints are sleeplessness and headache." (*Public Health Impacts of Wind Turbines*)
- "The Minnesota nighttime standard ...appears to underweight penetration of low frequency noise into dwellings." (*Public Health Impacts of Wind Turbines*)
- Low frequency noise is attenuated less by distance. (6/20/2009; DOC 08-573)
- 'There appear to be fewer problems when turbines are at least ½-mile from homes.' (*Public Health Impacts of Wind Turbines*)
- The PUC should "...evaluate the low frequency noise component." (*Public Health Impacts of Wind Turbines*)
- Comparing the wind industry to the tobacco industry is "a good comparison." (Commissioner Ed Ehlinger, 2/2016)
- Some Minnesotans' health is being harmed by wind turbines. (DOC ID 20166-122162-01).

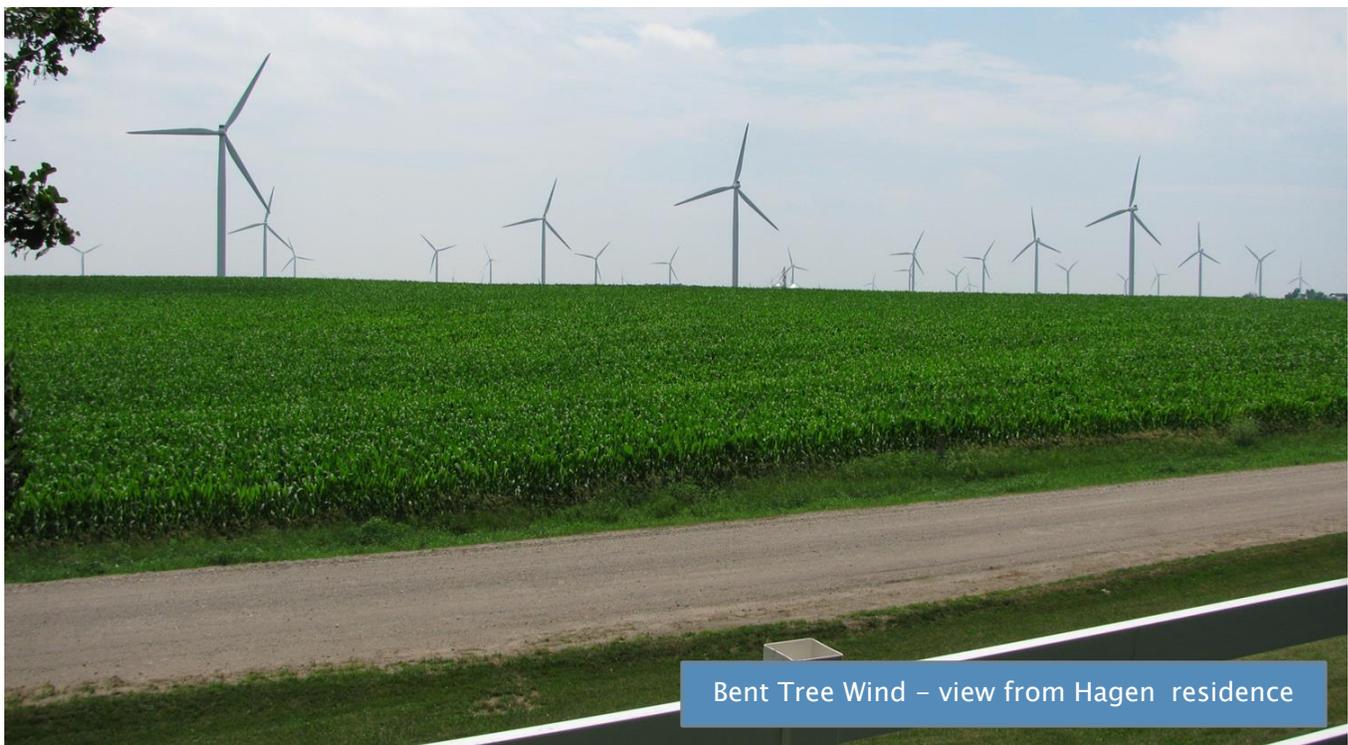
There are two wind projects named in *Public Health Impacts of Wind Turbines*: Noble Flat Hill and Bent Tree. When the PUC issued site permits, Noble Flat Hill's permit granted ½-mile setback to citizens who requested it. At Bent Tree many residents requested a minimum one-mile setback. No setback was granted other than the one determined by Alliant Energy in their own PUC-required noise model of the "not for wind turbines" M.R.7030. Multiple homes have 20 turbines within one mile. At least one turbine is 1000 feet from the turbine tower to the wall of a house; this means the blade tips pass about 850 feet from the home.

The PUC designated wind turbine noise as being a "material issue" in the Bent Tree site permit. Bent Tree is supposedly the project that would be the test case for the PUC to address low frequency noise in a wind site permit and to set the standard for all future wind project site permits. At the June 2009 Bent Tree PUC scoping hearing, the PUC

Wind Turbine Siting in Minnesota

received a letter from a Veterans Affairs doctor on behalf of Vietnam era veteran Bernie Hagen, stating that no turbines should be sited within ½-mile of Mr. Hagen’s home because wind turbines would make his service-related disability – tinnitus – worse and would endanger his health. There are 3 turbines within ½ mile and 20 within one mile of the Hagen home. Mr. Hagen’s doctor has advised him to leave his home.

Bent Tree citizens’ attorney requested LFN testing in homes before the site permit was issued. Individual citizens have requested this again on multiple occasions since Bent Tree started running. Since the problem identified by MDH and numerous other resources is LFN in homes, this seems like a logical step. This has never happened.



At the same June 2009 Bent Tree scoping proceedings, MDH’s Dr. Carl Herbandson stated, “The existing [audible Minnesota noise standard] ...appears to underweight the penetration of low frequency noise into dwellings.” “One way to quantitatively evaluate wind turbine noise is to use the current Minnesota [audible] standard. ...As stated in *[Public Health Impacts of Wind Turbines]*, ...this method may understate the potential impacts of wind turbine noise when compared to application of [M.R. 7030] to other noise sources.” “...The noise from multiple turbines can be greater than the noise from a single

turbine. This is especially true for low frequency noise (dB(C)) which is attenuated less by distance than the higher frequencies.” Wind projects should be required to perform low frequency noise modeling to help assess the potential impacts on the community. (*Public Health Impacts of Wind Turbines* 5/22/2009; and, MDH Carl Herbrandson 6/20/2009, DOC ID 20097-39262-01)

On February 22, 2010, three weeks to the day after the five PUC Commissioners made commitments to deal with LFN in wind turbine siting, the PUC held scoping meetings for Pleasant Valley Wind. Residents of nearby operating Minnesota wind projects testified to their unresolved wind turbine noise problems. State staff representing the PUC told citizens that their noise concerns are “going to be considered in [both] the certificate of need ...and the site permit process.” “These are exactly the type of issues we're going to look at.” That “because of the Bent Tree project and the problems with [turbine noise] the PUC has [opened the 09-845] docket to address some of these issues.” “On February 1, [2010] ...the PUC agreed with the public that there are a lot of unanswered questions ...that have to [be] dealt with. So [the PUC has] kept [the noise] docket open, they're going to address this.” Staff told the public that, “low frequency noise [is] considered in the design and layout of a wind turbine farm.” (PUC docket 09-1197)

Less than two months after Commerce and PUC staff made specific commitments to citizens at the Pleasant Valley scoping meetings that low frequency noise would be addressed, Commerce staff advised the Commission to only require Pleasant Valley to meet the State’s existing audible noise standard – M.R. 7030. This does not address the low frequency noise concerns raised in the scoping meeting that staff said the Commission was going to address. (DOC ID 20104-48996-01)

Hessler Associates is an acoustical engineering firm used by wind developers and the PUC and is considered supportive of the wind industry. The PUC requested, and provided state staff to collaborate with, David Hessler to write *Assessing Sound Emissions from Proposed Wind Farms & Measuring the Performance of Completed Projects*. Hessler writes, “...It would be advisable for any new project to attempt to maintain a mean sound level of 40 dB(A) or less outside all residences....” “Under no circumstances...should turbines be located in places where mean levels higher than 45 dB(A) are predicted by

Wind Turbine Siting in Minnesota

pre-construction modeling at residences. The PUC requested and received this information and then ignored it. (10/13/2011)

https://www.michigan.gov/documents/energy/MLUI9_NARUC_420200_7.pdf

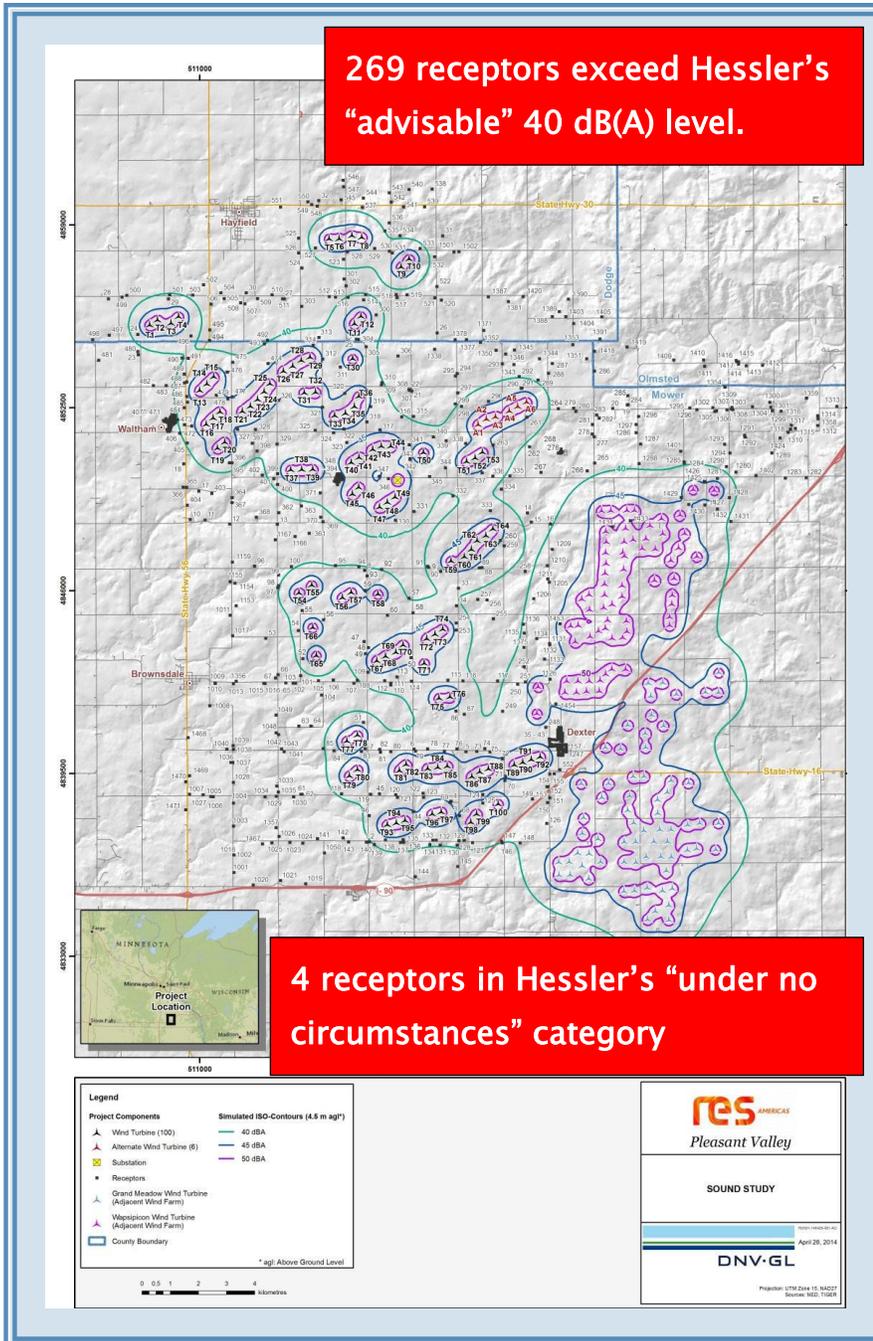
NOTE: The PUC/NARUC Hessler report was filed on the PUC's Public Health Impacts of Wind Turbines docket (09-845) by citizens, not by the PUC staff. When asked why the PUC did not file its own noise studies on its own noise docket, PUC staff responded that if they filed their own information on their own related open docket, this would be seen by

the wind industry as "favoritism."

There are approximately 60 new peer-reviewed studies about wind turbine LFN and human health effects since MDH produced *Public Health Impacts of Wind Turbines*. These were filed by citizens on the PUC's continuously open 09-845 docket. (List in Appendix.)

These were reviewed by MDH who concluded that the new studies support their earlier findings that LFN is the problem and MDH stated that the health of some Minnesotans is being harmed.

The PUC has done nothing in response.



Wind Turbine Siting in Minnesota

Bent Tree wind was the first project in Minnesota at which the State attempted to obtain post-construction noise measurement. The equipment consisted of microphones strapped to telephone poles in the ditches. The equipment was visibly damaged for most of the test period.

In response to ongoing substantiated and unresolved health complaints at Bent Tree that are almost certainly

associated primarily with LFN, the MPUC determined to perform additional audible noise testing at two locations during the summer of 2017. Alliant Energy curtailed turbines during much of the test period. When the turbines were not curtailed, data when wind speeds were above 11 mph were thrown out in accordance with MPCA's recommendation.

(DOC ID 20176-132697-01)



PUC's "complaint resolution process" has yet to demonstrate resolution of a noise complaint. The most common wind industry response is to tell their victims that they meet the requirements of their PUC-issued site permit – the "not for turbines" M.R. 7030.

Minnesota Attorney General Lori Swanson wrote to Alliant Energy stating, "I understand that some wind projects may negatively affect the ability of nearby landowners to enjoy their property." "Ms. Hagen ...requests long-term noise testing, that you shut down turbines [near] her home when she reports problems, or alternatively, that you buy out her home at a fair market price." Although a well written letter, this is not resolved and AG Swanson refused to follow up or to require a resolution. (1/15/16)

At the request of the PUC and of citizens living in Goodhue County, a bill to establish wind turbine setback standards came in front of the Legislature in 2011. After a six-hour hearing in the House Agricultural Committee, the bill failed on a tie vote taken while supporters of the bill were absent attending other committee votes. Multiple legislators from both parties have made verbal commitments to address wind siting in 2011, 2013, and 2015. None of them have followed through on their promises.

At his April 2013 Rochester town hall meeting, Governor Mark Dayton promised that he would address the wind turbine health complaints. This resulted in a meeting at the Governor's office on May 3, 2013, attended by MDH Commissioner Dr. Ed Ehlinger, MPCA Commission John Linc-Stine, and Commerce Commissioner Mike Rothman. The three Commissioners made specific commitments that they did not fulfill:

1. Review of the MPCA's Industrial Noise Standard for possible revision, modification, or addition to address wind turbine produced low frequency noise. This included the possibility of opening rule writing on the noise standard;
2. Updating the 2009 MDH study, *Public Health Impacts of Wind Turbines*, with current data and peer-reviewed studies occurring since 2009; and,
3. Commissioners Ehlinger and Linc-Stine agreed to explore the possibility of direct medical study of the health effects of wind turbines on the citizens of Minnesota and stated they would speak with colleagues at the University of Minnesota about performing such a medical study. (DOC ID 201511-115908-04)

At the repeated request of citizens, MDH undertook an updated literature review during early 2016 of approximately 60 peer-reviewed papers and studies on wind turbine noise and health published since the 2009 *Public Health Impacts of Wind Turbines*. MDH concluded that these peer-reviewed papers and studies support their earlier findings that the issue is low frequency noise and that some Minnesotans' health is being harmed. (PUC docket 09-845; DOC ID 20163-119078-01; DOC ID 20166-122162-01)

The PUC said citizens should petition for rulemaking in order to fix the problem. When someone did exactly that, the response was, "After consulting with colleagues at the Minnesota Departments of Health and Commerce, I have concluded that the current

Wind Turbine Siting in Minnesota

understanding of wind turbine noise and its potential effects is insufficient to support rule making at this time.” (MPCA Commissioner John Linc-Stine 9/12/2016; DOC ID 20169-124844-01)

Minnesota citizens have moved out of Minnesota, or have moved elsewhere in the State, in order to escape wind turbines in at least three Counties: Rock, Freeborn and Mower.



PUC approved research of LFN by the University of Minnesota that fails to study LFN in homes and the health of people living next to turbines.

Wind turbine generated sound: Targeted research to improve measurement, analysis, and annoyance thresholds based on measured human response. This is a \$620,000 study at the University of Minnesota paid from the Xcel customer-funded Renewable Development Fund. The U of M’s website says this research is being “performed in collaboration with wind industry partners”. MDH recommended that U of M researchers sit down and talk with Kristi Rosenquist about the design of the research project. The U of M declined, stating that they were not talking to the wind industry or to citizens so as not to be perceived as bias. The U of M has not followed this commitment.

Xcel has the largest wind portfolio of any utility in the United States and is a Board member of the American Wind Energy Association (AWEA). Xcel representatives, including the Manager of the Pleasant Valley Wind project, sit on the group that decides what projects get funded by the RDF. Xcel told the U of M researchers when and where to place their “artificial ear” at Xcel’s Pleasant Valley project.

The U of M is currently consulting with acoustician Bruce Walker – a wind industry consultant. Acousticians Robert Rand and Richard James have both expressed concerns that Bruce Walker is misleading the U of M about the characteristics of wind turbine infrasound and misapplying data gathered at the Shirley Wind project.

Since the identified problem is LFN in homes and the health of people living in wind projects, it seems logical to focus research on the identified issue. This U of M research does not attempt this.

<http://www.safl.umn.edu/featured-project-wind-turbine-generated-sound-targeted-research-improve-measurement-analysis-and-ann>



Audible Noise – agreement that 40 dB(A) should be the limit, but no good measurement protocol to determine if it is met

Rules Chapter 7030 is promulgated and administered by the Minnesota Pollution Control Agency (MPCA). It is an audible noise standard that is not designed for wind turbines and should not be used for wind turbines according to the MPCA. Audible noise for humans (the hearing range) is generally considered noise above 20 Hertz (Hz) and is measured on a scale with the designation dB(A). The decibel scale is logarithmic, so 50 dB(A) is twice as loud as 40 dB(A). <https://www.revisor.mn.gov/rules/?id=7030>

Most industrial noise can be reduced by noise control equipment and/or noise abatement structures around the noise source. The only noise control for wind turbines is distance or shut down (curtailment). Both the audible and inaudible noise from turbines are dependent on wind speed, direction, and other weather and ground conditions. Turbines produce impulsive noise when the blades pass the tower, when the blades flex, and in the flexing of the tower itself.

The World Health Organization (WHO) recommends that nighttime audible noise at residences should not exceed 35 dB(A). WHO recommended a strict limit of 40 dB(A) at night. Noise levels higher than that disturb sleep which is essential to health.

http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

David Hessler wrote, "...It would be advisable for any new project to attempt to maintain a mean sound level of 40 dB(A) or less outside all residences...". "Under no circumstances ...should turbines be located in places where mean levels higher than 45 dB(A) are predicted by pre-construction modeling at residences." (*Assessing Sound Emissions from Proposed Wind Farms & Measuring the Performance of Completed Projects* (10/13/2011). https://www.michigan.gov/documents/energy/MLUI9_NARUC_420200_7.pdf

Vermont: 45 dB(A) or 5 dB(A) 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 dB(A) or 5 dB(A) above background levels (measured at the L-90 sound level) at all other times during each day. (State of New Hampshire Site Evaluation Committee 10/7/2015)

<http://www.nhsec.nh.gov/projects/2014-04/documents/10-07-15-sec-2014-04-2015-12-final-proposal-re-filing.pdf>

Michigan Study: 40 dB(A)/1.25-mile home setback. Current Michigan Standards are 55 dB(A)/1000-foot setbacks. This study was drafted but not published because the wind industry did not like the findings. “In an April 25, 2011 email, the head of the Great Lakes Renewable Energy Association advised state employees to delete emails pertaining to a potential recommendation that Michigan's noise level limit for wind turbines be lowered. The email advising state employees delete conversations was one of several emails obtained through the Freedom of Information Act pertaining to the wind turbine noise level issue.” (7/12/2012 by Jack Spencer in Michigan Capitol Confidential)

<http://www.michigancapitolconfidential.com/17219>

South Australia Environmental Noise Guidelines: Wind Farms increased the allowable audible noise limit from 35 dB(A) to 40 dB(A) in response to wind lobbyists wishes. Even with the increase, Australia’s limit is half as loud as allowed in Minnesota. (2009)

<http://iiccusa.org/wp-content/uploads/2015/08/Wind-Turbine-Timeline.pdf>

The audible noise cannot be measured accurately outdoors, which is what the PUC requires. Commerce staff wrote *Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report* (October 2012) (Guidance). “The purpose of this guidance document is to aid wind developers in the preparation and use of a noise study protocol that standardizes sound monitoring methodologies, analysis, and presentation.”

The Guidance includes an MPCA letter which states in part, “It is appropriate to flag and remove noise data where surface wind speeds at the monitor were greater than 11 mph. In like manner, noise data during rainfall should also be excluded.” “Impulsive noise ... should be removed before analysis of the data....”

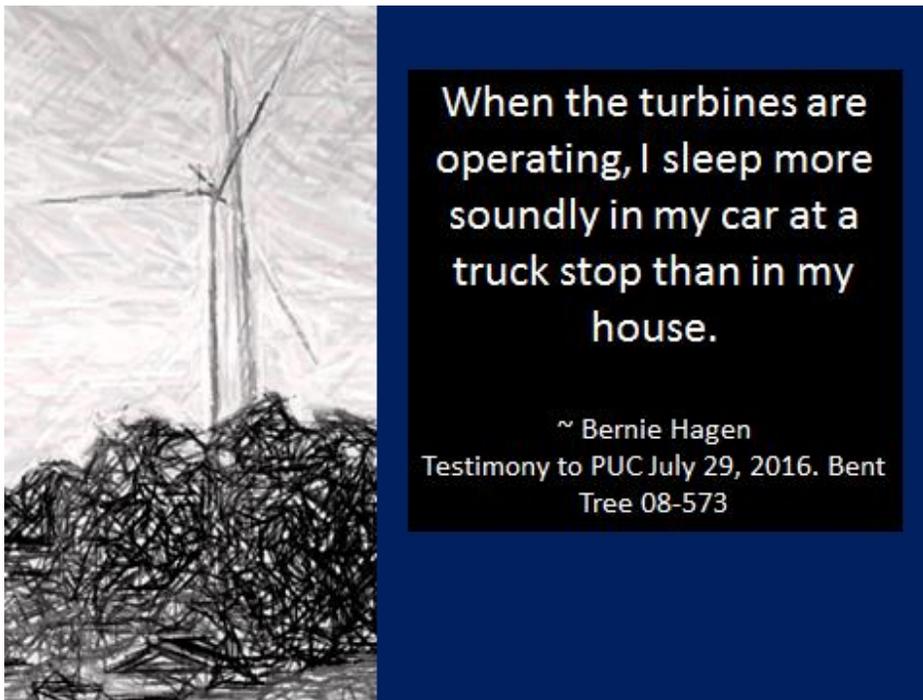
Large wind turbines “cut-in speed”, the wind speed at which they begin to work or produce electricity, is in the 6–8 mph range for most turbine models. Though wind speeds at the ground and wind speeds aloft can differ, this MPCA directive means that data with wind speeds during most of the turbine’s operational range (above 11 mph), and when the turbines are correspondingly most noisy, is thrown out.

This doesn’t mean that the humans can’t hear the audible wind turbine noise in wind speeds above 11 mph; it means that the technical means to accurately measure audible wind turbine noise when wind turbines are their noisiest apparently does not exist.

Wind Turbine Siting in Minnesota

Citizens report some of the worst audible noise during icing events and in late winter to early spring when the ground is frozen and bare. Also, wind turbines tend to produce the most electricity during spring and fall. In Minnesota, no noise testing has been performed in winter or very early spring when the ground is still frozen, and most of the noise testing has been performed in the summer. The noise testing is all outdoors. There has been no indoor testing in Minnesota by the State, industry or the U of M.

Former MPCA Commissioner Paul Aasen said, “[The MPCA noise testing] protocol doesn’t fit well for [wind] turbines.” (DOC ID 201510-114768-03)



Paul Schomer states, “...The probability that motion sickness-like symptoms experienced by wind farm residents are unrelated to wind turbine noise is less than two in a million. [The Cape Bridgewater] analysis proves that it is virtually certain that these individuals are adversely affected with serious health effects that result from the acoustic emission of nearby wind turbines. This changes the dynamic of the situation. Since it can no longer be said that there are no known health effects related to wind farms, it follows that the industry must prove that there will be no adverse health effects from what they plan to do, or that the industry must state what the adverse health effects will be.”

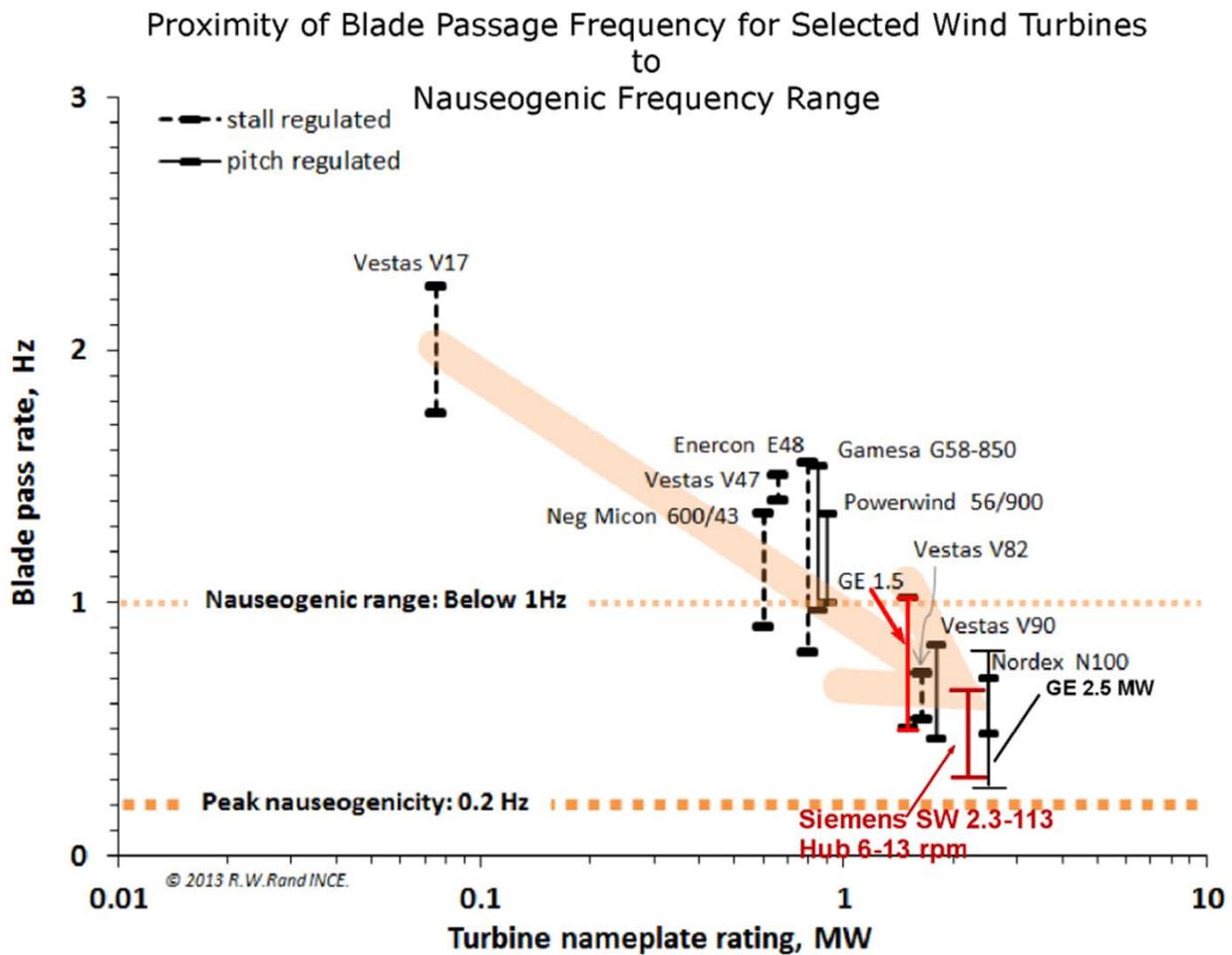
George and David Hessler have coauthored an article that recommended a noise limit of 40 dB(A) for wind farms, which has been shown to virtually eliminate noise-related complaints and health problems. “I (Paul Schomer) have done independent work and concluded that 39 dB(A) should be the maximum limit to avoid annoyance and health impacts from wind turbine noise. A ...paper that George Hessler and I coauthored explains how we independently arrived at these limits of 40 and 39 dB(A).” (Article presented at Acoustical Society of America/International Congress of Acoustics; Montreal, 6/2013) <https://docs.wind-watch.org/Schomer-Highland-Testimony-130729.pdf>)



Low Frequency Noise is the problem. Measurable – but no standards.

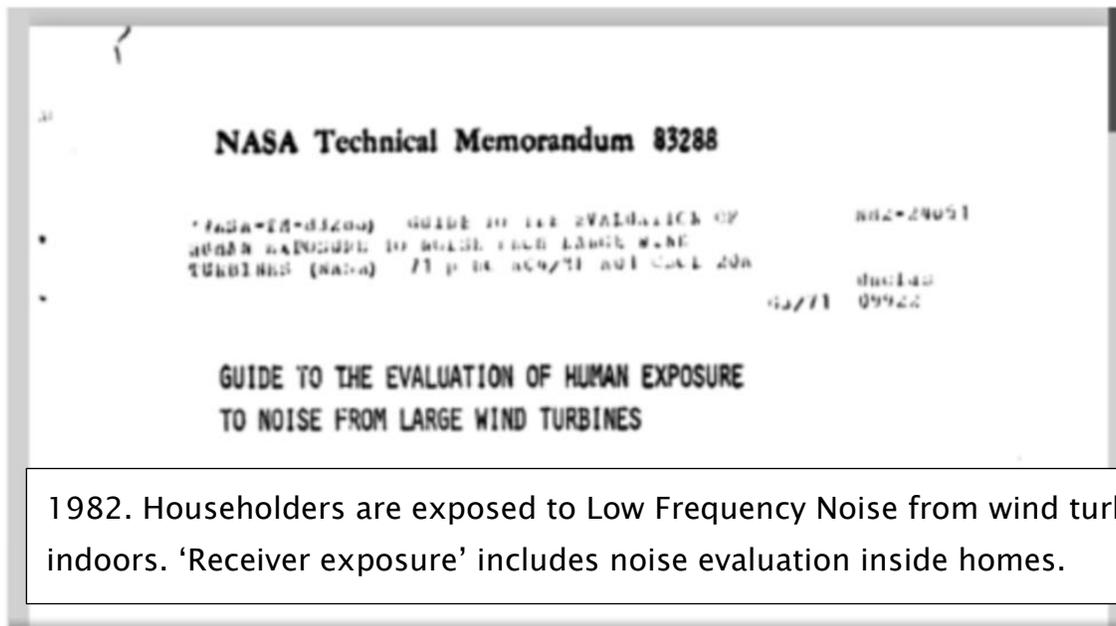
LFN is generally considered to be sound or noise impulses below 20 Hertz. Most of this range is considered to be below the hearing threshold for humans. Humans “also don’t hear high frequency. Your dog hears a dog whistle and you don’t.” “We may feel [high and low frequency sound] or perceive them in other ways. But the way that we measure sound for what’s audible doesn’t give the same weight to those low frequency noises.” (MPCA noise expert Anne Claflin testimony to the PUC 2/1/2010)

The critical part of the LFN or infrasound range is from 0 to 10 Hz for wind turbines, with 0 to 1 Hz being the most important frequency range. The *Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report* does not attempt to measure or evaluate noise in this very low range, and in fact, the equipment specified in the Guidance is incapable of doing so. (DOC ID 20161-117467-01 and 20161-117468-01)



Sleep deprivation, migraine headache, vertigo, and ringing in the ears (tinnitus) have been reported by people across the globe living in areas where large wind turbines are constructed and operated since at least the late 1970s. NASA published research about low frequency noise produced by their large wind turbine in the late 1970s and throughout much of the 1980s. Symptoms reported and studied at the NASA turbine are consistent with health problems reported at wind turbine complexes in Minnesota. A link to a historical time line of wind turbine noise and siting standards worldwide:

<http://iiccusa.org/wp-content/uploads/2015/08/Wind-Turbine-Timeline.pdf>



1982. Householders are exposed to Low Frequency Noise from wind turbines while indoors. 'Receiver exposure' includes noise evaluation inside homes.

The 60+ peer-reviewed studies on the 09-845 PUC docket include:

1. Shirley Wind, Brown County Wisconsin. Four acoustical investigating firms are of the opinion that enough evidence and hypotheses have been given herein to classify LFN and infrasound as a serious issue. (1/2013) The Brown County Board of Health declared the Shirley Wind project is "a Human Health Hazard for all people...who are exposed to Infrasound/Low Frequency Noise...." (10/14/ 2014) Brown County, WI https://apps.psc.wi.gov/vs2015/erf_view/viewdoc.aspx?docid=178200 <http://bccrwe.com/index.php/component/content/article?id=16:duke-energy-s-shirley-wind-declared-human-health-hazard>
2. Australia: Cooper S.: *Pacific Hydro Wind Turbine Noise Acoustic Survey* as reviewed by Paul D. Schomer and George Hessler. The conclusion of the commentary reads:

“Cooper’s test shows cause and effect for at least one non-visual, no-audible pathway to affect people. If one only wanted to test for the ability to sense the turning on of wind turbines, and not replicate the cause and effect portion of Cooper’s study, this reduced test could be accomplished in one to two months with a cooperative windfarm where there are residents who are self-selected as being very or extremely sensitive to wind turbine acoustic emissions and who also assert that they have this sensing ability. This study, a subset of the full Cooper tests, would only prove, again, that non-visual, non-auditory pathways exist by which wind turbine emissions may affect the body and “signal” the brain.”

“There is a singular importance to this study as the claim of no direct cause of adverse health effects by industrial wind turbines can no longer be sustained.”

<https://www.wind-watch.org/documents/results-of-an-acoustic-testing-program-cape-bridgewater-wind-farm/>

“...The probability that motion sickness-like symptoms experienced by wind farm residents are unrelated to wind turbine noise is less than two in a million. This analysis proves that it is virtually certain that these individuals are adversely affected with serious health effects that result from the acoustic emission of nearby wind turbines. This changes the dynamic of the situation. Since it can no longer be said that there are no known health effects related to wind farms, it follows that the industry must prove that there will be no adverse health effects from what they plan to do, or that the industry must state what the adverse health effects will be.”

~ Paul D. Schomer

What should the Minnesota Legislature adopt for a siting standard?

“...It really becomes a matter of sufficient setback that has a decent probability of mitigating complaints or impact ...versus not siting the project in that location versus ignoring setbacks and putting it there anyway.” (MPCA Commissioner Paul Aasen DOC ID 201510-114768-03; 9/22/2011)

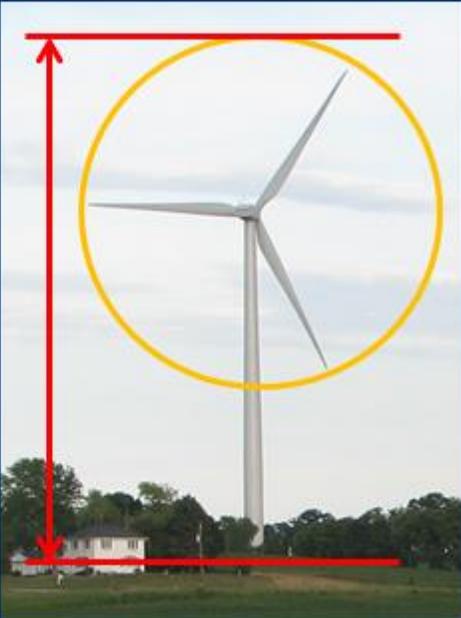
Goodhue County adopted a setback ten-times the rotor diameter of the turbine (10 RD). Larger turbines would have a larger setback; smaller turbines would have a smaller setback. A distance standard is simple to use, apply, interpret and test – unlike a noise standard. All one needs is a surveyor or a measuring tape. More recent data suggests that 10 RD is too short a distance to protect public health.

Both the German state of Bavaria and the country of Poland adopted ten-times the total turbine height as their setback standard. This is commonly referred to as 10 H. 10 H was challenged in Bavaria’s Constitutional Court and was upheld.

<http://www.windaction.org/posts/45003-constitutional-court-confirms-10h-turbine-setback-law#.WdE-fGdDFOw> <https://www.reuters.com/article/us-energy-poland-windfarm/poland-adopts-limits-on-where-wind-farms-can-be-built-idUSKCN0YE17V>

Setbacks to homes

- Goodhue County: 10 RD (ten times the rotor diameter)
- Michigan draft: 1.25 miles
- Most German States: 1000 meters (3281 feet) for one turbine, further for multiple turbines
- Bavaria, Germany & Poland: 10 H (ten times total height)



Appendix

A partial list of wind turbine LFN and health studies in PUC Docket 09–845:

| | | | | | | | |
|---------------------------------|--------|--------|--------------------------|----|-----------------|---|------------|
| 20166-122549-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PRESSURE LEVEL MEASUREMENTS OF INFRASOUND INSIDE HOME SHIRLEY WIND | 06/24/2016 |
| 20166-122550-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--APPLYING BRADFORD HILL CRITERIA OF CAUSATION | 06/24/2016 |
| 20166-122551-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CURRICULUM VITAE_DR. ROBERT MCMURTRY | 06/24/2016 |
| 20166-122552-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--INFRASOUND AND LOW FREQUENCY NOISE CASE STUDY | 06/24/2016 |
| 20166-122553-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--OCCUPATIONAL HEALTH AND INDUSTRIAL WIND TURBINES CASE STUDY | 06/24/2016 |
| 20166-122555-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CURRICULUM VITAE_ALEX SALT PHD BIO | 06/24/2016 |
| 20166-122556-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--ALEC N SALT PHD PUBLICATIONS UPDATED 2013 | 06/24/2016 |
| 20166-122557-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--PAUL D SCHOMER PHD RESUME | 06/24/2016 |
| 20166-122558-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CULLERIN RANGE WIND FARM SURVEY AUGUST 2012 | 06/24/2016 |
| 20166-122559-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--ANNOYANCE DUE TO WIND TURBINE_(EJA PEDERSEN) AND KERSTIN PERSSON WAYE | 06/24/2016 |
| 20166-122560-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--WIND TUBINE NOISE PUBLICATION_EJA PEDERSEN, KERSTIN PERSSON WAYE | 06/24/2016 |
| 20166-122561-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--NOISE FROM MODERN WIND FARMS IN THE NETHERLANDS | 06/24/2016 |
| 20166-122562-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--NOISE AND HEALTH VOL 14 NO 60 PGS 237 TO 243 | 06/24/2016 |
| 20166-122563-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--BULLETIN OF SCIENCE TECHNOLOGY AND SCIENCE VOL 31 NO. 334 2011 | 06/24/2016 |
| 20166-122565-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--MACARTHUR WIND FACILITY PRELIMINARY SURVEY | 06/24/2016 |
| 20166-122566-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CULLERIN RANGE WIND FARM SURVEY FOLLOWUP SURVEY JULY TO AUG 2013 | 06/24/2016 |
| 20166-122567-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--WATERLOO CASE SERIES PRELIMINARY REPORT | 06/24/2016 |
| 20166-122599-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--INAGAKI IN INT J ENVIRON SCI TECHNOL 2015 NO 12 PGS 1933-1944 | 06/24/2016 |
| 20166-122600-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--22ND INTERNATIONAL CONGRESS ON SOUND AND VIBRATION FORENCE ITALY | 06/24/2016 |

Wind Turbine Siting in Minnesota

| | | | | | | | |
|---------------------------------|--------|--------|--------------------------|----|-----------------|---|------------|
| 20166-122602-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--EURONOISE 2015 BRANCO ET AL CONTRIBUTIONS FROM PORTUGUESE WIND TURBINE CASE | 06/24/2016 |
| 20166-122604-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CASE STUDY OF MANJILWIND FARM IN N IRAN FLUCTUATION AND NOISE LTRS | 06/24/2016 |
| 20166-122615-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--2016 ICD 10 CM DIAGNOSIS CODE T75 23 VERTIGO FROM INFRASOUND | 06/24/2016 |
| 20166-122554-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--HHS PUBLIC ACCESS MANUSCRIPTS_ RESPONSES OF THE EAR TO LOW FREQUENCY SOUNDS, INFRASOUND AND WIND TURBINES | 06/23/2016 |
| 20166-122564-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--WIND FARM GENERATED NOISE AND ADVERSE HEALTH EFFECTS_BOB THORNE | 06/23/2016 |
| 20166-122375-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--SPANISH _INFRASOUND AND LOW FREQUENCY NOISE DOSE RESPONSESLVES_ MARIANA ALVES-PEREIRA E NUNO A. AND A. CASTELO BRANCO | 06/20/2016 |
| 20166-122376-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--INFRASOUND AND LOW FREQUENCY NOISE DOSE RESPONSESLVES_ALVES PEREIRA AND BRANCO | 06/20/2016 |
| 20166-122377-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--KROGH AND HORNER_HEALTH CANADA WIND TURBINE NOISE AND HEALTH STUDY | 06/20/2016 |
| 20166-122378-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--DIAGNOSTIC CRITERIA FOR ADVERSE HEALTH EFFECTS IN THE ENVIRONS OF WIND TURBINES | 06/20/2016 |
| 20166-122379-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--POLISH JOURNAL OF VETERINARY SCIENCES 16 4 PGS 579 THRU 686 | 06/20/2016 |
| 20166-122380-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--PUNCH AND JAMES 2014 NEGATIVE HEALTH EFFECTS OF NOISE FROM INDUSTRIAL WIND TURBINES | 06/20/2016 |
| 20166-122381-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--WIND TURBINE NOISE COMPLAINT PREDICTIONS | 06/20/2016 |
| 20166-122382-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CITIZENS REQUESTED A CRITIQUE OF GUIDANCE FOR LARGE WIND ENERGY CONVERSION SYSTEM NOISE STUDY PROTOCOL_RICK JAMES | 06/20/2016 |
| 20166-122383-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--PERCEPTION BASED PROTECTION FROM LFN SOUNDS MAY NOT BE ENOUGH_SALT AND LICHTENHAN | 06/20/2016 |

Wind Turbine Siting in Minnesota

| | | | | | | | |
|---------------------------------|--------|--------|--------------------------|----|--|--|------------|
| 20166-122384-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--RESPONSES OF THE INNER EAR TO INFRASOUND_SALT AND LICHTENHAN | 06/20/2016 |
| 20166-122385-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--NUMERICAL SIMULATION OF INFRASOUND PERCEPTION WITH REFERENCE TO PRIOR REPORTED LAB EFFECTS_SWINBANKS | 06/20/2016 |
| 20166-122386-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--FIRST INTERNATIONAL SYMPOSIUM ON ADVERSE HEALTH EFFECTS FROM WIND TURBINES | 06/20/2016 |
| 20166-122387-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--COOPER S MEASUREMENT OF INFRASOUND AND LOW FREQUENCY NOISE FOR WIND FARMS AMENDED | 06/20/2016 |
| 20166-122409-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--BULLETIN OF SCIENCE TECHNOLOGY AND SOCIETY VOL 31 ISSUE 4 PGS 296 TO 302 | 06/20/2016 |
| 20166-122411-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--ACOUSTICS TODAY IN WINTER 2014 PGS 20 TO 29 | 06/20/2016 |
| 20166-122412-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--WIND TURBINES CAN BE HAZARDOUS TO HUMAN HEALTH | 06/20/2016 |
| 20166-122413-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--J ACOUST SOC AM VOL 133 ISSUE 3 PGS 1561 TO 1571 | 06/20/2016 |
| 20166-122416-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--THE ACOUSTIC GROUP REPORT | 06/20/2016 |
| 20166-122417-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--DISTRIBUTED GENERATION INTERCONNECTION REPORT | 06/20/2016 |
| 20166-122418-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--SCHOMER THEORY TO EXPLAIN PHYSIOLOGICAL EFFECTS VOL 137 NO 3 MARCH 2015 | 06/20/2016 |
| 20166-122419-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--REPORT NO 122412 1 ON SHIRLEY WIND FARM IN BROWN COUNTY WI | 06/20/2016 |
| 20166-122420-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--LETTER TO THE ZONING BOARD OF APPEALS FROM | 06/20/2016 |
| 20166-122421-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--TECHNICAL MEMO | 06/20/2016 |
| 20166-122422-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--PEER REVIEW OF NCE REPORT AND KAPSAMBELIS PRESSURE WAVE FROM WIND TURBINES | 06/20/2016 |
| 20166-122430-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--STELLING INFRASOUND AND LOW FREQUENCY NOISE AND INDUSTRIAL WIND TURBINES | 06/20/2016 |
| 20166-122432-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--SUMMARY KROGH REFERENCES APRIL 2015 | 06/20/2016 |
| 20166-122434-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--CARL V PHILLIPS MPP PHD CURRICULUM VITAE | 06/20/2016 |
| 20166-122435-02 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | PUBLIC CITIZENS | PUBLIC COMMENT--BULLETIN OF SCIENCE TECHNOLOGY AND SOCIETY 2011 VOL 31 NO 4 PGS 303 | 06/20/2016 |
| 20166-122162-01 | PUBLIC | 09-845 | <input type="checkbox"/> | CI | MN DEPARTMENT OF HEALTH, DEPARTMENT OF COMMERCE & POLLUTION CONTROL AGENCY | LETTER--AGENCIES CONFIRM ISSUES WITH PUC USING A NOISE SITING STANDARD FOR WIND TURBINES | 06/13/2016 |