Wind turbines can harm humans: a case study

Carmen ME Krogh[a)]
Independent, Killaloe, Ontario, Canada, K0J 2A0

Roy D Jeffery[b)]
Independent, Manitolin Island, Ontario, Canada, P0P 1K0

Jeff Aramini[c)]
Intelligent Health Solutions, Fergus, Ontario, Canada,
N1M 3S9

Brett Horner[d)]
Independent, Killaloe, Ontario, Canada, K0J 2A0

In Canada the Ontario Government has adopted wind energy as a renewable energy source. Our research in Ontario documents some individuals living in the environs of wind turbines report experiencing physiological and psychological symptoms, reduced quality of life, degraded living conditions, and adverse social economic impacts. Some families have abandoned their homes or negotiated financial agreements with wind energy developers. Wind turbine noise is a reported cause of these effects; however, some commentators suggest sound from wind turbines does not pose a risk of any adverse health effect in humans. These competing claims can confuse authorities responsible for establishing noise guidelines. An Ontario Environmental Review Tribunal considered a wide body of evidence including expert testimony and found wind turbines can harm humans if placed too close to residents. Risks must be understood to ensure guidelines protect human health. Evidence including peer reviewed literature, case reports, freedom of information

[a)] email: krogh@email.toast.net
[b)] email: jeffery_07@sympatico.ca
[c)] email: jeff_aramini@ihealthsolutions.net
[d)] email: brett_horner@toast.net

documents and expert testimony will be presented which support the conclusion that wind turbines, if placed too close to residents, can harm human health.

1 INTRODUCTION

An increasing number of industrial wind turbines are being sited in close proximity to humans. Some commentators including wind energy promoters, public authorities and health professionals suggest that wind turbines do not pose a risk to human health. These suggestions are not supported by the totality of the evidence. A 2011 Ontario Environmental Review Tribunal considered evidence and testimony from both sides of the debate and found that wind turbines can harm humans if they are placed too close to residents[1].

This paper explores the impacts of industrial wind turbine on health and discusses reviewed literature, case reports, freedom of information documents and expert testimony which support the conclusion that wind turbines, if placed too close to residents, can harm human health.

2 WIND TURBINES CAN HARM HUMANS

In the United States a 2012 board of health resolution made a formal request for "…temporary emergency financial relocation assistance from the State of Wisconsin for those Brown County families that are suffering adverse health effects and undue hardships caused by the irresponsible placement of industrial wind turbines around their homes and property[2]."

Some individuals living in the environs of wind turbines report experiencing adverse health effects including annoyance and/or sleep disturbance and/or stress related health impacts and/or reduced quality of life[3,4,5,6,7,8 ,9,10,11,12]. In some cases the adverse effects have been severe enough that families have elected to abandon their homes.

Reports of wind turbine induced adverse health effects have been dismissed by some commentators including government authorities and other organizations. There is debate whether wind turbine noise poses a risk to human health. Industry and regulating agencies need to be informed about the health risks to ensure wind turbines are responsibly placed to protect the health and safety of humans.

2.1 Fundamental Rights and Definition of Health

A prerequisite for assessing the health impacts of any exposure is the application of an authoritative definition of health. The World Health Organization (WHO) definition of health has been accepted by many jurisdictions including the Canadian federal, provincial, and territorial governments and health officials[13]: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity[14]." The WHO "… recognizes the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being[15]."

2.2 Plausible Causes of Harm to Human Health

Wind turbine sound, visual and economic impacts have been identified as plausible causes of wind turbine induced annoyance and/or other adverse effects. It is suggested the reported health effects are not the result of "… a turbine-specific variable like audible noise[16]…". In 2009 a literature review was sponsored by the American Wind Energy Association and Canadian Wind Energy Association "… to provide an authoritative reference document for the use of

legislators, regulators, and people simply wanting to make sense of the conflicting information about wind turbine sound[17]." The literature review states in its conclusion: "Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans[17]."

Suggesting the sound from wind turbines does not pose a risk of any adverse health effects in humans is incorrect. Failure to understand the risks of wind turbine sound can result in noise regulations which enable harm to human health.

2.3 Serious Harm Includes Indirect Effects

Wind turbines can harm humans directly. Ice throw and structural failure present direct and potentially fatal public hazards to people or passing vehicles. Risk of injury can be minimized with setbacks of 200 to 500 m[18].

It has been suggested that wind turbine sound does not cause "direct physiological effects[17]" or that a "direct causal link[66]" between health effects and wind turbines has not been demonstrated. However wind turbines can harm humans indirectly. Failure to evaluate indirect causal pathways and the psychological harm of wind turbine exposure represents an error of omission[19].

Wind turbines produce sound which can become a risk to human health when it is perceived to be noise. Noise of a moderate level acts via an indirect pathway and can have health outcomes similar to those caused by high noise exposures on the direct pathway[15]. Specific health effects in the indirect pathway include: interference with communication; sleep disturbance effects; cardiovascular and psycho-physiological effects; performance reduction effects; effects on social behaviour and annoyance[20].

Referring to wind turbines an Ontario Environmental Review Decision found ""serious harm to human health" includes … indirect impacts (e.g., a person being exposed to noise and then exhibiting stress and developing other related symptoms). This approach is consistent with both the WHO definition of health and Canadian jurisprudence on the topic[1]."

2.4 Wind Turbines Are More Annoying

Sound is not the same as noise. The WHO defines noise as "unwanted sound"[20] perceived by humans. Some wind energy promoters have distributed literature which suggests that modern wind turbines are not noisy[21]. However, wind turbines produce sound which is perceived by humans to be more annoying than transportation noise or industrial noise at comparable sound pressure levels[22].

2.5 Annoyance: A Health Effect and Serious Human Health Risk

Annoyance is acknowledged to be an adverse health effect[23,24,25,26,47]. Annoyance has been defined as "… a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them[20]…" For chronically strong annoyance a causal chain exists between the three steps health – strong annoyance – increased morbidity[27].

Other symptoms associated with annoyance from various noise sources include: stress, sleep disturbance, headaches, difficulty concentrating, irritability, fatigue, dizziness or vertigo, tinnitus, anxiety, heart ailments, and palpitation[28,29,30]. Chronic severe annoyance induced by noise must be classified as a serious human health risk[31].

Dr. Nina Pierpont documented symptoms reported by individuals exposed to wind turbines to include: sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual

blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering when awake or asleep[32].

The American Wind Energy Association and Canadian Wind Energy Association sponsored a literature review which determined wind turbine symptoms documented by Dr. Pierpont "… are not new and have been published previously in the context of "annoyance"…" and are the "… well-known stress effects of exposure to noise[17]…". A coauthor of this literature review stated in a separate analysis: "I am happy to accept these symptoms, as they have been known to me for many years as the symptoms of extreme psychological stress from environmental noise, particularly low frequency noise … what Pierpont describes is effects of annoyance by noise – a stress effect … simply the well known effects of persistent, unwanted noise[33]…". The contents of these two references were reaffirmed by witnesses testifying under oath during a 2011 Ontario Environmental Review Tribunal[65].

2.6 Stress Effects Can Be Serious

Stress, if not controlled, can result in serious illness[34] and can affect life expectancy[35]. "The subjective experience of noise stress can, through central nervous processes, lead to an inadequate neuro—endocrine reaction and finally to regulation diseases[31]."

2.7 Mental Health Counts

Health Canada states: "Mental health is as important as physical health[36]." However the importance of mental health is not always appreciated. "Globally, many are victimized for their illness and become the targets of stigma and discrimination[37]." The WHO states:

> "For all individuals, mental, physical and social health are vital strands of life that are closely interwoven and deeply interdependent. As understanding of this relationship grows, it becomes ever more apparent that mental health is crucial to the overall wellbeing of individuals, societies and countries.
>
> Unfortunately, in most parts of the world, mental health and mental disorders are not regarded with anything like the same importance as physical health. Instead, they have been largely ignored or neglected[37]."

Many health effects of noise are psychologically mediated via the indirect pathway[15]. Some of those commenting on the health impacts of wind turbines appear to either overlook or discount mental health as a crucial element of overall well-being. During a public presentation focused on wind turbine noise and health one Ontario engineer stated "… it is almost a disservice to dwell on the negative aspects. It clearly does create health problems in certain individuals but primarily through the psychological influence and anxiety …". Some of those who consult for members of the wind energy industry have proposed the "mental and social well-being" of some individuals affected by wind turbines be traded off against the "… the larger demand for energy and its source[16]."

Consultant reports prepared for wind energy developers discuss people who subjectively evaluated themselves as disturbed by noise and state, "Regardless of whether the perceived impacts by affected individuals are physiological or psychological in nature, they are a serious matter and are considered as adverse health effects[63,64]."

It has been suggested that cognitive behaviour therapy could be used to treat those suffering adverse effects of wind turbine noise annoyance[16,17,62]. However prevention of health effects is a fundamental principle of public health policy[60] and noise management[20]. "Passively waiting for illness and disease to occur and then trying to cope with it through the health care delivery system is simply not an option[61]". Proposing treatment over prevention raises both ethical and legal considerations[38,39].

2.8 Quality of Life = Health

The president of the Canadian Wind Energy Association stated; "… the sound of wind turbines can be annoying for some individuals and that may cause them to feel some stress etcetera[40]." A 2011 Canadian Wind Energy Association media release advises: "When annoyance has a significant impact on an individual's quality of life, it is important that they consult their doctor[41]."

A 2009 Minnesota Department of Health literature review commented: "The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on quality of life[42]." Reduced or altered quality of life in the environs of wind turbines has been also documented in other studies published in 2011[9,11].

Quality of life represents a cornerstone of human health. Quality of life "… is a new name for an old concept that describes an individual's state of wellbeing[43]." Noise induced annoyance "…can mean a significant degradation in the quality of life. This represents a degradation of health in accordance with the WHO's definition of health, meaning total physical and mental well-being, as well as the absence of disease[26]."

2.9 Wind Turbine Noise and Attitudes

The willingness to accept the presence of a potential adverse effect does not mean there is no adverse effect. Those who benefit financially from wind energy projects typically waive their right to complain about noise and other adverse effects. Samples of wind turbine hosting contracts indicate participants of wind energy projects are granted the opportunity to decide whether or not they wish to be exposed to noise and visual impacts in exchange for financial compensation. The following excerpt is from a Canadian hosting agreement:

> "The Rent, in respect of the Specified Locations…represent compensation in full for…nuisance, noise, signal interference,…, casting of shadows and other inconveniences or damage…incurred by Lessor from the acts or omissions of Lessee[44]."

Non participating neighbors reporting adverse effects from wind turbine noise have been characterized as being unreasonable complainers. In one example, an adversely affected family was reportedly accused of "exaggerating and overreacting[45]". Negative attitudes toward wind turbines have been suggested as a cause of these complaints. However researchers comment that wind turbines were initially welcomed into the communities for their perceived economic[8] and/or environmental[11] benefits. "The reported adverse impacts were unexpected[10]."

Individuals who are adversely impacted often are faced with the financial and emotional burdens of retaining legal counsel to resolve these effects. The following passage is from a neighbour of a wind energy project in the United Kingdom who took allegations of private nuisance to the High Court in July 2011.

"Writing as someone who used to live 1km from a windfarm, and whose career has been involved in some way or other with public health. I make the following observations. We welcomed the wind farm, why would [*sic we*] not? We could not see the turbines from our home. We thought them to be admirable structures, a significant engineering achievement, and graceful in operation. We were completely and wholly unprepared for the noise and sleep deprivation that we immediately suffered from. None of my family have had problems sleeping before, but we did then, and being suddenly awoken in the early hours and being unable to get back to sleep night after night is very unpleasant, and rapidly makes normal day to day living almost impossible. It is well documented, and within the public domain that we tried (as other respondents have suggested) ear plugs, white noise machines, fans and medication. Nothing worked. Once we stopped sleeping at home, we were able to sleep normally again. We can sleep next to motorways, industrial sites, [*sic train*] stations and airports – but this was something else altogether. You do not habituate to it[46]."

The above nuisance case settled out of court before noise evidence was heard. "The terms of that settlement are strictly confidential, and the parties will not be answering any questions about the terms of that agreement[45]." A number of wind turbine nuisance cases have been settled out of court with non disclosure agreements[10]. Non disclosure agreements hinder opportunities to further understand what exactly the problem was and how to prevent it in the future.

2.10 Wind Turbine "Noise" on the Rise

Not all sounds are equal. "The capacity of a noise to induce annoyance depends upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time[20]."

The "…unique sound characteristics of wind farm noise and the different influences on the perception of this noise[47] …" have been noted. Wind turbine sound has a number of special sound characteristics which are identified as plausible causes for reported health effects. These characteristics include amplitude modulation[48], audible low frequency noise[49,42], infrasound[50], tonal noise, impulse noise[51] and night time noise[22].

Over the past decade wind turbines have increased in size, electrical power output and the amount of sound they produce[52]. At the same time wind turbine amplitude modulation and low frequency noise have become an increasingly significant part of the noise impact. "It must be anticipated that the problems with low-frequency noise will increase with even larger turbines[49]."

2.11 Wind Turbine Economics and Noise Guidelines

Wind turbines are being sited in close proximity to family homes in order to have access to transmission infrastructure[40]. Noise regulations can be a barrier to wind turbine development, as they can have a significant impact on wind turbine spacing, and therefore the cost of wind generated electricity[53].

Some wind turbine proponents have lobbied regulators to: increase permitted noise levels for wind turbines, remove requirements to address low frequency noise, avoid penalties for amplitude modulation.

Not all wind turbine siting guidelines are equally protective of human health. Annoyance to wind turbine noise starts at wind turbine dBA sound pressure levels in the low 30's and rises sharply at 35 dBA[22,52]. Wind turbine setback and/or noise limits vary by jurisdiction[54]. For example wind noise limits can be 55 dBA in one jurisdiction or 35 dBA in another. Some

jurisdictions apply noise limits at the property line. Others apply the limits at the façade of the building. Some jurisdictions have limits for indoor noise. Other jurisdictions consider low frequency noise, and/or amplitude modulation and/or wind shear.

Wind turbine compliance noise audits are typically based on an averaged "A"-weighted metric which is unsatisfactory for complaints of cyclical amplitude modulation and low frequency noise[55]. Furthermore wind turbine noise guidelines typically do not address the lack of night time abatement.

2.12 Sound Noise Management

The WHO published *Guidelines for Community Noise*[20] which identifies annoyance as a "critical health effect" and provides the following framework for managing noise such that human health and well-being are protected. Noise limits should be based on annoyance responses to specific noise sources and should protect humans indoors as well as outdoors. Human exposure to noise should be based on dose response relationships.

Reliance on noise guideline limits suggested by research on road, rail and air traffic noise is not appropriate for wind turbines. WHO noise guideline limits are based on research for road, rail and air traffic, not wind turbines[19, 52].

2.13 Wind Turbines in Ontario and Expected Health Impacts

The introduction of wind turbines into Ontario, Canada is a relatively recent development. Ontario wind turbines are typically sited in quiet rural settings which frequently have low population densities and can have ambient sound levels below 30 dBA[56].

Ontario wind energy projects typically undergo a provincial and sometimes a federal environmental review process. Ontario Ministry of Environment guidelines are based on an averaged "A"-weighted metric and permit noise of 40 dBA up to 51 dBA (formerly 53 dBA) depending on wind speed. Noise limits are measured at the façade of a receptor (i.e. home). Ontario does not have limits for wind turbine noise elsewhere on private property. Until 2011 the Ontario Ministry of Environment did not have a scientifically accepted field methodology to measure wind turbine noise to determine compliance or non compliance with approval limits. In August 2011 the Ontario Ministry of Environment introduced a "Compliance Protocol for Wind Turbine Noise" which explicitly excludes consideration of "health effects".

Ontario noise guidelines require a 5 dBA adjustment for other industrial noise that has amplitude modulation but not for wind turbines[19]. Ontario does not have "… measurement procedures or criteria for addressing indoor noise intrusions due to wind turbines[57] …".

Sound studies commissioned by wind energy developers or community members, and investigations by Ontario Ministry of Environment personnel have been conducted at various sites in Ontario. Assessments at some Ontario projects documented the wind turbine sound was tonal, contained low frequency components, and routinely produced an audible amplitude modulation.

Internal Ontario Ministry of Environment correspondence, obtained through a Freedom of Information Request, states "It appears compliance with the minimum setbacks and the noise study approach currently being used to approve the siting of WTGs will result or likely result in adverse effects[56] …". In 2011 the Ontario Ministry of Environment released a consultant report which concludes the sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, is "… expected to result in a nontrivial percentage of persons being highly

annoyed … research has shown that annoyance associated with sound from wind turbines can be expected to contribute to stress related health impacts in some persons[57]."

There have been numerous noise and health complaints coinciding with the commencement of operations of some Ontario wind turbine projects. In response to the lack of vigilance monitoring in Ontario, volunteers established WindVOiCe in March 2009. WindVOiCe is a self reporting health survey which follows the principles of Health Canada's Canada Vigilance Programs for reporting adverse events for prescription and nonprescription products, vaccines and other[9].

3 RESULTS

Reduced quality of life, sleeplessness and headaches are among the most common effects reported in other case studies[42]. The most common effects reported in the WindVOiCe survey included altered quality of life, sleep disturbance, excessive tiredness, headaches, stress and distress. The predicted probability of health effects diminishes with increased separation distance between the wind turbine and the participant's property. Nissenbaum et al.[8] also documented a reduction of sleep effects as wind turbine separation distances increased. These "effect versus distance relationships" are consistent with the physics of sound decay through absorption by ground and the atmosphere.

WindVOiCe catalogued other effects including migraines, hearing problems, tinnitus, heart palpitations, anxiety, and depression.

Physical living environments and socioeconomic position are acknowledged to be determinants of health[10,35,60]. "Ministry of Environment correspondence … describes how low frequency noise from Ontario IWT facilities resulted in annoyance, "sleep deprivation" and "uninhabitable" living conditions[19]." To escape the noise, some Ontarians report resorting to sleeping in vehicles, tents, trailers, basements lined with mattresses, garages, and at relatives or friends' homes[10].

Adverse social economic impacts from wind turbines are also being reported in Ontario[10]. The family home typically represents the one the largest financial and emotional investments for Canadian families[58]. Noise can have an impact on property values[20]. To protect their health some Ontario home owners reporting adverse health effects due to wind turbines have elected to sell their home. In Ontario the seller of real estate must disclose any issue which may influence a purchaser's decision to buy. The obligation to disclose the adverse effects of the neighboring wind energy project is being attributed for reduced sale prices.

In a number of cases adversely affected Ontarians have retained legal counsel and eventually negotiated financial agreements with the wind energy developer. These agreements are reported to contain non disclosure conditions which prevent the adversely affected party from discussing specific details of their experience[10].

At one Ontario wind project a number of homes were purchased from non participating residents by the wind energy developer and eventually resold for substantially lower prices[59]. Disclosure by the wind energy developer to prospective purchasers states the operation of the wind turbine facilities "…may affect the living environment of the Transferor and that the transferee will not be responsible or liable for, of and from any of the Transferor's complaints, claims, demands, suits, actions or causes of action of every kind known or unknown which may arise directly or indirectly from the Transferee's wind turbine facilities on the Leasehold Lands to the extent permitted by this Easement." The same disclosure also secures "… the right and privilege to permit heat, sound, vibration, shadow flickering of light, noise (including grey noise)

or any other adverse effect or combination thereof resulting directly or indirectly from the operation of the Transferee's wind turbine facilities."

The following testimony describes some of the adverse effects experienced by some residents living in environs of another Ontario wind project:

> "The family unit for each family has deteriorated and has been torn apart. We begged for sleep, and four families were billeted by the wind company from their homes for 90 to 180 days in motels, hotels and a rooming house. The consistent stress has broken apart the family unit—no gatherings, few or no celebrations at home. At present, one family has purchased a separate residence to live in, and two others had to, at the expense of thousands of dollars, modify their hydro connection to try and live in their homes that they've lived in for 19 to 35 years[10]."

After obtaining legal counsel five families in this Ontario wind project eventually reached a financial agreement with the developer and now live elsewhere.

4 DISCUSSION AND CONCLUSIONS

The references presented in this paper support the conclusion that, if placed too close to residents wind turbines can harm human health. Health is one of the fundamental rights of every human being and includes complete physical, mental and social well-being. Wind turbine noise can cause annoyance, sleep disturbance, stress related health impacts, reduced quality of life, degraded living conditions, and adverse social economic impacts. These effects can be psychologically mediated via the indirect pathway and can represent serious harm to human health. It is expected that at typical wind turbine setback distances and sound pressure levels a non trivial percentage of exposed individuals in Ontario will be adversely affected.

Those responsible for the production and regulation of wind turbine noise need to understand the risk to human health and adopt strategies to prevent harm. "Trade-offs" of health and/or treatment of wind turbine induced health effects can be prevented if setback distances and noise limits are developed using authoritative noise management techniques. Psycho-acoustical impacts of a noise source must be assessed in context to the soundscape being affected. Limits should be based on the physical characteristics of the specific sound source. Sound pressure level, spectral characteristics, as well as the variations of these properties over time should be assessed when determining the capacity of a noise to induce health effects.

5 ACKNOWLEDGEMENTS

The author(s) received no financial support for the research, authorship, and/or publication of this paper.

6 REFERENCES

1. *Erickson v. Director, Ministry of the Environment, Environmental Decision Case Nos. 10-121 and 10-122,* (2011, July) Retrieved from http://www.ert.gov.on.ca/english/decisions/index.htm

2. Brown County Board of Health, *Resolution Requesting Emergency State Aid for Families Suffering Around Industrial Wind Turbines*, Brown County, Wisconsin, (2012, January)

3. Hanning, C., & Evans, A., 'Wind Turbine Noise", *British Medical Journal*, BM J2012;344:e 1527, (2012)

4. Pedersen, E., & Persson Waye, K., "Perception and Annoyance Due To Wind Turbine Noise–A Dose Response Relationship", *Journal of the Acoustical Society of America*, **116**, 3460-3470, (2004)

5. Harry, A., *Wind Turbines, Noise and Health*, (2007, February) Retrieved from http://www.wind-watch.org/documents/windturbines-noise-and-health/

6. Phipps, R., Amati, M., McCoard, S., & Fisher, R. *Visual And Noise Effects Reported By Residents Living Close To Manawatu Wind Farms: Preliminary Survey Results*, (2007) Retrieved from http://www.wind-watch.org/documents/visual-and-noise-effects-reportedby-residents-living-close-to-manawatu-wind-farms-preliminarysurvey-results/

7. van den Berg, F., Pedersen, E., Bouma, J., & Bakker, R., *Project WINDFARM Perception: Visual And Acoustic Impact Of Wind Turbine Farms On Residents (Final Report FP6-2005-Science-and-Society-20, Specific Support Action, Project no. 044628)*, Groningen, Netherlands: University of Groningen and the University of Gothenburg, (2008)

8. Nissenbaum, M, Aramini J, Hanning C., *Adverse Health Effects Of Industrial Wind Turbines: A Preliminary Report*, 10th International Congress on Noise as a Public Health Problem (ICBEN) 2011, London, UK. (2011, July) Retrieved from http://www.windvigilance.com/about-adverse-health-effects/resource-centre

9. Krogh, C., Gillis, L., Kouwen, N., & Aramini, J., "WindVOiCe, A Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need For Vigilance Monitoring" *Bulletin of Science Technology & Society*, **31**, 334-345, (2011)

10. Krogh, C., "Industrial Wind Turbine Development and Loss of Social Justice?" *Bulletin of Science Technology & Society*, **31**, 321-333, (2011)

11. Shepherd D, McBride D, Welch D, Dirks KN, Hill EM, Evaluating the Impact of Wind Turbine Noise on Health-Related Quality Of Life. *Noise Health* **13**:333-9,(2011)

12. Rand R., Ambrose S., Krogh C., Occupational Health and Industrial Wind Turbines: A Case Study, *Bulletin of Science Technology & Society*, **31**: 359,(2011)

13. Health Canada, *Canadian Handbook on Health Impact Assessment: Vol.1. The Basics. A Report Of The Federal/Provincial/Territorial Committee On Environmental And Occupational Health*, (2004)
Retrieved from http://www.who.int/hia/tools/toolkit/whohia063/en/index

14. World Health Organization, *Preamble To The Constitution Of The World Health Organization As Adopted By The International Health Conference, New York, 19-22 June, 1946; Signed On 22 July 1946 By The Representatives Of 61 States*, *(Official records of the World Health Organization, no. 2, p. 100),* (1948, April 7)

15. World Health Organization, *Night Noise Guidelines For Europe*, (2009) Retrieved from http://www.euro.who.int/data/assets/pdf_file/0017/43316/E92845.pdf

16. Knopper & Ollson, "Health Effects and Wind Turbines: A Review of the Literature" *Environmental Health*, **10**:78, (2011)

17. Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B., *Wind Turbine Sound and Health Effects: An Expert Panel Review*, Washington, DC: American Wind Energy Association and Canadian Wind Energy Association. (2009)
Retrieved from
http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf

18. Rideout, K., Copes, R., & Bos, C., *Wind Turbines And Health*, National Collaborating Centre for Environmental Health. (2010).
Retrieved from http://www.ncceh.ca/sites/default/files/Wind_Turbines_January_2010.pdf

19. Horner B, Jeffery R., Krogh C., "Literature Reviews On Wind Turbines And Health : Are They Enough?", *Bulletin of Science Technology & Society* **31**: 399, (2011)

20. Berglund, B., Lindvall, T., & Schwela, D. H., *Guidelines for Community Noise,* Geneva, Switzerland: World Health Organization, (1999)

21. The Canadian Wind Energy Association, *The Sights and Sounds of Wind*, Fact Sheet, Retrieved from
http://www.canwea.ca/images/uploads/File/NRCan_-_Fact_Sheets/7_visual_sound.pdf

22. Pedersen, E., Bakker, R., Bouma, J., & van den Berg, F., "Response To Noise From Modern Wind Farms In The Netherlands", *Journal of the Acoustical Society of America*, **126**, 634-643, (2009)

23. Health Canada, Community Noise Annoyance, *Its Your Health,* (2005, September)

24. Michaud, D. S., Keith, S. E., & McMurchy, D., "Noise Annoyance in Canada", *Noise Health,* **7**, 39-47. (2005)

25. Pedersen, E., & Persson Waye, K., "Wind Turbine Noise, Annoyance and Self-Reported Health and Well Being in Different Living Environments", *Occupational and Environmental Medicine*, **64**, 480-486, (2007) doi:10.1136/oem.2006.031039

26. Suter, A. H., *Noise and Its Effects*, Washington, DC: Administrative Conference of the United States, (1991) Retrieved from http://www.nonoise.org/library/suter/suter.htm

27. Niemann Dr Hildegard, Maschke Dr Christian, *LARES Final Report Noise Effects and Morbidity,* World Health Organization, (2004)

28. Leventhall, G. (with Pelmear, P., & Benton, S.), *A Review Of Published Research On Low Frequency Noise And Its Effects*, (2003)
Retrieved from http://westminsterresearch.wmin.ac.uk/4141/

29. DeGagne, D. C., & Lapka, S. D., "Incorporating Low Frequency Noise Legislation for the Energy Industry in Alberta, Canada", *Journal of Low Frequency Noise, Vibration and Active Control*, **27**,105-120, (2008)

30. Schust, M., "Effects Of Low Frequency Noise Up To 100 Hz", *Noise Health*, **6**, 73-85, (2004)

31. Maschke, C., & Niemann, A., "Health Effects Of Annoyance Induced By Neighbour Noise", *Noise Control Engineering Journal*, **55**, 348-356, (2007)

32. Pierpont, N., *Wind Turbine Syndrome: A Report on a Natural Experiment*, Santa Fe, NM: K-Selected Books, (2009)

33. Leventhall, H. G., *Wind Turbine Syndrome: An Appraisal*. Testimony before the Public Service Commission of Wisconsin (PSC Ref#121877 20), (2009, October)

34. Health Canada, "Mental Health - Coping With Stress", *Its Your Health,* (2008, January)

35. Manuel DG, Perez R, Bennett C, Rosella L, Taljaard M, Roberts M, Sanderson R, Meltem T, Tanuseputro P, Manson H., *Seven more years: The impact of smoking, alcohol, diet, physical activity and stress on health and life expectancy in Ontario,* An ICES/PHO Report. Toronto: Institute for Clinical Evaluative Sciences and Public Health Ontario, (2012)

36. Health Canada, "Mental Health Mental Illness", *Its Your Health*, (2006, May)

37. World Health Organization, *The World Health Report: 2001: Mental Health: New Understanding, New Hope*, (2001)

38. Phillips, CV, Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents, *Bulletin of Science Technology & Society,* **31**: 303, (2011)

39. Shain, M, Public Health Ethics, Legitimacy, and the Challenges of Industrial Wind Turbines: The Case of Ontario, Canada, *Bulletin of Science Technology & Society*, **31**: 256, (2011)

40. Hornung, R., Interview on Business News Network (Video), (2010, March 4) Retrieved from http://watch.bnn.ca/clip272347

41. The Canadian Wind Energy Association, *The Canadian Wind Energy Association Responds To October 14, 2011 Statement By Wind Concerns Ontario*, Media Release (2011, October 14) Retrieved from http://www.canwea.ca/media/release/release_e.php?newsId=133

42. Minnesota Department of Health, *Public Health Impacts Of Wind Turbines*, (2009, May)

43. New Zealand WHOQOL Group, *Quality of Life*
Retrieved from http://www.rover.org.nz/whoqol/Pages/quality_of_life.html

44. *Surface Lease for Wind Power Project*, Canada

45. *Couple Settle With Wind Farm Operators Over 'Unbearable Hum'*, *The Telegraph,* (2011, November 30)

46. Davis, Sarah Jane, "Wind Turbine Noise", *Posted comment British Medical Journal, Retrieved from* http://www.bmj.com/content/344/bmj.e1527/rr/580518

47. New South Wales. Parliament. Legislative Council. General Purpose Standing Committee No. 5, *Rural Wind Farms* (2009, December)

48. Leventhall, G., "Infrasound from Wind Turbines: Fact, Fiction or Deception", *Canadian Acoustics*, **34**, 29-36, (2006)

49. Møller, H., & Pedersen, C. S., "Low-Frequency Noise from Large Wind Turbines", *Journal of the Acoustical Society of America*, **129**, 3727-3744, (2011)

50. Salt, AN, and Kaltenbach, JA, "Infrasound From Wind Turbines Could Affect Humans", *Bulletin of Science Technology & Society*, **31**: 296, (2011)

51. Thorne, B. "The Problems With Noise Numbers For Wind Farm Noise Assessment" *Bulletin of Science, Technology & Society*, **31**, 262-290, (2011)

52. Shepherd D., Billington R., "Mitigating the Acoustic Impacts of Modern Technologies: Acoustic, Health, and Psychosocial Factors Informing Wind Farm Placement", *Bulletin of Science Technology & Society*, **31**: 389, (2011)

53. Canadian Wind Energy Association, Sound Level Limits for Wind Farms, (2004, June 15)
Retrieved from
http://www.canwea.ca/images/uploads/File/Wind_Energy_Policy/Environmental_Issues/SoundLevels.pdf

54. Walsh O., *No Global Standards*, First International Symposium on Adverse Health Effects from Wind Turbines The Global Wind Industry and Adverse Health Effects: Loss of Social Justice? Picton, Prince Edward County, Ontario, Canada October 29-31, 2010
Retrieved from http://www.windvigilance.com/international-symposium.

55. Richarz, W., Richarz, H., & Gambino T., *Correlating Very Low Frequency Sound Pulse To Audible Wind Turbine Sound*, Paper presented at the Fourth International Meeting on Wind Turbine Noise, Rome, Italy, (2011, April 12-14)

56. Ontario Ministry of Environment, *Internal Correspondence,* Obtained through Freedom to Information request (2011)

57. Howe Gastmeier Chapnik Limited, *Low Frequency Noise and Infrasound Associated With Wind Turbine Generator Systems: A Literature Review*, (2010, December 10)

58. Canada Mortgage and Housing Corporation. *Is Home Ownership Right For You?* Retrieved from http://www.cmhc-schl.gc.ca/en/co/buho/hoststst/hoststst_001.cfm 27/

59. Lansink Appraisals and Consulting, *Analyses of Purchases / Sales by Wind Turbine Controlled Corporations, Diminution in Land Value Injurious Affection,* (2012, January)

60. *Health, Not Health Care – Changing the Conversation. 2010 Annual Report Of The Chief Medical Officer Of Health Of Ontario To The Legislative Assembly Of Ontario*. Queen's Printer for Ontario 2011, (2011, November)
Retrieved from
http://www.health.gov.on.ca/en/public/publications/ministry_reports/cmoh_10/cmoh_10.pdf

61. Standing Senate Committee on Social Affairs, Science and Technology, Subcommittee on Population and Health. *A Healthy, Productive Canada: A Determinant of Health Approach.* (2009, June) Retrieved from:
http://www.parl.gc.ca/Content/SEN/Committee/402/popu/rep/rephealth1jun09-e.pdf

62. Leventhall Geoff, *Development Of A Course In Computerised Cognitive Behavioral Therapy Aimed At Relieving The Problems Of Those Suffering From Noise Exposure, In Particular, Exposure To Low Frequency Noise (NANR 237)*, Queen's Printer and Controller of HMSO 2007.(2009, June)

63. Jacques Whitford Stantec Limited, *Byran Wind Project Environmental Review Report, Prepared for SkyPower Corp.*, (2009, August 25)

64. Stantec Consulting Ltd., *Ostrander Point Wind Energy Design and Operations Report, Prepared for: Gilead Power Corporation*, (2010, September)

65. Erickson v. Director, Ministry of the Environment, Environmental Review Tribunal, Case Nos. 10-121 and 10-122, (Official Transcripts) Appeal of Renewable Energy Approval, Kent Breeze Corp. and MacLeod Windmill Project Inc. (Kent Breeze Wind Farms) c/o Suncor Energy Services Inc.

66. Chief Medical Officer of Health of Ontario, *The Potential Health Impact of Wind Turbines*, (2010, May)