Comment Letter V

Dear Mr Schneider,

The following message bounced, so I have removed some of the documents and will send separately in 2 other emails.

Kind regards,

Dr Sarah Laurie

Begin forwarded message:

From: Dr Sarah Laurie <sarah@waubrafoundation.com.au>
Date: December 23, 2011 2:26:53 PM GMT+10:30
To: Matthew Schneider <Matthew.Schneider@sdcounty.ca.gov>
Cc: Donna Tisdale <tisdale.donna@gmail.com>
Subject: Comments on Wind Energy Zoning Ordinance & Plan Amendment POD 10-007; LOG NO 09-00-003; SCH NO 2010091030

Attn:
Eric Gibson, Director
Matthew Schneider, Project Manager
Dept of Planning and Land Use
5201 Ruffin Road, Ste B
San Diego, CA 91923
Comments on Wind Energy Zoning Ordinance & Plan Amendment POD 10-007; LOG NO 09-00-003; SCH NO 2010091030

Dear Mr Gibson,

I am writing to you at the request of Donna Tisdale, who has alerted me to the ongoing denials of any human health impacts resulting from the installation and operation of industrial wind turbines. V-1

You need to be aware that this situation is no longer tenable, for a number of reasons, and anyone who continues to promote this erroneous view is dangerously misled.

There is mounting evidence wordwide that wind turbines do indeed cause serious harmful effects on human health, which has now been acknowledged by the judiciary in Ontario, Canada, on the basis of expert evidence provided to that court. I have reproduced the relevant section of that particular judgement below: V-2

Response to Comment Letter V

Waubra Foundation
Dr. Sarah Laurie
December 23, 2011

V-1 The County acknowledges this introductory comment.

V-2 There is much disagreement among experts regarding potential adverse health effects from wind turbine projects. The County's Health and Human Services Agency prepared a position paper on the health effects of wind turbines on July 10, 2012. It concluded that "there are no direct pathological effects from wind turbines and that any potential impact on humans can be minimized by following existing planning guidelines." This paper can be viewed as part of the staff report to the July 20, 2012 Planning Commission starting on Page 1-53 available at http://www.sdcounty.ca.gov/pds/advance/POD_10-007_july202012pcstaffreport.pdf. It should be noted that disagreement among experts does not result in an inadequate EIR (CEQA Guidelines Section 15151).

This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. *The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree."* (p. 207) (*Emphasis added*)

V-3

[i] Environmental Review Tribunal, Case Nos.: 10-121/10-122 Erickson v. Director, Ministry of the Environment, Dated this 18th day of July, 2011 by Jerry V. DeMarco, Panel Chair and Paul Muldoon, Vice-Chair, http://www.ert.gov.on.ca/english/decisions/index.htm

There is an ever increasing number of adverse event reports, now numbering in the thousands rather than the hundreds, from around the world. Professor Carl Phillips analysis of the existing evidence is particularly pertinent in that respect, and I have attached his paper, which can also be downloaded from the following website:
http://www.wind-watch.org/documents/properly-interpreting-the-epidemiologic-evidence-about-the-health-effects-of-industrial-wind-turbines-on-nearby-residents/

As a result of the ongoing field work which the Waubra foundation has been conducting over the past 18 months, we have now spoken to over 90 people who have clearly suffered adverse health impacts, many serious, which have directly resulted from the installation and operation of industrial wind turbines close to their homes or their workplaces. Because of the ongoing denials of a problem because of "lack of peer reviewed published evidence" the Foundation took the step of issuing an Explicit Cautionary Notice on 29th June, 2011. It is attached below, and I urge you to read it carefully and consider the implications of proceeding without due regard for human health, having received it. It was drafted by a former judge of the Supreme Court of Victoria, Justice Clive Tadgell, and myself. Justice Tadgell is one of the directors of the Waubra Foundation. I have also attached my submission to the Australian Federal Senate inquiry, which gives some background to the information which led to the Explicit Cautionary notice being issued.

V-4

Since that notice was issued, there are a number of other important papers and reports which have emerged, which again I would urge you to read and take notice of. Some of these, or summaries of the recent evidence, are attached below. It is no longer justifiable to say "there is no peer reviewed Published Evidence" as it is starting to pile up. A notable paper is that by the Danish Acoustician Professor Moller, and his Swedish colleague, Professor Pedersen. (available to download from http://www.windturbinesyndrome.com/news/2011/the-bigger-they-are-the-more-lfn-denmark/)

There is also old information from peer reviewed published studies about the well known effects of low frequency noise on human health. I have attached a paper by Professor Leventhall and

V-5

V-3 As noted in response to comment V2 above, the County does not agree with the commenter's position that wind turbines have a direct link to human health impacts. However, the County agrees that large turbines have adverse effects on people, such as noise disturbance, if placed too close to residents. This is consistent with the analysis in the DEIR (see DEIR Section 2.8.1).

V-4 The County appreciates the information provided in this comment. This comment does not identify any deficiencies in the DEIR.

V-5 The County agrees that low frequency noise from turbines can have adverse effects on humans. This issue is evaluated in DEIR Section 2.8.1 and is the basis for including low frequency noise provisions in the draft ordinance.

colleagues, which make it clear that acousticians are well aware that low frequency noise from other sources can cause serious problems. What has not yet been properly recognised is that "annoyance" is actually hiding some very serious clinical pathology, some of which can be life threatening (Tako Tsubo Heart attacks, serious clinical depression, and acute hypertensive crises). This is not surprising, as so few medical clinicians are aware of these problems, and acousticians are not trained as clinical diagnosticians.

V-5 Cont.

The Australian Federal Senate Inquiry recommendations have taken notice of this emerging evidence that there is indeed a real problem, and have recommended research, amongst other things. The report relating to that inquiry and the recommendations themselves are available from the following website:
http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/report/index.htm

Even the identification of a direct causative mechanism of infrasound and low frequency noise as part of the causative agents of injury to health is being described - please see the very recent report from Falmouth by noise engineers Steven Ambrose and Robert Rand, attached below but also available from the following weblink, (http://www.windturbinesyndrome.com/news/2011/acousticians-confirm-wind-turbine-syndrome/). There are growing concerns amongst some of us working in the area that the cognitive and memory problems being noted are evidence of a brain injury process which with chronic exposure can result in permanent damage and functional defecits. The fact that infrasound can affect brain waves is illustrated in the Falmouth study, and clearly extensive further research into this area alone is required. I would also urge you to look at the following weblinks for the interviews of Rand and Ambrose's personal experiences in Falmouth.

http://blip.tv/windturbinesyndrome/dr-nina-pierpont-interviews-robert-rand-of-rand-acoustics-5803063

http://blip.tv/windturbinesyndrome/dr-nina-pierpont-interviews-acoustician-steve-ambrose-5818775

(I have sent the Falmouth Study separately)

Finally, of particular relevance, is the report by Mr Steven Cooper, an Australian Acoustician, relating to a current and proposed Infigen development - both in New South Wales. Mr Cooper has confirmed with his measurements that not only is the Capital wind development not in compliance with the current noise regulations, but he has also shown that there are levels of infrasound and low frequency noise inside people's homes which are consistent with the symptoms they are reporting, and which have been reported globally in conjunction with operating wind turbines.

(I have sent Mr Cooper's study separately)

V-6

V-6 The County appreciates all of the information provided in this comment; it has been thoroughly reviewed. This information is not inconsistent with the existing content of the DEIR.

The time for denial of any adverse health impacts is well and truly over, and the time for action is right now. In the meantime it is imperative that a precautionary approach is adopted IMMEDIATELY with respect to the siting of any new wind projects.

Finally, I request that you and all other relevant decision makers for these projects view the Waubra foundation's recent DVD on the issue of the need for action on an emerging global public health problem, and thoroughly investigate the references which are in the video citations document. The Waubra Foundation DVD is accessible via the following weblinks - the latter is one which can be downloaded and copied if required.
http://www.youtube.com/user/WaubraFoundation, http://www.wind-watch.org/video-waubra.php. We have deliberately made it freely available.

V-6
Cont.

Could you please acknowledge receipt of this email and its contents.

Yours sincerely,

Dr Sarah Laurie

Dr Sarah Laurie BMBS Flinders
Medical Director

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Researching the Health Effects of Wind Turbines close to Human Habitation.

ATTACHMENT TO LETTER V

Properly Interpreting the Epidemiologic Evidence about the Health Effects of Industrial Wind Turbines on Nearby Residents

Carl V. Phillips, PhD
Populi Health Institute

July 19, 2011

*This is a preliminary draft of the following article in press:

Carl V. Phillips, "Properly Interpreting the Epidemiologic Evidence about the Health Effects of Industrial Wind Turbines on Nearby Residents," Bulletin of Science, Technology, and Society, vol. 31, no. 4 (August 2011), pp. 303-315.

Abstract

There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type diseases, at a nontrivial rate. The bulk of the evidence takes the form of thousands of adverse event reports. There is also a small amount of systematically-gathered data. The adverse event reports provide compelling evidence of the seriousness of the problems and of causation in this case because of their volume, the ease of observing exposure and outcome incidence, and case-crossover data. Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including that the evidence does not "count", the outcomes are not "real" diseases, the outcomes are the victims' own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist. These claims appeared to have swayed many non-expert observers, though they are easily debunked. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than kilometers of distance, could sufficiently mitigate the effects. There has been no policy analysis that justifies imposing these effects on local residents. The attempts to deny the evidence cannot be seen as honest scientific disagreement, and represent either gross incompetence or intentional bias.

Introduction

There is overwhelming evidence that large electricity-generating wind turbines (hereafter: turbines) cause serious health problems in a nontrivial fraction of residents living near them. These turbines produce noise in the audible and non-audible ranges, as well as optical flickering, and many people living near them have reported a collection of health effects that appear to be manifestations of a chronic stress reaction or something similar. However, many commentators (dominated by those who stand to profit from national government subsidies for building wind turbines, particularly energy companies and local governments) have repeatedly claimed that there is no evidence of risk. This appears to be widely believed by those unfamiliar with the evidence but who believe that turbines are an eco-friendly energy source (a claim that is subject to debate) and think that anything "green" must be harmless to people.

While it is typical for industries and their supporters to downplay risks and argue that the benefits make the risks worthwhile, the wholesale denial of the evidence by both business and government in this case is reminiscent of such claims as "there is no evidence that smoking causes cancer" or "Iraq has weapons of mass destruction". However, unlike most industry denials or *casus belli*, where critical thinkers know to exercise some skepticism before accepting the claim, the denial of the evidence of turbines seems to have produced widespread credulity among those who would be expected to know better. This may be because the epidemiologic evidence is complicated and the attempts to deny it sound like the language of science. In response to that abuse of science, the goal of this paper is to empower interested observers to understand the nature and quality of the epidemiologic evidence and the weakness of the common arguments used in attempts to deny it.

It is argued here that there is ample evidence that turbines cause a constellation of health problems, and attempts to deny this involve claims that are contrary to proper methods of scientific inference. Moreover, there is no basis for claiming that current regulations and recommendations are sufficient to avoid substantial risk, and those who claim otherwise do so without any basis. Indeed, ironically, what is often presented as evidence that there are no risks shows no such thing, but does demonstrate that most claims about what constitutes sufficient regulation cannot be scientifically. Moreover, the balance of the necessary ethical analysis seems never to have been performed. Given these observations and consideration of public policy ethics, it is difficult to see how most of the ongoing siting of new turbines can be justified.

A brief review of the epidemiologic evidence

For those not familiar with the term, epidemiology refers to the study of health outcomes and exposures in people for purposes of making assessments about population health. The critical feature is the studying of actual health outcomes in actual people, as opposed to other sciences (like toxicology or, most relevant in the present case, acoustics) which might help predict health outcomes but can be quite wrong about them. Those other sciences sometimes suggest possible effects that the epidemiology shows do not actually occur to a measurable degree and other times fail to predict the health effects that really do occur. Epidemiology is a quantitative science, though the quantification ("effect estimates") that is the preferred endpoint for most epidemiologic research is not always possible, as in the present case. Most, but not all epidemiology, focuses on whether a particular *exposure* (possible cause experienced by people) causes a disease outcome. While epidemiology often depends on observational evidence,

sometimes experiments can be done; clinical trials are the most familiar, but a different kind of experiment has been done in the case of turbines.

There are many different types of evidence that contribute to epidemiologic knowledge. While the majority of formal epidemiologic studies use only three or four study designs, there are numerous other types of studies and sources of information. As with any science, when engaging in a directed inquiry to answer a particular question, one uses what information is available and purpose-builds further information-gathering, and often such information and study design differs from the most common study types. Indeed, in the present case some information is available from the common study types, but the vast majority comes from other sources, particularly *adverse event reports* (a particular type of what are known as case studies, sometimes denigrated as "anecdotes", that generally report on the rapid onset of a disease which appears to be related to a particular exposure) many of which involve *case-crossover* experiments. Both of these are useful and well accepted sources of epidemiologic information, and since they are intuitively recognized by both experts and lay-people seeking to assess whether an exposure is causing disease outcomes, people have collected this information for years (though it is not clear that anyone working in the area had identified the established terminology and it established history in the science value before I pointed them out last year).

Large collection of evidence

Most of the adverse event reports are self-published by those concerned about the health effects experienced by themselves or family members in the interest of contributing to public health knowledge on the subject. Most of these are yet to be organized, although efforts are underway. Others have been collected more systematically, such as the WindVOiCe collection

from Ontario (Krogh et al. 2011), the scholarly book by Pierpont (2009), and in a paper by Harry (2007). Since several research groups and NGOs have collections that number in the three-figure range, it seems safe to conclude that the total number published or collected in some form is in the four-figure range, and it is quite conceivable that the total number of adverse event reports numbers in five figures.

Excerpts from three of these from my research group's collection appear in the Appendix to illustrate some of the points that follow. These three were self-published by the authors on the web and are fairly typical, though they were chosen because they were good examples, not because they are somehow perfectly representative of the collection. The reports have been abridged to remove information not presently relevant, and to reduce length.

In cases of emerging and unpredictable disease risk, adverse event reports are the cornerstone of public health research. Since it is obviously not possible to study every possible exposure-disease combination using more formalized study methods, just in case an association is stumbled upon, collecting reports of disease cases apparently attributable to a particular exposure is the critical first step. The most familiar examples of hazards revealed by adverse event reporting are infectious disease outbreaks or side effects from pharmaceuticals, but the case of turbines and health also fits the pattern. Pharmaceutical regulators rely heavily on clearinghouses they create for adverse event reporting about drug side effects (and often become actively concerned and even implement policy interventions based on tens of reports). The WindVOiCe report collection is an example of this same well-accepted kind of active-recruiting data collection system.

As explained in the next few sections, useful self-reporting of adverse events is only possible for particular types of exposures and outcomes, but exposure to turbines and many of the reported health effects are just those types of exposures and outcomes.

Reasons the adverse event reports are compelling

Adverse event reports are under-appreciated as a source of evidence. The main reason for this seems to be overgeneralization from cases where they are indeed uninformative by those who do not understand what characteristics exposures and outcomes must have for them to be informative. It is always possible to find a single case study of an exposure-disease combination because even if there is no relationship between an exposure and a disease, it is statistically inevitable that someone will have both by coincidence. Thus, when political activists dig up a story about one such individual ("here is someone who had that exposure, and look what happened to him!"), we should be skeptical. This is especially true when the disease in question occurs frequently in the population and it is not possible to simply "see" the exposure that triggered it, like common cancers or heart disease. Many people get those diseases (and thus it is not difficult to find a few examples), the exposures that trigger them are invisible, and we cannot identify the onset to associate it with a proximate exposure. The challenge is greater still when the exposure itself is vague and difficult to precisely define, like "lived near the chemical factory". In such cases, it is nearly impossible to learn much from reports of adverse events, and indeed claims about a particular cause of one person's case of the disease can almost never be justified, and so more systematic studies are needed.

The reports about the effects of turbines are not such a case. The sheer volume of reports elevates the evidence beyond the few coincidental cases that can usually be found. The quantity

further tells us that the effects go beyond a few rare individuals who are extremely susceptible. It is a legitimate limitation of adverse event reporting, no matter how voluminous, that it does not allow an estimate of what portion of the exposed population suffers health effects. There are undoubtedly similar effects among those who have not made the effort to publish the information, but we can only guess how common they are. It should be noted, however, that pharmaceutical regulators often make decisions based on exactly that guess.

Moreover, most reported health problems are similar across reports and are plausibly related to each other and the exposure. As illustrated by the examples in the appendix, there is a core list of symptoms – sleep disorders, headaches, mood disorders, inability to concentrate, tinnitus, vestibular (balance) problems – appearing in most reports. The commonly reported problems all exist at the border of the psychological and physical, and can all be caused by either of two very plausible effects of wind turbine exposure: stress reactions or vestibular disturbance. There are also a few reports of hypertension and other mortality-causing conditions, though since this is difficult for individuals to monitor themselves it would be unlikely to appear in most adverse event reports.

The Appendix examples also illustrate that some people attribute various other conditions they are experiencing to the turbines; this is not surprising, but the volume of reports lets us sort out rare coincidences (which can indeed generate misleading "anecdotal evidence" if a single story is treated as overly informative) from common patterns. We need not, and should not, simply accept the assertion of one individual or their clinicians about causation, assertions which appear in most of the adverse event reports. Rather, we focus on the consistent patterns of diseases that occur after exposure onset. (It is possible that mining the case reports more thoroughly will reveal apparent associations to diseases that were not previously believed to have

been caused by turbines; such research is ongoing.) If people were complaining only about a collection of seemingly unrelated ailments, without the core overlap, it would suggest that they were just blaming the turbines for all their coincidental problems. But that is clearly not the pattern that emerges.

Most important, in contrast with exposures like invisible chemicals and diseases like cancer, individuals are capable of recognizing both the exposure and outcomes. Local residents are quite capable of observing that they are detecting noise or other effects. Moreover, people are capable of detecting their own insomnia, mood disorders, inability to concentrate, etc. Even more importantly, they are capable of detecting the *incidence* (i.e., onset) of these problems as well as when they cease, and while these problems are fairly prevalent in the population at any given time, their incidence is relatively uncommon and very often has a proximate cause.

For a relatively common condition, if we only had *prevalence* measures (i.e., how many people have the condition at any point in time), then in order to conclude that those living near turbines have a higher rate of the condition we would want to compare their rates to that of similar people not living near turbines. Similarly, if we were talking about cancer (where epidemiologists refer to the diagnosis as the incidence for convenience, but actually have no idea when the cancer initially began growing) we would want such a comparison. But for something that is very rare (e.g., not *having* a pattern of severe insomnia, which is not rare, but having that pattern *start a particular week*, which is) we can conclude the incidence rate is elevated without an explicit comparison. For example, many people have headaches at any given time, but if you have one that started at the time you suffered a trauma there is a good chance the trauma caused it because the probability of a headache starting at just that minute by coincidence is very low. Thus, people are quite capable of determining that incidence of these health problems occurs

after exposure to moving wind turbines begins, unlike claims about what caused a particular cancer where such observations are not possible. Some supposed experts who have merely memorized a few simplistic rules of thumb from first-year epidemiology classes are unlikely to understand this, but the knowledge of that incidence and its timing is compelling evidence of causation even without a formal comparison group.

The above observations alone show that the adverse event reports are strong evidence for a causal relationship. The fact that many of the published adverse event reports include case-crossover observations and experiments push the evidence beyond a hint of plausible doubt.

A case-crossover study is one of the most compelling sources of epidemiologic data. It consists of observing whether someone's outcomes change as their exposure status changes. This is often not possible because the outcomes only happen a single time as a result of long-term exposure (e.g., cancer) or the exposure cannot be changed. But the observed effects of turbine exposure lend themselves perfectly to such studies because the exposure is transient and the effects, while not instantaneous in their manifestation or dissipation, are generally transient over a period of days or weeks at most. Thus, unlike a case of a lifelong exposure or non-transient disease, where we can only make one observation about disease and outcome per person, the effects of turbines allow multiple observations by the same person, including experimental interventions.

The case-crossover study design was first formally documented as a method for epidemiologic inquiry by Maclure (1991) though undoubtedly it was recognized as extremely useful for drawing conclusions about health effects from before the time our ancient ancestors achieved the rank of *H.sapiens*. A case-crossover study is the most natural form of scientific inquiry: "I ate that and my stomach hurt; I did not eat it again for a while and had no problem; I

ate it again and my stomach hurt again; I think I there is a causal relationship here". This natural understanding of scientific inference is why such a large portion of the adverse event reports include crossover data. People observe, and report, that the exposure stops when the wind is not blowing or the subjects remove themselves from the area for a while, or especially when they relocate, and they observe whether the health problems abate. Some of these crossovers are observational (the change in exposure status was unplanned) but many are experimental (people intentionally avoid the exposure for a while to see if their health problems abate). Most of the reported crossover data confirms the causal inference that comes from the initial crossover from unexposed to exposed, the start of operations of the nearby turbines, which would be the only observation possible if it were impossible for exposure status to change again (as it is with such exposures as "ever smoked", "received a high dose of radiation", or "got older"). The examples in the Appendix include several of the common versions of crossover data, including complete relief upon relocating, the ability to sleep well when staying somewhere other than the subject's own home, and reactions to whether the wind was blowing through the turbines at any given moment.

An additional feature of the data in this case is *revealed preference* information about individuals' conviction regarding the causal relationship and intensity of costs inflicted upon them. Many people report expending substantial resources – retrofitting their houses to reduce noise, selling their properties at a loss, or even abandoning their homes without being able to sell them – in order to try to reduce the health impacts. (The Appendix includes examples of such revealed preference.) Thus, rather than just claiming they were confident about the causal relationship (perhaps thanks to personal case-crossover experiments) and describing the intensity of their suffering, they "put their money where their mouth is" and endure great expenditure,

demonstrating great confidence in their assessment and that the magnitude of the suffering warrants such expenditure. Similar revealed preference can be found in the inability of owners of property near turbines to be able to sell it at a price comparable to other homes or land that is not near turbines. It is sometimes claimed that few people believe there are harmful effects or that they would experience them if they lived near turbines, but property values and sales collapse only if almost everyone is uninterested in living there. If merely a few people believed the claims that there were no problems, and were willing to intentionally relocate to live near turbines, then they would take advantage of the bargains and move in; alternatively, speculators – perhaps the energy companies or local turbine proponents – would snap up the bargains. This is apparently not happening, suggesting that no substantial number of people, even those making the claims, genuinely believe that the turbines are harmless.

In sum, the present situation lends itself perfectly to having useful adverse event data, in terms of exposure and outcome that are easily identified, incidence times that are easily identified, the possibility of case-crossover data, and the possibility of revealed preference. The empirical reality is that we have an enormous volume of data, the outcomes reported are plausibly related, many people have performed case-crossover experiments that support the conclusions, and there is indeed revealed preference data.

This still leaves the inherent limitations of this type of non-systematically gathered data: Because the data does not have known sampling properties from a well-defined population, it does not itself tell us how many others might have reported adverse events had they experienced them, but did not. This information is the denominator that would be required to calculate the portion of all exposed people who experienced the adverse events. We have some information that lends itself to estimating that figure, from a handful of systematic studies and using

estimates from where there was a focused effort to collect all local adverse event reports, but not as much as we would like. The data we have also offers limited opportunity to estimate how much the risk changes with characteristics (in particular, that means we do not know how far away turbines need to be from residences to reduce the risk below some particular level).

Nevertheless, in terms of demonstrating that there is a substantial risk of serious health problems, the adverse event reports are more compelling than any small number of systematic studies could be. Moreover, the sheer volume of data makes it possible to mine it for some information that is normally only available from systematic studies, like the effectiveness of crossovers at eliminating the health problems and the dose (distance) response; such mining is underway.

Systematic epidemiologic evidence

While not providing as much information as the adverse event reports, the few systematic studies (with data gathered from a defined population, allowing calculation of outcome prevalence), offer the reassurance that different sources of information support the same conclusions.

There is a small collection of systematic studies from Europe by Pedersen and colleagues (2004, 2007, 2009, 2010). These studies suggest that some substantial portion of exposed individuals experience harms, some of which constitute health problems by any modern definitions of health. The studies have various limitations, but they provide a quantification of a nontrivial number of cases. Phipps (2007) also tends to support the claim. Nissenbaum et al. (2011: personal communication) was the most effectively purpose-built study to date. It surveyed residents living near turbines about most of the above-mentioned health conditions and

compared them to similar people living further away. The results (unpublished at the time of this writing) appear to support most of the widely-stated hypotheses about the health effects of nearby turbines. Importantly, there do not appear to be any systematic studies whose results suggest conclusions contrary to those we draw from the adverse event reports. In particular, there is no evidence to support the claim that the relevant health problems are similar in unexposed and exposed populations.

Attempts to deny the epidemiologic evidence, and their fundamental flaws

Because of the revenue that is at stake from government subsidies to wind power producers (including to land owners and local governments), there are wealthy organized interests who would prefer everyone doubt that the observed health problems exist. There also appears to be some "not invented here syndrome", with some acousticians and clinicians resenting the fact that they cannot explain the observed health problems, and thus seeking to deny the epidemiology. Whatever the motivation, there has been a pattern of anti-scientific claims aimed at denying the evidence. While there is individual variation, a pattern has emerged within the denial tactics (and that word choice is intentional: it is difficult to see these as anything other than directed efforts to secure a particular goal). The following divides these into three categories and explains why each of the common arguments is groundless. While this does not cover every single argument anyone makes, it is comprehensive in the sense that I am aware of no common or potentially-credible argument against the validity of the epidemiologic evidence that is not addressed here.

<u>1. Pretending that there is no evidence of health effects</u>

Many pro-turbine reports sponsored by industry or government simply ignore all of the adverse event reports. Any reader limiting himself to those supposed summaries of the evidence would not even be aware of the majority of the evidence. Obviously this is blatantly anti-scientific conduct. It is perfectly legitimate to argue that the ostensible evidence against your claim is uninformative or wrong, but anyone pretending it does not exist is attempting to mislead their readers and is presumably not confident their claims can stand up to the evidence.

When turbine proponents acknowledge the evidence and seek to deny its usefulness, they are more honest, but no more convincing. Many such denials translate roughly into, "we do not recognize the informative value of adverse event reporting and case-crossover studies, and therefore we are going to declare they are not informative." In practice this differs little from simply pretending there is no information – no one ever admits, "there are thousands of case studies that report crossover data that correspond to the causal claim", before going on to argue that we should not believe them. But it bears separate mention because it is common, particularly among the epidemiologists from consulting firms that industry likes to hire. Their claims are not merely that some types of evidence are more useful than others when answering a particular question (which is true) or that there is some rigid epistemic hierarchy wherein one type of study always trumps another (which is false, but is commonly believed by non-experts who know a bit about the subject), but sometimes that there are only two types of epidemiologic studies.

These authors' limited understanding of epidemiologic methods may stem from the fact that most of their work is defending against claims of cancer and other diseases that have the characteristics described above, where it is difficult (but not impossible) to learn much from anything other than one of those two types of studies. What they do not seem to understand is

that exposures and diseases are often not epistemically similar to chemical exposures and cancers. The evidence that is most useful depends on the question being asked. (For more on these points and others in this section about how to interpret epidemiologic evidence, see Phillips 2011.)

So, to pick a recent example, if many people gathered in a North African city started sending out messages that government forces are shooting into the crowd, it is very good evidence that shooting is happening. Yes, we could do a controlled study to find out if the number of gunshot wounds treated at hospitals was higher that day than the same day the year before. But it is possible that such a study could miss the effect – it could sample from the wrong hospitals, or the government could act to suppress the information, or the study could suffer from any number of problems. It is true that some systematic survey, rather than individual reports, would be necessary to quantify the toll. But the event reports coming from eyewitnesses would be the most definitive source that the event was occurring, and if they were provided in enough detail by enough people they would be systematic enough to be the best way to estimate the toll. To claim that we know nothing about those events until we have multiple systematic studies (what some turbine industry proponents have argued) requires a willful suppression of normal human reasoning. This example is not meant to be a cartoon; it is actually a reasonable analogy. In terms of witnesses' ability to detect the exposure and outcome and the potential limitations of more systematic studies, turbines are much more similar to gunfire than they are to the effects we normally attribute to noxious facilities.

The other common method for trying to claim that the adverse event reports are not informative (again, typically coupled with trying to imply there are only handful of them, failing to acknowledge the quantity) is to note that they are not "peer reviewed". It seems likely that

most people repeating this claim do not even understand what peer review does; if this is not the case then they are pretending not to understand. At its best, peer review by health science journals provides a cursory review to make sure that a study follows some basic guidelines, and occasionally (very rarely) corrects an important error. Reviewers rarely comment on the quality of analysis methods, let alone the data being analyzed, because they do not even provided with the statistical programs or data. Reviewers see nothing more than what eventually appears in the journal, which almost never allows the reader to know critical features of the study design, let alone assess whether they were carried out adequately. And that is the best case scenario; more typically peer review in the health science does more to censor politically incorrect evidence and discourage innovation than it does to improve what is published. It is easy to get an absolutely terrible study published, so long as the authors jump through particular hoops, stick to simple methods, and do not reach a conclusion that is controversial (the conclusion need not follow from the data, however). It is quite difficult to publish a high-quality innovative study that engages if more complex analysis or demonstrates something new – e.g., the present analysis or WindVOiCe. Moreover, peer review has drifted from being a minimal but useful gatekeeper to primarily being a method for university employees to keep score for their annual reviews.

That is all it is, and treating it as more fetishizes it, in both of the technical senses of the word: It is treated as some kind of magical process, and it has become a stand-in for the phenomenon (good and accurate research whose essential elements have been assessed and improved by multiple experts) that it is supposed to represent. While it may be necessary for casual readers with absolutely no expertise in a field to defer to rules of thumb like "only look at the peer reviewed literature and 'expert' reports" to avoid falling victim to the worst quackery, that merely means that it provides some filtering, not that the rule is a useful guide for serious

scientific inquiry. A debating society or a grade school term paper needs rules to structure the artificial exercise, and so can just as easily choose "peer reviewed references only" as any other rule. There are also arguments to be made for (and against) the use such rules of evidence in liability trials and other formal processes that need some rules of conduct. But there is no justification for legalistic rules of evidence when engaging in scientific inquiry and its extension, science-informed policy making.

Moreover, even though value may be added from peer review of the best kind (which usually takes the form of circulating a paper among colleagues, not relying on the triage system of the journals to add much value), no peer review can vouch for the accuracy of data without actually reviewing the data collection method. This means that adverse event reports, which consist of someone reporting their data as best they can (we can ignore the authors' own analyses and conclusions and focus just on the events data), would not be improved by peer review. That is not to say that the adverse event reports will never be represented in the peer reviewed literature; they will almost certainly become the data for analyses in journal articles, but will not be rendered any more accurate as a result of that.

Indeed, eventually most of the useful information on a topic is referenced somewhere in journal articles, and at that point relying only on those articles alone does not cost us too much information, but we are currently far from that point for this topic. For supposed experts, acting as consultants or otherwise writing "expert" reports, the fetishization of peer reviewed literature is basically a concession by the authors that they are not really experts in either the relevant scientific methods, the subject matter, or both. Actual experts are the ones who can look at something and assess its usefulness; after all, being an expert means being capable of performing the peer review rather than relying on someone else's assertions.

Moreover, until there is a sufficient body of literature, the adverse event reports will continue to be more compelling than the formal studies. Anyone who is familiar with epidemiology knows that it is easy to design a study that, as reported in the cursory description of methods that peer reviewers ever see, reads like it is solid and would detect the phenomenon of interest if it exists, but is actually almost guaranteed to find nothing. Consider how easy it would be to conduct the study, "I searched the apartment for my keys but did not find them", in a way that would likely fail even if the keys were in your apartment (e.g., search for only five seconds; search the neighbor's apartment instead of your own; keep your eyes closed; put the keys in your back pocket before you start). Designing a study to fail to find a health effect from turbines would be equally easy, and it is actually a bit surprising that the industry has not done this already.

It is also quite possible to design a study that is likely to "detect" a phenomenon that does not exist. This is a bit trickier than intentionally finding nothing, and sometimes requires detectable subterfuge like defining-down the phenomenon studied to something common and unimportant but then reporting the result as if it were dramatic (e.g., asking "have you ever noticed turbine noise while trying to fall asleep" and then reporting "our results show turbines cause sleep disorders"). Setting aside the details and the direction of likely bias, the general lesson is that in an advocacy situation, opaquely complex studies of the type published in health science journals can easily be gamed by a researcher without even violating the rather weak norms in the field, while gaming thousands of adverse event reports would require massive fraud.

Finally, it can be argued that those who seek to deny the evidence are making an implicit promise to believe the evidence of health effects as soon as it appears in peer reviewed journals,

and they should be reminded of that implicit promise in the future. Most people reading this paper will do so after it has the imprimatur of "peer reviewed publication". That means that the adverse event reports contained in the Appendix are peer-reviewed journal publications. Does that make them any more valid than when originally published by the author? Of course not. The reviewers had no way to assess the accuracy of the report, just as reviewers of health science papers can never vouch for the accuracy of the data that underlies an analysis. But those who protest that lack of peer review is the reason for not believing much of the evidence are now obliged to accept the report in the appendix as fact.

2. Trying to claim that theory and historical guesses outweigh the evidence

If no one could figure out any way that turbines could possibly affect people's health then we would have reason to seriously question whether the epidemiology was correct. But we know that noise and light effects from turbines impact people's senses and otherwise affect their bodies, and so there is a plausible causal pathway from the turbines to diseases. Furthermore, we know that some of the impacts create distressing awareness which causes stress reactions, which might or might not explain many of the observed health problems, but it plausibly could explain them. There are also more complex theories about pathways that are the subject of debate by those who are expert in the biophysics.

Thus, it is not yet clear which of the hypothesized pathways play a significant role in health effects. But it is clear, given the list of plausible candidate pathways, that there is no legitimate basis for claiming it is impossible for turbines to cause health effects. Yet that is exactly what some commentators have claimed. Generally this takes the form of someone proposing one pathway by which noise might cause health problems, probably the one he has

studied, and offering a single model for assessing whether the outcome is likely to occur. When his model cannot explain the problems, he concludes that there are no problems.

The flaw in this reasoning should be obvious, though it is remarkable how convincing some people apparently find it. Sciences like toxicology and, in this case, acoustics can help predict whether an exposure might cause a health problem before we have actually observed whether it does so. But the epidemiology trumps the predictive evidence. Acoustics and other science still have an important role to play in helping figure out *why* the turbines are causing health effects, but their role as predictive sciences is over: we now have epidemiologic results which the other sciences apparently failed to predict. Continuing to rely on predictions about whether the exposure might cause disease once we have seen that it does cause it is like trying to figure out whether it is raining right now by looking at last week's weather forecast for today.

A particular observation takes the form of claims like, "there are health effects associated with living near a turbine, but the physical sciences show there are no *direct* effects." These assertions about "no direct effects" are presented as if the phrase has some scientific meaning, and thus the reader should be impressed. But anyone with expertise in studying causation will realize that the statement is vacuous because there is no such construct as "direct effect". It is always possible to insert an intermediate step in between two points in a causal pathway, or remove all the intermediates from consideration, and thus it means nothing to call an effect either direct or indirect. Moreover, though this is generally a component of strained arguments that are attempting to deny the evidence, it should be recognized that those making this claim are saying "the physical effects caused by the turbines impact people's bodies, but it is only when some biological or psychological process is caused by that impact that the diseases we observed are then caused". That admission that the turbines are causing health problems is certainly an

accurate statement, just as it is accurate to say that cigarettes do not "directly" cause lung cancer because the cancer only happens when their impact on the body, interacting with other factors, triggers a complicated biological process that eventually causes a tumor.

There is one key lesson we can take from the inability of the physical modelers to agree about why the health outcomes occur, and the fact that there are steps in the pathway that we cannot yet be sure about: It is currently impossible to know how to change the exposure to mitigate the health effects with much confidence, other than by separating people and turbines by a great distance. The existing epidemiology does not answer this question either. Yet some proponents of turbines argue that the regulations that have been created in this state of ignorance must be sufficient to protect people. It should be obvious how absurd this claim is. Those regulations are a hodgepodge of different rules that are generally based on old recommendations that predate the recognition of the health effects and which, to the extent they were based on any science at all, were based on the science that incorrectly predicted that there would be no problem. Even if one believes that the regulations were as well thought-out as they could have been, the epidemiology shows that people suffer health effects when the regulations are adhered to.

A variation on this theme is to claim that the health problems exist only when current regulations are not met, or even when the original regulations under which the turbines are operating are violated. It is certainly reasonable to condemn operators and regulators who allow the violation of the regulations, a fairly common occurrence according to the adverse event reports. However, since those making the argument that current regulations should be adhered to do not seem to be offering such condemnation or conceding that turbines do sometimes cause health problems, it is difficult to accept their implicit assertions that adherence to current

regulations is genuinely the difference between causing health problems and not doing so. But the argument that some set of more stringent regulations is sufficient to eliminate the health problems (or that it will be obeyed) is no better supported by science than the claims that previous regulations were sufficient. Moreover, there is no shortage of aphorisms about how unwise it is to believe someone who is telling you "we were wrong, or perhaps even lied to you, about the previous regulations being sufficient, but trust us when we assert, in exactly the same way, that everything will be fine with new regulations." This is especially true when they still do not even admit that the previous regulations were insufficient.

In any case, regulatory choices and guidelines are decisions that, at best, are science-based, but offer no scientific information in themselves. It should be clear that believing last week's government decree about what the weather should be today is even less useful for figuring out whether it is raining right now than would be looking at last week's forecast. Unless, that is, we are in an Orwellian world where the language is redefined to make government decrees always correct. Some of the tactics for denying the evidence of health effects actually seem quite similar to that.

3. Claiming that the observed health effects are not really health effects

Failure to understand how to draw scientific conclusions and myopia about a single method for modeling physical health effects are problematic, obviously. But they are not so clearly reprehensible, from an ethical standpoint, as telling people that their suffering does not really "count" for some technical reason.

A common claim is that the health outcomes do not constitute a "disease" because there is no officially recognized labeled disease along the lines of "wind turbine syndrome". But even

if we set aside that the individual diseases people are suffering, like chronic stress and sleep disorders, are often well-defined (they are just not defined in terms of a specific cause), and the fact that the term "disease" is quite broad in practice, this would still only be a semantic point. There is no epistemic significance to the health outcomes in question having or not having a label.

Sometimes the denial takes the form of saying that people are just suffering "symptoms" but not a "disease", which is nonsense since in this context the word "symptoms" is shorthand for "symptoms of a disease" and, moreover, can roughly be defined as "those manifestations of a disease that are (in addition to mortality) what people actually care about". Another semantic game says that what people are suffering is not "disease" but "annoyance". The jargon used in the noise and health literature refers to effects of noise that are apparently psychologically mediated (i.e., most everything other than hearing damage) as "annoyance". The rhetorical game is to try to confuse readers into thinking this has the natural language meaning of "mere annoyance". However, the jargon meaning of annoyance includes everything from "mere annoyance" up through a life-ruining source of severe distress. Moreover, even "mere" annoyance can itself have severe health consequences when someone is forced to exist in a chronic state of annoyance.

Another somewhat common pseudo-argument is that we should dismiss the health effects because they are all "subjective". This is not actually true since, for example, insomnia can be objectively measured by looking at a clock and even long-term stress itself can be measured via hormone levels. The authors seem to be confusing "subjective" with "psychologically mediated", which most of the observed effects might well be (though there are hypotheses about non-psychological pathways).

But being subjective or psychologically mediated does not mean these effects are minor or less real. Indeed, there is a case to be made that such diseases, which include everything from transient headaches to chronic pain and depression, account for the majority of the total burden of disease in our society.

A recent addition to the rhetoric that the effects are of no consequence are assertions that effectively assert, "the problems are caused by the victims' own psychology, not the turbines." It is claimed that perhaps people fear the turbines, as people are known to irrationally fear toxic chemicals, and it is fear, not the noise or light, causing all the problems. This is a variation on the theme that was popular a year ago (though it can still be found) where it was claimed, based on one study that found a correlation between people's attitudes toward the turbines and their reported health effects, that attitudes were causing the problems. These claims sound more scientific than some of the other rhetoric, but are easily shown to be wrong.

First, the assertions themselves are rather weak. The fact that there is a relationship between suffering health effects from an exposure and disliking the exposure hardly comes as a surprise. If those who were trying to deny the evidence had read the adverse event reports, they could have found much more compelling evidence supporting this point (the feeling is apparent even in the Appendix examples despite the abridgements focusing on outcomes rather than judgments); however, in most cases it is clear that the people's dislike of the turbines was a result of their physical effects, not vice versa.

We do know that people have irrational fears of invisible hazards like radiation or "toxins", but it is difficult to imagine why someone would find a fairly simple object and exposure (metal, tower, fan blade, motor/generator mechanisms, wind, noise, flashing lights) to invoke the irrational fears that often result from invisible spooky exposures. If someone were to

try to make a plausible claim along these lines, a better case could be made that that sensitization to the serious effects of turbines is psychologically contagious; that is, once some people start to suffer serious health problems, those around them are more likely to suffer distress reactions that lead to sersious health problems. This is still a speculative hypothesis, though unlike the purely speculative claims about irrational fears, one that is supported by some evidence (as illustrated by one of the examples in the Appendix, serious health problems that are attributable to turbine exposure tend to run in families, which might be due to their similar genetics or exposures, but might be a contagion effect).

But whether or not contagion or fear occurs to some extent does not excuse the turbines. This is not a case, like some commentators have tried to portray, that is similar to many people working in a building getting sick, apparently due to mass hysteria since no contamination or infectious agents are found. Unlike a single building, people with no knowledge of or worry about the health effects from other turbines, and who have never known anyone who experienced those problems, have discovered they are having health problems when turbines were built near their homes. Moreover, everyone suffering health problems does detect and usually complains about the sensory effects from the turbines, so it is clear that their entire experience is not imaginary. It is, of course, possible that some personal characteristic sensitizes them to be more bothered by the sensory effects, increasing any psychologically-mediated effects. But it is inevitable that some personal characteristics will be *causal cofactors* (factors that, along with the turbine, are part of the necessary constellation of causes for there to be a disease effect). This is true for every exposure-disease combination: Some exposed people get the disease and some do not, and sometimes we can identify other differences between the two groups. None of this changes the fact that the turbines are causing disease, and are the one of the many causes that we

refer to as "the" cause in a legal or ethical sense. Compare: If someone is killed in a robbery, the cause of death was the assailant, but the death was also caused by the victim being at the wrong place at the wrong time, and perhaps because those around him were not skilled medics and that he was frail. However, the murderer's blameworthiness is not diminished by (inevitable) existence of causal cofactors.

Some commentators who are unfamiliar with causal analysis in epidemiology seem to believe there is something unusual about personal characteristics being correlated with the outcome. They then compound their error by declaring that if there is something psychologically different about the people who suffer disease, then we can "fix" them with counseling. This has been presented as being a reason why we should not worry about the observed health effects, even though the usefulness of counseling is a purely speculative hypothesis (there is no evidence it has ever been successful in these cases), and one that is built on speculation about there being a "treatable" causal cofactor that is a necessary component of the causal pathways. To return to the lung cancer analogy, someday we will invent a drug that keeps the injured lung cells from turning into cancer, which would mean that smoking would no longer cause lung cancer among people who took the drug, but that is obviously not an argument that smoking is not really causing such harm now; indeed, we would probably still consider the propensity of smoking to trigger lung cancer as consequential even if the hypothetical drug were available.

Moreover, the fact that we have no reason to believe we can actually counsel away the suffering caused by turbines is only part of the problem with such claims. Even if the counseling were useful at reducing the health effects, causing people to need counseling (a substantial cost in their lives even if it is completely successful) can hardly be considered a harmless and ethically inconsequential act. It has complicated ethical implications that evoke the Orwell's

teaching someone to love Big Brother, and at a more prosaic level it would not eliminate suffering from the moment of first exposure. We have counseling methods that can reduce the long-term damage that someone suffers from being a victim of sexual assault, after all, but its existence does not change the fact that the assault does damage, let alone does it cause us to decide to allow the assaults because the damage can be undone.

Any claim that might stick

It is worth pointing out the dishonesty inherent in presenting many of these claims together, as is often done. It is a legitimate tactic for a criminal defense attorney to argue that the prosecution has failed to show that his client was at the scene of the crime, and that the evidence showed that if he was there it was after the crime was committed, and also that he was just along for the ride and did not know anything about his friend's plan to commit a crime. However, this is not a legitimate tactic in scientific analysis. Proponents of wind turbines have claimed, often simultaneously, that the physical models show there is no possible problem, that there is no problem if some particular rule is obeyed, that there is no evidence of health effects, that the reported evidence of health effects does not count because it in the wrong format, that there is evidence of effects but they are not real diseases, and that the diseases are really the victims' own fault. They also sometimes argue that the benefits outweigh the costs, the point taken up in the final section below.

We can perhaps excuse lawyers who work for the industry for making this contradictory mélange of arguments, assuming that we think it is acceptable for industry to act as selfishly as a criminal defendant is expected to act, and that it is up to others to make the opposing case. But there is no such defense available to consulting scientists who are supposedly writing reports as

independent experts, or to government officials. They should be conducting the best possible scientific analysis. If one of them really believes that, for example, we should not worry about the health effects because people can and should be counseled to get over them, then they are still obliged to recognize the enormous number of adverse event reports and point out that acoustical theories predicting no effects are apparently wrong, before then going on to argue that the effects are something that is easily fixed. Similarly, someone who genuinely believes that there is not evidence that people are suffering cannot also argue that this non-existent suffering has characteristics that make it less important. Some arguments can legitimately be made in combination, of course. But even honest activists, let alone honest scientists, do not use the approach of throwing every claim that could possibly be made in support of their position against the wall to see what sticks.

Ethical policy decision-making

Public policies often impose substantial costs on people. We generally try to prevent a large share of the burden from falling on a small number of identifiable involuntary victims (e.g., people living near the site of a new noxious facility), but sometimes this is not possible. Generally in such cases it is considered ethically mandatory to compensate the victims. But even setting aside tricky questions of just compensation, there is the simple principle that the total social benefits should outweigh the costs, which include the health costs. There is currently no evidence to support the claim that this is true for the installation of new industrial wind turbines in populated areas.

It is beyond the present scope to even rough out such an analysis, but it is possible to provide the steps that are necessary and point out how nothing remotely sufficient exists. First

the net costs and benefits from a purely industrial standpoint (the resource cost to install, maintain, and decommission the turbines and transmission lines compared to the value of the electricity generated) need to be calculated; this is presumably negative since the industry depends on subsidies of various kinds. A common claim is that this negative value is more than outweighed by the net benefits of pollution reduction, though there is substantial debate about this point. Before there is any possible justification for inflicting involuntary health risks on people, whatever their magnitude, it is incumbent upon the industry to present a convincing analysis that shows there are substantial net benefits when all benefits and costs – apart from those imposed on local residents – are considered. Only such net benefits could justify impose the local costs.

It does not appear that this has ever been done, but for purposes of the exercise assume it has and the result is indeed positive. Then the health and other local impacts need to be quantified and compared to that benefit. While there can be no perfect quantification of such effects, estimates are possible employing well-used straightforward methods. The first step is to admit that there is a problem, which might be made easier by dropping any disagreement about whether the suffering constitutes health effects, since all costs to the local community, health and otherwise, should be identified and quantified. If there are indeed methods for mitigating the damage, and if particular regulatory standards can substantially reduce it, then this should be demonstrated and then implemented to lower the costs. These costs, lowered as much as possible, should then be compared to the other benefits

Many of us have guesses about how this comparison will come out, but the main issue right now is that it has never been done. No one has even taken a rough cut at the numbers, and so there is simply no basis for claiming that the benefits justify the costs. Indeed, this may

explain why many proponents of turbines insist on making the extreme and obviously incorrect claim that there are no health effects at all. Once some numbers are estimated, we can begin to discuss whether the tradeoffs are justified, how to offer justice, and other policy questions. In the meantime, it makes no sense to take expensive largely irreversible actions, rather than exercising some easily reversed prudent delay until we better understand the situation.

Conclusions

It is always possible that further research will reveal that, under certain circumstances, turbines can be sited near people's homes with minimal health risk. Such is always possible for any exposure, given the nature of science (open to additional information) and changing technology. But our current knowledge indicates that there are substantial health risks from the existing exposure, and we do not know how to reduce those risks other than by keeping turbines several kilometers away from homes.

Similarly, it is quite possible a public policy case could be made for the claim that the costs are justified by the benefits. But the key is that the case must be made, including a quantification of the impacts on local residents, which has not been done. Those who pretend that there are no serious impacts on local residents cannot contribute any useful analysis. Moreover, it seems unlikely that it will ever be considered ethically acceptable to force susceptible individuals to suffer serious health problems, to say nothing of the non-health complaints and effects on communities, without much greater and more reliable compensation than has been offered to date.

Dismissal of health effects cannot be seen as honest disagreements about the weight of the evidence. Honest disagreements about scientific points are always possible. But when

proponents of one side of the argument consistently try to deny the very existence of contrary evidence, make contradictory claims, appeal to nonsensical and non-existent rules, treat mistaken predictions as if they were evidence of actual outcomes, play semantic games to denigrate the reported outcomes, and blame the victims, then they are not being honest, scientific, or moral. They are preventing the creation of optimal public policy and damaging the credibility of science as a tool for informing policy. Moreover, since their lack of plausible arguments suggests there are no defensible arguments to be made on that side of the issue, their persistence in making implausible arguments is directly responsible for hurting significant numbers of people.

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Appendix: Excerpts fromt three adverse event reports

Case 1, first person report by male, 2007

....

The first 2 turbines were operating in may 2004. One was 4000ft from our home, the second 4700ft. A 120 day trial period was required to monitor their productivity. We could hear them well and …, my wife was experiencing ringing in her ears. Visitors would comment that the one 4000ft away seemed really close. Some neighbors were complaining they were bothered by them at night.

....

February, 2005 the windfarm was fully operational, 17 wind turbines. The windmill 4000ft away seemed far off compared to the one 1000ft from our home. They are loud. They've been compared to jet engines, a plane that will not take off. There is no gentle swoosh, it is a whoosh noise. They grind, they bang, they creak. The noise is like surround sound, it's omnidirectional. It feels like there's this evil thing hovering above you and it follows you everywhere, it will not leave you alone. This noise will not allow you to have your own thoughts, the body cannot adapt, it's a violation of your body. It is a noise that the human body cannot adapt to even after more than a year of exposure. As time progresses the noise becomes even more unbearable.

Our 5 year old son … was afraid and unable to sleep in his own bed for more than one year. He would get in our bed or in his brother's bed. We would put him to bed at 8:30 and many nights at 11:00 he would still be awake. Finally he would fall asleep wrapped up in the blankets in the fetal position with his head covered and with a fan at his head. we had to create more noise to mitigate the windfarm noise. The body can adapt to the fan noise. In the morning he would get up tired and cranky. In september 2005 he started school and he was not getting enough rest. He began getting more and more aggressive with his friends. He was very defiant We knew he was suffering terribly. He's had throat infections and often had a fever and not feeling well.

....

We abandoned our home February 21st, 2006.

Since the move [aforementioned son] has been doing much better. He sleeps in his own bed every night. He sleeps partially covered with his arms and legs spread everywhere. It was only ten days after the move while he was having his back rubbed in bed he said "it's nice to be able to go to bed and sleep". He is much less defiant. He has become the kind gentle little boy he was before the windfarm nearly destroyed his life.

Knowing what we know now we should have moved a year before.

Our 9 year old son ... was sharing a room with [5-year-old]. He was also very sleep deprived. He would get up in the morning very tired. We would send him to school tired. He was tired and

unable to concentrate and his school work suffered. He was also unable to concentrate on his homework. He began to withdraw within himself. He also began getting aggressive. [He] seemed to be always angry. His teacher asked us what was the problem with [him] because his change in behavior was something she would never have expected from him. [His] ear drum burst while we were there in 2005. He's had many throat infections and many headaches. He has developed allergies. He's the only one of 6 children that has allergies.

Since the move [he] has improved so much in his school work and his behavior and participation in class that the teacher says she cannot believe that he's the same child. He has not been aggressive with his friends. He's so kind and caring for everyone. His headaches are less frequent and less severe.

Our 13 year old daughter ... had dramatic behavioral changes. She became withdrawn and was spending too much time alone in her room. She dropped her friends and lost interest in school work. She was also angry. She dropped all sports (basketball, volleyball. soccer, badminton). [She] always had headaches. She became very defiant.

Since the move [she] is doing better in school. Her behavior is steadily improving. Her health is improving and she is socializing. She is feeling better about herself.

[...reports on other family members omitted for length...]

As for myself I always felt a sensation in my chest which was very discomforting. On extremely rare occasions when the windfarm was off I could sense they were off without seeing them. The noise was just a relentless attack on our bodies. Every time the blades passed the towers I could feel it within my body. I was unable to concentrate well enough to read in my bed.

Since the move I don't have that sensation in my chest but it returns when I spend a few hours at our house.

These physical and psychological effects develop gradually and sometimes it seems silly to associate them with a windfarm until you learn that others experience the same thing under similar conditions.

If we would have had absolutely nowhere to go, if we would have been forced to stay in our home, I hate to think what kind of physical and mental state we would be in now.

During the months that the sun is low in the sky we get a flickering in the morning and late afternoon as the sun passes behind the turbines. This induces headaches quickly to those who are more susceptible to them. When the full moon rises and passes behind the turbines the flickering is intense.

We are devastated, we are broken because we have lost the home we built with our own hands and we have lost the land which has been in the family for generations.

Our house is now unsellable. There is nobody in the community that wants to live there because of the windfarm. Nearly everybody supports us privately but they are afraid to speak out publicly.

We are a community of 2000 people and I did a survey of 216 people and 96% said the windfarm was too close to [their] house. Also 89% said the windfarm was too loud at [their] house and 78% said that they felt they were not properly notified of the impact this windfarm would have on the community. ....

Case 2, first person report by female, 2009

....

My home now sits among huge, massive turbines. Sixteen turbines surround me, all within a 3 km radius of my home. The closest is 400 metres from my back door. People often ask me what my problem is with the turbines. ("They are not very noisy," I am told.)

The noise is constant, some days louder than others. It is not noise I enjoy or choose to be around. It is noise I cannot escape.

....

I live with the movement of shadow flicker created by the rotation of the turbines, coming through my dining room window as I drink my coffee in the morning. I have developed a sensitivity in which now I cannot even tolerate the movement of a small ceiling fan.

The skies where I live are no longer clear but dotted with blinking red lights marking the height of the turbines. When the turbines are down, a constant buzzing noise is emitted from the motionless structures. I have developed tinitus [sic] in my ears. I hear and feel the pulsating of the turbines and buzzing in my ears. I also feel the pulsating in my throat and chest.

Two homes have been abandoned where I live because of health reasons related to the effects of the turbines. One of these properties is host to 2 turbines. Many properties are for sale. In fact most of the properties where landowners reside on premises are for sale.

Real estate sales in my area are significantly less than other [similar places]. Some real estate brokers will not touch a property adjacent to a turbine for fear of future law suit. Nothing is selling in Turbine Town. Land value has decreased significantly because of the turbines.

....

I have:

- nausea (often) & dizziness (often)

- significant hearing loss

- itchy eyes

- high blood pressure (recently, an immediate and intense elevation to 180/118, causing severe headache and complete dysfunction)

- heart palpitations

- achy joints

- short term memory loss

- severe sleep deprivation on a regular basis

Results of a sleep study I had done showed 214 interruptions in a 6 hour period (note: 6-8 is considered normal; 214 is comparable to someone who has attention deficit disorder). I have very little if any regenerative sleep periods. I have been told that I have developed a sensitivity that does not leave my body when I leave the vicinity of the turbines. The term used was "toxic" -- my body is in a toxic state.

I have an ulcer in my nose that does not heal. I am awaiting an appointment in November with an ears, nose and throat specialist (otolaryngologist).

I often have blood in my urine (never was a problem in the past). I am having problems with my lymph nodes. I have been anaemic because of excessive blood loss. Blood work and other tests do not indicate changes which may cause this haemorrhaging. I have spent time in the emergency room at the hospital because of this.

I once thought my degenerating health was part of the natural aging process. I did not believe the turbines could be the cause of my health issues. I questioned myself as to whether or not it was all in my head. I now believe exposure to the turbines accelerate these processes as well as create other health problems.

I am angry, helpless, and disappointed our government would let something like this happen. I am appalled at their ignorance and lack of compassion. It saddens me to watch my family and friends suffer from the same effects of the turbines.

It is also very saddening for me to see my dogs suffering. I cannot imagine the distress they must be enduring because of their sensitive hearing. I have not figured out what to do about it.

I spend as much time as I can away from my home, away from my son who is also sleep deprived and moody. We are exhausted and miserable. I often seek refuge with friends, often falling asleep minutes after I arrive. They are very understanding

....

Case 3, first person report by male, 2010

I am an abutter to ..., a 1.65MW Vestas 400 foot tall goliath. Since it went into operation in early 2010, quite a number of us abutters have suffered serious medical detriments and a gigantic loss of quality of our lives from the noise impact of this machine.

My own home is 1662 feet from the turbine, and the effects of the sound on me have caused

-anxiety

-stress

-nervousness

-sleep deprivation

-hypertension

-migraines

-dizziness

-blurred vision

-palpitations

-irritability

-anger

-upset stomach

-depression

These ailments are well documented by my medical providers.

....

The noise these turbines make is unlike regular noise. It is not the loudness of the noise but a characteristic to it that gets in your head and becomes entrenched. The sound can go on for days,

or it can be absent, or it can be intermittent. When it is not there, one listens for it and is fearful of its return.

The garden that was a sanctuary to me for 30 years is now more like a torture chamber. Some of the abutters have started using the term "turbine torture." When the turbine first went into operation in March 2010, and then through April, I tried to acclimate myself to live with this thing.

After dropping into a three-month depression, I finally avoided my own home for the month of August, and pulled out of the depression. I returned on Labor Day weekend to find that after ten minutes of hearing the turbine, my anxiety and panic condition were returning. At least two persons have thought of suicide while this issue drags on through the creep of political process.

....

Anyone out there whose town or neighbor is proposing a wind turbine, I recommend for you to do your homework now before the machine is up and running, and you begin to plan to sell your home. I have been told, by the way, that if you are trying to sell and a turbine is visible from your home, your potential buyer list will drop by 50%.

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EXPLICIT CAUTIONARY NOTICE

TO THOSE RESPONSIBLE FOR WIND TURBINE

SITING DECISIONS

Including Specifically Directors of Wind Developers, Publicly Elected Officials from Federal, State and Local Government, and Bureaucrats in Relevant Departments

BE ADVISED that, as a result of information gathered from the Waubra Foundation's own field research, and from the clinical and acoustic research available internationally, ***the following serious medical conditions have been identified in people living, working, or visiting within 10km of operating wind turbine developments.*** The onset of these conditions corresponds directly ***with the operation of wind turbines:***

- chronic severe sleep deprivation;
- acute hypertensive crises;
- new onset hypertension;
- heart attacks (including Tako Tsubo episodes);
- worsening control of preexisting and previously stable medical problems such as angina, hypertension (high blood pressure), diabetes, migraines, tinnitus, depression, and post traumatic stress disorder;
- severe depression, with suicidal ideation;
- development of irreversible memory dysfunction, tinnitus, and hyperacusis.

Other symptoms include those described by Medical Practitioners such as Dr Amanda Harry, and Dr Nina Pierpont in her landmark Case Series Crossover Peer Reviewed Study (submission No 13 to the Australian Federal Senate Inquiry into Rural Wind Farms) and published in Dr Pierpont's book entitled "Wind Turbine Syndrome, A Report on a Natural Experiment", 2009, published by K-Selected Books, Santa Fe.

These serious health problems were also identified by Australian GP Dr David Iser in 2004. Dr Iser formally notified the Victorian Government of the time after his patients became unwell following the start up of the

Toora wind project. His warnings were ignored without being properly investigated by the authorities and politicians.

All this and supportive material has been made available to the Boards of the major developers, State Ministers for Health and Planning and senior health bureaucrats. The time for denial, and of using the Clean Energy Council to shoulder the increasingly difficult task of denying the link between adverse health and operating wind turbines, is over.

At the Toora and Waubra wind projects, some seriously ill affected residents have been bought out by the developers; but only after they signed confidentiality agreements specifically prohibiting them from speaking about their health problems. This buy-out activity would support a conclusion that developers are aware of the health problems.

Meanwhile, wind developments have continued, with developers asserting that their projects meet acceptable standards, and thereby implying that they cannot be causing health problems.

The Foundation is also concerned that Vibroacoustic Disease, as recorded and described by Professor Mariana Alves-Pereira's team from Portugal, will develop in people chronically exposed to wind turbines. The disease has already been identified in the occupants of a house with levels of infrasound and low frequency noise identical to levels the Foundation is recording in the homes of affected residents in Australia.

The Foundation is aware of over 20 families in Australia who have abandoned their homes because of serious ill health experienced since the turbines commenced operating near their homes. Most recently, five households from Waterloo in South Australia have relocated, where the larger 3 MW turbines have had a devastating impact on the health of these residents. Some of these people have walked away from their only financial asset, to live in a shed or a caravan on someone else's land.

The Foundation notes the mid-2010 advice from the National Health and Medical Research Council that a "***precautionary approach***" be followed. We are not aware that either industry or planning authorities have adopted this exceedingly valuable and important advice.

The Foundation's position, as the most technically informed entity in Australia upon the effects of wind turbines on human health, is this: ***Until the recommended studies are completed, developers and planning authorities will be negligent if human health is damaged as a result of their proceeding with, or allowing to proceed, further construction and approvals of turbines within 10km of homes. It is our advice that proceeding otherwise will result in serious harm to human health.***

We remind those in positions of responsibility for the engineering, investment and planning decisions about project and turbine siting that their primary responsibility is to ensure that developments cause no harm to adjacent residents; and, if there is possibility of any such harm, then the project should be re-engineered or cancelled. To ignore existing evidence by continuing the current practice of siting turbines close to homes is to run the dangerous risk of breaching a fundamental duty of care, thus attracting grave liability.

The Waubra Foundation, 29 June, 2011

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SUBMISSION TO THE AUSTRALIAN FEDERAL SENATE INQUIRY ON RURAL WIND FARMS

10th FEBRUARY, 2011

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BMBS (Flinders 1995)
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EXECUTIVE SUMMARY

1. There are reports from around the world of people living adjacent to wind turbine developments becoming unwell with the same range of symptoms

2. The few studies which have been done by concerned medical clinicians have consistently found these problems

3. The medical evidence which exists from Dr Pierpont's landmark peer reviewed case series cross over study clearly links exposure to turbines with the symptoms being described

4. Not all adjacent residents are affected

5. Some developments appear to have more seriously affected residents than others

6. Some residents are affected immediately, others are progressively affected over weeks to months of constant exposure

7. Chronic exposure appears to have a cumulative effect

8. The time taken to achieve full resolution of symptoms is proportional to the time exposed to turbines

9. Not all symptoms are reversible after chronic exposure, when affected residents move away

10. Some extremely ill residents in desperation have signed confidentiality agreements with wind developers, who have purchased their properties, in exchange for agreeing not to talk publicly about their health problems, in order to leave their homes and regain their health.

11. Residents are describing symptoms from a distance of up to 10km away from the nearest turbine

12. Elevations of blood pressure associated with proximity to operating turbines are an emerging issue

13. Some people appear particularly vulnerable to developing wind turbine syndrome symptoms, and they include children and the elderly

14. There a number of possible mechanisms for these symptoms and they include but are not limited to:

- Audible noise causing chronic sleep deprivation (we know from affected residents that wind turbines can be very noisy, both upwind and downwind)
- Wind turbine specific pulsatile infrasound and low frequency noise causing many of the symptoms of wind turbine syndrome (probable, based on current but limited experimental evidence, and recent measurement of wind turbine specific pulsatile infrasound)
- Possible health effects from electromagnetic radiation issues in a few specific cases – in situ measurement required initially in these homes to determine if this is an issue for further investigation

RECOMMENDATIONS

1. There is an urgent need for further INDEPENDENT medical, acoustic and scientific research, looking specifically at the populations affected by the currently constructed and operating wind developments in Australia

2. An immediate temporary halt in construction of wind turbines closer than 10km to human habitation until adequate research is completed, in order to determine what is a safe setback of turbines from homes and workplaces

3. Current planning and noise guidelines will need to be updated on the basis of this new knowledge

4. There should be an immediate ban on the operation of wind turbines on days of high, extreme and catastrophic fire danger, because of the difficulties in fighting such fires, and the risk to lives should such a fire occur

5. Measurement of wind turbine specific infrasound and low frequency sound needs to be included in post construction noise assessments, and ALL these assessments MUST be performed by experienced Acousticians who are COMPLETELY INDEPENDENT of the wind developers

BACKGROUND

My name is Dr Sarah Laurie, and I am a legally qualified Medical Practitioner (Bachelor of Medicine, Bachelor of Surgery Flinders University 1995), with subsequent completed post graduate training as a Rural General Practitioner (Fellowship of the Royal Australian College of General Practitioners (FRACGP) 1999, and Fellowship of the Australian College of Remote and Rural Medicine (FACCRM) 2000). I have served as an examiner with the RACGP, and a member on the South Australian AMA State Council. My work as a Rural GP has been exclusively in South Australia, predominantly at Crystal Brook, but also included Balaklava, Port Pirie Aboriginal Community Health Centre, and Nganampa Health Council on the APY lands. I have a particular interest in Mental Health, and was the Mid North Division of General Practice Representative on the local Mental Health Advisory committee.

Since 2002 I have been on leave from my profession, because of personal and family health issues and extended family caring responsibilities. I was preparing to return to my career as a practicing rural General Practitioner in March/April last year when I became aware of a proposed wind turbine development for the hills adjacent to my home, where I live with my husband and seven year old twins. Origin Energy are the proponents, and the initial map one of their employees presented at a community meeting showed that there were to be five turbines at approximately 1km from my home, with a total of approximately 90 turbines spread along a ridge of approximately 15km. There are approximately 90 people who will be within 3km of this development.

I told the Origin Energy PR employee who rang me to tell me of the proposal that I had no objections, and indeed supported the project, because of my longstanding concerns about climate change/global warming, and my concerns about the financial problems faced by farmers (some of whom had previously been my patients) and the issues rural families face because of lack of local employment opportunities for their children.

I did, however, say that my support was on the assumption that there were no adverse health concerns, as I had read an article in an edition of The Australian weekend magazine about a couple from Ballarat who had reported becoming unwell after a turbine development started operating near their home. The Origin employee was very quick to reassure me that "just that week, the Chief Health Officer of Victoria had issued a public statement to the effect that there was no evidence of any adverse health effects from wind turbines".

I was reassured by that, at the time.

However, a month later, a neighbour presented me with Dr Amanda Harry's study, and after reading this I was immediately very concerned that there were indeed some serious health problems emerging. Dr Harry was a rural General Practitioner in the UK, who did a community survey after becoming aware of a new pattern of symptoms and health problems emerging after a turbine development had commenced operation close to where she was practicing medicine.

I also became aware of a Rural Australian GP, Dr David Iser, from Toora in Victoria, who had done his own small study, based on Dr Harry's survey. Dr Iser had found a similar range of problems, some of which were serious. When I contacted Dr Iser to ask him more about his experiences he told me that most of the affected residents had since left the district and were therefore no longer his patients. **Dr Iser mentioned that**

some former residents whose health had been particularly badly impacted had been bought out by the developer, but only if they signed confidentiality ("gag") agreements, which specifically prevented them from talking publicly about their health problems. I have since learned from my international colleagues that such practice is widespread in countries with industrial wind developments.

I then decided to devote my time into researching the issue more thoroughly. By the time I spoke at a public meeting at Laura on 18th July, 2010 I was convinced there was a very real problem, that it was global, and that there was a significant lack of primary research into the health effects being described by adjacent affected residents.

For example, nowhere in the world had a population or epidemiological study of the adverse health effects been conducted. Given the existence of "gag" agreements, whose key purpose could be to keep the adverse health effects story out of the public arena and in particular scrutiny by health authorities, this was hardly surprising.

What research there was, however, done by Medical Practitioners who were actually seeing patients or conducting patient interviews, showed that there were significant and serious problems being reported, including people resorting to walking away from their homes.

FORMATION OF THE WAUBRA FOUNDATION

In late July 2010, I was contacted by Mr. Peter Mitchell, from Victoria, who had set up the structure of a not for profit organization he had called the Waubra Foundation, to help further the progress of facilitating and commissioning independent research into the adverse health effects being reported in residents adjacent to wind turbines in Australia. Mr Mitchell was looking for someone to help run the Foundation, and I agreed to help him.

My expenses incurred in working on this issue have been funded by my husband, and some have been reimbursed by farmers and neighbours who have asked me to travel to help educate their communities. I have donated my time in a voluntary capacity, often working 18 hours a day.

The **aims of the Waubra Foundation** are multiple but in summary they are:

1. To act as a catalyst to ensure that the best quality **independent** acoustic, scientific and medical research is urgently done into the adverse health effects of wind turbines being reported

2. To support affected residents

3. To provide information to health professionals treating such affected residents, and facilitate information sharing amongst those health professionals both nationally and internationally

4. To provide information to communities who are being targeted by wind developers, where those proposed developments are closer than 10km to homes and workplaces

5. To lobby government, to ensure that these serious concerns are addressed and considered by health and planning authorities, and other relevant individuals

For further information, please see the Waubra Foundation Objectives on Page 33.

Importantly, the Waubra Foundation does not take a pro or anti wind position, and our endeavours are to ensure that wind turbines are sited so that they will not adversely impact human health, if they are used as part of a renewable energy strategy.

RELEVANT LITERATURE

I will not go into the details of my personal literature review here, but instead refer everyone to the recent scholarly work on this topic submitted to this inquiry by my Canadian colleague, Dr Robert McMurtry, with which I concur. Dr McMurtry is the cofounder of an organization with similar aims to the Waubra Foundation in Canada, called the Society for Wind Vigilance (windvigilance.com). The Society convened the first International Symposium of the Adverse Health Effects of Wind Turbines in Ontario, in late October last year, which I attended.

Nor will I comment specifically on the Australian National Health and Medical Research Council document entitled the "Rapid Review of the Evidence" relating to the adverse health effects of wind turbines which was released in July 2010. This document has

been extensively critiqued by others, including the Society for Wind Vigilance (please see Haste Makes Waste, on windvigilance.com). I will say that after reading that NH&MRC document when it was released in July 2010, I became extremely concerned for a number of reasons:

- its heavy reliance on what were obviously wind industry sponsored "reports/reviews/studies" where there was an **obvious conflict of interest**, without the author(s) appearing to perceive this.

- The way in which the unknown author(s) dismissed Dr Pierpont's work – it was not clear to me that the author(s) had actually read and understood Dr Pierpont's study, or read the detailed case study / raw data section of her book. Their criticisms of her work appeared to mimic wind industry comments, rather than a thorough critical analysis of the one detailed peer reviewed study available, by a qualified medical practitioner.

- there did not seem to be any understanding that there was "**no evidence" because so little research had been done**, rather than that there was "no problem**".**

- The lack of identity of the author(s). I am particularly interested to find out if a medical practitioner or practitioners, experienced in taking clinical histories from patients, were part of this rapid review. To date, the author(s) of this review remain a mystery.

Despite these and other serious inadequacies which have been highlighted by many nationally and internationally, this NH&MRC report in particular has been extensively relied upon publicly by the wind industry, despite employees in the industry clearly being aware of these health problems when they have signed agreements with 'gag' clauses, with affected residents. **Some wind industry employees have privately admitted this to me, and encouraged me with the Waubra Foundation's work, as they also know this current situation is wrong, and should not be allowed to continue.**

This NH&MRC document has also been extensively relied upon by politicians and public servants at all levels of Government in Australia. In particular, the respective health and planning politicians and public servants have kept referring to it, concurrently ignoring the escalating reports of ill health they are directly receiving from affected

residents, without making any plans to commission or fund any independent research to investigate these serious health concerns, or any plans to change current planning guidelines which determine appropriate siting of wind turbine developments. In my opinion, this situation cannot be allowed to continue.

STUDIES BY MEDICAL CLINICIANS, INVOLVING AFFECTED RESIDENTS

There have been an increasing number of reports from around the world particularly in the last 10 years, of people adjacent to wind developments developing a range of symptoms not previously described in the medical literature. At the same time the turbines are getting taller, the blades longer, both factors increasing their power output but also their noise emissions, and they are being built closer to larger rural populations, in order to be close to transmission lines.

The first Medical Practitioner to describe the new illness in a formal study was a UK rural GP (**Dr Amanda Harry**), who carried out a community survey after her patients presented to her with new symptoms and health problems, which they developed after large wind turbines commenced operation near her village in Cornwall.

Subsequently an Australian GP **Dr David Iser** (Toora, Victoria) documented the same range of conditions, using Dr Harry's initial survey form. Follow up work by the Canadian Wind Vigilance Society's WindVOICE, cofounded by Dr Robert McMurtry, used Dr Amanda Harry's survey as a basis for their self reporting survey, and found exactly the same range of symptoms being reported, in rural Ontario (please see windvigilanc.com for the WindVOICE survey reports).

Dr Nina Pierpont (an American Rural Paediatrician) progressed the research by performing the landmark study which examined the individual case histories of the members of 10 families from around the world, who had lived adjacent to wind developments, and become so unwell that they needed to leave their homes.

She meticulously recorded details of their health prior to, during, and after exposure to the turbines, after they had left their homes because of severe ill health in one or more family members. What she described was a pattern of symptoms which developed or were exacerbated by the operation of the turbines, and which disappeared when the subjects left their homes, only to return again when they returned back to their homes. She called the constellation of symptoms "Wind Turbine

Syndrome". **Her study, together with the raw data / case histories, has been published in a book with the same name**, available from **windturbinesyndrome.com**, and submitted by her to the Senate Inquiry.

Unfortunately, these practicing clinician's reports and studies to date have been completely ignored by health authorities globally, who continue to prefer to rely particularly on wind industry sponsored reviews or "independent" studies, for example the AWEA/CANWEA funded review by Colby et al (2009), **without seeming to understand there is a major conflict of interest.** Dr Robert McMurtry also highlights this important point, in his submission to the Senate.

Other researchers including acousticians and medical sociologists have completed large studies on noise and annoyance, (particularly in Scandinavia). At times, they have purported to examine "health effects". I refer readers again to Dr McMurtry's report to the Senate for his discussion of this literature.

I note Dr Pierpont's letter to Dr Leventhall on the matter of acousticians commenting on medical diagnoses, submitted as part of her evidence. I can only concur with her words. Acousticians and Medical Sociologists are **not** medical practitioners, they are **not** trained to elicit symptoms or detect new illnesses**. As they do not have the requisite specific training in taking a symptom history from a patient, and assessing the meaning of those symptom descriptions, they are in no position to make any comments on the accuracy or otherwise of the diagnostic and symptom descriptions of Dr Harry, Dr Iser, or Dr Pierpont's work, nor are they in a position to accurately and thoroughly carry out such an assessment themselves.**

Dr Pierpont's detractors claim her study is nothing more than a collection of anecdotes, which is untrue - it is a case series cross over design, which clearly shows the changes which occurred in those subjects with exposure to the turbines, and what happened after they left (almost complete resolution of the symptoms).

Detractors claim it is not peer reviewed, which is also untrue, it has been extensively reviewed and refereed by a number of eminent peers, experts in their particular field (also published in the book, and submitted by Dr Pierpont in her evidence to this Senate Inquiry).

Detractors also denigrate it for being self published. Dr Pierpont's reasons for doing this were multiple; the study itself was too long to be published in a peer reviewed

medical journal, and it was impossible to cut it down further without compromising the completeness of the study. PhD papers are in a similar position – they are far too long to be published in a journal, but they are important bodies of work which are also peer reviewed, and contribute to new knowledge about a particular subject.

She was also keen to make it freely available to the many affected people across the world, who were contacting her for information, at the lowest possible price.
After seeking advice from colleagues, Dr Pierpont decided her study was most valuable accompanied with the case histories or raw data, as much of the description of these new symptoms needed to be in the subject's own words to retain maximum accuracy.

Dr Pierpont was also keen for her work to be accessible to lay people with no understanding of medical concepts. This was to help affected residents understand as much as possible about the illness they or their relatives were experiencing; including the symptoms, and the known science at the time which could help to explain the symptoms.

Dr Pierpont did not claim her work was the only work required on the topic, she clearly outlined the need for further research, to determine the exact mechanisms for causation of these symptoms, particularly involving low frequency sound (20 - 200 Hz) and infrasound (0-20 Hz). Her book has now been published in multiple different languages, **testament to both the importance of her clinical research, and the extent of the increasing epidemic of wind turbine syndrome across the world.**

After listening now to many affected residents in Australia and some in Canada, it is my experience that Dr Pierpont's reports of patient's own descriptions of their symptoms in her study are identical to those being described to me by affected residents in Australia; most of whom had no prior knowledge of her, or her work.

Other Medical Practitioners who have subsequently become concerned and involved in the international research effort include Dr Robert McMurtry (Canada), Dr Michael Nissenbaum (USA), Dr Christopher Hanning (UK), and Dr Noel Kerin (Canada).

Some of the Acousticians with extensive experience in this field of work who are independent of the wind industry and very concerned about what is going on include Dr Bob Thorne (Australia & NZ), Mr Rick James (USA), Mr George Kamperman(USA), and Dr Daniel Shepherd (New Zealand). There are other Acousticians, similarly independent of the wind industry, who are also very concerned.

The most recent completed clinical research done was done by Dr Michael Nissenbaum, and involved data collected from two wind turbine developments in North America, at Maine and Vinalhaven. Dr Nissenbaum presented some of this research at the conference in Ontario in October. It is now awaiting publication in a peer reviewed journal, and hence is not yet in the public domain.

In it he showed that there is a clear relationship between the distance a turbine is from a home, and various health indicators of residents, which included sleep quality, depression, and quality of life (using internationally validated questionnaires).

MY FIELD OBSERVATIONS IN AUSTRALIA

The symptoms and health problems well described by the doctors mentioned above, are absolutely identical to the symptoms which have been described to me, in my interviews with over 60 affected residents from wind developments in NSW (Cullerin, Crookwell and Capital), Victoria (Toora, Cape Bridgewater and Waubra) and South Australia (Mt Bryan & Waterloo). **Information from those interviews have been provided to this Senate Inquiry confidentially in a deidentified state, in order to further protect individual privacy**.

Many of these individuals I have interviewed had never heard of Dr Nina Pierpont, or Wind Turbine Syndrome. Indeed, I too had not read her book before I interviewed the first thirty residents, but this was deliberate, so I was able to approach their interviews with a completely open mind. My first question was "Have you noticed any changes since the turbines started operating in your area?". Further clarification was sought as necessary. Some of these interviews have been conducted over the phone, and on multiple occasions. They are an ongoing work in progress, and are being used to determine future research priorities for independent researchers to pursue.

Many people I have interviewed had no idea that these symptoms they had individually noticed were in any way related to the turbines. Their knowledge of their symptoms has been greatly informed by starting to keep personal health journals, which have enabled them to see the connections between turbine operation and their symptoms. This has had the additional benefit of assisting some of their GP's to also see the connections, in particular with blood pressure changes.

I have now spoken directly with Rural Medical Practitioners (General Practitioners and Specialists) from Portland, Ballarat, Clunes, Toora, and Bungendore, who are concerned about the symptoms being experienced and the deteriorating health and sleep patterns of their patients.

The symptoms are characterised by developing after the turbines commence operating in their neighbourhood, and are being noted up to 10km away from the nearest turbines in both South Australia (Mt Bryan & Waterloo) and New South Wales (Cullerin).

Sometimes people develop symptoms straight away, but more commonly nothing is noticed for a few weeks to months apart from the audible noise, and the general pattern is that slowly, symptoms seem to progress in severity.

Sometimes people have described a particular event of exposure where they felt very unwell, and after that they seem to become rapidly worse in terms of symptoms experienced. Often people describe only realizing how unwell they have felt when they go away for over a week, and it is when they return that they suddenly notice the symptoms return, seemingly worse than before.

Some preexisting conditions such as migraines, high blood pressure and tinnitus are noted by affected residents to get worse, with exposure to turbines. It is important to note that not everyone is adversely affected by the turbines. This individual variability is also noted in laboratory experiments which examine the effect of infrasound on blood pressure and heart rate (Qibai & Shi), and work performance (Perrson Waye et al).

The longer people are exposed to the turbines (months – years), the longer it is taking for their symptoms to disappear, if they move away. Disturbingly, some people are reporting that some symptoms appear to be persisting, even after they have not lived at their homes for over a year. These particularly include tinnitus, extreme noise sensitivity (hyperacusis) and impaired memory.

In my experience, residents who are affected and have lived near turbine developments for more than 6 months, are generally able to accurately predict which direction the wind is blowing from by the symptoms they are experiencing, and can also tell without looking whether or not the turbines are operating, on the basis of the symptoms they are experiencing, even when they cannot hear or see the turbines.

Symptoms which have been described to me by Australian affected residents include but are not limited to the following:

Severe chronic sleep deprivation:

- from the audible turbine noise,
- from waking up anxious and hyperalert, in a panicked state, for no good reason, and often a number of times a night. They describe being so instantly awake that it takes a long time to get back to sleep again. These residents often tell me that they cannot hear the audible turbine noise at the time
- from markedly increased nocturnal urination – often experienced by many people at the same time in the same household
- for parents, newly disturbed sleep of their children is an additional contributor to their own sleep deprivation, and this can include regular bedwetting (when previously dry at night for some years) and waking up with night terrors
- waking up in the morning not remembering that they had woken up, but nevertheless not feeling at all refreshed
- trying to get to sleep, or back to sleep having been woken up during the night, in a bed which is literally vibrating

Severe frequent headaches:

- describing their head feeling as if it was “in a vice”, or with a “tight swimming cap on” (some children also badly affected by this, having previously rarely suffered from headaches)
- significant exacerbation of the frequency and severity of their migraines, particularly but not exclusively from shadow flicker. Some people describe their migraines being triggered by just a few seconds of shadow flicker, enough to put them out of action for 24 hours
- frequent severe headaches in children who have never previously complained of them

tinnitus (buzzing/ringing in one or both ears, both new onset and exacerbation of a pre existing condition)

ear pressure sensations (in one or both ears, uncomfortable and sometimes painful, especially if previous tympanic membrane surgery & scarring)

hyperacusis (extreme noise sensitivity to 'normal' sounds)

nausea (sometimes severe)

motion sickness, vertigo symptoms, and balance disturbances, particularly with residents aged over 60 with chronic exposure

visual blurring, which only occurs with turbine operation. Some are also describing sensitivity to flouro lights, particularly in supermarkets, where they are unable to see detail in people's faces

irritability, extreme anger, and other mood disturbances

- this is also being described by current and former **workers** on the turbines, or is being observed by their partners. These individuals do not generally have the additional night time exposure to operating turbines, unless they also live adjacent to the turbine development.

memory and cognitive deficits,

- increase with prolonged exposure, and do not always completely resolve with relocation away from the turbines
- particularly being noted in relation to school children living and/or attending school close to turbines, by parents and by teachers. Appear to resolve (according to parents) with relocation of home and attending a different school in an area not exposed to turbines

depression, sometimes severe, with suicidal ideation

anxiety, sometimes acutely severe, with episodes of extreme panic, sometimes waking them up at night (as mentioned previously, children are waking with night terrors, and bed wetting, never previously experienced)

high blood pressure (hypertension) which can be a new problem, or an exacerbation of a previous condition, and which is sometimes occurring in conjunction with other symptoms suggestive of an acute hypertensive crisis

tachycardia, coinciding with turbine operation

body vibrations, which people describe particularly in their chest, their abdomen, their lower limbs whilst in bed, and also their upper lip. Sometimes this upper lip vibration is

visible to others

RECENT DEVELOPMENTS

Most recently in Australia and in Canada I have heard multiple descriptions of angina, chest tightness, and heart attacks occurring when the turbines are operating. These have occurred at a number of different wind developments, in all three states, and require urgent further thorough investigation and analysis. I am hearing from my Canadian colleagues that the same reports are emerging there, in addition to the ones I heard about directly from affected residents in Ontario in October 2010.

Some heart attacks are occurring in patients who do not appear to have any signs of arterial blockage from subsequent angiograms, performed by their treating cardiologists. There is a condition which is now described as Tako Tsubo, in which sudden shock is causing myocardial dysfunction, and recent Japanese research has highlighted the role which stress hormones including adrenaline appear to be playing in this condition. There is also experimental research which has shown an increase in secretion of stress hormones including cortisol and adrenaline, and also evidence of myocardial damage in animals subjected to infrasound exposure. (NIEHS Toxicology of Infrasound review, 2001)

At Waubra particularly, a number of affected residents have started measuring their blood pressures at multiple times during the day and overnight, and some are finding that both their blood pressures and their heart rates are markedly elevated when the turbines are operating, but decrease when either they are away from home, or when the turbines are turned off for any length of time (days). Many of these patients did not have high blood pressure prior to the turbines operating, as measured by their GPs in their surgeries. Some of the blood pressure increases being reported to me include an **increase** in systolic blood pressure of up to 80mm Hg when the turbines are operating.

Below is an extract from an email sent to me recently by an affected resident, who has realized that his blood pressure problems could be connected with the turbines:

“Last night was the first night for a month that we had constant westerlies. Noise was low to average. However the BP readings are of interest. 6 weeks ago at my regular

medical, my blood pressure was 120/75. Last night on arriving home from a day out, it was 107/78; and 12 hours later after a night of constant turbine noise, 150/79"

I have also been told of episodes of extremely high blood pressure in conjunction with severe headaches and nausea, a sensation of one's heart leaping out of one's chest, and a "sense of impending doom". This clinical description is identical to that described by patients experiencing acute hypertensive crises.

Such a clinical condition has previously been described in conjunction with the clinical use of excess adrenaline, and with a very rare adrenal tumour called a phaeochromocytoma. In some of the affected residents where this clinical situation has been described, both these explanations for their symptoms have been positively excluded. The cause of these episodes is still unknown. One affected resident has had five episodes of this, only ever occurring when the turbines are turning.

Further independent research is urgently required, as some of these clinical effects are occurring at greater distances than previously described (especially some of the body vibrations). **Specifically, hypertension in conjunction with turbine operation has been reported up to 5km away, and body vibrations and nocturnal wakening in a panicked state up to 10km**.

Acousticians independent of the wind industry have confirmed to me that when these large modern turbines are placed on ridges, and there is a temperature inversion effect or cloudy weather, sound waves (audible and infrasound) they generate could certainly travel that distance, particularly in the weather conditions described.

Observed Mental Health Issues

Specific mention needs to be made of the extent and severity of psychiatric morbidity being described by affected residents. This is very noticeable, and is evident both in the populations currently exposed to turbines, but also those who are the subject of proposed developments. I believe the social division which is created and amplified by the activities and strategies of the wind developers (including specifically the confidentiality agreements and the secrecy which surrounds the proposals) is directly responsible for much of this morbidity.

I have been told on many occasions by affected residents that it has destroyed the long

standing close knit fabric of all the small communities I have been to, and has set family members and old friends against each other, divided church congregations and school communities, and created rifts in important rural social and service networks such as the CWA, the CFA/CFS, to name just a few examples.

Residents of rural communities in Australia already have significant stressors, including the effect of the long term drought which has recently been experienced in much of south eastern Australia, followed by the recent floods. They are significantly disadvantaged with respect to access to health care, particularly mental health care. They do not need the extra burden of serious psychiatric illness which these turbine developments are currently contributing to. There is an urgent need to properly assess, measure and describe what is actually going on in these communities with respect to mental health issues, and to ensure that the appropriate help is made available.

The most positive start would be formal acknowledgement that these are serious psychiatric illnesses, rather than being dismissed as "psychosomatic". For too long, non medical professionals (medical sociologists and acousticians particularly) with no clinical diagnostic expertise or training have dominated the analysis, discussion, and study of these problems.

CONSEQUENT EFFECT OF THESE SYMPTOMS, ILLNESSES AND SOCIAL DIVISION ON DAILY LIFE – some examples of the hidden costs

Dr Robert McMurtry, in his submission to this inquiry, has well described the current state of knowledge in the relevant medical literature, particularly with respect to the multiple serious adverse health consequences from sleep deprivation, noise, and stress. Others, such as Professor Arline Bronzaft, have made specific reference to particular situations, such as children, and the effect of noise.

From what I have seen and heard, the overall effect on their day to day lives, for those people and their families affected by the turbines, is profound. Another effect has been the extensive and extraordinarily damaging community division which these developments have directly resulted in, often before they have even been built. I have listed some relevant specific examples I have direct knowledge of below:

- severe sleep deprivation resulting in people describing microsleeps when they

are driving, with multiple 'near misses', and reported increased frequency of farming accidents

- office / business workers finding their chronic sleep deprivation is severely affecting their work performance, and unable to do anything about it – apart from take work home to try and keep up, resulting in yet more stress. Some have had to leave paid employment, some are finding it very hard to find subsequent employment and keep it

- viscious circle of sleep deprivation affecting mental health which then affects sleep adversely, which further affects mental health, especially anxiety and depression. There is little GP's can suggest to help, other than sleeping tablets (addictive & risk of falls), or to move

- People can't move if their house is unsaleable, and they have no other financial assets. All too often, I have been told this is the case. One person has had his property on the market for over 10 years, with no buyers when they discover it is near a wind development. Many people affected are close to retirement age, and have no way of generating the resources needed to move. They are literally trapped, in what some describe as a "living hell"

- families are being split, because of adverse health impacts on some members, who cannot stay living in the family home. This has particularly been the case with some families with young children, and is causing extreme financial and emotional hardship for those families

- Marriages are under significant extra pressure, particularly if one person wants the turbines, and the partner does not, and a parent or the children subsequently get sick

- Some people are self medicating their depression and anxiety symptoms with alcohol, with predictable and serious consequences for themselves & their relatives

- longstanding extended family members are no longer talking to each other, directly as a result over conflict concerning turbines. In previously tight knit rural communities, this is having a devastating effect on longstanding community and family relationships

- concern from extended family members **where there are families who are hosting turbines and there is reluctance to get help for vulnerable members of those families who are being severely affected (particularly elderly parents and children)** – I have direct knowledge of a number of these situations, from concerned extended family members, and from concerned teachers

- the secrecy which the wind developers encourage, by way of confidentiality agreements, and the subsequent feelings of betrayal of trust which others in the community have when they realize, often at the last minute, what is going on. This erosion of trust is particularly damaging to the very fabric of close interrelationships which country life relies on, particularly in times of hardship, which are based on good relationships and cooperation between neighbours. I believe from what I have seen and heard that this alone has a very damaging effect on individual and rural community mental health, even before the turbines are built.

OCCUPATIONAL HEALTH AND SAFETY CONCERNS

I have a number of concerns with respect to occupational health and safety issues.

1. Farmers have workplaces in the vicinity of wind developments, and are themselves employers, as well as employees. Some farmers have said to me that they are very concerned about the health effects of the turbines on their workers, and are concerned about their ability to provide a safe workplace, and their liabilities with respect to this issue. Some have sought advice from the relevant government departments, but with none forthcoming, as officially "there is no health problem".

2. Some farmers have given me instances where their workers have had to leave, because of health problems they developed which included symptoms of motion sickness, headaches, painful ear pressure, and inability to cope with the audible noise of the turbines. One worker from his description may have been having episodes of acute hypertensive crises, and has told me he will never work again near a wind development, as he felt so unwell.

3. I am also concerned about the health of workers employed by the wind

development companies, on site. I am told by current and ex employees of different wind developments that they are not advised of any health issues or monitoring required, as officially "there are no health problems". I am particularly concerned about the need to monitor blood pressures of workers on turbine developments, as elevated blood pressures are generally symptom free.

4. The new national work health and safety laws are to be enacted this year, and will take effect from 1st January, 2012. In those new laws, there is a specific onus on individuals conducting a business to provide a safe workplace, and health is specifically described as including both physical and psychological health. This will further increase the pressure on those farmers to "provide a safe workplace", which it is clearly impossible for them to do if they are surrounded by wind turbines.

MECHANISMS OF CAUSATION of Illness resulting from Wind turbines, and related regulatory issues

The exact mechanisms for causation of all the ill health resulting from turbines are not all clear, however I make the following comments

1. Audible Noise

Wind Turbines can be noisy, even some elements of the wind industry have admitted this (eg Sloth, 2010, summary page). There is no doubt that some people are particularly affected by the audible noise from turbines, which is uniquely disturbing or annoying for many people at much lower sound pressure levels than for other sources of noise. I am not going to discuss the extensive medical evidence which exists in the published peer reviewed medical literature about the adverse effects of audible noise on health, and on sleep, but again refer readers to Dr Robert McMurtry's submission to the Senate Inquiry on this topic.

In addition, Dr Bob Thorne and Dr Daniel Shepherd's work on individual noise sensitivity is highly relevant here (please refer to their respective Senate Submissions) – what is disturbing to one individual who is noise sensitive, may not disturb another. This is yet another reason to ensure that turbines are sited well away from human habitation, to ensure that those who are noise sensitive are not going to be adversely impacted, with direct health adverse consequences because of chronic sleep

deprivation from audible noise.

The issues of increased night time noise from turbines is something which a number of acousticians have written extensively about, particularly Dr Bob Thorne, Dr Frits Van Den Berg, and Mr Rick James. What I hear from affected residents is that their sleep and therefore their health is particularly affected by audible noise on nights where there is ridgetop wind, but the background noise around their home is quiet. On these nights, the audible noise can mean that some affected residents get very little sleep.

This noise has been described to me from residents of houses up to 8km away from the turbines, and I have heard it myself from turbines at a distance of 4km, on such a night, at Waubra. It literally can sound like a loud overhead jet engine, which doesn't ever leave. Other residents describe the noise as being like a washing machine, or a truck or train constantly making a noise, and never going anywhere. I have recently visited a number of houses adjacent to the Capital Wind Development in NSW, and have heard this variation in sound for myself.

I am not an acoustician, but acousticians I work with tell me that current audible noise measurements are based on averages, rather than actual peaks of audible noise intensity. As Professor John Harrison made clear at the Symposium in Ontario, "the ear does not hear 'averages', it hears the peaks (please see his conference paper on the windvigilance.com website).

If the audible sound "peaks" are what is waking people up, then consideration needs to be given to changing the current guidelines, ensuring that such peaks are measured, and then acted on, if the adverse and serious health consequences of chronically disturbed sleep are to be prevented.

In addition, many people I spoke to described how their ears / brains seemed to 'tune into' the sound of wind turbine audible noise, so that what was not annoying for the first five minutes became intensely annoying or disturbing after a few hours or days, let alone months.

Mr Erik Sloth, in his frank presentation to the Clean Energy Council in May 2010, referred to some inadequacies of current acoustic modeling in predicting actual wind turbine noise – certainly the perspective of affected residents I have spoken with is that the noise they are living with on a regular basis is very loud, and very disturbing.

There is a major problem with the process, if the noise predictions used by the wind developers in their planning applications bear no reality to the noise actually generated in the field post construction, as is happening currently at multiple wind developments to my knowledge, specifically Waubra, Waterloo, and Mt Bryan. It is simply not good enough for the developers to admit, post construction, that "we didn't realize they would be so noisy".

One of the more damaging and disempowering wind company practices is to refuse to release post construction audible noise monitoring data when requested to do so by the affected residents, giving the excuse that it is "inconclusive", or releasing it in such a form that it is impossible for them to interpret (eg a wad of sheets of paper with noise numbers). According to affected residents I have spoken with, this has happened at Mt Bryan, Waubra, Toora, and Capital wind farms.

2. Low Frequency Noise (LFN) and infrasound

Low Frequency noise is generally defined as sound waves with a frequency less than 200 Hz. Infrasound has a frequency of less than 20 Hz, which is generally imperceptible to the human ear, but may be perceived as a vibration. It is important to note that all the current noise regulations specify dBA or audible noise level limits, but there appears to be little or no regulation specifically governing the acceptable or 'safe' sound pressure levels of infrasound**.**

Dr Alec Salt has shown experimentally how infrasound can adversely affect the mechanisms operating the sensitive inner ear function at much lower sound pressure levels than are perceptible to human hearing. This means that even though you cannot 'hear' the infrasound waves, they are still impacting on your inner ear and brain. (see conference proceedings on windvigilance.com). His work is leading the world in this area, and has been peer reviewed and published.

Dr Nina Pierpont has also referred to the current research literature relating to the brain and the vestibular system in particular, in both her study and in her recent presentation and paper for the International Symposium, (available at windvigilance.com) and submitted to the Senate committee.

There are also published peer reviewed scientific studies which confirm that the effects of exposure to infrasound are cumulative (Perrson & Waye,), can affect cognition & memory (ibid), can affect mood & work performance (ibid), and can result in elevated

blood pressure, heart rate, and affect mood (Qibai & Shi).

Whilst these experiments have not been done with wind turbine specific pulsatile infrasound, they are highly suggestive that infrasound may indeed by a causative agent in many of the symptoms of wind turbine syndrome. There is an urgent need for further research into this specific area, because of the finding below.

Mr Rick James (Acoustician) showed a sound spectogram during his presentation at the International symposium in Ontario on October 29th, 2010, and stated that he had measured the wind turbine specific pulsatile infrasound using a Sound Quality Analysis Instrument, and found infrasound up to a sound pressure level of 90 dB, which was a much higher sound intensity than previously thought possible from modern upwind turbines (available on windvigilance.com, second last page of his presentation, further details available on request).

There are animal studies which clearly show that infrasound at this sound pressure level of 90dB can cause physiological changes, in particular stimulation of the body's fight / flight response, or sympathetic nervous system. There is also evidence of tissue damage with long term high intensity infrasound exposure. There are multiple relevant papers which are cited in a Review of the toxicology of infrasound, (2001) by the National Institute of Environmental Health Sciences.

A number of the patterns of symptoms which affected residents have described would certainly fit with the experimental evidence of stimulation of the sympathetic nervous system by infrasound; particularly the waking up in the middle of the night panicked, the anxiety symptoms, the elevated blood pressure, the tachycardia, the episodes of acute hypertensive crises, Tako Tsubo induced heart attacks, to name a few.

There is certainly an urgent need for further specific research into the effects of acute and chronic infrasound and LFN exposure on humans and animals, at the measured levels of wind turbine specific pulsatile infrasound in the field being emitted by the turbines. Professor Colin Hansen, Acoustics Professor from Adelaide University, has expressed an interest in being involved in such studies, in conjunction with a Physiologist or Clinician.

This basic infrasound measurement in the field and in the affected people's homes has not ever been done, and urgently needs to be. Both Dr Bob Thorne and Professor Colin Hansen are keen to do this.

We don't know what a 'safe' level of infrasound emission from a turbine is, particularly with cumulative chronic exposure, and particularly with exposure of particularly vulnerable populations, especially the elderly, children, and unborn babies.

Some clinicians working in this area are now concerned that the illness called Vibro-Acoustic disease, which results from chronic long term high intensity infrasound exposure, (particularly in the aviation / defence industries) may be relevant in this context of chronic exposure to wind turbine infrasound, given the recent high intensity levels of pulsatile wind turbine specific infrasound, recorded by Mr Rick James, in Ontario, (previously mentioned).

Given what we do know already about infrasound exposure, it would seem imperative to immediately adopt the precautionary approach, and not site turbines within distances where people are currently experiencing symptoms (10km), until such detailed infrasound studies are done.

Dr Bob Thorne, Dr Daniel Shepherd and their colleagues from Massey University have submitted a study proposal which would significantly increase current knowledge in this area, which is ready to start immediately, as are the subjects for the study. All that is required is the funding. Dr Thorne has told me that useful results could be available by six months from commencement of the study**.**

Other mechanisms

It may well be that other mechanisms are eventually identified as causative agents for some of the symptoms which are being experienced by affected residents, but these remain unidentified at this time. There is certainly concern on the part of some residents that electromagnetic radiation may be playing a part.

At present there is little evidence to support this, however a preliminary step would be to actually measure the electric and magnetic fields in those locations where people are actually experiencing symptoms or other problems suggestive of electromagnetic interference, such as flouro lights lighting up by themselves, as has been reported by some residents.

THE NOCEBO ARGUMENT

There is no experimental or study data which support the wind industry assertion that these symptoms are due to the “nocebo” effect.

In my experience, many of the affected residents currently living adjacent to turbine developments actually supported the turbines coming in to their community, and some worked on the turbine construction.

In my judgement, assertions of the nocebo effect in these circumstances is evidence of a culture of victim blaming which is pervasive within the industry, rather than a valid scientific hypothesis.

SOME AREAS REQUIRING FURTHER INDEPENDENT RESEARCH

1. the duration, frequency and intensities of pulsatile infrasound and low frequency noise currently being emitted from turbine developments, under different weather & wind conditions, over weeks to months, and the concurrent measurement with symptoms being experienced by affected residents in their homes (Dr Bob Thorne et al's proposed research)

2. the sleep patterns of affected residents, documented by in situ sleep studies, correlated with turbine operation, and concurrent measurement of audible sound and infrasound

3. the effect on blood pressure of sound and infrasound from turbines, as measured concurrently by sound and infrasound measurement devices and continuous ambulatory blood pressure monitoring

4. the effect of long term chronic infrasound exposure on adults (using a range of health indices), and in particular investigation of any irreversible long term sequelae (possible permanent memory deficits, hyperacusis (noise sensitivity) and permanent tinnitus have been described in residents who have relocated away from turbines some time ago)

5. the effect of chronic infrasound exposure, and exposure to wind turbines on children & unborn babies, (particularly their growth, development, cognitive

development, & learning)

6. ascertain the range and severity of psychiatric illness being observed in populations exposed to turbines, compared with a non-exposed group, with follow up work to determine the causative agent(s) and appropriate and effective therapeutic interventions

OTHER IMPORTANT HEALTH/PLANNING ISSUES - FIRE

Finally, particularly in south eastern Australia, there is the issue of increased fire risk which operating wind turbines pose.

1. Turbines can and do catch fire (at least three in South Australia in the last few years - Cathedral Rocks, Lake Bonney and Starfish Hill), and have significant quantities of highly flammable oil in their gearbox.

2. There are significant impediments to fighting wind turbine fires - both the fire authorities and the turbine developers admit there is little that can be done in the event of a fire except just watch it burn, and try and put out any spot fires.

3. CFS staff in South Australia advise me they have been told they cannot approach a burning turbine closer than 300 metres, and the Country Head of Safework SA has confirmed that there are further restrictions if the turbine blades are on fire and spinning, as happened recently at Starfish Hill, requiring the CFS to move back to at least one kilometre from the burning, spinning turbine blades. Preliminary discussions with people interstate have revealed the same issues and restrictions.

4. Finally, there are restrictions on the use of aerial fire fighting apparatus in close proximity to turbines, because of the turbulence the turbines generate. I have been advised that this applies whether the turbines are operating or not.

There is currently no restriction on the operation of turbines on days of increased fire danger (high, extreme, and catastrophic). In my opinion, this is a major public health disaster, just waiting to happen.

RESTRICTIONS TO OPERATION OF TURBINES ON THESE DAYS SHOULD BE

IMMEDIATELY IMPLEMENTED.

OTHER RELEVANT ISSUES:

Why has this research not yet been done, anywhere in the world?

I believe the issue of the adverse health effects of wind turbines has not yet been properly examined by my Medical colleagues with the exception of the people already mentioned, **because they have been unaware that there was a problem**.

I believe there has been an organized effort on the part of the wind industry to keep this issue of adverse health effects out of the public arena, by the combined use of:

1. **deliberate 'spin' and misinformation**, particularly on the part of the wind industry bodies e.g. the Clean Energy Council in Australia (for example comments such as "after 20 years and 100,000 turbines there have been no problems" despite members of this industry being party to 'gag' agreements

2. '**shooting the messenger'** in the form of attempting to intimidate or discredit the clinicians who have identified problems. I have experienced both, on multiple occasions, from wind industry and government representatives

3. **by the use of confidentiality agreements** with some of the affected residents, who have signed these agreements which prevent them from speaking publicly about their health problems.

I have direct knowledge of these confidentiality agreements occurring in multiple sites with different developers in Australia, and in Canada, and have been advised by my colleagues internationally of this widespread and longstanding industry practice elsewhere.

FAILURES OF PROCESS AND REGULATION and the consequent effects on mental health of affected residents

In my experiences listening to the stories of affected residents across south eastern Australia, the overwhelming impression I have is one of collective anger and deep

despair at being lied to, ignored, or arrogantly dismissed, by both wind developers, their consultants, their lawyers, and politicians and bureaucrats, particularly those in health, environment and planning departments at all layers of government (Federal, State and Local).

There are a few notable exceptions, where individuals have taken affected residents seriously, but they are very few indeed.

The direct health consequence of this failure has been an escalation of the significant mental health problems which have previously been described. These are occurring in people already living adjacent to the turbines, but they are also occurring in significant numbers in those populations who are confronted with a proposed development in their "backyard".

Many people I have spoken to in such situations describe it as being "akin to a war", consuming every waking moment, not to mention considerable financial resources, if available. **They also describe feeling utterly abandoned by the authorities such as the health department and the EPA, who are meant to be there to protect the health and well being of all individuals, but particularly those vulnerable individuals such as the elderly, and the children**.

For example, I am told by **all** the affected residents I have spoken with that they have **never** been contacted by any state or federal health bureaucrat, apart from receiving letters telling them "there is no evidence" that they could be suffering from the health problems they describe. Some have also been told this by their doctors. I understand how this situation has arisen, given the lack of research, with the exception of the studies previously mentioned, but such disbelief has only perpetuated the trauma of their experiences.

I have met with such health bureaucrats, or have sometimes received correspondence from them. None of the health officials I have met with to date had actually read the studies I have referred to, particularly Dr Nina Pierpont's study.

I have been told by them they will "monitor developments" and "it is only a few people anyway". Another response has been that it is "for the greater good" of the community – this has also been enshrined in some Australian court judgements, and planning decisions.

Consequently affected rural residents are feeling utterly abandoned, desperate, and very angry, as well as feeling very unwell, mentally and physically. Many have been significantly financially impoverished by their experiences. One couple I know of are effectively homeless, as they become so sick within minutes to hours of returning home, if the turbines are turning. They would be homeless if it wasn't for the kindness of friends and relations.

I sincerely hope that the deliberations of this Senate Committee will result in their voices being heard, and significant and urgent action being taken.

I believe Independent scientifically conducted research is the ONLY way to progress this issue, with the competing and conflicting interests of all the parties involved.

RECOMMENDATIONS

1. **There is an urgent need for further INDEPENDENT medical, acoustic and scientific research, looking specifically at the populations affected by the currently constructed and operating wind developments in Australia**

2. **An immediate temporary halt in construction of wind turbines closer than 10km to human habitation until adequate research is completed, in order to determine what is a safe setback of turbines from homes and workplaces**

3. **Current planning and noise guidelines will need to be updated on the basis of this new knowledge**

4. **There should be an immediate ban on the operation of wind turbines on days of high, extreme and catastrophic fire danger, because of the difficulties in fighting such fires, and the risk to lives should such a fire occur**

5. **Measurement of wind turbine specific infrasound and low frequency sound needs to be included in post construction noise assessments, and ALL these assessments MUST be performed by experienced Acousticians who are COMPLETELY INDEPENDENT of the wind developers**

OBJECTIVES

1. Gather, investigate and review complaints of health problems that have been perceived by the complainants as being associated with living or working close to wind turbines or such other industrial sources that may be considered as relevant.

2. Continue to gather additional information from existing and new wind projects or other sources as it becomes available.

3. Build the existing and new data into a high quality data base suitable as a start point for properly constructed studies and review by qualified others.

4. Use the data to engage in co-operative studies with independent researchers both in Australia and internationally.

5. On the basis of data gathered plus local, overseas and co-operative studies, provide relevant and independent advice to communities, the public at large and local, state and federal governments and to the wind turbine industry and other relevant organisations.

6. Promote research into the effects and causes of illnesses that may be associated with living or working close to wind turbines and other relevant sources.

7. Make the results of such research widely available, to members of the public, health professionals, and other interested parties.

8. Facilitate the establishment of individual networks of relevant specialities of medical practitioners and other health practitioners to enable the rapid sharing of information and expertise in the diagnosis, management and treatment of patients with symptoms of wind turbine syndrome

9. Provide such advice and assistance as can be given to individuals and communities who believe that their health is or may be impacted by adjacent wind turbines or other sources.

10. Assemble the necessary resources to carry out the objectives.

11. Raise such funds as may be possible to assist in the work of the Foundation.

12. At all times to establish and maintain complete independence from government, industry and advocacy groups for or against wind turbines.

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A Summary of new evidence:

Adverse health effects and industrial wind turbines

August 2011

Carmen M.E. Krogh, BScPharm

Brett S. Horner, BA, CMA

To whom it may concern

In previous communications, evidence has been provided regarding the risk of adverse health effects and industrial wind turbines (IWTs). Up to now, the siting of IWTs in Ontario is based on predictive computer modelling. While there is ample evidence regarding adverse health effects, the conduct of human health studies to determine regulations for setbacks and noise levels that protect health is still lacking.

The purpose of this document is to inform authorities and decision makers of new evidence, including articles published in peer reviewed scientific journals which advance knowledge on the topic of adverse health effects of IWTs.

Based on the evidence compiled in this document, no further IWT projects should be approved in proximity to humans until human health studies are conducted to determine setbacks and noise levels that will ensure the health and welfare of all exposed individuals.

Furthermore where there are reports of adverse health and/or noise complaints IWTs should be decommissioned until the human health studies have been conducted to determine regulations for setbacks and noise levels that protect health.

This summary may be used and submitted by other individuals.

No financial compensation has been requested nor received for this summary.

Denial of adverse health effects

For years now, the Canadian Wind Energy Association (CanWEA) has denied that wind turbines can cause adverse health effects. However, based on previously known and recent information, this denial is incorrect.

A 2008 CanWEA media release informs the world "Scientists conclude that there is no evidence that wind turbines have an adverse impact on human health." [1] None of references included in this CanWEA media release state "there is no evidence that wind turbines have an adverse impact on human health."

An April 2009 CanWEA fact sheet states "Findings clearly show that there is no peer-reviewed scientific evidence indicating that wind turbines have an adverse impact on human health." [2] The fact sheet contains eight references, none of which state "there is no peer-reviewed scientific evidence indicating that wind turbines have an adverse impact on human health."

A 2009 CanWEA convened literature review concludes "Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans." [3] However, the contents of the literature review contradict this conclusion by acknowledging IWT noise

may cause annoyance, stress and sleep disturbance and as a result people may experience adverse physiological and psychological symptoms. The literature review acknowledges possible symptoms include distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension.

The above CanWEA sponsored statements which deny risk of adverse health effects are scientifically incorrect.

Assertions that IWTs do not pose a risk to human health only serve to confuse authorities and the public on the issue wind turbines and health effects.

For example, Ontario Minister of Health Matthews reportedly stated "There is no evidence, whatsoever, that there is an issue related to turbines," [4] This statement is scientifically incorrect.

July 2011 Environmental Review Tribunal (ERT) Decision, Ontario

As noted above, the CanWEA sponsored Colby et al. (2009) literature review stated "Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans." [5] Three of the co-authors of this statement, Drs. Colby, Leventhall, and McCunney testified on behalf of the Respondents (Ministry of Environment, Suncor Energy Services Inc.) during an Ontarian Environmental Review Tribunal (ERT).

Evidence provided at the ERT demonstrated the above statement authored by the CanWEA sponsored panel experts is incorrect.

The July 2011 ERT decision for an IWT project in Ontario [6] confirmed IWTs can harm humans:

> "While the Appellants were not successful in their appeals, the Tribunal notes that their involvement and that of the Respondents, has served to advance the state of the debate about wind turbines and human health. This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. *The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree."* (p. 207) (*Emphasis added*)

Evidence and testimony provided to the ERT by witnesses called by the Appellants served to advance understanding of IWT induced health impacts. It is now acknowledged that IWTs do pose a risk of adverse health effect in humans if they are improperly sited.

All ten of the witnesses called upon by the Appellants were qualified as expert witnesses. The expert witnesses called upon by the Appellants have been involved in original

research on the health effects of IWTs and/or have had related articles accepted in peer reviewed scientific journals.

During the ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWTs sound is perceived to be more annoying than transportation noise or industrial noise at comparable sound pressure levels.

Peer reviewed articles and other references acknowledge annoyance to be an adverse health effect. (Pedersen & Persson Waye, 2007 [7]; Michaud et al. 2005 [8]; Health Canada, 2005 [9]; Suter, 1991 [10])

During the ERT expert witnesses for both the Respondents [11], [12], [13], [14] and the Appellants provided evidence and/or testimony which acknowledge annoyance to be a health effect.

Research confirms for chronically strong annoyance a causal chain exists between the three steps health–strong annoyance–increased morbidity [15] and must be classified as a serious health risk. [16]

During the ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWTs "will" cause annoyance, which can result in stress related health impacts including 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, and depression.

During the ERT witnesses for both the Respondents and/or the Appellants provided evidence and/or testimony which indicate plausible causes of these health effects include: IWT amplitude modulation, audible low frequency sound, infrasound, tonality, lack of nighttime abatement, shadow flicker, visual impact, economic impacts or a combination thereof.

It is acknowledged Ontario regulations and/or noise guidelines will not protect all individuals from these health impacts. A 2010 final draft report prepared for the Ontario Ministry of Environment (MOE) states:

> "The audible sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, *is nonetheless expected to result in a non-trivial percentage of persons being highly annoyed*. As with sounds from many sources, research has shown that annoyance associated with *sound from wind turbines can be expected to contribute to stress related health impacts in some persons*." [17] (*Emphasis added*)

MOE documents obtained through a Freedom of Information request confirm current Ontario IWT guidelines will cause adverse effects. One 2010 MOE internal memorandum 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 contrary to subsection 14(1) of the EPA" [18]

Another MOE reference documents Ontario families that have abandoned their homes due to sleep disturbance caused by exposure to wind farms. [19] Sleep disturbance is an adverse health effect. MOE correspondence also documents families that have moved out of their homes and have made financial settlements with the respective IWT developer. [20]

Based on original research in Ontario, and elsewhere, a peer reviewed article states:

> "It is acknowledged that IWTs, if not sited properly, can adversely affect the health of exposed individuals. In addition to physiological and psychological symptoms there are individuals reporting adverse impacts, including reduced well-being, degraded living conditions, and adverse societal and economic impacts. These adverse impacts culminate in expressions of a loss of fairness and social justice.
>
> The above impacts represent a serious degradation of health in accordance with commonly accepted definitions of health as defined by the WHO and the Ottawa Charter for Health Promotion." [21]

August 2011 peer reviewed articles published in a scientific journal

Subsequent to the July Ontario ERT decision nine peer reviewed articles have been published in a special August, 2011 edition of the scientific journal, *Bulletin of Science, Technology and Society* (*BSTS*). These articles explore health and social impacts of IWT installations. [22], [23], [24], [25], [26], [27], [28], [29], [30]

The Special Edition is entitled *Windfarms, Communities and Ecosystems.* Included in the special edition, is a commentary by the editor, Willem H. Vanderburg. [31]

The SAGE website states:

> "*The goal of the* ***Bulletin of Science, Technology and Society*** *is to provide a means of communication within as wide of a spectrum of the STS community as possible. This includes faculty and students from sciences, engineering, the humanities, and social science in the newly emerging groups on university and college campuses, and in the high school systems, all of which teach integrative STS subject matters. It also includes professionals in government, industry and universities, ranging from philosophers and historians of science to social scientists concerned with the effects*

of science and technology, scientists and engineers involved with the study and policy-making of their own craft, and the concerned general leader. A third category of readers represents "society": all journalists dealing with the impacts of science and technology in their respected fields, the public interest groups and the attentive public." [32]

One article presents the result of WindVOiCe, an Ontario self reporting health survey that follows the principles of Health Canada for vigilance monitoring of pharmaceuticals and other products. [33]

Another article documents social justice impacts when people cannot obtain mitigation or resolution and in some cases, have abandoned their homes due to IWT exposure. [34]

An article authored by Dr. Bob Thorne documents his research on IWT noise and correlates this with reported IWT adverse health impacts. Based this field work Dr. Thorne concludes a sound level of LAeq 32 dB outside the residence is required to avoid serious harm to human health. [35]

Ontario MOE documents obtained from a Freedom of Information request support a 32 dBA sound limit for IWTs. Based on real world field investigations MOE field officers advised the Ministry about IWT adverse effects and stated "… the setback distances should be calculated using a sound level limit of 30 to 32 dBA at the receptor, instead of the 40 dBA sound level limit." [36]

Dr. Robert McMurtry, former Dean of Medicine, University of Western Ontario, and 2011 recipient of Member of Order of Canada, published a case definition to facilitate a clinical diagnosis regarding adverse health effects and IWTs. [37]

Other articles explore topics including how to properly interpret IWT epidemiological evidence, [38] the physics of IWT noise, [39] public health ethics, [40] potential IWT noise impacts on children, [41] and potential IWT infrasound sound impacts on the human ear. [42]

These articles are critical to anyone interested in the safe siting of IWTs. It is recommended that authorities and regulators obtain a copy of each of the nine articles.

Please use this link if you wish to access these articles http://bst.sagepub.com

Downloads of these articles can be obtained with an individual subscription for $100. This will allow you to download these and other articles from the BSTS scientific journal.

IWT low frequency noise and infrasound

In the past some commentators have stated low frequency noise from IWTs is not an issue. Other references indicate most available evidence suggests that reported IWT health effects, such as sleeplessness and headache, are related to audible low frequency noise. [43]

A June 2011 Federal Australian Senate committee investigating IWT and adverse health effects report recommended:

> "… noise standards adopted by the states and territories for the planning and operation of rural wind farms should include appropriate measures to calculate the impact of low frequency noise and vibrations indoors at impacted dwellings." [44]

A June 2011 peer reviewed article on IWT low frequency noise is available. [45]

The abstract states:

> As wind turbines get larger, worries have emerged that the turbine noise would move down in frequency and that the low-frequency noise would cause annoyance for the neighbors. The noise emission from 48 wind turbines with nominal electric power up to 3.6 MW is analyzed and discussed. The relative amount of low-frequency noise is higher for large turbines (2.3–3.6 MW) than for small turbines ([1] 2 MW), and the difference is statistically significant. The difference can also be expressed as a downward shift of the spectrum of approximately one-third of an octave. A further shift of similar size is suggested for future turbines in the 10-MW range. Due to the air absorption, the higher low-frequency content becomes even more pronounced, when sound pressure levels in relevant neighbor distances are considered. Even when A-weighted levels are considered, a substantial part of the noise is at low frequencies, and for several of the investigated large turbines, the one-third-octave band with the highest level is at or below 250 Hz. It is thus beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbors."

Annoyance from audible low frequency noise is acknowledged to be more severe in general. Low frequency noise does not need to be considered loud for it to cause annoyance and irritation. [46] Low frequency noise causes immense suffering to those who are unfortunate to be sensitive to it [47] and chronic psychophysiological damage may result from long-term exposure to low-level low frequency noise. [48] Some symptoms associated with exposure to low frequency noise include annoyance, stress, sleep disturbance, headaches, difficulty concentrating, irritability, fatigue, dizziness or vertigo, tinnitus, anxiety, heart ailments and palpitation. [49], [50], [51]

Møller and Pedersen, (2011) indicate IWT low frequency noise is more of an issue for large turbines of 2.3 MW and up. [52] However low frequency noise from smaller turbines (ie 1.5MW) can also cause adverse health effects. Freedom of Information documents

obtained from the MOE document low frequency noise issues from smaller IWTs (i.e., 1.5 MW) at Ontario wind farms. The MOE documents how IWT low frequency noise caused a home to be "uninhabitable" resulting in family members abandoning trying to sleep there. [53] For further discussion see Krogh (2011) [54] and Thorne (2011). [55]

Research on the potential impacts of IWT infrasound has been published in two peer reviewed scientific journals (Salt and Hullar, 2010 [56], Salt and Kaltenbach, 2011 [57]). These articles conclude that it is scientifically possible that infrasound from IWTs could affect people living nearby and more research is needed.

Wind Turbines Noise, Fourth International Meeting

During the Rome Conference Fourth International Meeting on Wind Turbine Noise Rome Italy 12-14 April 2011 there were a number of presentations documenting IWT noise issues.

The Wind Turbine Noise (2011) post-conference report states:

> "The main effect of daytime wind turbine noise is annoyance. The night time effect is sleep disturbance. These may lead to stress related illness in some people. Work is required in understanding why low levels of wind turbine noise may produce affects which are greater than might be expected from their levels." [58]

A number of conference papers addressed human health impacts of IWTs. For example one research team conducted a study which demonstrated those living in the immediate vicinity of IWTs scored worse than a matched control group in terms of physical and environmental health related quality of life (HRQOL). [59]

The Ontario ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWT amplitude modulation and/or audible low frequency noise are probable causes of IWT adverse health effects.

Research related to low frequency noise "…confirms the importance of fluctuations as a contributor to annoyance and the limitation of those assessment methods, which do not include fluctuations in the assessment." [60]

In addition, the World Health Organization states:

> "Noise measures based solely on LAeq values do not adequately characterize most noise environments and do not adequately assess the health impacts of noise on human well-being. It is also important to measure the maximum noise level and the number of noise events when deriving guideline values. If the noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse

effects considerably. When prominent low-frequency components are present, measures based on A-weighting are inappropriate." [61]

Consultants for the Ontario MOE, Aercoustics, submitted a paper at the Fourth International Meeting on Wind Turbine Noise which states:

"Sound emissions from operating wind farms frequently give rise to noise complaints. Most compliance-based noise audits measure hourly "A"-weighted Leq, thereby removing the low-frequency contents of the wind turbine sound. The metric is also insensitive to amplitude modulation and is unsatisfactory when sensitive receptor are annoyed by the low frequency sound and amplitude modulation." [62]

Current Ontario guidelines are based on the A-Weighted Leq metric and hence must be considered unsatisfactory to protect individuals from the health impacts of IWT amplitude modulation and/or low frequency noise.

The need for research

The authors of a Canadian Wind Energy Association sponsored report state they do not "advocate for funding further studies." [63]

The April 2011 Wind Turbine Noise post–conference report states:

"Work is required in understanding why low levels of wind turbine noise may produce affects which are greater than might be expected from their levels." [64]

A June 2011 Australian Senate committee investigating IWT and adverse health effects report recommended:

"… the Commonwealth Government initiate as a matter of priority thorough, adequately resourced epidemiological and laboratory studies of the possible effects of wind farms on human health. This research must engage across industry and community, and include an advisory process representing the range of interests and concerns." [65]

The July 2011 Ontario ERT decision also acknowledged that more research is needed. [66]

"Just because the Appellants have not succeeded in their appeals, that is no excuse to close the book on further research. On the contrary, further research should help resolve some of the significant questions that the Appellants have raised." (p. 207)

International experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm that research is required. [67], [68], [69], [70], [71], [72], [73], [74], [75], [76]

Inappropriate use of literature reviews

Literature reviews can be useful tools for summarizing existing literature related to a particular topic. In order to be considered reliable a literature review must be complete, accurate, and objective.

In recent years a number of literature reviews have been produced which purport to explore the health effect of IWTs. Some literature reviews which have been relied upon to deny IWTs can adversely affect the health of humans. These literature reviews include Chatham-Kent Public Health Unit. (2008), [77] Colby et al, (2009), [78] Ontario Chief Medical Officer of Health, (2010), [79] and the National Health and Medical Research Council (Australia) (2010). [80] None of these literature reviews have been published in a peer reviewed scientific journal.

Reliance on these literature reviews is inappropriate as they contain errors of omission and/or commission and are neither convincing nor authoritative. Many of the conclusions are incomplete, inaccurate, lack objectivity and consequently only serve to confuse the issue of IWT health effects.

For example, these literature reviews limit their discussion to direct effects using qualifiers such as “direct physiopathological effects” or “direct causal links”. Failure to carefully evaluate the indirect causal pathways and the psychological harm of IWT exposure represent errors of omission. Annoyance, sleep disturbance, cognitive and emotional response, and stress are health effects that occur through the indirect pathway. [81] The health outcomes associated with the indirect pathway are significant:

> “Physiological experiments on humans have shown that noise of a moderate level acts via an indirect pathway and has health outcomes similar to those caused by high noise exposures on the direct pathway. The indirect pathway starts with noise-induced disturbances of activities such as communication or sleep.” [82]

The Ontario Environmental Review Tribunal expressed concern that the Director for the MOE relied on references which did not address the indirect pathway. [83]

As a consequence of their weaknesses some literature reviews have been criticized for their poor quality.

In March 2011, the Chief Executive Officer of National Health and Medical Research Council stated regarding their July 2010 literature review:

> "We regard this as a work in progress. We certainly do not believe that this question has been settled. That is why we are keeping it under constant review. That is why we said in our review that we believe authorities must take a precautionary approach to this." [84]

Chatham-Kent Public Health Unit (2008), [85] Colby et al, December 2009, [86] Ontario Chief Medical Officer of Health (2010), [87] share many of the same weaknesses as National Health and Medical Research Council (2010). [88] These literature reviews cannot be relied for Renewable Energy Applications and/or Renewable Energy Approvals to support the contention there is no evidence that IWTs can cause adverse health effects. For detailed analysis of some of these literature reviews visit www.windvigilance.com

Conclusion

Based on the best available evidence the following conclusions can be made

1. The Canadian Wind Energy Association sponsored statements that IWTs do not pose a risk of adverse health effects in humans are scientifically incorrect.

2. Experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm IWTs can harm human health if they not sited properly.

3. Acknowledged adverse health effects include: annoyance, stress, 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. Other adverse impacts include reduced well-being, degraded living conditions, and adverse societal and economic impacts. These adverse impacts culminate in expressions of a loss of fairness and social justice.

4. The above impacts in conclusion 3 represent a serious degradation of health in accordance with commonly accepted definitions of health as defined by the WHO and the Ottawa Charter for Health Promotion.

5. It is expected that at typical setbacks and with the noise study approach currently being used in Ontario to approve the siting of IWTs, a non trivial percentage of exposed individuals will experience serious degradation of health.

6. Harm to human health can be avoided with science based regulations based on research conducted on human response to IWT exposure.

7. Experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm that research is required to establish scientifically based IWT regulations to protect human health.

8. Until scientifically based research has been conducted IWTs should not sited in proximity to human habitation.

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lessen the impacts of noise from all sources. Furthermore, based on our knowledge of the harmful effects of noise on children's health and the growing body of evidence to suggest the potential harmful effects of industrial wind turbine noise, it is strongly urged that further studies be conducted on the impacts of industrial wind turbines on their health, as well as the health of their parents, before forging ahead in siting industrial wind turbines.

Alec N. Salt and James A. Kaltenbach **Infrasound From Wind Turbines Could Affect Humans**: 296-302. Wind turbines generate low-frequency sounds that affect the ear. The ear is superficially similar to a microphone, converting mechanical sound waves into electrical signals, but does this by complex physiologic processes. Serious misconceptions about low-frequency sound and the ear have resulted from a failure to consider in detail how the ear works. Although the cells that provide hearing are insensitive to infrasound, other sensory cells in the ear are much more sensitive, which can be demonstrated by electrical recordings. Responses to infrasound reach the brain through pathways that do not involve conscious hearing but instead may produce sensations of fullness, pressure or tinnitus, or have no sensation. Activation of subconscious pathways by infrasound could disturb sleep. Based on our current knowledge of how the ear works, it is quite possible that low-frequency sounds at the levels generated by wind turbines could affect those living nearby.

Carl V. Phillips **Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents**: 303-315. There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder-type diseases, at a nontrivial rate. The bulk of the evidence takes the form of thousands of adverse event reports. There is also a small amount of systematically gathered data. The adverse event reports provide compelling evidence of the seriousness of the problems and of causation in this case because of their volume, the ease of observing exposure and outcome incidence, and case-crossover data. Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including that the evidence does not "count," the outcomes are not "real" diseases, the outcomes are the victims' own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist. These claims appeared to have swayed many nonexpert observers, though they are easily debunked. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than kilometers of distance, could sufficiently mitigate the effects. There has been no policy analysis that justifies imposing these effects on local residents. The attempts to deny the evidence cannot be seen as honest scientific disagreement and represent either gross incompetence or intentional bias.

Robert Y. McMurtry **Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis**: 316-320. Internationally, there are reports of adverse health effects (AHE) in the environs of industrial wind turbines (IWT). There was multidisciplinary confirmation of the key characteristics of the AHE at the first international symposium on AHE/IWT. The symptoms being reported are consistent internationally and are characterized by crossover findings or a predictable appearance of signs and symptoms present with exposure to IWT sound energy and amelioration when the exposure ceases. There is also a revealed preference of victims to seek restoration away from their homes. This article identifies the need to create a case definition to establish a clinical diagnosis. A case definition is proposed that identifies the sine qua non diagnostic criteria for a diagnosis of adverse health effects in the environs of industrial wind turbines. Possible, probable, and confirmed diagnoses are detailed. The goal is to foster the adoption of a common case definition that will facilitate future research efforts.

Carmen M. E. Krogh **Industrial Wind Turbine Development and Loss of Social Justice?** 321-333**.** This article explores the loss of social justice reported by individuals living in the environs of industrial wind turbines (IWTs). References indicate that some individuals residing in proximity to IWT facilities experience adverse health effects. These adverse health effects are severe enough that some families have abandoned their homes. Individuals report they welcomed IWTs into their community and the negative consequences were unexpected. Expressions of grief are exacerbated by the emotional and physical toll of individuals' symptoms, loss of enjoyment of homes and property, disturbed living conditions, financial loss, and the lack of society's recognition of their situation. The author has investigated the reported loss of social justice through a review of literature, personal interviews with, and communications from, those reporting adverse health effects. The author's intention is to create awareness that loss of social justice is being associated with IWT development. This loss of justice arises from a number of factors, including the lack of fair process, the loss of rights, and associated disempowerment. These societal themes require further investigation. Research by health professionals and social scientists is urgently needed to address the health and social impacts of IWTs operating near family homes.

Carmen M.E. Krogh, Lorrie Gillis, Nicholas Kouwen, and Jeff Aramini **WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring**: 334-345. Industrial wind turbines have been operating in many parts of the globe. Anecdotal reports of perceived adverse health effects relating to industrial wind turbines have been published in the media and on the Internet. Based on these reports, indications were that some residents perceived they were experiencing adverse health effects. The purpose of the WindVOiCe health survey was to provide vigilance monitoring for

those wishing to report their perceived adverse health effects. This article discusses the results of a self reporting health survey regarding perceived adverse health effects associated with industrial wind turbines.

Martin Shain **Public Health Ethics, Legitimacy, and the Challenges of Industrial Wind Turbines: The Case of Ontario, Canada**: 346-353. While industrial wind turbines (IWTs) clearly raise issues concerning threats to the health of a few in contrast to claimed health benefits to many, the trade-off has not been fully considered in a public health framework. This article reviews public health ethics justifications for the licensing and installation of IWTs. It concludes that the current methods used by government to evaluate licensing applications for IWTs do not meet most public health ethical criteria. Furthermore, these methods are contrary to widely held fundamental principles of administrative law and governmental legitimacy. A set of decision-making principles are suggested to address this situation that are derived from existing and emerging legal principles in Canada and elsewhere. These include the Precautionary Principle, the Least Impactful Means (Proportionality) Test, and the Neighbor Principle.doi: 10.1177/0270467611412552

The Bruce McPherson Infrasound and Low Frequency Noise Study

Adverse Health Effects Produced By Large Industrial Wind Turbines Confirmed

December 14, 2011

Stephen E. Ambrose, INCE (Brd. Cert.)
Robert W. Rand, INCE Member

"The idea that infrasound doesn't or can't affect the ear is just flat-out wrong."

– Dr. Alec Salt
Department of Otolaryngology
Washington University School of Medicine
St. Louis, Missouri, 63110, USA

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Executive Summary

This study was commissioned through a private philanthropic grant created to determine why there were so many strong complaints about the loss of well-being and hardships experienced by people living near large industrial wind turbines operating in Falmouth, Massachusetts. The purpose of this study was to investigate and confirm or deny the presence of infrasonic and low frequency noise emissions (ILFN) from the "WIND 1", a municipally-owned Vestas V82 industrial wind turbine. In March of 2011, after many months of vigorous neighborhood complaints and strong appeals to the town, selectmen voluntarily decided to curtail WIND 1 operations when hub height wind speed exceeded 10 m/s. This required that this study focus on noise emissions from the nearby "NOTUS" wind turbine, an identical make and model.

Acoustics

This study was conducted at a representative neighbor's home in Falmouth and confirmed that there are dynamically modulated low frequency acoustic amplitudes and tones produced by the nearby wind turbine. Dynamic amplitude modulations occurred at 1.4 second intervals that were consistent with the blades rotating past the wind turbine tower (the blade pass rate). Dynamic amplitude modulations below 10 Hz were stronger indoors than outdoors. Modulations measured indoors were 0.2 Pascal peak to peak consisting mostly of energy below 20 Hz. Two tones were detected from both the NOTUS and the WIND 1 turbines, at 22.9 Hz and 129 Hz, and are considered signatures of the wind turbines' acoustic profile. Outdoors, the A-weighted sound level decreased at a predictable rate of 6 dB per doubling of distance from the nearest turbine. The linear unweighted sound level decreased according to cylindrical spreading at 3 dB per doubling of distance and was controlled by acoustic energy below 20 Hertz. A-weighting does not reveal this low-frequency information. Sound-level averaging with Leq for any time length hides the low-frequency dynamic amplitude modulations.

Health effects

The investigators were surprised to experience the same adverse health symptoms described by neighbors living at this house and near other large industrial wind turbine sites. The onset of adverse health effects was swift, within twenty minutes, and persisted for some time after leaving the study area. The dBA and dBC levels and modulations did not correlate to the health effects

experienced. However, the strength and modulation of the un-weighted and dBG-weighted levels increased indoors consistent with worsened health effects experienced indoors. The dBG-weighted level appeared to be controlled by in-flow turbulence and exceeded physiological thresholds for response to low-frequency and infrasonic acoustic energy as theorized by Salt. The wind turbine tone at 22.9 Hz was not audible yet the modulated amplitudes regularly exceeded vestibular detection thresholds. The 22.9 Hz tone lies in the brain's "high Beta" wave range (associated with alert state, anxiety, and "fight or flight" stress reactions). The brain's frequency following response (FFR) could be involved in maintaining an alert state during sleeping hours, which could lead to health effects. Sleep was disturbed during the study when the wind turbine operated with hub height wind speeds above 10 m/s. It took about a week to recover from the adverse health effects experienced during the study, with lingering recurring nausea and vertigo for almost seven weeks for one of the investigators.

Further epidemiological and laboratory research needed

The research is more than just suggestive. Our experiencing of the adverse health effects reported by others confirms that industrial wind turbines can produce real discomfort and adverse health impacts. Further research could confirm that these ill effects are caused by pressure pulsations exceeding vestibular thresholds, unrelated to the audible frequency spectrum but are instead related to the response of the vestibular system to the low frequency noise emissions. The vestibular system appears to be stimulated by responding to these pressure pulsations rather than by motion or disease, especially at low ambient sound levels. Dysfunctions in the vestibular system can cause disequilibrium, nausea, vertigo, anxiety, and panic attacks, which have been reported near a number of industrial wind turbine facilities. The study emphasizes the need for epidemiological and laboratory research conducted by medical health professionals and acousticians working together who are concerned with public health and well-being. This study underscores the need for more effective and precautionary setback distances for industrial wind turbines. It is especially important to include a margin of safety sufficient to prevent inaudible low-frequency wind turbine noise from being detected by the human vestibular system.

Acknowledgements

This study was initiated by the concerns of a private citizen, Bruce McPherson who enjoyed the many quality of life benefits of living on Cape Cod. He was disappointed that there were no efforts being made by developers or government agencies, to determine the real cause for the many complaints from Falmouth residents living near three new industrial wind turbines. He knew that neighbors were constantly complaining to town officials about receiving excessive noise, adverse health effects and the loss of well-being. Thanks are given by so many for the generosity of Mr. McPherson, who initiated and funded this independent investigation.

To the residents of Falmouth who welcomed us into their homes and lives, extended us their hospitality, told us their stories, and gave us their time and assistance, our deepest appreciation.

Sincere appreciation is given to Dr. Alec Salt, Dr. Timothy Hullar, Mr. Richard James, and Mr. Charles Ebbing for their insightful correspondence, professional reviews and comments.

Prologue

Falmouth is one of many communities having learned the unfortunate outcome for locating industrial wind turbines too close to residences in a quiet rural environment. The responses to wind turbines by neighbors close by are very similar to those experienced in other communities that have wind turbines improperly sited too close to homes; complaints that are vigorous and very vocal. Wind turbine complaints can be divided into two distinct categories; excessive noise and physiological symptoms. This study was launched with the mission of identifying for the presence or lack of low-frequency and infrasonic sound. Due to the direct exposure to adverse health symptoms experienced during the field measurements, this study was inspired to investigate further for the potential causes for these physiological symptoms. This involved looking for significant changes in the low and very low frequencies related to acoustic and atmospheric pressure fluctuations produced by wind turbines. It was not the intent of this study to determine the direct cause of the physiological symptoms. Yet there were strong correlations established.

Authors Comments:

This study is written in a format to assist the average reader. We need to understand why so many neighbors are having such a hard time living near industrial wind turbines located in quiet areas. We would like to start this report by sharing our experiences, which we ourselves did not fully acknowledge or even understand until the morning of the second day of our investigation.

Our study began with our arrival at a nearby home. These neighbors had experienced and reported their many months of adverse health symptoms. Shortly after our first meeting and polite conversation, the homeowners invited us to use their home as the base of operations for our acoustical investigation. We respectfully accepted and were allowed to use their dining room for our field office.

As is our custom on field surveys, we were enthusiastic and ready to begin our work. It was a beautiful spring afternoon, warm with a strong westerly wind aloft at the wind turbine blade height. We observed that there was a soft southeasterly

wind extending from ground level to tree top (about 60 feet). Within twenty minutes of being inside their house, while setting up our instruments, each of us started to lose our initial enthusiasm and actually started to feel less well. As time went on, we got progressively worse. We each experienced unpleasant symptoms of motion sickness, including ear pressure, headache, nausea, dizziness, vertigo, especially when moving about. We had a sense that the room was moving or slightly displaced from where it appeared. We experienced a loss of appetite, cloudy thinking, fatigue, some anxiety and an inexplicable desire to get outside; similar to motion sickness we have experienced on a boat or plane. We felt slightly better when we did go outside.

> According to the conflict hypothesis (Brandt, 2003) motion sickness is the consequence of discordant (not in agreement or harmony) inputs to the brain information about the position and motion of the body from the vestibular and the visual systems, and from other sensory sources [1].

On the morning of the second day we left the house to go out for breakfast. About 30 minutes later and a few miles away we shared a light conversation about the night before... We talked about the difficulties we had staying motivated and the challenges we encountered performing our usual work. As time went we started to feel better, and then by the contrast in our state of mind, it hit us. We realized and understood the true extent of the debilitating symptoms expressed by neighbors; we had experienced many of them the previous evening.

[1] BRANDT T. (2003) Vertigo: its multisensory syndromes. London, New York: Springer, 2003.

1 INTRODUCTION

This study was commissioned through a private philanthropic grant created out of concern for strong complaints of hardships experienced at residences near large industrial wind turbines operating in Falmouth, Massachusetts. Our investigation grew in scope as we were performing our analysis. One lead led to another, and we found ourselves immersed in technical research bridging acoustics, otolaryngology, and neuroscience. Our ears do more than just listen; they play an integral part in sensing environmental conditions. The ear performs many interrelated functions that condition and inform our personal state of well-being.

1.1 Background

Low frequency sound may play an important part in the cause for adverse community reaction to large industrial wind turbines installed close to residences in quiet areas. However, this has been proven to be very difficult to determine based on only A-weighted sound level measurements, which is often the only quantifier used for compliance by local and state regulations. The A-weighting filter severely attenuates low frequency signals (the primary frequency range of most community noise complaints) and essentially eliminates acoustic signals below 20 Hertz where "infrasound" is located in the acoustic frequency spectrum. Wind turbine noise standards and most regulations require A-weighting which suppresses the amplitude of low frequency noise predictions in modeling and application submittals.

Research (detailed in Section 4) has established that infrasonic thresholds for human hearing are well below those previously assumed from traditional sinusoidal hearing tests.

It has been noted that other noise sources can generate infrasonic energy, such as surf and thunderstorms. However wind turbine low frequency energy presents a recurring and/or unpredictable pressure signature, with audibility or detectability occurring over a much longer period of time than other environmental sources of low frequency energy. When an audible or detectable acoustic or pressure signature is found, this is very valuable for subsequent monitoring system design and correlating with complaints.

1.2 Falmouth Wind Turbines

Over months of town meetings in 2009 and 2010, Falmouth approved the installation of two municipal wind turbines and one privately owned. These approvals required the town to receive sufficient information from the wind turbine applicants to make their decisions. We understand that during numerous presentations, town officials and neighbors were assured by the applicants, environmental engineers and scientists, that the proposed wind turbines would not cause an adverse public reaction or generate excessive noise impacts. Acoustic professionals concluded that any changes in the acoustic environment would not be sufficient to be found either objectionable or disruptive. These statements were based on assessments of the A-weighted sound level predicted for the wind turbines. (We have not seen community reaction assessments or discussions of low-frequency or sound quality comparisons to the existing environment.)

Strong appeals to stop the noise and complaints of health problems were voiced by neighbors after the municipal and privately-owned wind turbines started operating.

There are currently three industrial wind turbines (Vestas, Model V82, 1.65 MW each) installed in Falmouth with two, municipally-owned and operated, near the wastewater treatment facility. Figure 1 shows the locations for the two municipal wind turbines; WIND 1, WIND 2, and further east, the private NOTUS wind turbine owned by Daniel H. Webb and operated by NOTUS Clean Energy LLC, in the Falmouth Technology Park. All of the turbines are located east of Route 28, north of Blacksmith Shop Road and south of Thomas B Landers Road as shown on Figure 1. Commercial operation of the Town of Falmouth's Wind 1 turbine began on March 23, 2010, while WIND 2 is still waiting for start-up. The NOTUS turbine also started operation in 2010. For reference, the study measurement locations were at two residential homes, shown as ML1 (indoors and outdoors) and ML2 (outdoors).

Figure 1 - Wind turbine and measurement locations

1.3 Noise Complaints

We understand that shortly after WIND 1 became operational in 2010 several neighbors began to complain about excessive noise produced by the new wind turbine. The same reactions surfaced for homeowners living near the new NOTUS wind turbine when it started operating in 2010. Neighbors continued to complain for many months and they just could not adjust their lives to this new sound. The noise was reported to be constantly fluctuating with "swishing" or "thumping" sounds. Neighbors found this noise to be very annoying, intrusive and disruptive. During moderate wind speeds the noise was clearly audible outdoors and for some even indoors. At times the noise had an audible low-frequency tone that came and went. Neighbors commented that it was more annoying indoors and that it interfered with relaxation and sleep.

> *We believe that these complaints could have been predicted by using the results of studies funded by the United States Environmental Protection Administration (USEPA). These studies have a long history having been used as standard*

> *practice to predict the public response to a new noise source. At the beginning of an environmental noise assessment, it is appropriate to first develop a noise level design criteria to avoid producing an adverse community response. The documented community response to wind turbine noise expressed by nearby neighbors in Falmouth varies from "highly annoyed" to "strong pleas to stop the noise". This community reaction typically indicates at least a 10 to 20 dB increase over the background ambient sound level (without wind turbine).*
>
> *Unfortunately, Falmouth officials were not made aware of these studies and the wind turbine project teams chose not include this information in their presentations.*

Fortunately, the Town did respond to the numerous public complaints by requiring post-operational noise surveys. Noise measurements were also performed for and by adversely affected neighbors. Most measurements were performed by qualified acousticians near the impacted neighbors. The primary acoustical descriptor measured was the A-weighted sound level (dBA). The sound levels generally ranged from the mid-30s to mid-40s dBA. Some noise level variations were due to differences for time of day, wind speed and wind direction (upwind or downwind). The measured sound levels were fairly consistent from survey to survey. However, the interpretations of the measured noise levels were different for assessing neighbors' complaints. We understand that while complaints were logged by the Town, the complaints were not correlated by distance or noise level and the health complaints remained unaddressed.

> *Similar adverse health symptoms have been associated with noise complaints such as "sick building syndrome", correlated by field study to low-frequency pulsations emanating from ventilation systems [2,3]. That is, adverse health effects from low frequency noise exposure in buildings have been studied and confirmed by the acoustics profession. However: As of the date of this report we have not observed any substantive effort by the wind turbine industry and their acoustical consultants to acknowledge and investigate the mechanisms including*

[2] Burt, T., Sick Building Syndrome: Acoustical Aspects, Indoor and Built Environment January 1996 vol. 5 no. 1 44-59. "Symptoms resulting from exposure to infrasound can include fatigue, headache, nausea, concentration difficulties, disorientation, seasickness, digestive disorders, cough, vision problems and dizziness."

[3] Shwartz, S., Linking Noise and Vibration to Sick Building Syndrome in Office Buildings, EM Magazine, awma.org, March 2008.

possible low frequency noise underlying the numerous documented complaints of similar adverse physiological symptoms by people living near large industrial wind turbines. We have not yet observed wind facilities designed with noise criteria selected by the wind acoustic consultant to prevent adverse health effects and complaints. With respect to the adverse impacts to indoors locations in homes near wind turbines, we have not yet observed the wind industry following the best practices of the HVAC industry as published in the ASHRAE journals. We have seen suggestions, from wind facility developers to learned acoustical scholars to state commissioners of health, to the effect that it is a "psychological" issue and that wind turbines do not emit excessive low frequency noise. Having experienced adverse physical health effects ourselves directly as a result of being indoors in a home near a large industrial wind turbine, as presented in this report, with dramatically increased low-frequency and infrasonic sound levels that exceed vestibular thresholds for detection and processing by the inner ear, we must emphatically reject any such dismissive notions.

1.4 Physiological Complaints

We understand that Falmouth neighbors reported having difficulties living in their home for a variety of unpleasant health-related experiences. They were no longer able to feel comfortable, at peace while at home, unable to relax; felt tense for unknown reasons, and had a strong desire to go outside or leave the area entirely. They were unable to concentrate or stay focused on normal, at-home activities.

Some complained about headaches, ear pressure, dizziness, nausea, apprehension, confusion, mental fatigue, lassitude (inability to concentrate, lethargy). These feelings occurred when WIND 1 and/or NOTUS were operating during moderate to strong winds.

Some neighbors experienced extreme discomfort. They moved their bedrooms into the basement in an attempt to get a good night’s sleep. Others left home altogether to sleep farther away with family or friends.

These complaints are clearly indicative of a serious adverse public health impact and the personal loss of well-being for those affected.

We understand that as of the date of this report, there been no substantive health investigations, medical evaluations, or epidemiological studies by public health officials of the health effects experienced by folks living near the wind turbines in Falmouth, Massachusetts[4]. In October 2011 the Falmouth Board of Health conditionally supported the intent of an article "to ease negative health effects" apparently only after repeated, strong pleas to stop the noise, while noting "wind turbines have to be studied before the causes can be known for sure"[5]. In November 2011, the Town decided to shut down WIND 1 for a period of six months, and start up WIND 2 with a complaint monitoring process.

2 STUDY OBJECTIVES

We understood prior to the study's launch that people were complaining more about discomfort indoors than outdoors. Typically, indoors the A-weighted sound level is *lower* than outdoors when human activity is at a minimum. This strongly suggested that the A-weighted sound level might not correlate very well the wind turbine complaints. This may be indicative of another cause such as low- or very-low-frequency energy being involved.

The attenuation and band-pass filters used for dBA and dBC weighting exclude the very low frequency energy below 20 Hz even when the background is quiet.

The purpose of this study therefore was to investigate for the presence of infrasonic pressure pulsations (acoustic amplitudes lower in frequency than 20 Hz) and low-frequency sound emissions (20-200 Hz) from the large industrial wind turbines; and, assess if they 1) are greater than or uniquely distinguishable from the ambient background levels, and 2) exceed human detection thresholds.

To date, wind turbine noise studies have focused on the A-weighted sound level and are set by international standards (IEC 61400) to use A-weighting for overall and octave and one-third octave band data. We have noticed that infrasonic emissions by wind turbines have been dismissed by the wind industry and their acoustical consultants as too weak to be of any consequence. Simultaneously,

[4] Todd Drummey, Falmouth, MA; personal communications, 2011.

[5] The Enterprise, Cape News, 18 October 2011.

> *many wind industry acousticians, by saying that it is everywhere in the natural environment, may have overstated the presence of naturally occurring infrasonic energy and missed the fact that wind turbine acoustic signatures are both tonal and regularly modulated. We have not seen evidence that naturally occurring infrasound is comparable to the strong dynamic amplitude modulations created by industrial wind turbines operating in quiet environments.*

The scope of this study was conducted at one home that is representative of the many neighbors that have complained about noise and adverse health effects. We assessed differences between the outdoors and the indoors environment, where neighbors have said the wind turbines bother them the most and the discomfort is worst.

3 METHODOLOGY

Acoustic measurements were made with precision sound measurement instruments and dual-channel computer-based signal analyzer software. These instruments were capable of measuring very low frequency energy, as low as 1 Hz. Frequency response was flat (within 1 dB) to 2 Hz and 6 Hz for the two primary measurement channels. During computer analysis, response was compensated flat between 1 and 6 Hz using manufacturer specifications for microphones and preamplifiers and dual-channel end-to-end system response checks.

Outdoor measurements were conducted consistent with ANSI 12.9 [6] and ANSI 12.18 [7]. Simultaneous measurements were made using two microphones, one outdoors and one indoors, to determine the outside-to-inside level reduction (OILR) for the exterior walls and roof. The OILR measurements were performed in accordance with ASTM E966-02. The indoor microphone was fitted with a 4-inch windscreen and mounted on a microphone stand in the master bedroom at a location where the reported adverse symptoms were more pronounced. The outdoor microphone was fitted with a 4-inch windscreen and placed inside a RODE Blimp for improved wind and shock mount protection. The entire system was mounted on a tripod, positioned 5 feet above the ground, and located away from house and trees. Wind speeds were light at the outdoor microphone position.

3.1 Instrumentation

Instrumentation configurations are itemized in Table 1.

[6] ANSI/ASA S12.9-1993/Part 3 (R2008) - American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound, Part 3: Short-Term Measurements with an Observer Present.

[7] ANSI S12.18-1994 (R2004) American National Standard Procedures for Outdoor Measurement of Sound Pressure Level.

Table 1 - Instrumentation List.

Description	Manufacturer	Model	Serial No.
Microphone	Bruel & Kjaer	4165	844497
Preamplifier	Larson Davis	2221	0107
Microphone	GRAS	40AN	27538
Preamplifier	Larson Davis	902	0235
Sound Meter	Larson Davis	824	0914
Calibrator	Bruel & Kjaer	4230	1103065
Audio Interface	Sound Devices	USBPre2	HB0411005004
Recorder	M-Audio	Microtrack II	139ADC8107245
Microphone	Svantek	SV22	4012682
Preamplifier	Svantek	SV12L	5552
Sound Meter	Svantek	949	6028
Calibrator	Larson Davis	CAL200	2425
Audio Interface	ROGA	DAQ2	06pnd0097
Recorder	TEAC	DR100	0030486

Each sound level measurement system was independently field-calibrated (end-to-end) prior to and verified after the survey measurements. Each system had its own acoustic sound level calibrator (Brüel and Kjær Type 4230 or Larson Davis CAL200), generating a 1-kHz tone of 1 Pa [94 dB sound pressure level (SPL) re 20 µPa root mean square (RMS)]. Sound level meters and acoustic calibrators had current laboratory calibration certificates traceable to NIST.

It is worth noting that Type 1 instrumentation's ANSI filter characteristics have a long impulse response time at low frequencies. At 1 Hz, the ANSI 1/3 octave band impulse response is close to 5 seconds! Thus, unfortunately, **ANSI filters do not capture the fast peak pressure changes occurring in the low and infrasonic frequencies** [8]. The RMS levels reported in this study are understating the true range and modulation of the levels obtained compared to *the time response of the human ear*. The octave-band and FFT results in this study should be considered suggestive of the possible range of pressure changes and detectability for the human ear, thereby prompting the need for more extensive field and laboratory research.

We were able to improve our ability to perform fast signal analysis by using an external digital filter in series with the digital recording playback output, and then analyzing the digital data with

[8] Bray, W., James, R., Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception, Noise-Con 2011.

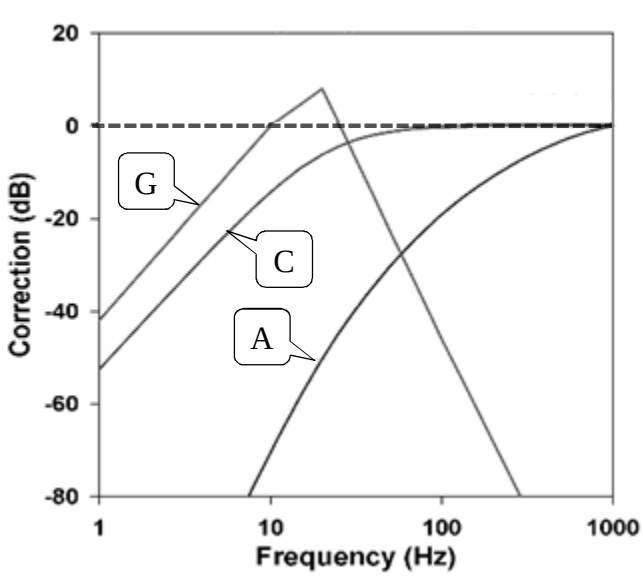
a faster response signal analyzer to observe the time history. This method revealed large modulations for the wind turbine tone at 22.9 Hz (see section 4.1.3).

The A- and C-weighting as well as octave band and FFT analysis were performed with Spectraplus software in real-time and recording mode on site. Later the recorded data was analyzed off-site using the post-processing features. G-weighted sound levels were computed using fast FFT settings for octave band analysis of the G-filtered 4, 8, 16 and 31.5 Hz octave bands using the following constants [9] which are the average value for the one-third octave bands comprising each octave band. While coarse in approach, the method was determined to be a usable trade-off between analysis time, accuracy, and computational requirements.

Octave Band, Hz:	**4**	**8**	**16**	**31.5**
dBG correction, dB:	-16	-4	7.7	-4

The A-, C-, G-weighting and un-weighted (dashed) functions are shown in **Figure 2** below [10].

Figure 2 – Weighting functions



The A-weighting filter cuts out most low frequency sound and gives the lowest reading. C-weighting includes more low frequency sound contributions and gives a higher reading than A-weighting. G-weighting measures infrasound frequencies centered in the 10-20 Hz range.

[9] ISO 7196:1995, Acoustics – Frequency weighting characteristic for infrasound measurements.

[10] Adapted from figure at http://oto2.wustl.edu/cochlea/wt4.html.

Un-weighted (dBL) measures include the entire sound signal and give the highest peak readings.

3.2 Weather Conditions

Outdoor measurements were made when weather conditions were favorable for measurements (ground level winds ≤ 9 mph and no precipitation) Publicly accessible long-term weather observation data was obtained from the nearest met tower at the Otis Air National Guard Base located a few miles away, as shown in Appendix A, B, and C.

The survey period commenced in the late afternoon of April 17, 2011 and concluded during the morning of April 19, 2011. The weather generally showed an early summer pattern with wind speeds at the hub of 20 to 25 m/s by midmorning. Low-level surface winds at the home were light and *southeasterly*, contrary to upper level *westerly* winds. At night, hub-height wind speed was light, with ground wind speed about zero. Wind speeds continuously exceeded 18 m/s during the evening of April 17 and the daytime hours of April 18. Wind gusts exceeded 30 m/s (66 miles per hour) on April 17, meaning that the NOTUS wind turbine was operating in "gale force" wind speeds at hub height, while ground level winds were generally light. This indicates "high wind shear", which is present in most of New England including the Falmouth area of Cape Cod. The conditions are summarized as follows:

> *Day 1: Changeable with wind speeds 25 to 30 meters per second at the hub, gusting to more than 35 meters/ second. Wind direction west–southwest. Barometer "low" and variable. Sunny and partly cloudy. Temperature 45 to 50 degrees Fahrenheit*
>
> *Day 2: Sunny with wind speeds 15 to 20 meters per second at the hub, gusting to 25 to 30 meters/second. Wind direction west–southwest. Barometer "low" and rising during the day. Temperature 45 to 50 degrees Fahrenheit*
>
> *Day 3: Winds stopped in morning and the field study concluded.*

3.3 Wind Turbine Operations

WIND 1 and NOTUS turbines were installed with nearest two residences having separation distances as close as 1300 feet and 1700 feet, respectively. In the spring of 2011, Falmouth imposed a maximum wind speed restriction on the WIND 1 turbine in an effort to reduce the

noise levels and mitigate the adverse responses from neighbors. Wind 1's operational control software was modified to stop power generation whenever the hub-height wind speeds exceeded 10 m/s (22 miles per hour).

There was no noise reduction requirement imposed on the Webb-owned NOTUS wind turbine, even though NOTUS is as close to homes as WIND 1. The manufacturer's operational program includes a trip setting for a maximum hub-height wind speed at 32 m/s (70 miles per hour).

Thus when winds exceed 10 m/s at wind turbine hub height for any length of time, WIND 1 is shut down and NOTUS can continue to operate.

During this survey, the authors noted that the NOTUS wind turbine was clearly audible outdoors at ML1 and audible indoors at ML1 during the stronger winds. WIND 1 was not operating for most of the survey period. However, during the last day with very light wind conditions, NOTUS was seen as not turning, and WIND 1 blades were visibly rotating. This was a good opportunity for obtaining digital recordings at ML1 with only WIND 1 operating.

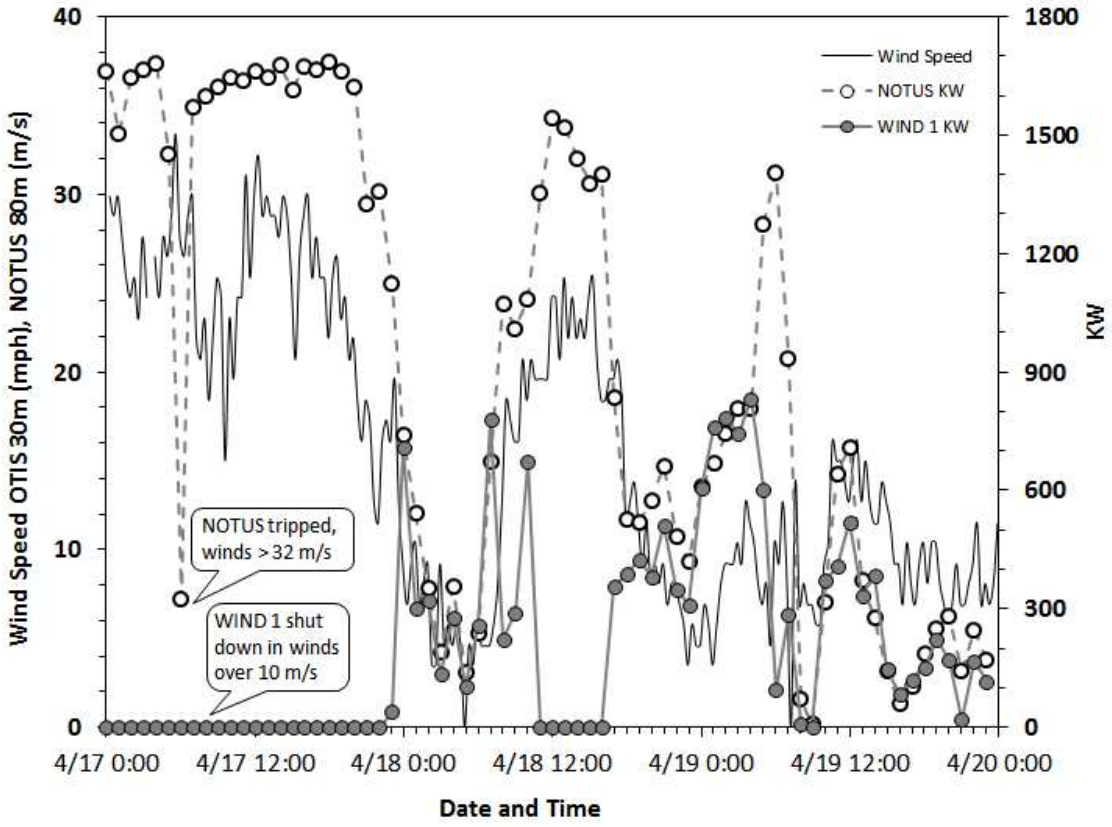
Wind turbine power outputs were obtained from the WIND 1 and NOTUS websites. Wind speed data was obtained from the nearest weather station tower at the Otis Air National Guard Base a few miles away. This data was then graphed by date showing the wind speed and correlating power output, as shown on **Figure 3**.

The wind turbines rotated at a nominal blade pass rate of 0.7 Hz or 1.4 seconds between blades passing by the turbine mast.

The NOTUS wind turbine dominated the acoustic environment the first and second day while operating. The third day, in the morning, with winds too light for NOTUS to turn, audible sounds included intermittent loading operations in a nearby sandpit, very distant traffic, and occasional cars passing by on the neighborhood roads several hundred feet distant.

Figure 3 - Wind Turbine Operations

(Showing dates, power output and wind speed)



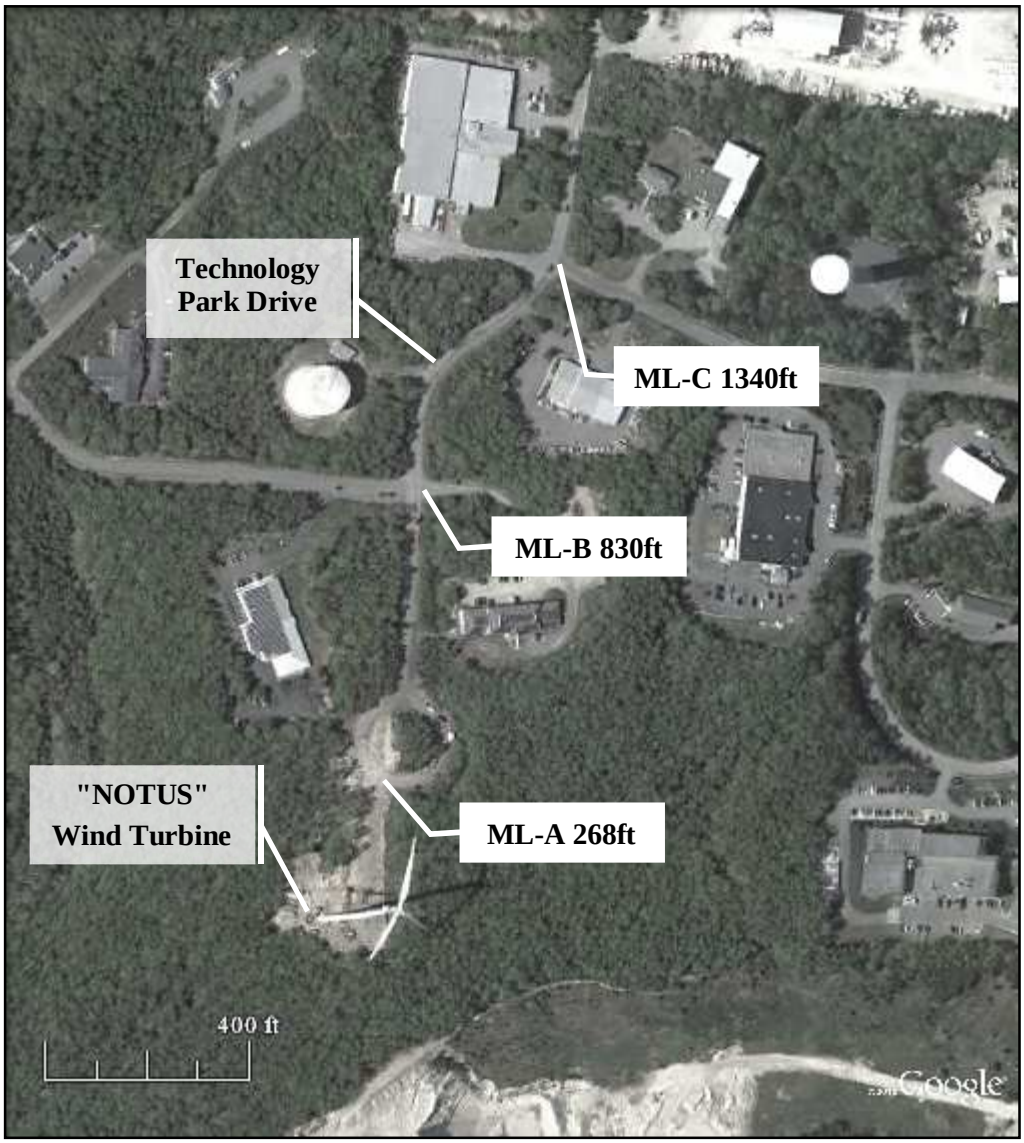
3.4 Sound Level versus Distance

Sound level measurements were made at different distances from the noise source to depict the noise level decrease with distance. This is a very useful method to use especially in quiet environments where the noise source under investigation is prominent at great distance. This measurement technique is referred to as; "level versus distance", "walk-away", or "stepped distance".

"Stepped distance" measurements were made at four locations; three in the Falmouth Technology Park (at 260, 830, 1340 feet) and one at 1700 feet at the residence under investigation (ML1) as shown in **Figure 4**. Distances from the wind turbine for the three closest locations were obtained with a laser range finder aimed at the tower base. A Google Earth satellite image was used to determine the separation distance between the wind turbine and

residence (ML1). It is worth noting that noise from the wind turbine was always dominant at all measurement locations.

Figure 4 – Stepped Distance Measurement Locations



4 ANALYSIS AND RESULTS

4.1 Operations and adverse health effects felt

The survey took place over a three day period. We experienced adverse health symptoms within twenty minutes of starting the survey. Our health symptoms were tabulated with the measured data for wind speed, NOTUS output, locations, dBA, dBG & dBL levels as shown on Table 1.

Table 1 - NOTUS data and adverse health effects
(ML1 at 1700 feet away from NOTUS)

Hub wind speed, m/s	NOTUS output, kw	Study	dBA	dBG	dBL	Symptoms Experienced
Day 1: 25 with gusts to 35	1600-1700	Indoors	n/a	n/a	n/a	Nausea, dizziness, irritability, headache, loss of appetite, inability to concentrate, need to leave, anxiety.
		Outdoors	n/a	n/a	n/a	Felt miserable, performed tasks at a reduced pace.
Night 1: 0-9	150-350	Indoors	18-20	n/a	n/a	*Slept with little difficulty*
Day 2: 20 with gusts to 30	1350-1500	Indoors	18-24	51-64 pulsations	62-74 pulsations	Dizzy, no appetite, headache, felt miserable; performed tasks at a reduced pace. Desire to leave.
		Outdoors	41-46	54-65 pulsations	60-69 pulsations	Dizzy, headache, no appetite. Slow. Preferred being outdoors or away.
Night 2: 4-12	150-350	Indoors	18-20	n/a	n/a	*Slept fitfully, woke up*
Day 3: 6 calm	OFF	Indoors	18-20	39-44 random	50-61 random	Improvement in health. Fatigue and desire to leave.
		Outdoors	32-38	49-54 random	57-61 random	Improvement in health. Fatigue and desire to leave.

During the start of the survey, we were attempting to perform normal activities associated with our investigation; setting up instruments, observing measurements, concentrating, using computers, leaving the house for late night, stepped-distance measurements and, returning to retire for the night. Within twenty minutes, we found ourselves having difficulties performing our ordinary tasks. For example, we had difficulty determining which wires to use and what components to connect together in what sequence. We were unsure about our calibrations, and checked them repeatedly. Within an hour, we were debilitated and had to work much harder mentally. As hours passed, the severity of the symptoms increased. We were unable to acquire meaningful data at ML1 during the first evening when winds were strongest. However, we believe that the levels not acquired on April 17 were probably similar to or several dB higher than those acquired on April 18.

Later that night after 11 PM, the winds dropped below 10 m/s. We were able to confirm calibration on our instruments and collect outdoor data after midnight at the NOTUS stepped-distance locations before it started to rain. We then retired for the night in the home under study; the winds remained under 10 m/s.

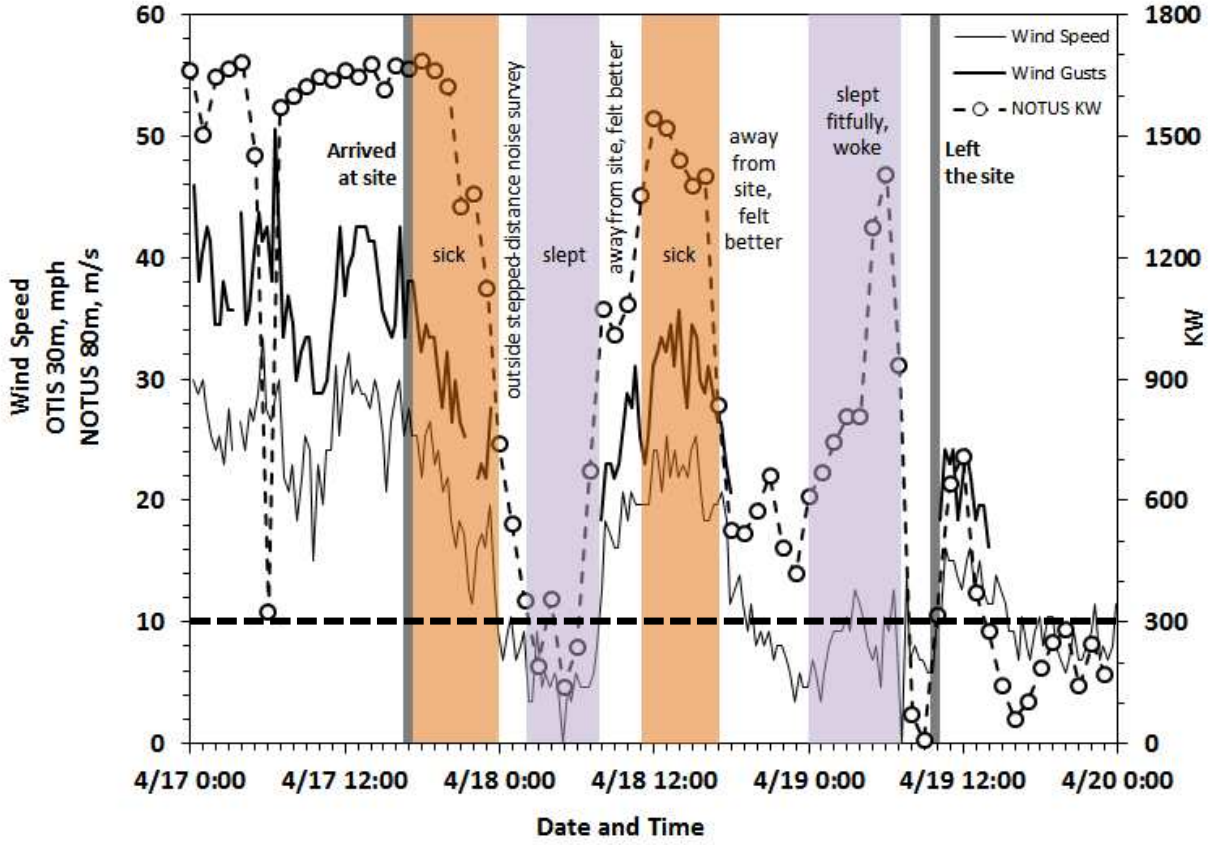
However, the adverse health symptoms at the house continued through the second day with wind speeds over 10 m/s, especially when indoors. We obtained partial relief when working outdoors.

We felt improvement in health on the morning of the third day when NOTUS was OFF and felt better over time when we left the area influenced by wind turbines. It took a week to recover, with recurring symptoms of nausea and vertigo over the next seven weeks for one of us.

We annotated Figure 2 data (NOTUS power output) with the physiological-symptoms and activities listed in Table 2, with the combined information presented on **Figure 5**.

Figure 5 - Survey Operations at ML1

(Average and gusty wind speeds)



We found that there is an *unexpected* correlation between our symptoms occurrences with the hub-height wind speed. It is worth noting that Falmouth had elected to set an operational cap on the WIND 1 at 10 m/s, *shown for reference* as a horizontal dashed line in Figure 5. *We were noticeably affected when the wind speeds were over 10m/s at hub height for NOTUS, 1700 feet from our study location.*

We found a strong correlation between the symptoms experienced by us with versus the wind speed and the NOTUS power output. The graph in Figure 5 shows that the most severe symptoms (labeled as "sick") occurred when the winds were the strongest (well above 10 m/s), as confirmed by power output. To our best knowledge, there have been no such physiological complaints made by neighbors in Falmouth *prior to* the installation of NOTUS (and WIND 1).

Further, the graph in Figure 5 shows when we were not severely affected. When the wind speeds dropped below 10 m/s the first night, we recovered enough to be able to go out and measure the stepped distance data. We also did not complain about sleeping difficulties during the first night with winds remaining below 10 m/s. However, we *both* experienced difficulty

sleeping during the *second* night when the average hub-height wind speeds *increased to above 10 m/s several times* during the early morning hours.

4.1.1 Physiological Symptoms

During moderate to high wind speeds, we experienced adverse physiological symptoms very similar to those described by neighbors. We arrived fresh and ready to work, without the ill effects of missing a good night's sleep. We had no personal attachment to place, no concerns about shadow flicker or diminished real estate value. Instead we found ourselves encountering a very *visceral* discomfort (proceeding from instinct, not intellect), unexpected in this peaceful rural environment. The severity was directly related to the strength of the dBG-weighted and the un-weighted amplitude-modulated infrasonic acoustic pressure level that was proportional to wind speed.

> *We found that individuals prone to motion sickness (as both researchers are) can experience unpleasant physiological symptoms, especially indoors near a wind turbine. We also acknowledge the large body of medical evidence of vestibular medical conditions that can cause problems with balance and orientation, nausea, dizziness, anxiety, and other health effects, that that can be worsened by adverse environmental conditions.*

4.1.2 Current Research

From our experience in April, we know now that understanding the adverse health effects reported by neighbors living near large industrial wind turbines requires coordinated research involving several branches of science, including neuroscience, otolaryngology, and acoustics. We will not attempt here to present the vast areas of knowledge represented by the disciplines just listed. We will cover a very small portion in order to lay the basic framework for presentation of Dr. Salt's work on the response of the ear to infrasound.

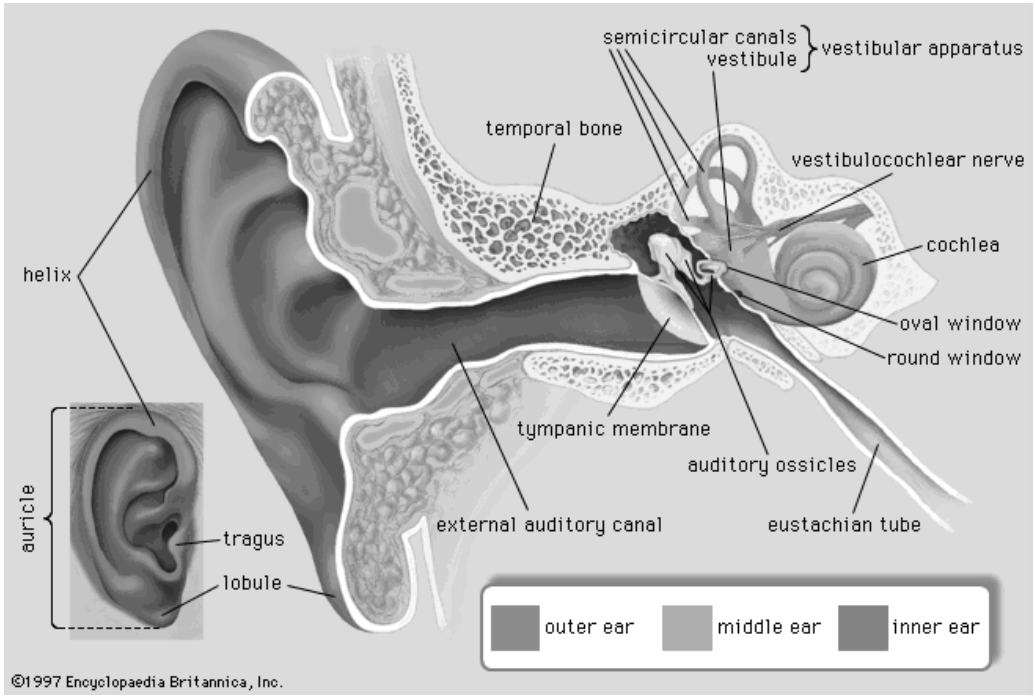
Sound pressure is the small alternating deviation above and below atmospheric pressure due to the propagated wave of compression and rarefaction. The unit for sound pressure is the Pascal (symbol: Pa). Sound pressure level (SPL) or sound level is a logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level. The commonly used "zero" reference sound pressure in air is

20 µPa RMS, which is usually considered the median threshold of human hearing (at 1 kHz). Some 16 percent of the population is about 6 dB more sensitive than the median. Frequency is measured by the number of waves per second or Hertz (Hz). The average range of hearing is 20-20,000 Hz with the greatest sensitivity in 1000-4000 Hz. At the most sensitive frequency around 4 kHz, the amplitude of motion of the eardrum is about 10^{-9} cm, which is only about 1/10 the diameter of a hydrogen atom. Thus, the ear is very sensitive, detecting signals in the range of atomic motion.

The term "infrasound", which refers to acoustic energy at frequencies below 20 Hz, is misleading for most, not being "sound" at all as we know it but either felt or inaudible. However as determined by Dr. Salt, the ear detects and responds to infrasound.

We present for reference a diagram of the ear in **Figure 6**. Note that the inner ear's vestibule and semicircular balance canals are as close to the eardrum as the cochlea which processes sound.

Figure 6 – Diagram of the ear



The vestibular system in the brain does more than just allow us to stand upright, maintain balance and move through space [11]. It coordinates information from the vestibular organs in the inner ear, the eyes, muscles and joints, fingertips and palms of the hands, pressors on the soles of the feet, jaw, and gravity receptors on the skin and adjusts heart rate and blood pressure, muscle tone, limb position, immune responses, arousal and balance. The auditory system is also highly involved in vestibular functions. The vestibular and auditory nerves join in the auditory canal and become the eighth cranial nerve of the brain. Anything that disrupts auditory information can also affect vestibular functioning.

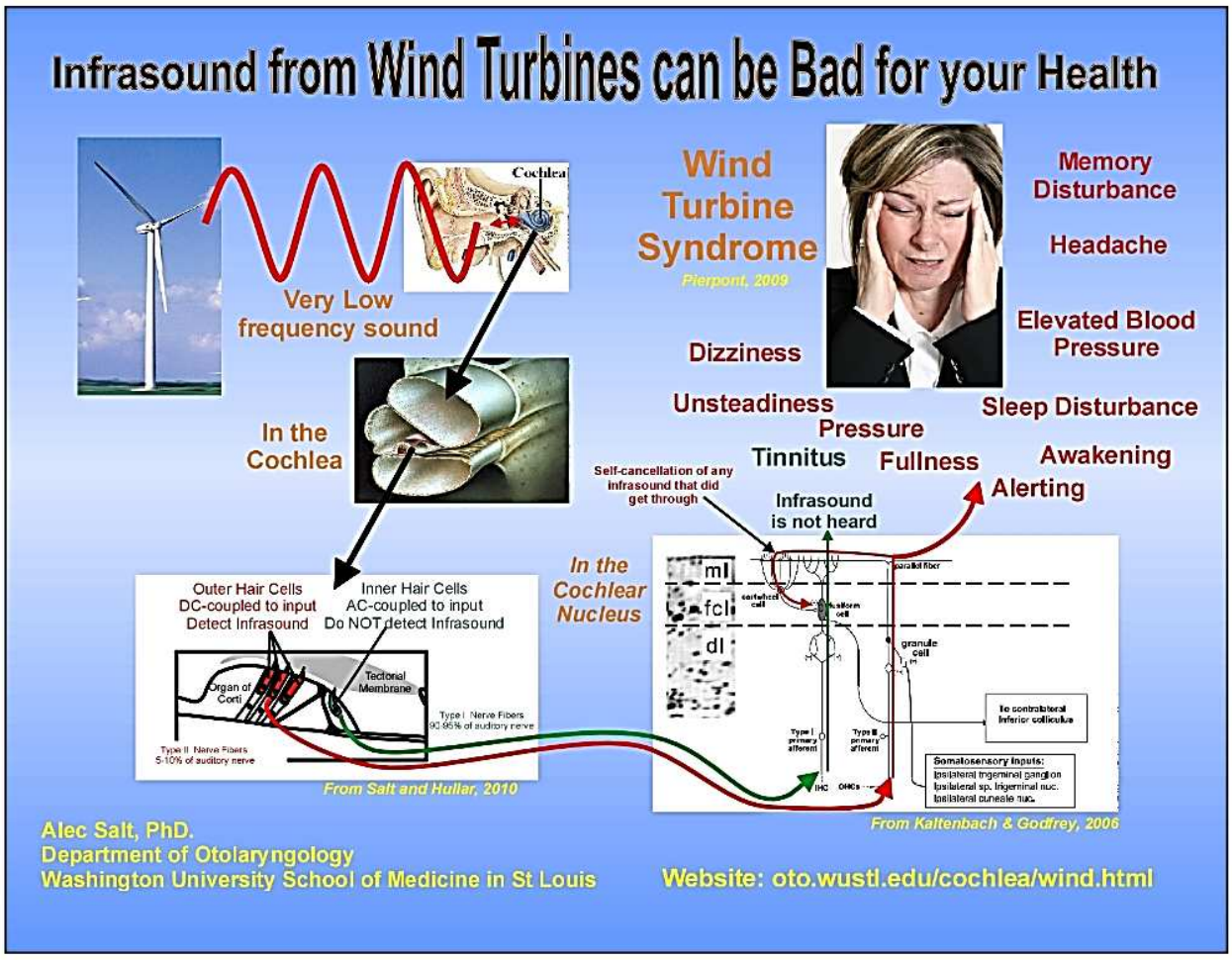
> *Our symptoms (ear pressure, dizziness, vertigo, anxiety) suggested that there was atmospherically transmitted energy that directly affected our vestibular systems. Yet we were puzzled by the fact that we were most severely affected when sitting relatively still indoors, not moving about. What were our vestibular systems responding to? Were the vestibular canals being moved? Were the otolithic crystals being displaced [12]? Was the endolymphatic fluid volume being affected? Was a vestibulosympathetic reflex involved? Was the ear triggering fight or flight reactions in response to low frequency sound?*

Dr. Alec Salt [13] has conducted extensive research into vestibular response to sound pressure pulsations. His research shows that ***the ear responds to sound we cannot hear***.

There are two types of hair cells in the cochlea, the inner hair cells (IHCs) and the outer hair cells (OHCs). The IHCs are fluid-connected and *velocity*-sensitive, responding to minute changes in the acoustic pressure variations based on frequency, with sensitivity decreasing at a rate of -6 dB per downward octave. ***IHCs detect audible sounds and they are insensitive to low frequency and infrasonic acoustic energy.*** In contrast, the OHCs are motor as well as sensory cells. OHCs are found only in mammals. OHCs are mechanically connected, responding to small changes in *displacement*, with a more uniform sensitivity across the acoustic frequency spectrum. ***OHCs respond to and contract with infrasonic stimulus*** and then act to reduce vibration stimulus at the IHCs. Thus there are actually *two* specialized receptors, or transducers, in each ear, as outlined in Dr. Salt's slide in **Figure 7**.

[11] http://www.braintraining.com/vestibular.htm.
[12] "...small crystals of calcium carbonate (also referred to as "otoliths" or “canaliths”) that are normally attached to the otolithic membrane in the utricle of the inner ear.", http://www.vestibular.org.
[13] Department of Otolaryngology, Washington University School of Medicine, St. Louis, Missouri, USA.

Figure 7 – Ear response to very low frequency sound



Dr. Salt's research reported the following [14]:

- The ear is sensitive and responds to low frequency and infrasonic pressure modulations at levels that are not heard (sub-audible).

- Low frequency pressure modulations produce a *biological* amplitude modulation of nerve fiber responses to higher frequency stimuli. This biological amplitude modulation cannot currently be detected by even the most sophisticated sound level meter.

[14] Salt, A., "Responses of the Inner Ear to Infrasound" - presentation to the Wind Turbine Noise Conference, Rome, April 11-14, 2011.

- The outer hair cells of the ear are directly attached (DC-coupled) to movements of the sensory structure and respond to infrasound stimuli at moderate levels.

- Low frequency stimulation of the outer hair cells (OHC) may be used in the brain to eliminate infrasound from hearing (improving and optimizing the signal to noise ratio of the audible-range ear mechanism in most acoustic environments, except the very quiet.) Low frequency stimulation of the OHCs is also linked to the attention state and arousal, so stimulation could disturb sleep.

- Outer hair cell responses to infrasound are the most sensitive when ambient sound levels are low.

In summary, Dr. Salt indicates very simply,

> *"The idea that infrasound doesn't or can't affect the ear is just flat-out wrong."* [15]

Our field experience in Falmouth in April 2011 is consistent with Dr. Salt's research findings. As detailed in the following sections, we experienced the most adverse health symptoms indoors where the acoustic energy was 0.2 Pascal peak-to-peak, modulated at 0.7 Hz, with portions of the low-frequency energy modulated above the OHC threshold, while occurring in a very low background sound level of around 20 dBA. Our symptoms lessened somewhat outdoors, where the pressure pulsations at 0.7 Hz were slightly lower than indoors, and the background level was in the low 40s dBA.

We understand that some families living near wind turbines and experiencing similar effects indoors, yet not ready to abandon their homes, have resorted to sleeping outside in tents. This lessening of effects outdoors (compared to indoors) is consistent with findings of low-frequency noise effects documented in [2].

Dr. Salt formally identified in 2011 a number of areas requiring more research:

Stimulation of vestibular hair cells (saccule, utricle).
Vestibular hair cells are "tuned" to infrasonic frequencies.
No-one has ever measured sensitivity to acoustic infrasound.
Symptoms: unsteadiness, queasiness

[15] Salt, A., http://oto2.wustl.edu/cochlea/wt7.html.

Disturbance of inner ear fluids (e.g. endolymph volume).

Low-frequency sound at non-damaging levels induces endolymphatic hydrops (a swelling of one of the fluid spaces).

Infrasound does affect endolymph volume – it is the basis of a treatment for hydrops (Meniere's disease).

No one has ever measured what level of infrasound causes hydrops.

Symptoms: ear fullness, unsteadiness, tinnitus

Infrasound – affected structures and long-term exposure effects, ranked by sensitivity:

Outer hair cells — "Overworked, tired, irritated" OHC, type II fiber stimulation

Inner ear fluid homeostasis — Volume disturbance, endolymphatic hydrops

Saccular hair cells — Stimulation

Other, non-ear, receptors — Stimulation

Inner hair cells/hearing — None

Sensitivity and sensations remain to be quantified: ear pressure or fullness, discomfort, arousal from sleep; ear fullness, tinnitus, unsteadiness; unsteadiness; stress, anxiety.

4.1.3 OHC & IHC Sensitivity Analysis

A representative average (not peak) wind turbine noise spectrum, obtained during the second day (April 18, hub-height winds 20 m/s and gusting) when the researchers were experiencing moderate-to-severe adverse health effects, was compared with Dr. Salt's OHC and IHC threshold data [16]. When the wind turbine noise was dominating, the sound level was in the low 40s dBA outdoors and about 20 dBA indoors.

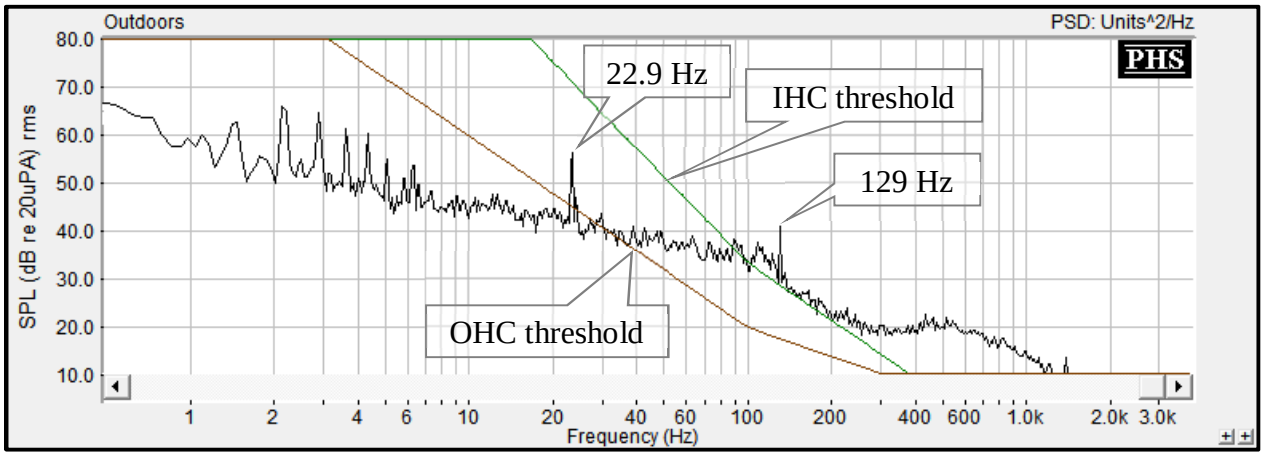
The outdoor RMS spectrum presented in **Figure 8a** shows that both the 22.9 & 129 Hz wind turbine tones exceed the OHC threshold levels along with all frequencies above 30 Hz. The 22.9 Hz tone was not audible outdoors. However, the 129 Hz tone was clearly audible outdoors since it exceeded the IHC audibility threshold.

The indoor RMS spectrum presented in **Figure 8b** shows that both the 22.9 & 129 Hz wind turbine tones exceed the OHC threshold levels. Again, the 22.9 Hz tone was inaudible indoors and the 129 Hz tone was frequently audible, more so than reflected in the averaged RMS level.

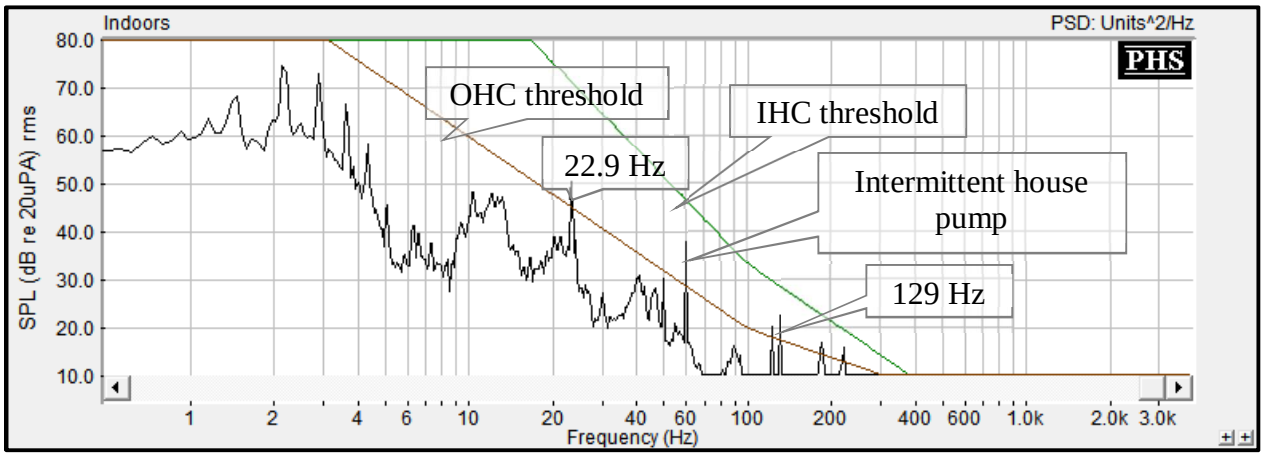
[16] Curves furnished by Dr. Salt via private communication, 2011.

Figure 8 – OHC & IHC Thresholds vs. RMS Wind Turbine Spectrum (4/18/2011)

8a – Outdoors (RMS)



8b – Indoors (RMS)



We were drawn to evaluating the potential significance of the 22.9 Hz tone. The amplitude modulation of the 22.9 Hz tone was evaluated using an external 10th-order digital bandpass filter (20 to 24 Hz) applied to the digital recording output and then analyzed with SpectraPlus software at 23 millisecond intervals using Hamming weighting. The time history presented in **Figure 9** shows that the indoors 22.9 Hertz tone modulates significantly above and below the OHC threshold of 45 dB SPL at 22.9 Hz.

Figure 9 – 22.9 Hz tone and its OHC threshold

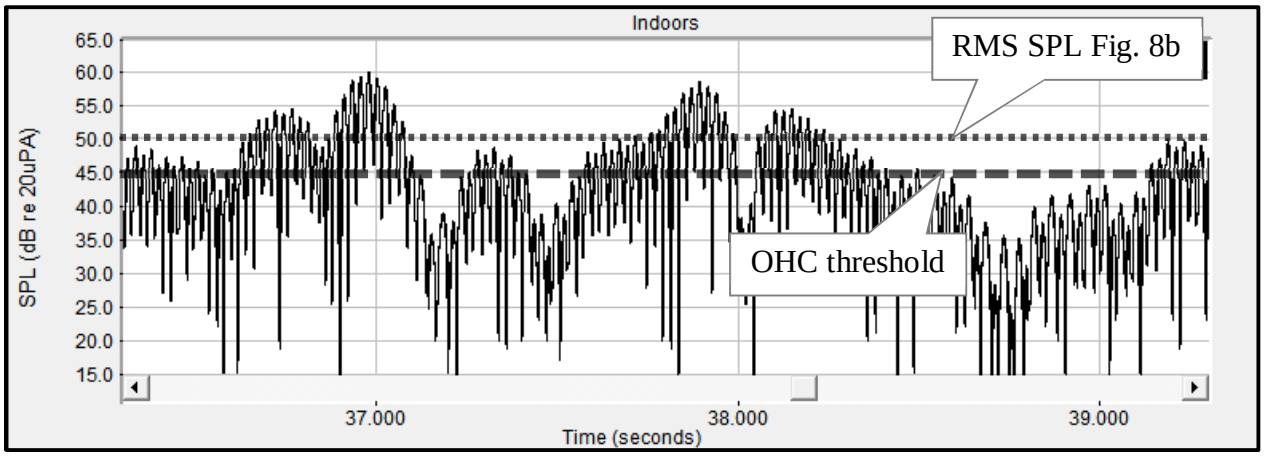


Figure 9 reveals a remarkable range of modulation in the 22.9 Hz tone, which peaks in this example time record as high as 60 dB SPL, 10 dB higher than the 50 dB SPL mean established by the FFT averaging. Nulls between peaks drop down several tens of decibels below the OHC threshold. The figure suggests that the inner ear OHC circuitry is receiving individual low-frequency pressure events 43 milliseconds apart at the 22.9 Hz driving frequency. The tone does not reach the IHC threshold (about 72 dB SPL at 22.9 Hz) and in fact we did not find the 22.9 Hz tone to be distinctly audible. Based on Dr. Salt's research, these 22.9 Hz pressure events are undetected by the IHC circuitry, yet strong enough to trigger the OHC circuitry which then drops gain on the IHC circuitry.

Example dBG-weighted time histories for the second day (4/18/2011) can be reviewed in **Figures 10a & 10b** with the 60 dBG guideline shown as a dashed line.

Figure 10a – dBG levels, indoors

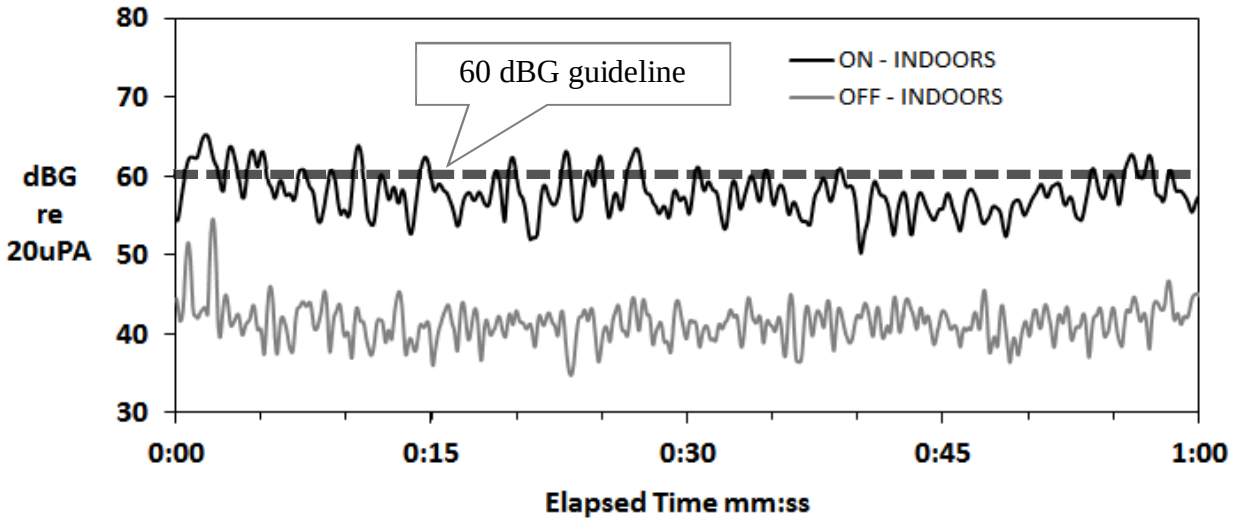
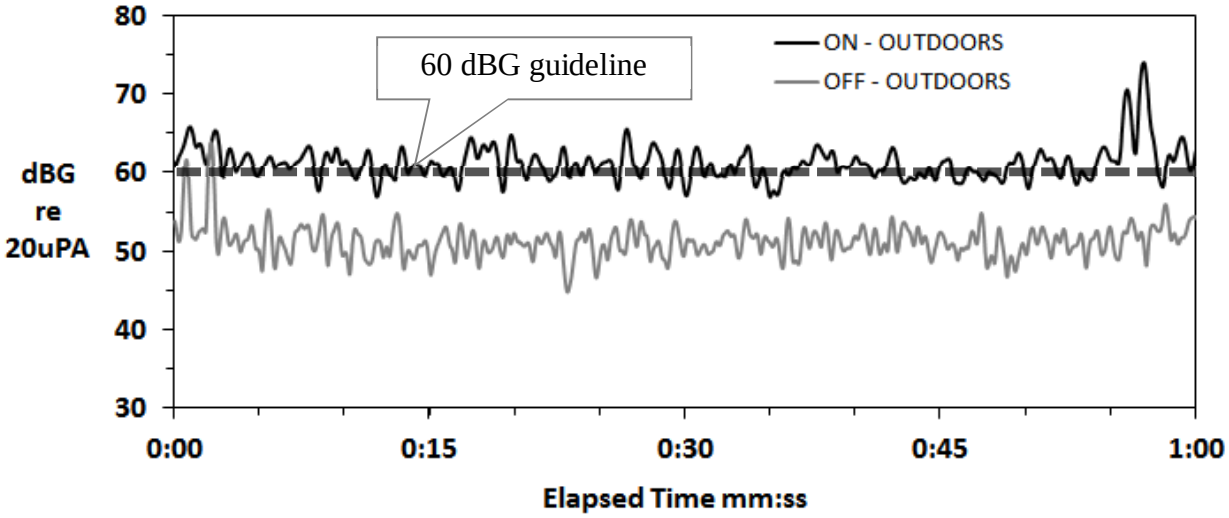


Figure 10b – dBG levels, outdoors



These figures (10a & 10b) clearly show the dBG-weighted levels exceeding Dr. Salt's 60 dBG guideline when the NOTUS wind turbine is operating. Again, based on Dr. Salt's research, these low-frequency pressure events are undetected by the IHC circuitry, yet strong enough to trigger the OHC circuitry which then drops gain on the IHC circuitry.

Indoors, the dBG level was modulated above 60 dBG with turbine ON and was down in the high 30s to low 40s (dBG) with turbine OFF. Indoors, we observed a 20 dB increase in dBG due to the wind turbine operation.

Outdoors, the dBG level was modulated above 60 dBG with NOTUS ON and was down in the low 50s (dBG) with NOTUS OFF. There we observed a 10 dB increase in dBG due to the wind turbine operation.

As a point of reference, relief started to set in for us when NOTUS was off with resulting dBG levels generally not exceeding 55 dBG outdoors and below 45 dBG indoors.

4.1.4 Discussion: Effects on Sleep and Wake States

Sleep Disturbance

We found that sleep was disturbed during the second night with hub-height winds above 10 m/s. However the background sound levels were low indoors, around 20 dBA. What could have been disturbing our sleep? This experience demands further study. We offer here a possible link.

> *From our direct experience that night, we hypothesize that sleep was disturbed when the wind turbine's principal modulation frequencies including the 0.7 Hz*

blade pass modulated in-flow turbulence pressure pulsations and 22.9 Hz tone became sufficiently detectable to the ear's vestibular system to engage the brain centers through the auditory frequency following response, or FFR [17,18]), and may have created conflict with the brain's sleep operations which would have its own sequences and frequency states during the night.

In sleep the brain is normally in Theta (4-7 Hz) or Delta (up to 4 Hz) states, as seen in **Figure 11**.

Figure 11 – Brain Waves

Type	Frequency (Hz)	Behavior
Delta	up to 4	• Slow wave sleep in adults, and some continuous attention tasks.
Theta	4 – 7 Hz	• Drowsiness or arousal in older children and adults, idling.
Alpha	8 – 12 Hz	• Relaxed/reflecting, closing the eyes.
Beta	12 – 30 Hz	• Alert/working, active, busy or anxious thinking, active concentration.
Gamma	30 – 100 +	• Perception which combines two different senses, such as sound and sight and short term memory matching of recognized objects, sounds, or tactile sensations.

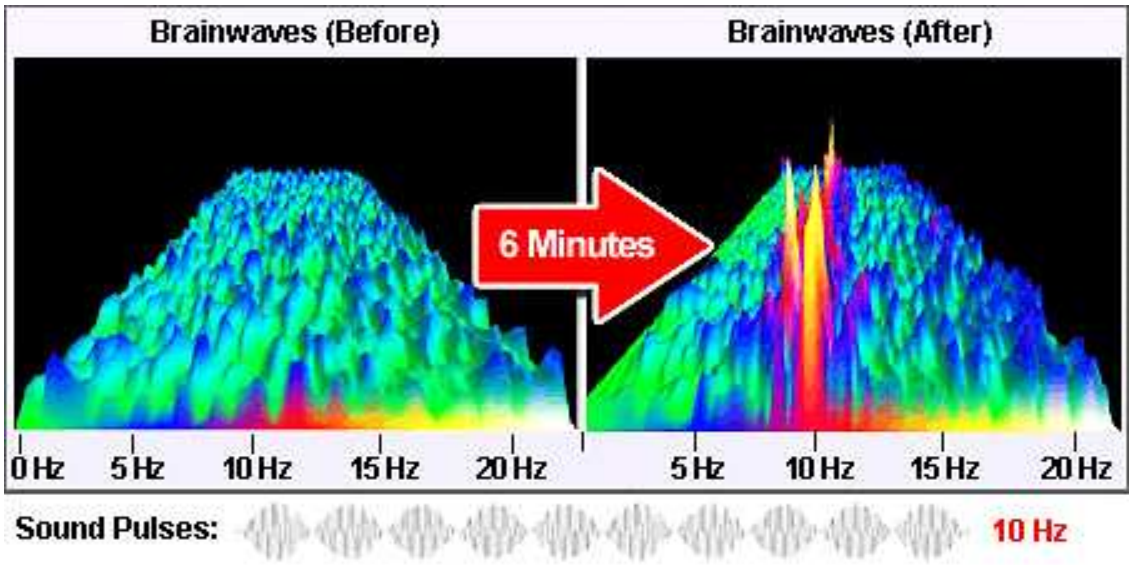
The wind turbine's 22.9 Hz tone lies in the "high Beta" range of brain wave frequencies (understood to be 23-30 Hz). Beta brain wave activity is understood to be associated with alert brain state, anxiety, and stress. Conversely, the wind turbine's blade pass frequency of 0.7 Hz, with which the wind turbine turbulence and tonal energy is amplitude-modulated, lies in the deep Delta brain wave range. We understand that medical researchers have established that entrainment to an external frequency when the brain would normally be operating at its own frequency requirements may result in brain activity conflict. That is certainly what we

[17] Frequency-following responses (FFRs), sustained evoked potentials based on precisely phase-locked responses of neuron populations to low-to-middle-frequency periodical acoustical stimuli.

[18] Du, Y. et al, Auditory frequency-following response: a neurophysiological measure for studying the "cocktail-party problem". Neurosci Biobehav Rev. 2011 Nov;35(10):2046-57. Epub 2011 May 27.

experienced. The brain entrains through FFR to external acoustic stimulus [19], example shown in **Figure 12**.

Figure 12 – Brain Response to 10 Hz Entrainment



This line of reasoning suggests that we may have experienced FFR with wind turbine acoustic emissions. We were unprepared to acquire brain wave (EEG) states during the field work to confirm FFR. If the medical protocols can be established, would EEG field testing be useful? It appears so.

Wake State

We experienced cloudy thinking, lethargy and difficulty with activities especially indoors during the daytime hours when wind speeds were strong at hub height. The wind turbine's 22.9 Hz tone increased in strength with increasing hub-height wind speed. Again, the 22.9 Hz tone is in the "High Beta" frequency band. There is clinical evidence that "synchronizing cortical activity in the beta frequency band slows voluntary movement" [20]. Other researchers [21,22] have investigated the abnormally high amounts of beta wave oscillatory brain activity in Parkinson's' Disease. Their research "demonstrated abnormally synchronized oscillatory activity at multiple levels of the basal ganglia-cortical loop. This excessive synchronization correlates with motor deficit".

[19] Original source reference being sought.

[20] Pogosyan A, Gaynor LD, Eusebio A, Brown P., Boosting Cortical Activity at Beta-Band Frequencies Slows Movement in Humans. Curr Biol. 2009 Oct 13;19(19):1637-41. Epub 2009 Oct 1.

[21] Hammond, C., et al, Pathological synchronization in Parkinson's disease: networks, models and treatments. Trends Neurosci. 2007 Jul;30(7):357-64. Epub 2007 May 25.

[22] Eusebio, A., Brown, P., Synchronisation in the beta frequency-band — The bad boy of parkinsonism or an innocent bystander? Exp Neurol. 2009 May; 217(1): 1–3. doi: 10.1016/j.expneurol.2009.02.003.

We understand a number of people worldwide have experienced cardiovascular upset near wind turbines; pains in chest, heart racing, palpitations. Were our cardiovascular systems being influenced through entrainment during the Falmouth study?

> *According to the principle of entrainment [23], two systems will entrain or align their rhythms if exposed to each other for a sufficient length of time. At 42 modulations per minute, the 0.7 Hz blade pass frequency falls in the range of resting heart rates for athletes. Our heart rates are normally closer to 65-70 bpm. Could our heart rates have slowed? Could entrainment have spurred adaptive vestibular attention to signals from vascular baroreceptors for confirmation of the incoming pressure pulsations? We do not know. We were unprepared to monitor heart rate variability or cardiovascular condition during the study.*

What do these lines of thinking suggest?

First, they suggest that brain oscillations may synchronize to the wind turbine. Our experience told us that our mental functions shifted dramatically within a short period of exposure to the wind turbine noise. The effect may be more pronounced or occur more quickly when winds are strong, and from our own experience, can affect sleep and waking states. Anxiety could have emerged for the very reason that the incoming energy processed and reported by the vestibular system was inaudible.

Second, they suggest that a complex of physiological conditions may be triggered by the vestibular processing of the incoming low-frequency energy that is inaudible yet exceeds the vestibular threshold. These human responses strongly suggest that this is in fact *a medical problem*. Medical doctors and researchers should evaluate the health effects reported by neighbors living near wind turbines in Falmouth through epidemiological and laboratory work.

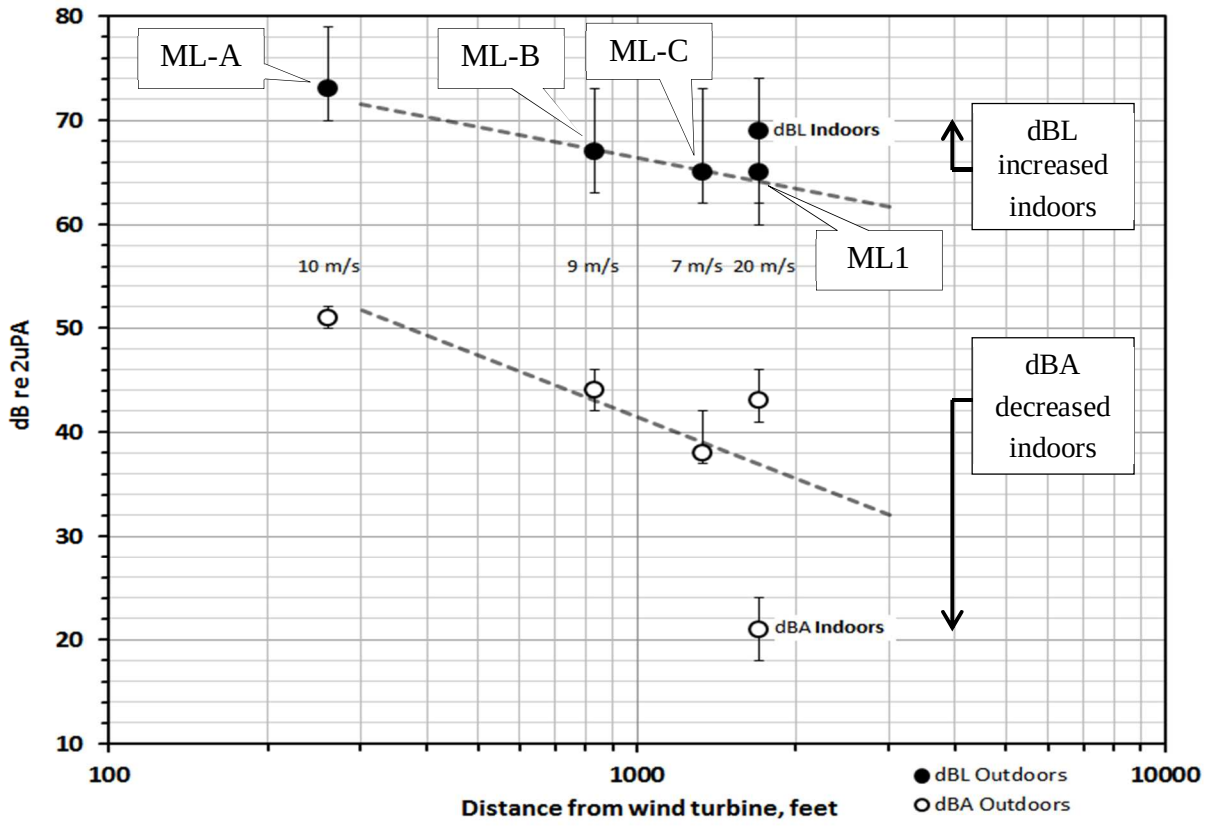
[23] "a synchronization of two or more rhythmic cycles," a scientific phenomenon discovered by Dutch scientist Christian Huygens in 1665. Following the law of the conservation of energy, when two closely related rhythmic cycles interact they synchronize with each other.

4.2 Sound Level versus Distance

Outdoor dBA sound levels decrease at 6 dB per doubling of distance (6 dB/dd) as depicted by the inverse square law for acoustic frequencies. Sound level versus distance measurements were plotted *using a semi-log scale for distance*. This graphing method typically shows the drop of sound level as a straight line as the distance increases.

The "stepped distance" data combined with the data at ML1 clearly show that the NOTUS noise level decreases with distance uniformly, as shown on **Figure 13.**

Figure 13 - NOTUS RMS Sound Level vs. Distance
(Showing wind speeds, and average noise levels with max-min ranges)



There are two trend lines; the lower dashed one showing the dBA decreasing at a predictable 6 dB/dd. The dBA trend line is faired through a wind speed of 8 m/s which is the wind turbine specification wind speed. The upper line is for the unweighted sound level, which is controlled

in these measurements by energy at frequencies less than 20 Hz. The data indicate a decrease with distance consistent with cylindrical spreading; about 3 dB/dd.

> *Outdoor sound wave propagation generally occurs in one of three ways; spherical or hemispherical, represented by a decrease of 6 dB per doubling of distance, or cylindrical, with a decrease of 3 dB per doubling of distance.*

Measurements at the house were measured indoors and outdoors. The dBA measurements show that the indoor levels were more than 20 dB quieter than outdoors, depicting a well-built house with good noise reduction. A closer look reveals an important bit of information. The un-weighted linear (dBL) levels *indoors* were actually several dB *higher* than those *outdoors*. This indicates that the house is reinforcing and amplifying the very low frequency energy.

Analysis of the WIND 1 digitally recorded data using signal analyzer software shows that there are series of repetitive low-level infrasonic pulses with energy in the range of 0.7 to 6 Hz at multiples of the blade pass rate of 0.7 Hz. These are unique to the wind turbine, and we have not located similar data for environmental sources. They are presented in the sections 4.3 to 4.5.

4.3 House Noise Reduction

Field testing was conducted general accordance with the applicable ANSI Standards; ANSI Standards S12.18-1994 (Procedures for Outdoor Measurement of Sound Pressure Level, Method 1) and S12.9-1993/Part 3 (Procedures for Short-Term Measurements with an Observer Present) and ASTM E996-02 [24]. Measurements were made with the NOTUS wind turbine operating with hub height wind speeds averaging about 20 m/s. A simultaneous dual-channel analysis was performed using two precision condenser microphones; one located inside (master bedroom) and another outside (lawn well clear of house and trees). The one-minute time-averaged transfer function analyses are shown on **Figures 14a and 14b**, FFT and octave band, respectively.

[24] "Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements", ASTM Designation: E 966 – 02. Definition: outdoor-indoor level reduction, OILR—in a specified frequency band, the difference between the time-averaged exterior sound pressure and the space-time average sound pressure in a room of a building.

Figure 14a - Outside-to-Inside Level Reduction (OILR), FFT

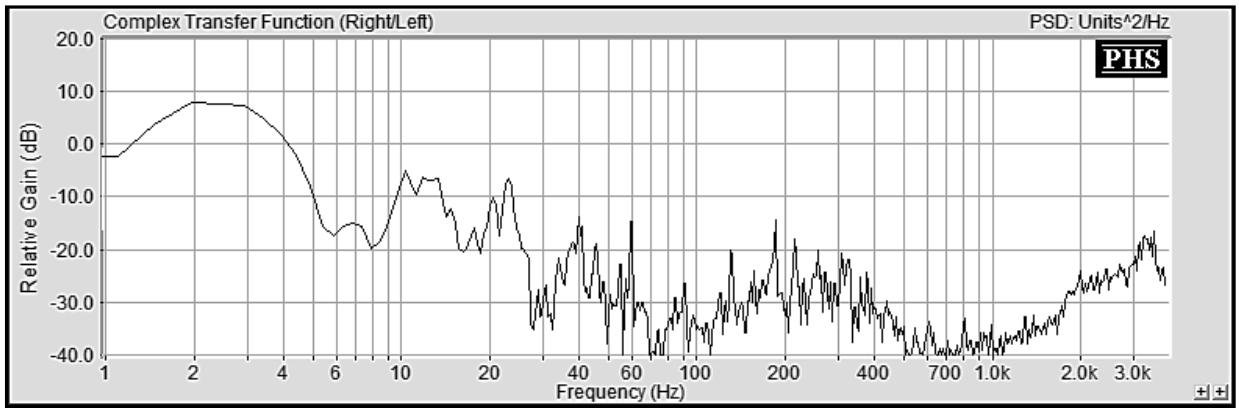
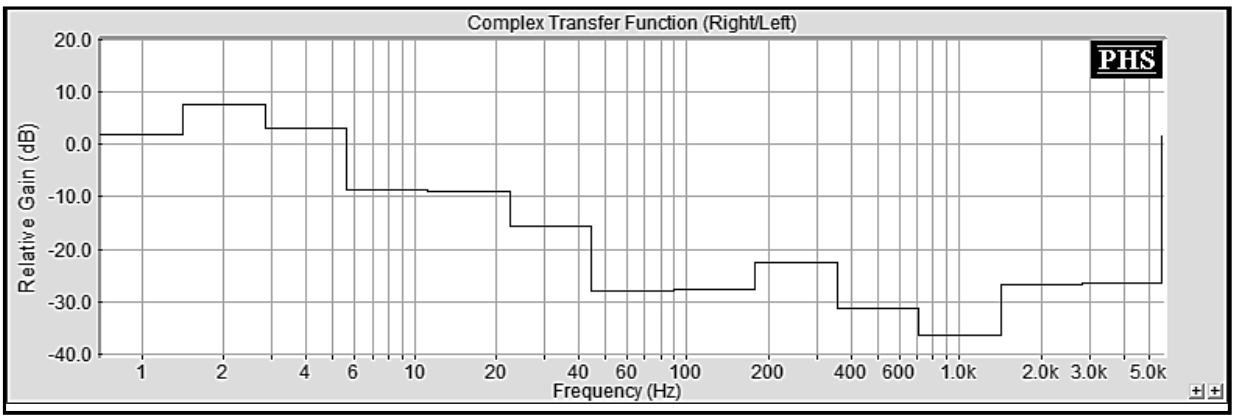


Figure 14b - Outside-to-Inside Level Reduction (OILR), Octave Band



The graphs in Figures 14a & 14b present a preliminary assessment of the outside-to-inside-level-reduction (OILR), or "noise reduction" (NR) provided by the house exterior walls and roof.

Negative values indicate attenuation or NR, while positive values indicate amplification. There is on average more than 20 dB of NR for frequencies greater than 31.5 Hz, and about 15 dB in the 31.5 Hz band. From 16 to 8 Hz the NR is reduced to 10 dB. However, below 8 Hz there is no NR, but rather there appears to be amplification for the very lowest frequencies. This is evident in a review of the octave-band sound pressure in Pascal shown in **Figures 15a & 15b**.

Figure 15 – Sound pressure, NOTUS ON (4/18/11)

Figure 15a - Outdoors

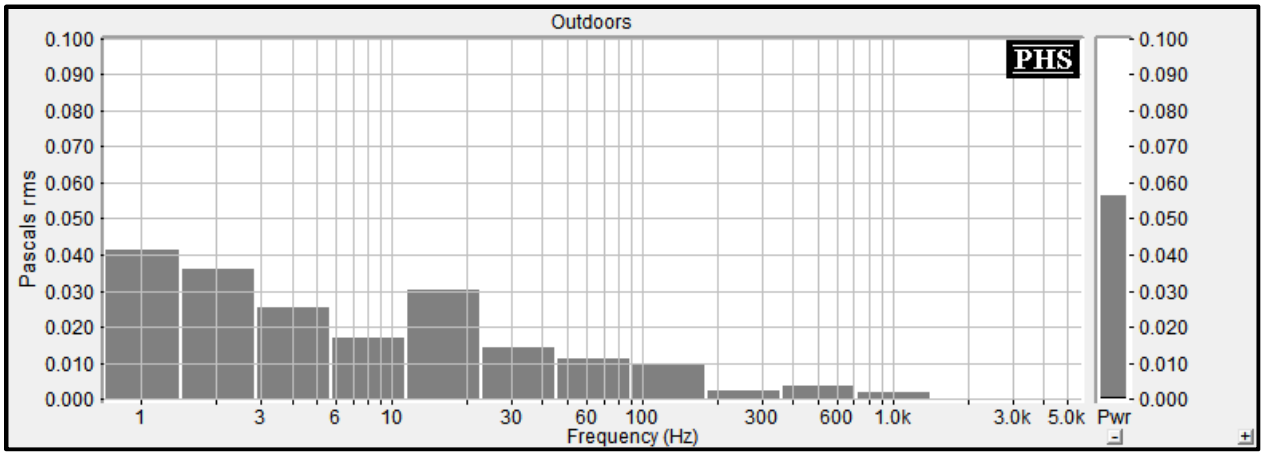
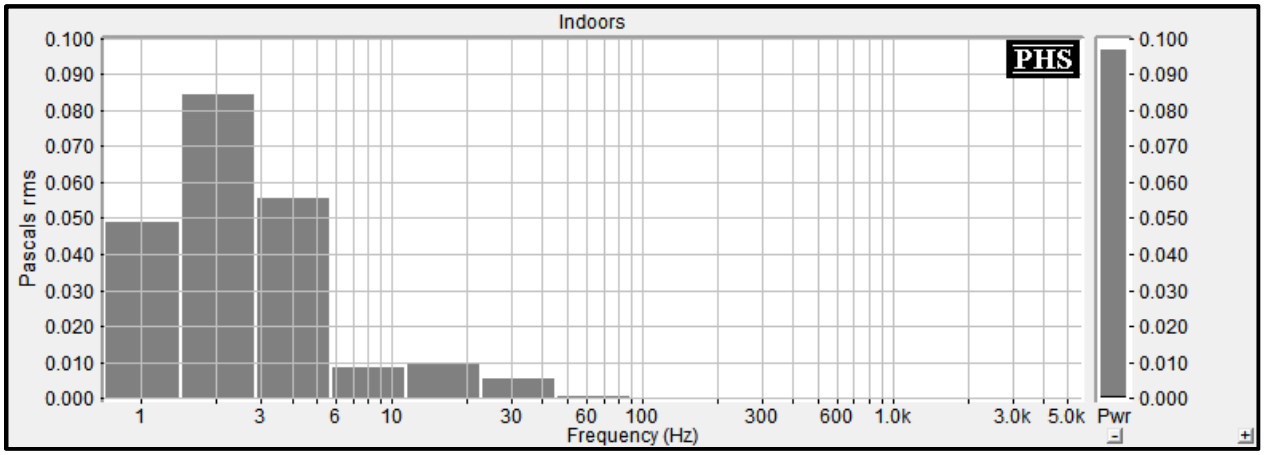


Figure 15b - Indoors



4.4 Acoustic Coupling to Home Interior

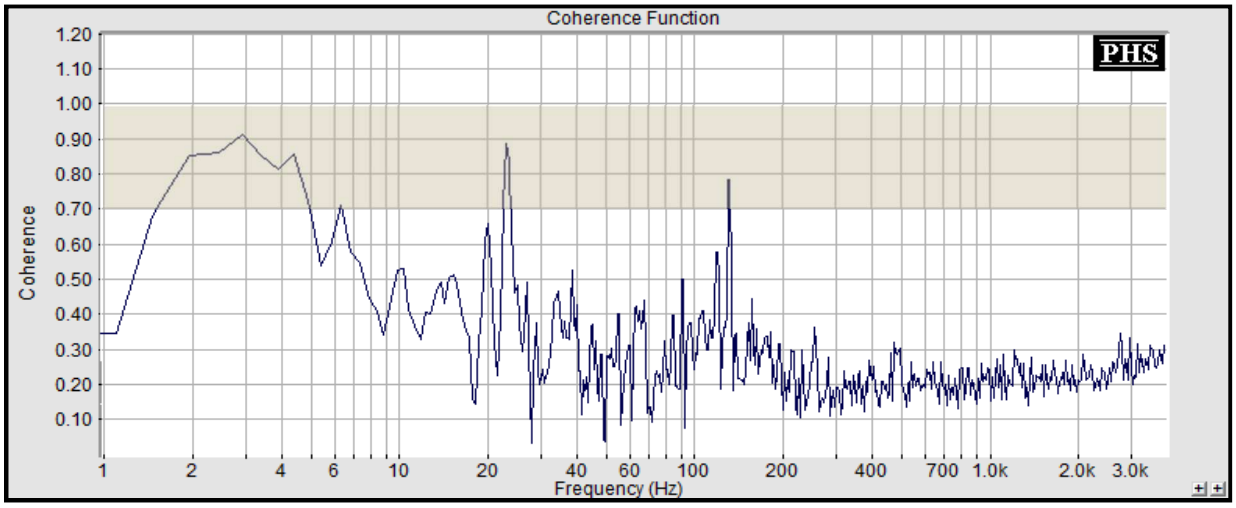
"It's like living inside a drum".

This comment has surfaced several times during wind turbine facility investigations. Is the wind turbine acoustic signature acting like a drum stick striking on the house-as-drum? Is the acoustic energy outside coupled into the interior space? To evaluate what acoustic energy emitted by the wind turbine was coupled into the house interior, a coherence analysis was conducted from a series of averaged frequency-amplitude measurements of the outdoor and indoor microphone

signals (**Figure 16**). Coherence is the ratio of the squared magnitude of the cross-spectrum and the product of the auto-spectrum of both channels. It measures the *degree of linearity* between the channels and is analogous to the squared correlation coefficient used in statistics. Two perfectly coherent signals have a coherence value of 1.0. A coherence value of 0.7 or more (highlighted below) was considered for this analysis as indicative of strong acoustic coupling, the acoustic energy *indoors* highly correlated to the acoustic energy *outdoors*.

Figure 16- Coherence, Outdoors to Indoors

(April 18, 2011, 3:22 pm)

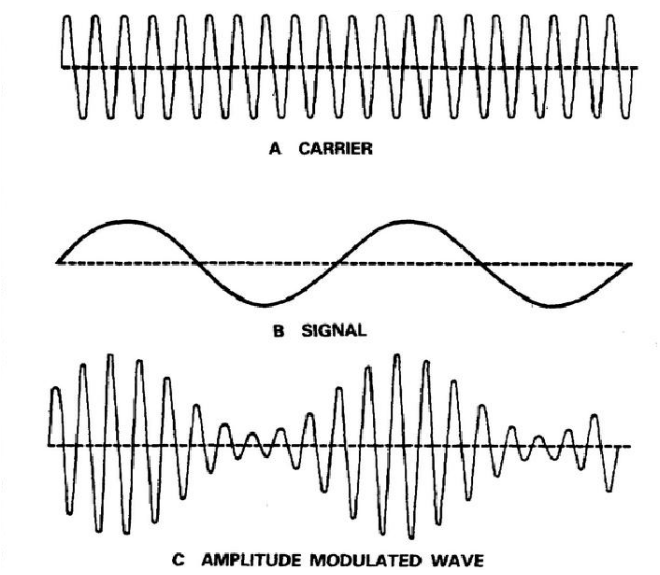


The coherence values indicate that the very-low-frequency energy found below 10 Hz was very-strongly coupled into the house interior, consistent with the indoors pressure amplification noted in section 4.3. This suggests a "whole-house" *cavity response* of the interior house volume. The 22.9 Hz and 129 Hz tones were also strongly coupled outdoors to indoors.

4.5 Dynamic Amplitude Modulation

Wind turbine noise presents a characteristic that distinguishes it from ambient noise; dynamic amplitude modulation. The process of amplitude modulation is familiar to those who understand the fundamentals of AM radio broadcasts. In amplitude modulation (AM), a carrier wave's amplitude is modulated by a lower-frequency signal (**Figure 17**). The frequency of the carrier wave remains unaltered but its amplitude is caused to vary by an amount proportional to the amplitude of low frequency signal and at the rate proportional to the frequency of the signal and the modulated wave obtained.

Figure 17 - AM modulation



In AM radio, we do not hear the modulated broadcast carrier. For example, a medium-wave AM radio transmission uses a carrier frequency in the 520-1610 kHz radio frequency band which is beyond the range of human hearing. In contrast, the carrier signal for wind turbines is for the most part audible; and complex, consisting of the collective modal and aerodynamic acoustic emissions radiated by the wind turbine; *some in the infrasonic range, some in the audible acoustic range*. The "signal" consists of the dynamic sound pressure modulations recurring at the blade pass rate.

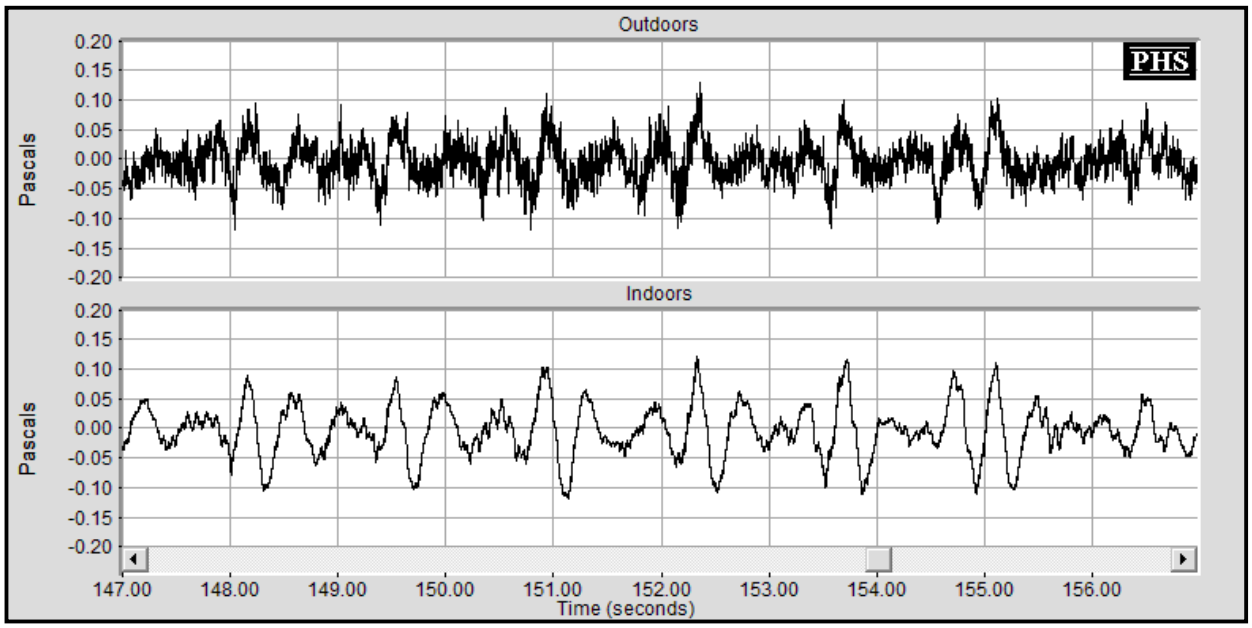
There are several acoustic components experiencing dynamic modulation at the blade pass rate; among these, very-low-frequency blade bending and twisting modes interacting with turbulence; vortex shedding off the end of the blades (interrupted or slapping against the wind turbine mast); dynamic stall along the blades (influenced by cyclical and abrupt variations of wind vectors along the blades); the in-flow turbulence (below 20 Hz for the large units- peak frequency dependent on blade length, affected by blade position during rotation through turbulent layers); gear and generator tones rising and falling with wind load and radiated by the mast and blades.

A sample time history "strip chart" in **Figure 18** shows the primary dynamic modulation at the blade pass frequency is clearly visible every 1.4 seconds. The modulation repeats but is not sinusoidal. Peaks and dips occur suddenly with rise and fall times exceeding 10 dB per second. The "Outdoors" graph shows the higher frequency details associated with the wind turbine's

characteristic "swish" sounds. The "Indoors" graph shows the house-envelope-filtered-and-amplified very-low frequency content of the wind turbine sound. What is apparent is that the negative pressure swings (vacuum) are more pronounced indoors compared to outdoors.

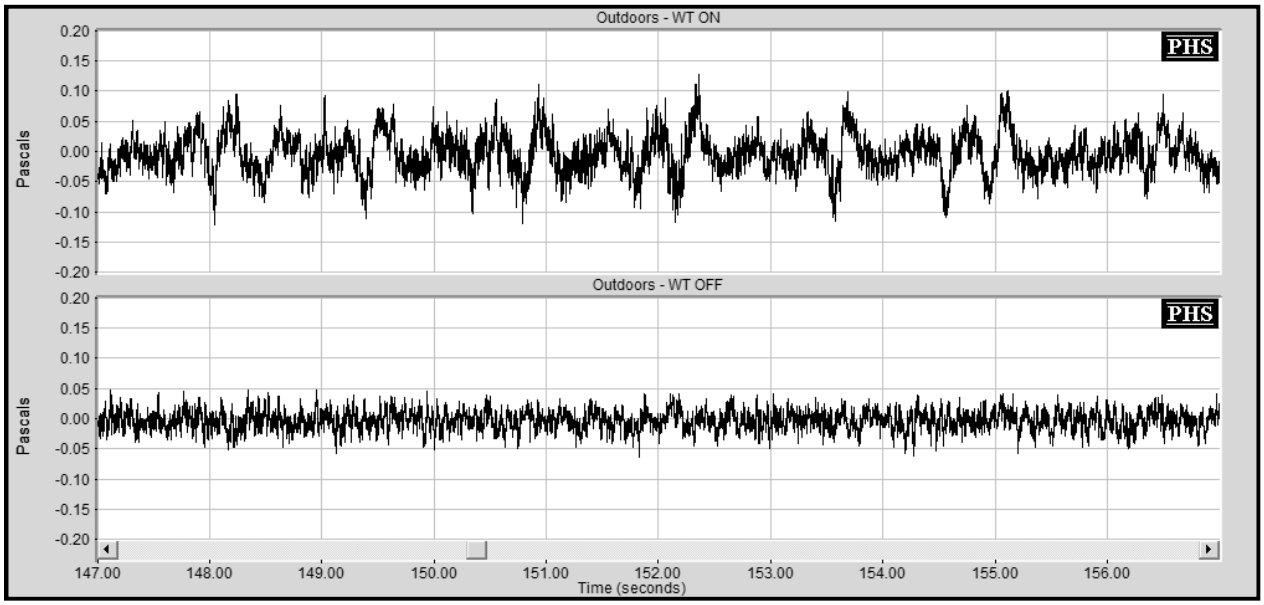
Figure 18 -Acoustic pressure fluctuation time-history

(Outdoors and indoors; April 18, 2011, 3:22 pm)



Despite the apparent increase in energy indoors, the wind turbine was almost inaudible indoors. The house envelope blocked most of the frequency content above 10 Hz, and amplified the remaining low frequency pulsations, *much like a drum*. The acoustic pressure swung from positive (compressed) to negative (rarified) 0.2 Pa peak-to-peak. As shown in the composite dual time history in **Figure 19**, the infrasonic AM signature was absent when the NOTUS was OFF.

Figure 19 – Outdoors, linear sound pressure, NOTUS ON (4/18/11) and OFF (4/19/11)



The infrasonic and low-frequency pulsations are *hidden* by the A-weighting filtering normally used by noise consultants to assess noise *levels*; yet, these pulsations are clearly visible in the linear, un-weighted time history in Pascal (Figures 18, 19). Pressure pulsations are even more evident in the *indoors* record in Figure 10, which is almost entirely composed of the "signal" dynamic amplitude modulation of the "carrier" wind turbine acoustic emissions below 10 Hz. A-weighting, then, serves to hide a large portion of the wind turbine acoustic emissions; the dynamically modulated sound pressures below 100 Hz.

Our instrumentation reported the Crest Factor at 11-12 dB outdoors and indoors. This suggests that **the RMS measurements reported on our graphs are well below the peak levels detectable by the human ear**.

The C- and A-weighted levels were compared to the un-weighted linear (dBL) sound level and shown in **Figure 20** below. Occasionally in this record, we heard the audible modulation of the upper-frequency "swish" sounds, which show up in the dBA record. However those were relatively small compared to the repetitive amplitude modulations in the linear sound pressure record which occur below 20 Hz. While the dBA and even the dBC filtered levels reveal little of the underlying "signal" from the NOTUS wind turbine, the linear sound level (dBL) contains the entire sound pressure signature, and clearly shows the extent of the variations in sound pressure. This is even more evident indoors, as shown in **Figure 21** below.

Figure 20 –Outdoors sound levels, NOTUS ON (4/18/11)

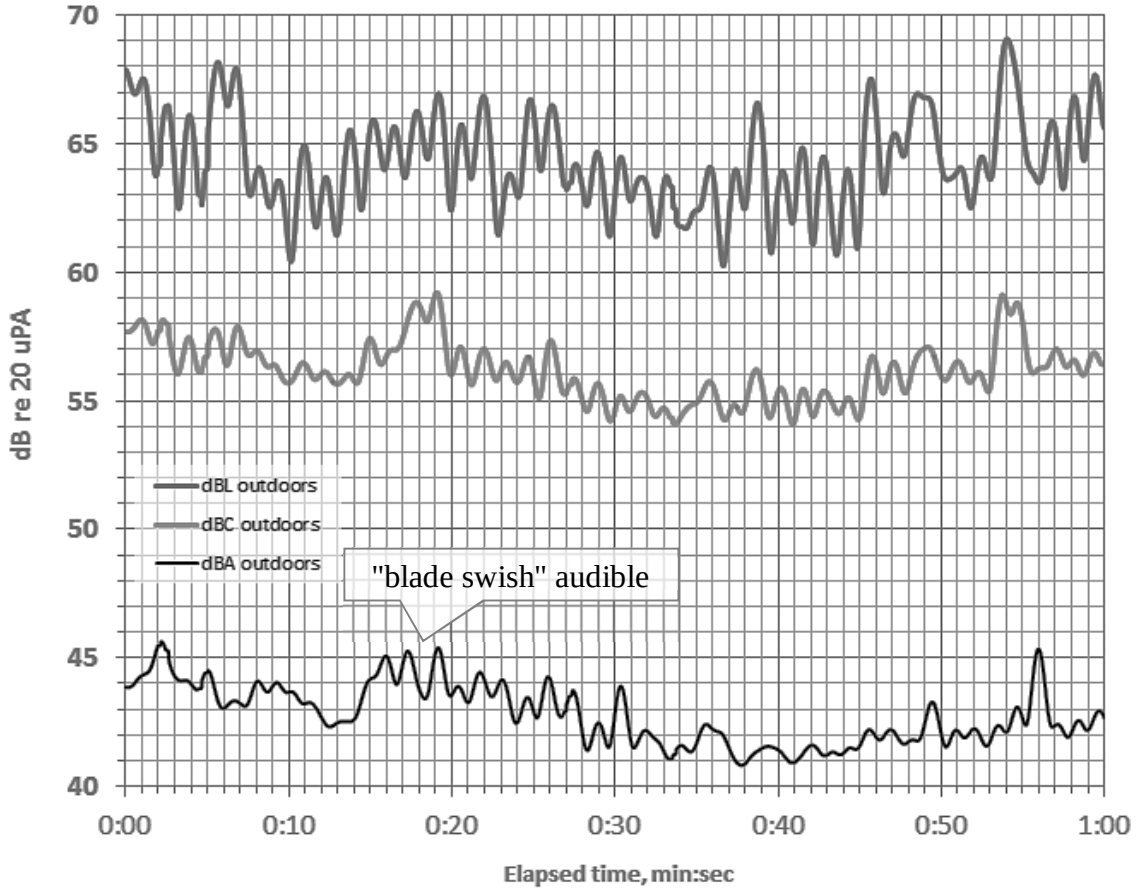
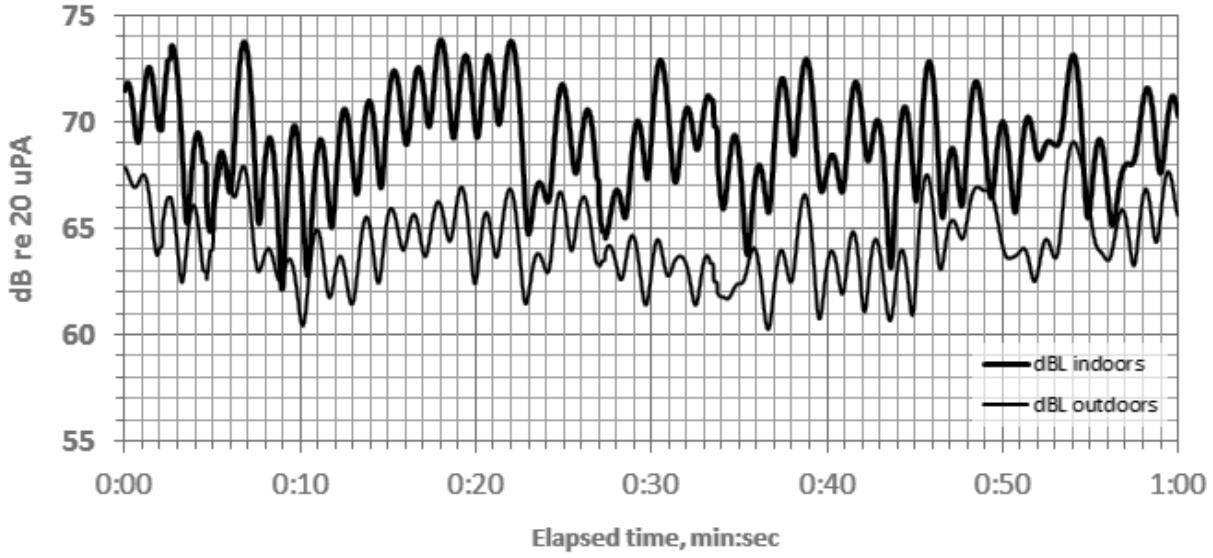


Figure 21 - Acoustic pressure fluctuation time-history

(Indoors versus outdoors; April 18, 2011, 3:22 pm)



The house amplification (the inaudible yet pervasive sound pressure "drum-beat") is clearly evident again in Figure 13, with increases of 2 to 6 dB, outdoors to indoors.

4.6 Pressure Pulsation Exposure and Dose-Response

It is generally accepted that human response and cumulative effects increase with the quantity and the peak level of intrusive noises. Peak noise events are additive. The relative impact of noise level and number on human reactions is measured by the decibel equivalent number effect (k) expressed as the number of decibels which have an effect equivalent to that of a tenfold increase in number of events [25]; 10log(n), where n is the number of events.

We experienced onset of adverse health effects shortly after starting our work indoors. Over the first fifteen minutes at 1.4 seconds blade pass rate, we estimate that we were subjected to a repetitive exposure of 642 peak pressure events. Over each hour we were exposed to an estimated 2571 pressure events. Over a period of five hours on the first day during the highest winds when we were most severely affected, we estimate that we were exposed to over 12,800 blade pass peak pressure events. Of those pressure pulsations, we estimate that well over fifty percent exceeded the 60 dBG threshold (from Salt).

The occurrence of pressure events at 22.9 Hz is much greater. Over a five-hour period, some 412,200 pressure events would have occurred 43 milliseconds apart, and we estimate that 1/2, or some 200,000 of those would have entered the ear (inaudibly to the IHC circuitry), then they would have been detected and processed by the OHC circuitry, repeatedly and rapidly changing gain on the IHC circuitry.

We would not automatically assign a conventional dose-response relationship to these low frequency inaudible pressure events compared with the health effects from nuisance and annoyance as commonly associated with *audible* sound events. However, we experienced vestibular impact or conflict which ramped up over time (within twenty minutes) and took time to dissipate (hours to days or more). The time to onset and recovery suggest that dose-response is involved with these pressure events.

[25] Fields, J., The effect of numbers of noise events on people's reactions to noise: An analysis of existing survey data. J. Acoust. Soc. Am. Volume 75, Issue 2, pp. 447-467 (1984).

5 CONCLUSIONS

5.1 Noise and Pressure Pulsations

The acoustic energy from the wind turbine was found to be:

1) Greater than or uniquely distinguishable from the ambient background levels, and
2) Capable of exceeding human detection thresholds.

This research revealed dynamically modulated low frequency and infrasonic energy from the nearby wind turbine occurring at the blade pass rate; energy which was found to be amplified indoors below 10 Hz. These dynamic infrasonic modulations were absent when the wind turbine was off. The wind turbine has tonal energy at 22.9 and 129 Hz. The wind turbine acoustic emissions were strongly coupled to the indoor environment at very low infrasonic pulsations and at the 22.9 and 129 Hz tones.

The dBA levels were inversely correlated to adverse health effects experienced; effects were more severe indoors where dBA levels were much lower (around 20 dBA). However the dBL (un-weighted) and dBG (infrasonic-weighting) levels were more strongly modulated indoors. This increase in modulation indoors was consistent with the stronger adverse health effects indoors. The increase in total sound pressure indoors appears related to a "whole-house" cavity response; the outside pressure pulsations exciting the interior acoustic pressure much like a stick hitting a drum. Especially, the degree of negative pressure increased significantly indoors compared to outdoors.

5.2 Adverse Health Effects

This research revealed that persons without a pre-existing sleep deprivation condition, not tied to the location nor invested in the property, can experience within a few minutes the same debilitating health effects described and testified to by neighbors living near the wind turbines.

The debilitating health effects were judged to be visceral (proceeding from instinct, not intellect) and related to as yet unidentified discordant physical inputs or stimulation to the vestibular system.

The dBG levels indoors were dynamically modulated at the blade pass rate and tonal frequencies and exceeded the vestibular physiological threshold guideline of 60 dBG provided by Dr. Salt.

Health effects moderated when dBG levels fell well below the 60 dBG guideline when the wind turbine was OFF.

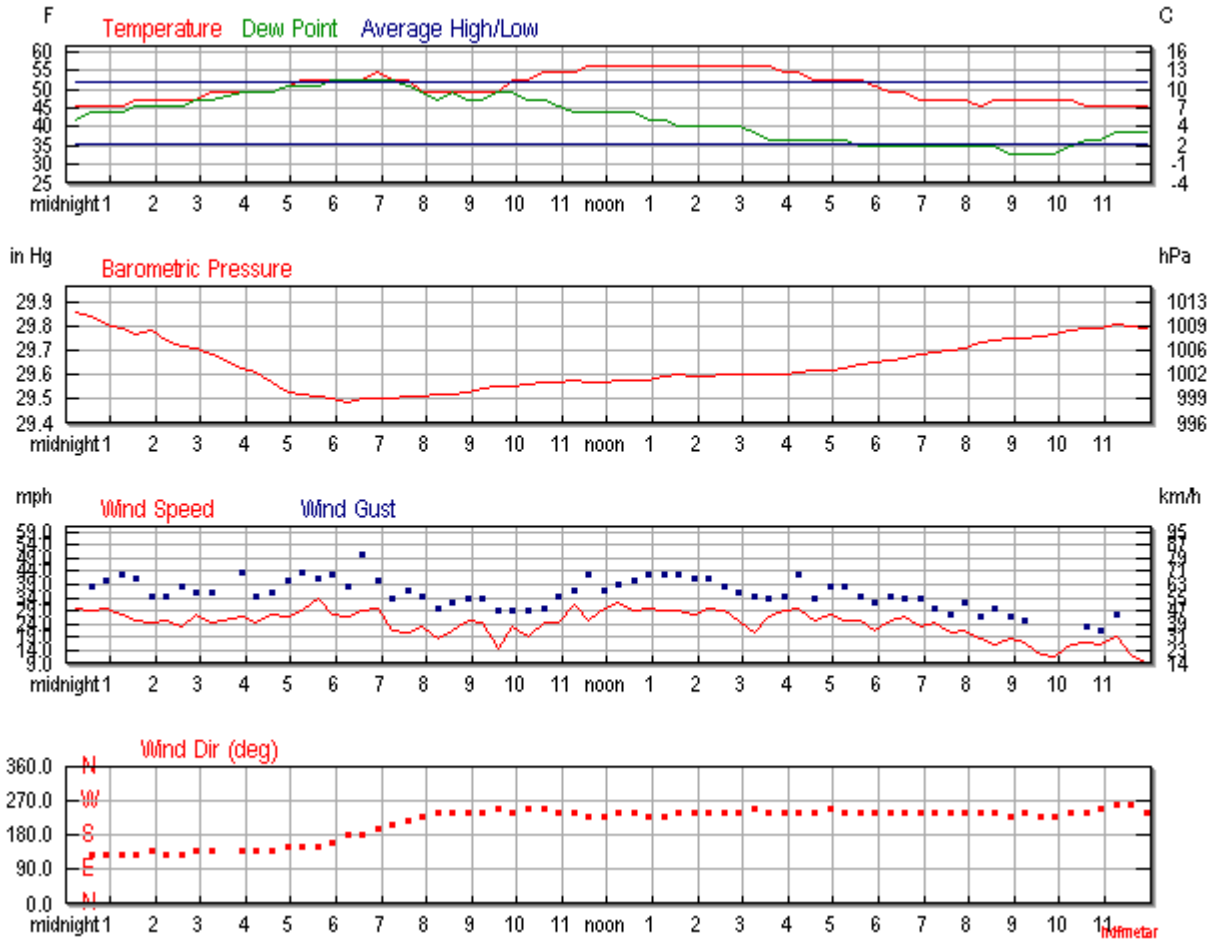
Wind turbine tonal energy at 22.9 Hz lies in the brain's "Beta" range which is associated with alert mental activity and anxiety; antithetical to sleep. The dynamic 0.7 Hz modulations of in-flow turbulence and tonal energy lie in the deep Delta range associated with deep sleep. Clinical evidence of frequency following response (FFR) in the brain suggests that entrainment with wind turbine modulations, pulsations and tones may pose conflict for the brain's natural rhythms, leading to stress when the conflicting signals (the wind turbine) cannot be turned off. Other physiological mechanisms may be in play. Medical epidemiological field and laboratory investigation is needed.

The study confirms that large industrial wind turbines can produce real and adverse health impacts and suggests that this is due to acoustic pressure pulsations, not related to the audible frequency spectrum, by affecting the vestibular system especially at low ambient sound levels. The study results emphasize the need for epidemiological and laboratory research by medical health professionals and acousticians concerned with public health and well-being. This study underscores the need for more effective and precautionary setback distances for industrial wind turbines. It is especially important to include a margin of safety sufficient to prevent inaudible low-frequency wind turbine noise from being detected by the human vestibular system.

Attachment A

Weather Conditions
April 17, 2011

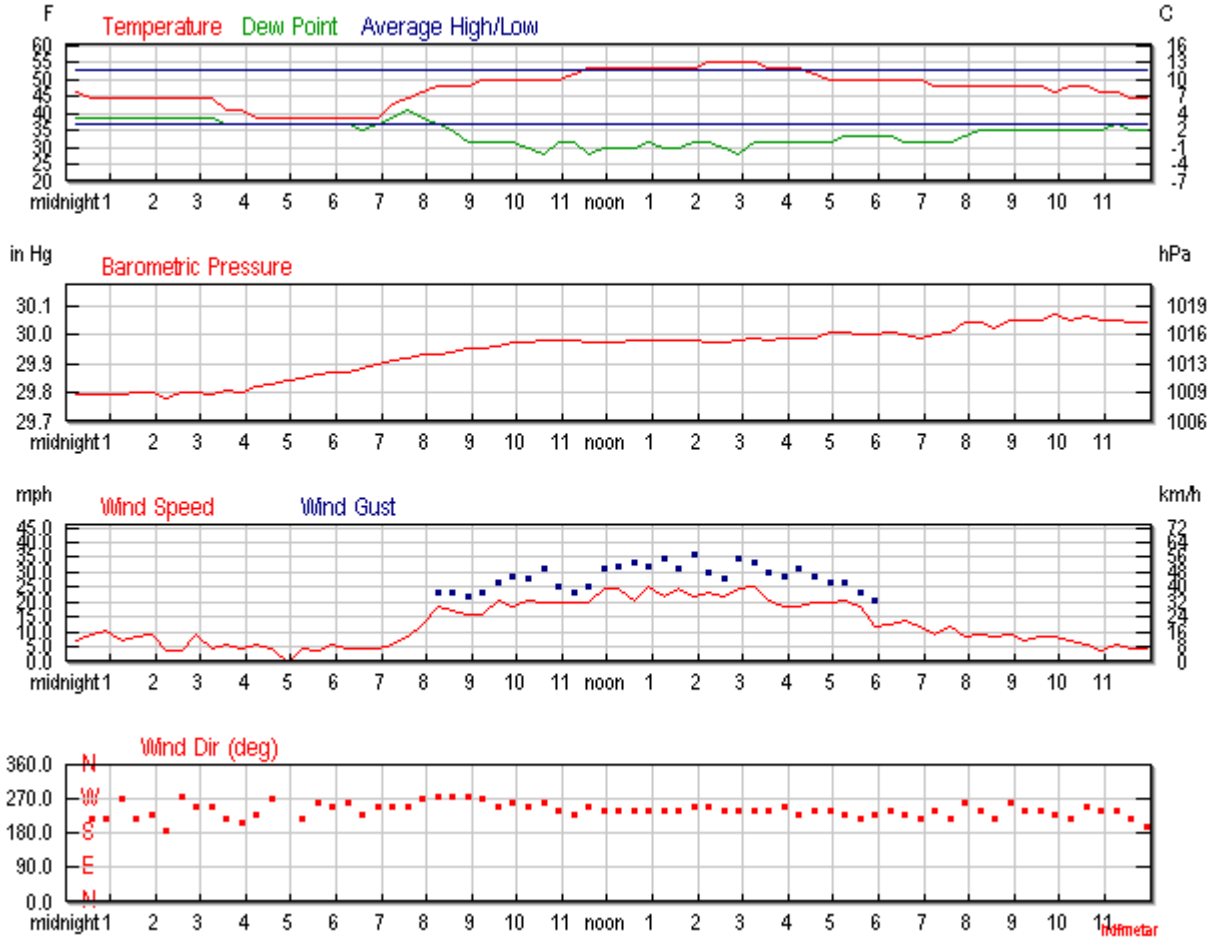
Otis Air National Guard Base
Falmouth, Massachusetts



Attachment B

Weather Conditions
April 18, 2011

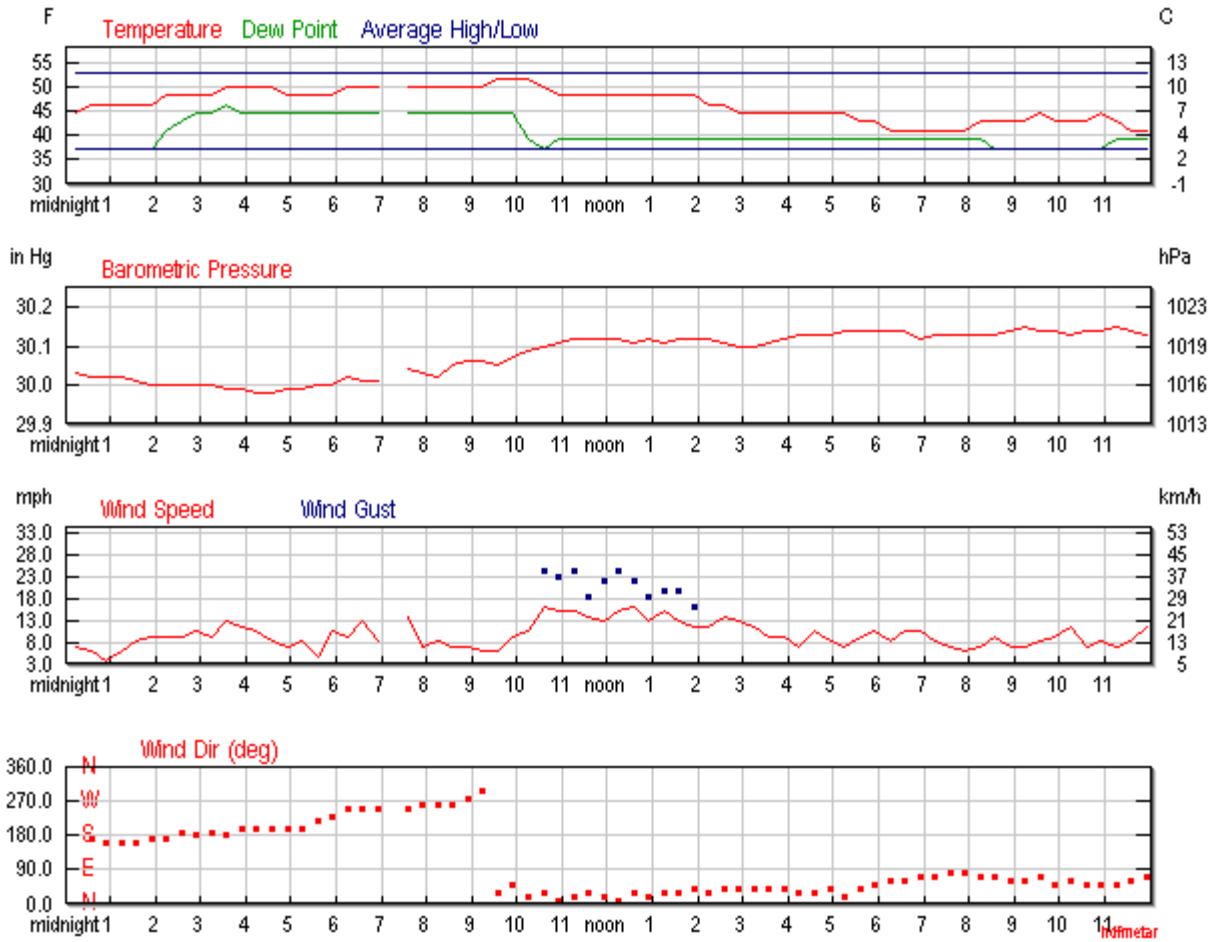
Otis Air National Guard Base
Falmouth, Massachusetts



Attachment C

Weather Conditions
April 19, 2011

Otis Air National Guard Base
Falmouth, Massachusetts



Wind Turbines & Public Health – It's Time to Act
Video Citations

Listed below are the citations for references that were made in the *Wind Turbines & Public Health* video.

QUOTED MATERIAL

Rapid Review

"there are no direct pathological effects from wind farms"

Australian National Health and Medical Research Council (NHMRC), July 2011.
Rapid Review and the Public Statement are available from:
http://www.nhmrc.gov.au/guidelines/publications/new0048

Professor Warwick Anderson's Oral Testimony to the Australian Federal Senate Inquiry into Rural Wind Farms, 31 March, 2011, Perth, Australia. Professor Warwick Anderson is the CEO of the National Health and Medical Research Council.

"we do not say that there are no ill effects" p. 88

"we believe authorities must take a precautionary approach to this" pp. 86–87

"this is very important here because of the very early stages of the scientific literature" p. 87

www.aph.gov.au/**hansard**/**senate**/commttee/S13730.pdf

Ontario Court Judgment, Canada

"This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree." (p. 207)

[i] Environmental Review Tribunal, Case Nos.: 10-121/10-122 Erickson v. Director, Ministry of the Environment, dated this 18th day of July, 2011 by Jerry V. DeMarco, Panel Chair and Paul Muldoon, Vice-Chair.

The judgment can be viewed on the following website; scroll down to the release date (18 July, 2011): http://www.ert.gov.on.ca/english/decisions/index.htm

Australian Federal Senate
Community Affairs, References Committee
The Social and Economic Impact of Rural Wind Farms, June 2011

The Senate made seven recommendations. The three listed in the video are:

Recommendation 1
2.44 The Committee considers that the noise standards adopted by the states and territories for the planning and operation of rural wind farms should include appropriate measures to calculate the impact of low frequency noise and vibrations indoors at impacted dwellings.

Recommendation 3
2.69 The Committee recommends that further consideration be given to the development of policy on separation criteria between residences and wind farm facilities.

Recommendation 4
2.101 The Committee recommends that the Commonwealth Government initiate as a matter of priority thorough, adequately resourced epidemiological and laboratory studies of the possible effects of wind farms on human health. This research must engage across industry and community, and include an advisory process representing the range of interests and concerns.

The full report and recommendations from the Inquiry can be viewed here:
http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/report/index.htm

Explicit Cautionary Notice to Those Responsible for Wind Turbine Siting Decisions
The Waubra Foundation, 29 June, 2011.

http://media.crikey.com.au/wp-content/uploads/2011/07/caution.pdf
or
http://www.waubrafoundation.com.au/~waubra/Y2NpZD0xJmNhaWQ9MTMmYWlkPSZjcmM9MTQ0OTg1MjMyOA%3D%3D

INTERVIEWEES

Footage was obtained on location from affected residents and concerned clinicians in August and November 2011.

Dr David Iser
Rural General Practitioner in Toora Victoria for over 30 years. He first saw patients affected by wind turbines in 2003, then performed a small survey based on Dr Amanda Harry's work in 2004.

Mrs Rose Anable
Born At Elmgrove, Crookwell and lived there all her life. Property settled by her grandfather. Has lived with symptoms for 13 years, ever since Crookwell 1 commenced operating. This wind development has had four different owners, the current one being Eraring Energy.

Mr Carl Stepnell
Farmer at Waubra, together with his parents, wife and children. Having endured a year of worsening symptoms after Acciona's Waubra Wind Development started operating, the family doctor advised Carl and his wife to leave their home due to the seriousness of the health problems the two of them were experiencing. These included symptoms such as constant

nausea, vertigo, severe chronic sleep deprivation, severe headaches, painful ear pressure, worsening tinnitus, chest pain, frequent and prolonged nose bleeds and severe depression. Moving away helped resolve their sleep problems, but many of the other symptoms return when they go to work at the property and the turbines are turning. These are worsening with ongoing exposure. Of concern is the fact that their daughter, a farm apprentice who has started working full-time on the family farm, is now experiencing rapidly worsening symptoms, having not experienced them before. The Stepnells were originally offered wind turbines but turned down the offer. They have been active members of the local Landcare group and have planted many trees around their property.

Mr Donald Thomas
Farmer in the Waubra / Evansford region all his life. Parents Noel and Enid have owned the property for 54 years. All were initially supportive of the development, as they thought it would be good for the community.

Dr Wayne Spring
Specialist Sleep Physician in Ballarat. Dr Spring has seen patients from both Waubra and Evansford (Acciona's Waubra Wind Development) and the Leonard's Hill and Daylesford region (Hepburn Community Wind Farm).

LIST OF CONCERNED PROFESSIONALS

Since 2003, Health Professionals, Scientists and Noise Experts from around the world have recorded a common set of symptoms and health problems among people living near industrial-scale wind turbines.

Concerned professionals include:

Dr Amanda Harry, 2003

Dr David Iser, 2004

Dr Nina Pierpont, 2009

Professor Robert McMurtry, 2010

Associate Professor Jeffrey Aramini

Professor Arline Bronzaft

Dr Chris Hanning

Professor John Harris

Mr Rick James

Dr Sarah Laurie

Dr Michael Nissenbaum

Professor Carl Phillips

Mr Rob Rand

Professor Alec Salt

Dr Daniel Shepherd

Dr Malcolm Swinbanks

Dr Bob Thorne

FOR MORE INFORMATION, PLEASE VISIT

Waubra Foundation website
www.waubrafoundation.com.au

The Society for Wind Vigilance
www.windvigilance.com
Proceedings and papers presented at the First International symposium held in Ontario, Canada in October 2011 are available here together with other useful information.

Wind Turbine Syndrome website
www.windturbinesyndrome.com
Papers and details of journal articles are available from this website using the search function.

National Wind Watch website
www.wind-watch.org
The Documents section on this website contains many relevant documents and papers from various journals and conferences.

Submissions to the Federal Senate Inquiry
http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/submissions.htm
Further information from affected residents, concerned professionals and independent acousticians who sent submissions into the Australian Federal Senate Rural Wind Farm inquiry can be viewed here.

Some submissions of interest that include information about adverse health effects include:

Submissions from Medical Practitioners, other health practitioners and Scientists

13 Dr Nina Pierpont (US Paediatrician)

41 Professor Arline Bronzaft (US Psychologist and expert on the effect of noise on Children & Learning)

54 Dr Helen Parker (US Psychologist)

390 Dr Sarah Laurie, Medical Director, Waubra Foundation

888 Dr Alan Watts (GP from Carcoar)

955 Dr Chris Hanning (UK retired Sleep Physician)

Additional Materials No 4 Dr Herb Coussos, Wisconsin (submitted by Lynda Barry)

Additional Materials No 4 Dr Michael Nissenbaum (submitted by Lynda Barry)

Additional Materials No 7 Professor Alec Salt (submitted by Dr Nina Pierpont)

Additional Materials No 15 Dr Hazel Lynn (Grey Bruce Health Unit, Ontario)

Additional Materials No 16 Professor Robert McMurtry (former Dean Medical School Western Ontario)

Additional Materials No 33 Dr Sarah Laurie – from European Heart Journal paper by Professor Carpuccio, Warwick University

Additional Materials submitted by Carmen Krogh, retired Pharmacist, on behalf of Society for Wind Vigilance (Nos 8,9,10,11,12,13)

Submissions from Acousticians

112 Dr Bob Thorne

540 Dr Daniel Shepherd

785 Mr Les Huson

Submissions from some of the Affected Residents

72 Pam Di Lorenzo

97 Elizabeth Banks, Wonthaggi

99 Yvonne McCrae

129 Carl Stepnall, Waubra

130 Samantha Stepnall, Waubra

170 Gail Dawes, Waubra

171 Rosa Dawes, Waubra

321 Stephen Coleman, Waubra

355 Glen Brew, Waubra

367 Robyn Brew, Waubra

370 Steven Gallina, Waubra

442 Dooley family, Crookwell

463 Helga Hung, Germany

478 Marion Parsonage, Waubra

479 Martin Wynne, Waubra

480 Andrew Reid, Waubra

491 David Edmonston, Waubra

492 Gordon Mitchell

520 Sarah Benson, traveller in Greece

588 Peter Dawes, Waubra

622 Rod & Ruth Corrigan, Capital

664 Noel Thomas, Waubra

665 Enid Thomas, Waubra

666 Maggie Reid, Waubra

667 Donald Thomas, Waubra

673 Peter Nash, Waubra

677 Berni Janssen, Waubra

714 Sonia Trist, Cape Bridgewater

951 Wanda Allott, Waterloo