association to protect
AMHERST ISLAND

REVIEW OF THE HEALTH CANADA WIND TURBINE NOISE AND HEALTH STUDY

Denise Wolfe / November 2014

FOREWORD

This review of the information provided by Health Canada (HC) pertaining to the HC *Wind Turbine Noise and Health Study* is intended to serve as a starting point for further discussion. Any thorough review of the information provided by Health Canada with regard to the preliminary results published on the HC *Wind Turbine Noise and Health Study* requires the careful consideration of a number of reports / articles / pamphlets. Specifically, the following found on the HC website Wind Turbine Noise page:

- *Summary of Results*
- *A Primer on Noise*
- *Frequently Asked Questions*
- *Results Pamphlet*
- *Additional Information*
- *Health Impacts and Exposure to Sound from Wind Turbines: Updated Research and Design and Sound Exposure Assessment*
- *Notice to Stakeholders – HC Wind Turbine Noise and Health Study*

In addition, the following article, referred to in the *Summary of Results*, can be found in the trade news publication *Noise News International*. Please note this is a trade publication, not a peer-reviewed academic journal.

> *Self-reported and Objectively Measured Health Indicators among a Sample of Canadians Living Within the Vicinity of Industrial Wind Turbines: Social Survey and Sound Level Modelling Methodology*

For ease of review, sections copied from the various HC reports/articles listed above will be presented in the following discussion in blue typeface and indented from the left hand margin.

EXECUTIVE SUMMARY

David Oliver's article in the *British Medical Journal (BMJ)* states, "We need evidenced-based policy rather than policy-based evidence."[1] The following statement is from the first paragraph of the HC *Updated Research and Sound Exposure Assessment*, "The continued success and viability of wind turbine energy in Canada, and around the world, will rely upon a thorough

[1] *BMJ* 2014; 349 doi: http://dx.doi.org/10.1136/bmj.g5538 (Published 23 September 2014)

understanding of the potential health impacts and community concerns." It is absolutely astonishing that Health Canada should express concern over the "continued success and viability of wind energy" in the context of a study supposedly designed to objectively measure the potential negative health impacts that could result from exposure to wind turbine noise.

The information provided in this review is the foundation for the opinion that the *Wind Turbine Noise and Health Study* information so far released by Health Canada cannot be used as the basis for the claims that are being made by Health Canada that there is no association between wind turbines and specific adverse health effects[2].

The HC *Pamphlet* includes the following question "*How will the information be used*?" (Emphasis is mine):

> Health Canada will consider the results of this study, along with other scientific research available, when providing advice on the health impacts of wind turbine noise.
>
> These findings will also support decision-makers, such as provincial and territorial governments, in the development of decisions, advice and policies related to wind power development proposals, installations and operations.
>
> **These results are considered preliminary until published in the peer-reviewed scientific literature.**

It is beyond concerning that "Health Canada will consider the results of this study …. when providing advice on the health impacts of wind turbine noise" although the results are considered preliminary. Additionally the following critical review of this study identifies that the preliminary results are unreliable based on serious weaknesses/flaws in study design, data collection procedures, adherence to the initial protocol, incomplete and/or overreaching statistical analysis and flawed interpretation of the preliminary results. Further, while the preliminary results have been released, important analysis and interpretation are still pending.

Based on everything that has been reviewed to date regarding the survey, reliable conclusions cannot be drawn and it is imperative that a larger, more robust and scientifically rigorous trial be performed. This is underlined by the fact that the results of this cross section survey appear

[2] The *Summary of Results* states that while some individuals reported some of the health conditions below, the prevalence was not found to change in relation to WTN levels and that the following were not found to be associated with WTN exposure:

- self-reported sleep (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);
- self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and
- self-reported perceived stress and quality of life.

to disagree with a similar trial completed by researchers at the University of Waterloo in Canada.

A future study may require the use of Big Data[3] from large healthcare databases using a more rigorous study design with a much larger sample, such as a case control or a nested case control study that takes into account the time factor and evaluates for a broader range of health care outcomes.

Additionally, the absence of children in the HC cross-sectional survey was extremely problematic; vulnerable groups need to be included in any future studies.

This review has been broken down into two sections: the first section details issues with study design and implementation; the second section addresses issues pertaining to the presentation of the HC *Wind Turbine Noise and Health Study* information on the HC website.

The following are key points of the study design issues identified, with further details provided in the body of the report.

- The epidemiological study design selected is, generally speaking, considered useful for "raising questions," not designed for "testing a hypothesis"
- The cross-sectional survey fails to meet its stated sample size and target statistical power calculations, resulting in a failed study in statistical terms
- The self-reported questionnaires and health outcomes results do not provide data as to the date of data collection and most importantly, season of administration
- Wind Turbine Noise (WTN) statistical modeling ceased when "predicted" noise levels were achieved
- 27% of the sample population did not provide any data to be included in the study analysis.
- No information was provided on how researchers deal with Responder Bias
- "Distance to turbine" calculation was completed exclusively for "annoyance"

[3] Big Data: Extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations. Users of such data include academic institutions, governments and health care companies. These data are often tied into large health insurer's databases that provide millions of years of patient health care information and are made available to researchers on a fee for service basis while maintaining individual patient anonymity. Health care information such as prescription use, hospital admissions, procedures and diagnosis could be collected in a data set. A separate data set of individuals living close to industrial wind turbines could then be analyzed in association with the health care data set. A control of individuals living nowhere near industrial wind turbines could be utilized for comparison. A case controlled study enjoys greater control over procedural biases, making the results far more reliable with respect to tests of association.

- The sound modeling does not include all necessary parameters for accurate modeling, thereby providing inaccurate results
- The calculated outdoor A-weighted WTN levels are the results of modeled average WTN
- No children were included in the sample population
- No breakdown is provided as to the height, sound power levels, operational times, etc. of the wind turbines included in the HC cross-sectional survey
- The HC Study does not treat "annoyance" as an adverse health outcome yet the World Health Organization (WHO) classifies "annoyance" as an adverse health effect; The study does not provide a definition for "highly annoyed"
- The summary of results was released without any analysis or presentation of key infrasound data, arguably the most important factor in impacting health outcomes
- Data was collected from meteorological towers up to 50 km away from the nearest turbine(s)
- The "other" government funded research study reveals statistically significant associations between industrial wind turbines (IWT) and undesirable health outcomes

Following are the key points related to the HC "presentation of information" issues identified in this review, with further details being provided in the body of the report:

- The claim that the much-referred-to publication by investigator David Michaud appeared in a peer-reviewed scientific journal is false
- Descriptions of findings are misleading, suggesting certainty of Health Canada's claims
- The Summary of Results was released without access to Raw data which should be a matter of public record
- The *Summary of Results* was released prior to apparent scientific review of their results, and is not accompanied by a peer-reviewed paper or presentation
- The information provided is inconsistent between HC publications

A – ISSUES WITH THE STUDY DESIGN:

1.0 EPIDEMIOLOGICAL STUDY DESIGN LIMITATIONS

Although described as such in the Michaud et al. article in *Noise News International* publication, *Self-reported and Objectively Measured Health Indicators among a Sample of Canadians Living Within the Vicinity of Industrial Wind Turbines: Social Survey and Sound Level Modelling Methodology*[4], the Health Canada *Summary of Results* does not state that the study is an epidemiological cross-sectional survey. Following is from the book, *Epidemiology in Medicine* (C. Hennekens, M.D., Dr.P.H. and Julie Buring, ScD, 1987).

> *For factors that remain unaltered over time, such as sex, race, or blood group, the cross-sectional survey can provide evidence of a valid statistical association. Such instances are rare, however, and for the vast majority of associations evaluated, the temporal relationship between exposure and disease cannot be clearly determined. Thus, cross-sectional studies are, in general, useful for raising the questions of the presence of an association rather than for testing a hypothesis.*[5.]

Several published methods for ranking study designs with respect to their individual "weight of evidence" have been developed; one of the most widely accepted is listed below.[6] While systematic reviews and meta-analyses are usually assessed using the GRADE system, which is arguably the gold standard of assessing a body of evidence, taken alone as an individual study, a cross-sectional survey ranks as the least reliable method of study, marginally above individual case reports and expert opinion. The following is the hierarchical list in descending order of study type reliability:

1. Systematic reviews and meta-analyses
2. Randomized controlled trials (RCT) with definitive results (confidence intervals that do not overlap the threshold clinically significant effect)
3. Randomized controlled trials with non-definitive results (a point estimate that suggests a clinically significant effect but with confidence intervals overlapping the threshold for this effect)
4. Cohort studies
5. Case-control studies
6. **Cross-sectional surveys**
7. Case reports (individual patient evaluations)

[4] http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/scientific-journal-publications-scientifique-eng.php
[5] Epidemiology in Medicine (C. Hennekens, M.D., Dr.P.H. and Julie Buring, ScD. (1987 / Page 21)
[6] Guyatt GH, Sackett DL, Sinclair JC, Hayward R, Cook DJ, Cook RJ. Users' guides to the medical literature. IX. A method for grading health care recommendations. JAMA 1995; 274:1800-4.

A poorly implemented cross-sectional survey cannot support the grandiose claims made in the HC *Results Pamphlet*:

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

Furthermore, one would expect a "landmark study" providing "significant contributions to the global knowledge base" to be published in at least one peer-reviewed academic journal. At an absolute minimum, one would expect to find a long list of prestigious academic journals to which a paper (or papers) had been submitted for peer review. The lack of either published or submitted papers speaks volumes to the claim of "innovative, leading edge research."

In addition, while the epidemiological study design limitations are discussed in the *Research Outcomes and Limitations* section of the *Updated Research Design and Sound Exposure Assessment*, the *Study Results* section of the HC study is somewhat misleading on the issue of "causality." This is from the *Research Outcomes and Limitations* section[7]:

> The current cross-sectional study is an observation study at one point in time among a sample of subjects living various distances from wind turbines. The temporality of the relationship renders it difficult to establish if exposure to WTS precedes the investigated health endpoints or if the health endpoints are already present before being exposed. Therefore, this design does not permit any conclusions to be made with respect to causality. As well, the nature of this study does not allow any investigation regarding the length of time exposed to WTS in relation to any of the measured health endpoints. However, it will be possible to have a global estimate of an individual's history of exposure by matching historical operations with self-reported duration of residency.

This is from the *Preliminary Research Findings* section of the HC *Summary of Results*

> - results do not permit any conclusions about causality

As stated in the *Research Outcomes and Limitations*, in fact, it is not the *results* of the study that do not permit any conclusions about causality, it is the *study design* that does not permit any conclusions about causality. The statement above erroneously suggests that had the "results" been "different," then causality between health concerns and wind turbine noise could have been established.

Further, the statistics implemented in this study give rise to a false sense of scientific rigor being present. While the statistical tests are admirable, they are also valueless if the study planning

[7] Acronyms: WT is Wind Turbine; WTN is Wind Turbine Noise; WTS is Wind Turbine Sound

and design, the basic study assumptions, the data sampling procedures, and proposed purposes of the interim and final analyses are flawed, as they are in this study.

2.0 STUDY FAILS TO MEET STATED SAMPLE SIZE AND TARGET STATISTICAL POWER CALCULATIONS

Location on HC website: Updated Research Design and Sound Exposure Assessment (Statistical Power of Report)

The following is from the *Statistical Power* section of the *Updated Research Design and Sound Exposure Assessment* (emphasis is mine):

> As sleep disturbance is a frequent health complaint associated with WTN in observational and case studies, one of the primary research objectives in the study is to quantify the magnitude of sleep disturbance due to WTN. There are currently no population-based normative data that are derived from actimetry from communities exposed to WTS. **Therefore, statistical power in the study is based on reported sleep disturbance.** Estimated sleep disturbance in the general adult population is approximately 10% (Riemann et al., 2011; Tjepkema, 2005), with some estimates as high as 40% (National Sleep Foundation, 2005). In calculating the sample size needed for statistical power to detect a sleep disturbance in this study, the conservative estimate of 10% will be used. Based on a sample of 2000 dwellings and assuming that 20% of the sample live in close proximity to wind turbines (at 40 dBA or above) investigators will be able to detect at least a 7% difference in prevalence rates between the general population and the sample of individuals living in closest proximity to wind turbines, with a 5% false positive rate and a power of 80%.
>
> This sample size calculation incorporates the following assumptions: a) there will be an 80% occupancy rate for dwellings in rural areas and b) there will be a 70% participation rate for sleep actimetry. **A sample size of 1800 dwellings would be required, however given the possibility that not all assumptions may be met and that prevalence rates will be adjusted for other covariates in a logistic regression model (for example gender, age, receiving financial benefit, house construction type among others), the sample has been increased to 2000 dwellings**. Based on the estimated sample size of 2000 dwellings, **all other objective endpoints should be equally predicted with similar confidence**. Other studies that have used actimetry to characterize aircraft sound impacts on sleep are based on far fewer subjects (Passchier-Vermeer et al., 2002; Fidell et al., 1995; Horne et al., 1994; Ollerhead et al., 1992).

Issue: The number of participants in the case controlled survey is listed at 1,234, not the 1,800 dwellings (upped to 2,000) required per protocol to establish a statistical power of 80%. Therefore, the “reported sleep disturbance” analyses and “all other objective endpoints” in this

study are simply not reliable; in fact, the study failed to meet its own sample size and target power calculations, as stated in the *Updated Research Design and Sound Exposure Assessment*. Assuming work done for the study followed the study design identified in the *Updated Research Design and Sound Exposure Assessment*, the study cannot identify the key outcomes at the chosen incidence/prevalence levels. In short, the study does not have the statistical power to discern the prevalence of the key outcomes as identified in the protocol.

Therefore all statements along the lines of, "No evidence was found to support a link between exposure to wind turbine noise and (X outcome variable)" are not supported by the study and are apparently not based on the results of this study. In short, the study has insufficient sensitivity and specificity.

3.0 SELF-REPORTED QUESTIONNAIRE, OBJECTIVELY MEASURED HEALTH OUTCOMES RESULTS DO NOT PROVIDE DATA AS TO DATE (SEASON) OF ADMINISTRATION

Issue: Information should have been provided as to the time of year when the Self-reported Questionnaires were administered, and for the time of year when the data for the objectively measured health outcomes was collected. If the data was collected in the summer and early fall, when low wind conditions prevail, then the data captured would reflect the health of an individual during the time of year that they would likely experience the least negative impacts from WTN.

A table detailing the dates that the data was collected for both the self-reported health, hair cortisol and sleep measurements using the Actiwatch2™ portion of the survey is critical to the interpretation of the data and would be expected in any peer-reviewed publication.

Furthermore, this information must be included in the calculations for negative health effects and would be very important to see even in a non-peer-reviewed- (i.e., not academic) article. Last, what are the confidence limits for no association between self-reported sleep disorders, illness and quality of life and wind turbine noise?

4.0 WTN STATISTICAL MODELING VERIFICATION PROCESS CEASED WHEN "PREDICTED" NOISE LEVEL ACHIEVED
Location on HC website: Frequently Asked Questions (Why did Health Canada take noise measurements in the summer when there is very little wind?)

> It is true that wind is, on average, lower during the summer months compared to other times of the year. In order to minimize awareness bias, noise measurements in any given community only began after Statistics Canada had completed the in-home interview. This meant that noise measurements began in June 2013 and continued

> through October 2013. Some of the field measurements needed to be carried out during the summer months simply due to the timing of the collection period. Taking measures during summer months simply meant that it sometimes took longer to acquire enough data (waiting for windy periods). It is important to note that field measurements were taken only to the extent that enough data was collected to validate the calculated A-weighted values used in the study. This objective was met.

Issue: Of particular concern is the following statement.

> Taking measures during summer months simply meant that it sometimes took longer to acquire enough data (waiting for windy periods). It is important to note that field measurements were taken only to the extent that enough data was collected to validate the calculated A-weighted values used in the study. This objective was met.

This seems to suggest that "validation" consisted of noise measurement equipment being installed in *some* homes during the relatively windless summer months. The equipment then remained at the home until the model-predicted average sound level was reached and then noise measurement ceased.

If this assumption is correct, then any collection of sound data that provided results outside of the "modeled expected results" was effectively collected in error as it was collected after "enough data was collected to validate the calculated A-weighted values".

One could reasonably expect that a well-designed study's validation process would be designed to capture outliers. This would require the continued collection of sound data past the point when "enough data was collected to validate the calculated A-weighted values". One could reasonably expect that a well-designed study would then investigate the outliers. If such investigation is outside the scope of the study, then one would expect, at a minimum, a table providing the following information:

- Location Number
- Distance to Nearest Turbine
- Number of Turbines within 1 km of each Location
- Number of Turbines within 2 km of each Location
- Predicted dBA at Location (Sound Modeling)
- Sound Measurement at home date (specify indoor / outdoor)
- Average dBA per 24 hours
- Highest dBA recorded in 24 hrs.
- Lowest dBA recorded in 24 hrs.

In summary, the HC data underwent several layers of modeling. Each procedure introduces error and uncertainty. It is important to note that the study fails to adequately explain why raw

data at source could not be used and why the more accurate distance bins as pre-specified in the protocol were not used to both assess all outcomes and to compare/contrast against the sound data.

5.0 COMPLETE LACK OF DATA FOR 27% OF SAMPLE POPULATION
Location on HC website: Summary of Results (Study Population and Participation)

> Of the 2004 locations sampled, 1570 were found to be valid dwellings [(1)] of which a total of 1238 households with similar demographics [(2)] participated, resulting in an overall participation rate of 78.9%.
>
> Foot note (1) above: 434 were not valid dwellings; upon visiting the address Statistics Canada noted that the location was either demolished for unknown reasons, under construction, vacant for unknown reasons, an unoccupied seasonal dwelling, residents were outside the eligible age range, or not a home at all.
>
> Foot note (2) above: Non-response bias may be a problem depending upon the extent to which non-participation is associated with the exposure of interest (in this case wind turbine exposure). This study did not include a non-response survey, however refusing to participate was not related to the distance between the resident and the nearest wind turbine.

Issue: 434 "not valid" dwellings is an important number, suggesting that the method of identifying "homes" is highly inaccurate and could therefore introduce error in sampling.

An explicit breakdown of the numbers of homes with refusals needs to be presented with the published data. What if those not at home, properties vacated or demolished, or people who were not there for unknown reasons, were somehow not there for reasons actually associated with disturbed health? Because of the potential for bias in this analysis, the manner in which this claim of "respondent refusal" not being associated with distance from wind turbines needs to be appropriately calculated and thereby established with rigor and openness. This needs to be carefully explained in any publication to provide clarification for the reader / reviewer.

According to information provided by HC, 98 dwellings were ineligible for participation as the residents were outside the prescribed age range of study. Subtracting the 98 from 434 leaves us with 336 homes. As the total sample size is 1,238, this means that 336 represent 27% of the total sample population.

In effect, 27% of the sample population did not provide any data to be included in the study analysis.

Migration in and out of areas of interest in epidemiological studies is not abnormal but should be accounted for if it could influence study outcome, such as in this cross-sectional survey. Ignoring it does not make the risk of the potential for missing relevant data points go away.

A table detailing the number of homes within each sound/distance "bin" identifying the reason for the home being "not valid" would be expected in any peer-reviewed publication. One would expect at a minimum, a table providing the following information:

- Sound "bin"
- Date range when homes in sound "bin" were visited
- Total number of homes in "bin"
- Total number of homes ineligible for participation as "residents outside prescribed age range of study"
- Total number of homes "demolished for unknown reasons"
- Total number of homes "under construction"
- Total number of homes "vacant seasonal dwelling"
- Total number of homes "not a home at all" (a definition is required is the "not a home" a barn, or other type of non-dwelling structure?)
- Total number of homes "vacant for unknown reasons" A definition and further breakdown is required. This could include:
    - Vacant (no evidence of ongoing residence)
    - Vacant (evidence of ongoing residence but no response to repeated visits)

Also, according to discussions with members of the Wind Concerns Ontario executive during a stakeholder briefing (November 7, Ottawa) , when a Health Canada representative was asked why they did not follow up on the former occupants of the "abandoned" homes, the response was that that action would remove the random nature of the subject selection.

This is not a valid argument. The residents at those addresses had already been randomly selected. It does not negatively impact the survey if they are interviewed in their "old" home or their "new" home. In fact, since we know that people are forced to leave their homes, have their homes purchased by the wind companies and destroyed or left vacant, seeking these individual home-owners out in their new residences may be a critical component to the study.

As well, the *Bias and Non Participation* section of the *Updated Research Design and Sound Exposure Assessment* states:

> … challenges associated with non-response may exist for a variety of reasons. Subjects may have abandoned their dwelling or they may be participating receptors under pressures that preclude them from participating. Health Canada has no way of knowing in advance the extent to which non-response may impact this study, but refusal

> conversion strategies will be employed by the interviewers and attempts will be made to acquire limited self-reported results from non-responders.

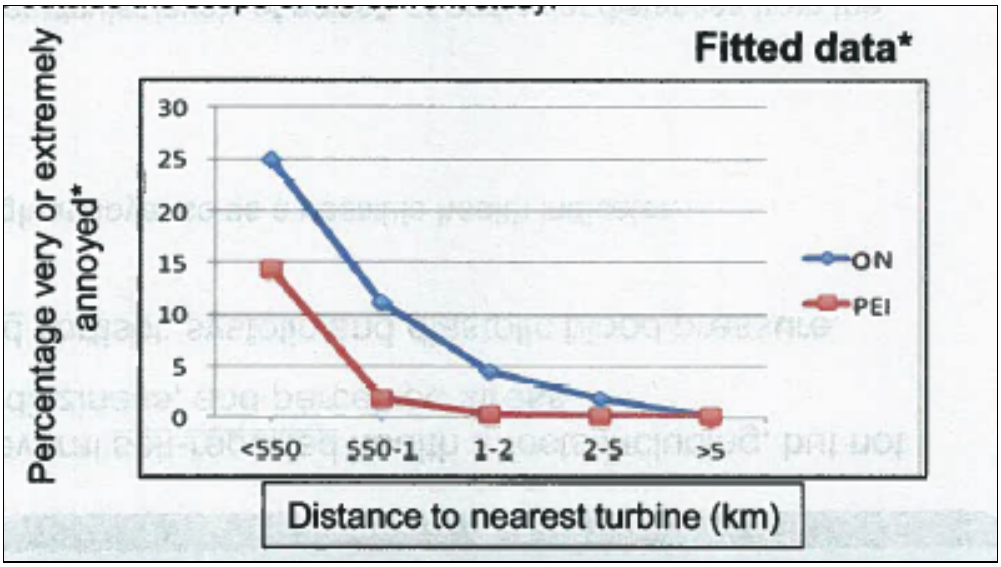
It would seem that contrary to study design / planned procedures, no attempts were made to "acquire limited self-reported results from non-responders" who had potentially vacated their homes due to wind turbine related health issues, clearly a key sub-group.

6.0 LACK OF CONSISTENCY BETWEEN SUMMARY OF RESULTS AND HC "PRESENTATION" AND HC INTERPRETATION OF "SCOPE OF CURRENT STUDY"
Location on HC website: Summary of Results (Community Annoyance Findings)

> Statistically significant exposure-response relationships were found between increasing WTN levels and the prevalence of reporting high annoyance. These associations were found with annoyance due to noise, vibrations, blinking lights, shadow and visual impacts from wind turbines. In all cases, annoyance increased with increasing exposure to WTN levels.
>
> The following additional findings in relation to WTN annoyance were obtained:

1. At the highest WTN levels (≥ 40 dBA in both provinces), the following percentages of respondents were highly annoyed by wind turbine noise: ON-16.5%; PEI-6.3%. While overall a similar pattern of response was observed, the prevalence of WTN annoyance was 3.29 times higher in ON versus PEI (95% confidence interval, 1.47 - 8.68).
2. A statistically significant increase in annoyance was found when WTN levels exceeded 35 dBA.
3. Reported WTN annoyance was statistically higher in the summer, outdoors and during evening and night time.
4. Community annoyance was observed to drop at distances between 1-2km in ON, compared to PEI where almost all of the participants who were highly annoyed by WTN lived within 550m of a wind turbine. Investigating the reasons for provincial differences is outside the scope of the current study.

Issue: HC presented a slide deck during the 7 November 2014 Wind Concerns Ontario stakeholder briefing. Slide 11 (below) includes a table that clearly depicts 25% of Ontario respondents and 15% of PIE respondents were "very or extremely annoyed" at a distance of less than 550 meters from the nearest turbine. The first point above, from the HC *Summary of Results* provides 16.5% and 6.3% as the percentages of respondents who were highly annoyed by wind turbine noise. The lack of consistency between HC publications on such an important point is very concerning and raises serious questions as to quality control and the potential for other data inconsistencies and errors.



Further, the Research Objectives and Methodology section of the HC Summary of Results states:

> The objectives of the study were to:
>
> - Investigate the prevalence of health effects or health indicators among a sample of Canadians exposed to WTN using both self-reported and objectively measured health outcomes;
> - Apply statistical modeling in order to derive exposure response relationships between WTN levels and self-reported and objectively measured health outcomes; and,
> - Investigate the contribution of LFN and infrasound from wind turbines as a potential contributing factor towards adverse community reaction.

However, point 4 above states (emphasis is mine): "Community annoyance was observed to drop at distances between 1-2km in ON, compared to PEI where almost all of the participants who were highly annoyed by WTN lived within 550m of a wind turbine. **Investigating the reasons for provincial differences is outside the scope of the current study**."

Considering the fact that the three objectives of the study included to "derive exposure response relationships between WTN levels and heath outcomes" and "investigate the contribution of LFN and infrasound from WT as a potential contributing factor" the idea that investigating the reasons for provincial differences is "outside the scope of the current study" is mind-boggling and calls to question what the researchers felt was "within" the scope of the current study.

During the briefing session held with Wind Concerns Ontario, Health Canada staff noted that many of the turbines studied in the PEI study area were less than 1-megawatt capacity, while some were 3-megawatt. This information pertaining to various turbine capacities, and

potential for more noise and infrasound, is critically important and could explain the difference between the Ontario and PIE results.

The investigation of a correlation between turbine size and annoyance would require the use of a rather simple statistical process. The HC *Summary of Results* states:

> Statistically significant exposure-response relationships were found between increasing WTN levels and the prevalence of reporting high annoyance. These associations were found with annoyance due to noise, vibrations, blinking lights, shadow and visual impacts from wind turbines. In all cases, annoyance increased with increasing exposure to WTN levels.

How could associations between annoyance and noise, vibration, blinking lights and shadow be identified without taking into account the size (i.e. megawatt capacity) of the turbines included in the calculations?

A table detailing the number of homes within each sound/distance "bin" identifying the "annoyance level" and the size of the turbines producing the sound would be expected in any peer-reviewed publication. An investigation of the reasons for the "differences" between the Ontario and PEI results could then included in a broader investigation as to why individuals living up to 1 or two km away from wind turbines expressed annoyance. This lack of information is highly concerning.

7.0 WIND TURBINES—NO BREAKDOWN PROVIDED (HEIGHT / SOUND POWER LEVEL, ETC.)

Location on HC website: Summary of Results (Study Population and Participation)

> The study locations were drawn from areas in ON and PEI where there were a sufficient number of homes within the vicinity of wind turbine installations. Twelve (12) and six wind turbine developments were sampled in ON and PEI, representing 315 and 84 wind turbines respectively.

Issue: There is no indication of a breakdown of the types/height/sound power levels of turbines included in the calculation. There is no indication of the length of time the turbines were operational prior to "participation/selection" in the study. It is not known if any turbines were not selected and if so for what reasons. A table detailing this information would be expected in any peer-reviewed publication. Furthermore, this information must be included in the calculations for all health outcomes.

8.0 ANNOYANCE CONUNDRUM

Location on HC website: Summary of Results (Community Annoyance Findings / Annoyance and Health)

- A statistically significant increase in annoyance was found when wind turbine noise levels exceeded 35 dBA.
- Wind turbine noise annoyance was found to be statistically related to several self-reported health effects including, but not limited to, blood pressure, migraines, tinnitus, dizziness, scores on the PSQI, and perceived stress. (PSQI is the Pittsburgh Sleep Quality Index).
- Wind turbine noise annoyance was found to be statistically related to measured hair cortisol, systolic and diastolic blood pressure.
- The above associations for self-reported and measured health end-points were not dependent upon the particular levels of noise, or particular distances from the turbines, and were also observed in many cases for road traffic noise.

Issue: The *Community Annoyance Findings and Annoyance and Health* section of the *Summary of Results* present a real conundrum. Statistically significant annoyance increases with turbine noise above 35 dBA and adverse health effects increases are statistically related to annoyance. We can therefore conclude that increased adverse health effects are related to turbine noise above 35 dBA. However, the HC results do not reflect this important finding. The authors inexplicably make no effort to address this key issue that clearly indicates an issue with one or all of the following: study design, data collection, sound modeling, data interpretation, responder bias and reporter bias.

Given that this is largely a public health study, funded by public monies, the cavalier attitude taken by the authors of the *Summary of Results* with respect to annoyance is extremely disconcerting. The attitude is clearly dismissive, and instead of opening a thoughtful consideration as to what these data mean, these significant findings seem to be considered essentially "malingering."

It is important to try to determine if the level of annoyance is associated with the level of increased cortisol observed across individual subjects. We have not seen this very important data that would be expected in any peer-reviewed publication. One would expect at a minimum, a table providing the following information:

- Subject Identifier
- Distance to Nearest Turbine
- Predicted dBA at Subject Location (Sound Modeling)
- Date of hair collection for cortisol analysis
- Average dBA for 3 months previous to collection of hair for cortisol analysis

- Highest dBA for 3 months previous to collection of hair for cortisol analysis
- Lowest dBA for 3 months previous to collection of hair for cortisol analysis
- Level of annoyance reported by subject
- Date of subject reporting their level of annoyance

Further, following is from the testimony of Dr. Michaud at the Environmental Review Tribunal ERT Case Numbers 13-084/13-085/13-086/13-087/13-088/13-089. The court proceedings can be found at the following link http://ontario-wind-resistance.org/2014/05/12/david-michaud-health-canada-study-testimony-falconer-llp/. (Emphasis is mine)

> Q. I believe you mentioned one of the things the study would be looking at is annoyance; is that correct?
>
> A (Dr. Michaud). Yes. It is community high annoyance.
>
> Q. Can you explain for us what community high annoyance is?
>
> A (Dr. Michaud). The full answer to this would take a long time to complete, so I will try to be as concise but as accurate as I can. Community annoyance, for one, is assessed through social surveys. It is something that you ask people about. There is an international standard on the specific question that you ask to a respondent in these surveys. That question has two scales of response. It has a 5-point adjectival scale ranging from not at all annoyed to extremely annoyed and it has an 11-point numerical scale ranging from 0 to 10.
>
> When we talk about high annoyance we are talking about the top 27 percent of the numerical scale or the top two categories on the adjectival scale collapsed. High annoyance is very and extremely collapsed together. That is one thing. The second thing is that the question itself requires that the respondent think about the last year or so while they are at their home when they are responding about annoyance towards any given source.
>
> The question is thinking about the last year or so while you are here, meaning at home, how bothered, disturbed or annoyed are you with, and then the source is named. In this case we could say wind turbine noise. And then they respond on those two scales. That is what community annoyance is. It is a response to that.
>
> It not a short-term annoyance that you might get while driving to work on a busy day. It is a reflection of their perception of their annoyance over an entire year and it is the high level, very and extremely.

Q. Does Health Canada recognize this high community annoyance as a link with any possible health effects?

A (Dr. Michaud). When we use community -- I should also add to that when we speak about community annoyance we use a certain change in the calculated percent of a community being highly annoyed. This gets back to the environmental assessment work that I was referring to earlier.

Part of our role is to provide advice to responsible authorities on whether or not noise mitigation is something they should consider. And so we use a 6.5 percent increase in that community annoyance in providing our advice. In the environmental assessment work we do, we do not administer social surveys.

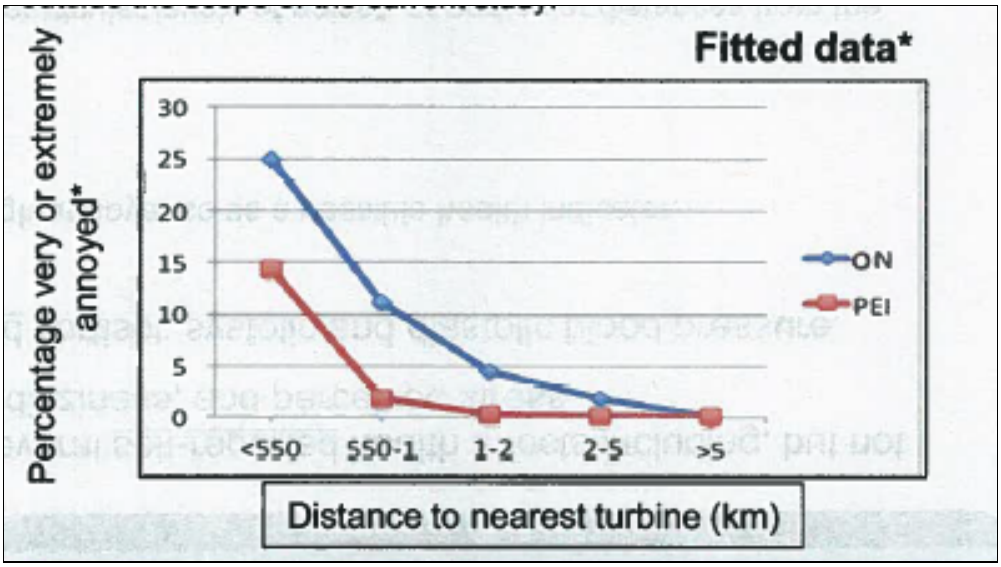
There is about six decades of work already done in the community annoyance area on various sources that has come to the point where there is an international standard that includes a function, a formula, for estimating community annoyance given baseline sound levels and project-related changes in sound levels.

So you have a certain baseline percent highly annoyed. It changes by a certain percent. When that percent goes beyond six and a half, the department would suggest noise-mitigation strategies be considered by a project's responsible authority. That is the gist of it.

Looking again at the graph on slide 11, individuals living greater than 5 km away from the nearest wind turbine do not record that they are “very or extremely annoyed” with wind turbines. However individuals living between 550 meters and 1 km to the nearest turbine begin to record being “very or extremely annoyed”. The percentage of individuals living less than 550 meters to the nearest turbine who record being “very or extremely annoyed” ranges from 15% to 25%.

If one considers the baseline to be 0, as 0 percentage of people living over 5 km from the nearest turbine record being “very or extremely annoyed”, and we consider 25% of individuals “very or extremely annoyed” to be the upper end of the “change”, clearly the “change” is greater than the six and half percent mentioned by Dr. Michaud in his testimony. Per Dr. Michaud, a change above six and half percent would require that “the department suggest noise-mitigation strategies be considered by a project’s responsible authority”.

Has Health Canada suggested to the “project’s responsible authority” that “noise-mitigation strategies be considered” for those projects above the 6.5%, as this is considered “part of their role”? If not, when will HC be fulfilling this part of their mandate? Further, why was this very important information not included in the Summary of Results?



9.0 NO INFORMATION ON PROCESS SELECTED TO DEAL WITH RESPONSER BIAS
Location on HC website: Updated Research Design and Sound Exposure Assessment (Bias and Non-Participation)

> As mentioned previously, there may also be factors that motivate people to under report (e.g. fear of reducing property values). For these reasons, it is Health Canada's view that the questionnaire should also endeavor to collect information that allows Health Canada to determine the extent to which bias may influence the results.

Below is from the *Community Annoyance Findings* section of the *Summary of Results* and is a clear example of Responder Bias.

> Annoyance was significantly lower among the 110 participants who received personal benefit, which could include rent, payments or other indirect benefits of having wind turbines in the area e.g., community improvements. However, there were other factors that were found to be more strongly associated with annoyance, such as the visual appearance, concern for physical safety due to the presence of wind turbines and reporting to be sensitive to noise in general.

The survey fails to describe how such responder bias was controlled for. According to the *Updated Research Design and Sound Assessments*, information attempting to identify bias was collected. How was this information applied to the statistical modeling? This information is critical to the interpretation of the data and would be expected in any peer-reviewed publication.

Furthermore, this information must be included in the calculations for negative health effects and would be very important to see even in a trade publication article. This attitude may be a confounder or a predictor of health outcomes, and questions should have been asked about this factor of all respondents. The factor could then be employed in the statistical model to determine its influence. This apparently was not done, or at least wasn't presented in the preliminary data.

10.0 SOUND MODELING BASED ON INCOMPLETE PARAMETERS

Location on HC website: Updated Research Design and Sound Exposure Assessment (Wind Turbine Sound Characteristics)

> The level and characteristics of sound at the receptor is dependent on several factors including the type of wind turbine, distance from the turbine, intervening structures, the existing background sound levels, wind speed and direction, topography, and meteorological conditions.

Issue: Factors influencing sound at the receptor also include, wind-speed gradient and reflectivity of the ground. Additionally, meteorological conditions must include turbulence and vertical temperature gradient. All of these factors must be considered in order to achieve as accurate a sound prediction as possible.

There is no indication that the additional factors listed (wind-speed gradient, reflectivity of the ground, turbulence and vertical temperature gradient) were considered in the wind turbine sound modeling for the HC study. As specifics have not been provided, it is impossible to ascertain if the sound modeling process selected by the HC team does provide accurate predicted sound levels.

Clearly, accurate sound modeling requires the collection/interpretation/extrapolation of a number of variables. Accurate measurement of distance from a turbine to a home requires only an Excel spreadsheet and Google maps.

Further, the *Updated Research Design and Sound Exposure Assessment* section states, "Modeling is considered more accurate in representing average wind turbine sound levels than discrete measurements". Below is from the Wind turbines and health: Summary of a scoping review May 2013[8]

> Models can produce extreme variation under identical conditions: Tickell found that four of these models (ENM, WiTuProp, NZS 6808, CadnaA) vary by 9 dB at 1000m[9]. For this reason, and others relating to misapplication and inappropriateness of some

[8] http://www.kflapublichealth.ca/Files/Research/Wind_turbines_and_health__Summary_of_a_scoping_review__May_2013.pdf
[9] Tickell C. Wind farm noise assessment in Australia and model comparison. Canadian Acoustics. 2006;34(2):37–44.

> assumptions, concerns have been raised about the validity of some of these sound models, in particular those based on ISO 9613-2 [10], [11],[12],[13]. A common recommendation is to take a conservative approach to modeling by assuming worse case conditions[14], and taking all local variables into account[15]……. Debate continues as to the appropriateness of the various models. The Ontario "Noise Guidelines for Wind farms" require the use of ISO 9613-2, with specified parameters.[16]

The statement ""Modeling is considered more accurate in representing average wind turbine sound levels than discrete measurements" does not appear to be supported by the literature.

11.0 CALCULATED OUTDOOR A-WEIGHTED WTN LEVELS ARE THE RESULTS OF MODELED AVERAGE WTN
Location on HC website: Summary of Results (Research Objectives and Methodology)

> To support the assessment and reporting of data, and permit comparisons to other studies, residences were grouped into different categories of calculated outdoor A-weighted WTN levels as follows: less than 25 dB; 25-<30dB; 30-<35dB; 35-<40dB; and greater than or equal to 40 dB (footnote below)
>
> Footnote: Categories are mutually exclusive. Only six out of 1,238 dwellings in the study were above 45dBA; an inadequate sample size to create an additional category.

Issue: It is known that calculated turbine noise is a poor predictor of measured turbine noise. As mentioned above, there are many variables that influence the actual turbine noise, some of which do not seem to have been incorporated into the HC modeling process. For example, the information provided by HC makes no reference to wind-speed gradient, turbulence, up-wind or downwind of the wind turbine or temperature gradient, all very important parameters in the sound modeling process.

---

[10] Thorne B. The Problems With "Noise Numbers" for Wind Farm Noise Assessment. Bulletin of Science Technology & Society. 2011 Aug 1;31(4):262–90.
[11] van den Berg GP. The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise [Dissertation]. [Rotterdam (NL)]: Rijksuniversiteit Groningen; 2006.
[12] Bastasch M, van Dam J, Søndergaard B, Rogers A. Wind turbine noise: an overview. Canadian Acoustics. 2006;34(2):
[13] Harrison JP. Wind Turbine Noise. Bulletin of Science Technology & Society. 2011 Aug 1;31(4):256–61.
[14] Keith S, Michaud D, Bly S. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Low Frequency Noise, Vibration and Active Control. 2008 Dec 1;27(4):253–65.
[15] Thorne B. The Problems With "Noise Numbers" for Wind Farm Noise Assessment. Bulletin of Science Technology & Society. 2011 Aug 1;31(4):262–90.
[16] Ministry of the Environment (ON). Noise guidelines for wind farms: interpretation for applying MOE NPC publications to wind power generation facilities. Toronto: Queen's Printer for Ontario; 2008 Oct. Report No.: PIBS 4709e.

Further, the *Wind Turbine Sound Modeling* section of the HC *Updated Research Design and Sound Exposure Assessment* provides the following information:

> Outdoor sound pressure levels will be predicted at receptors using Datakustic CadnaA and EMD International AS WindPro software. The latter software package will also be used to evaluate shadow flicker at the receptors. Sound modeling will include implementations of ISO 9613, Harmonoise, and Nord2000. For simplicity and comparison with other studies, outdoor sound pressure level predictions will also be made using a Swedish national method (Ljud från vindkraftverk, 2001), (Ljud från vindkraftverk, 2010).

There is no indication in any of the HC published documents that provides information as to whether the final numbers provided by HC represent hourly, daily, weekly, monthly or annual averages. In other words, are the sound "bins" of less than 25 dB; 25-<30dB; 30-<35dB; 35-<40dB; and greater than or equal to 40 dB representative of hourly, daily, weekly, monthly or annual averages? The "average" selected would clearly have a great impact on the data interpretation.

Section 7.2 *Prediction of long term noise levels* of the *Validation of the Nord2000 propagation model for use on wind turbine noise* report states (emphasis is mine)

> A major benefit of the Nord2000 model is that it is possible to predict long term noise levels like **annual average** of L_{Aeq} and L_{den}, statistical distributions of the noise and maximum and minimum levels.[17]

A paper presented at the Inter-noise 2004 International Congress entitled *Harmonoise: simplification of comprehensive source and propagation models into an accurate and practicable engineering method* states (emphasis is mine)

> Computations of Long Term Average Noise Indicators
> For the calculation of the **yearly average** noise indicators Lden and Lnight, the engineering method must take the dynamic characteristics of both noise emission and noise propagation into account.[18]

[17] Noise and energy optimization of wind farms Validiation of the Nord2000 propagation model for use on wind turbine noise Final Report: http://share.madebydelta.com/wp-content/publications/akustik/paper_og_rapport/Noise_and_energy_optimization_of_wind_farms.pdf

[18] R. Nota et al. Inter-noise 2004; Harmonoise: simplification of comprehensive sources and propagation models into an accurate and practicable engineering method.

As HC states that "Sound modeling will include implementations of ISO 9613, Harmonoise, and Nord2000" and both the Harmonoise and Nord2000 methods include the possibility of the analysis of yearly average noise, it is essential that HC provide details as to the "average" selected for data analysis.

In addition, the calculated outdoor A-weighted WTN levels reported in the HC survey are the result of a modeled average WTN. The *Wind Turbine Sound Characterization* section of the *Updated Research Design and Sound Exposure Assessment* states (emphasis is mine):

> Due to the large number of subjects, sound exposures will be based on predictions. A sub-sample of measurements will be taken at each selected site to validate predictions. This approach is considered preferable due to the technical limitations of measurement. **Modeling is considered more accurate in representing average wind turbine sound levels than discrete measurements**, which are sensitive to fluctuating variables and do not discern between sources of sound.

It is important to remember that an average WTN level of 46 dBA could have outliers of 60 dBA in the winter months and 0 dBA in the summer. These would be the "fluctuating variables" mentioned in the paragraph above. The upper level of the scale would be of most concern and so should be identified for each home.

Additionally, it seems unlikely that the six dwellings, noted in the footnote above, with an *average* WTN calculated above 45 dBA WTN are compliant with Ontario Guidelines listed below. Of equal concern is the fact that the number of homes that fall within 41 to 45 dBA are not identified. It is likely that these homes would also fall outside of the Ontario guidelines.

Below is from Ontario's *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*. Please note, these are "sound level limits," not averages.

> Receptors in Class 3 Areas (Rural)
>
> The sound level limits at a Point of Reception in Class 3 Areas (Rural) are given by the applicable values in Table 1, or by the sound level limits, established in accordance with requirements in Publication NPC-232. The wind turbine sound level limits are given at integer values of the wind speed. These sound level limits range from the lowest value of 40 dBA for Class 3 Areas and wind speeds at or below 4 m/s to the maximum value of 51 dBA for wind speeds at or above 10 m/s.

Table 1 Summary of Sound Level Limits for Wind Turbines

Wind Speed (m/s) at 10 m height	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 3 Area, dBA	40.0	40.0	40.0	43.0	45.0	49.0	51.0
Wind Turbine Sound Level Limits Class 1 & 2 Areas, dBA	45.0	45.0	45.0	45.0	45.0	49.0	51.0

12.0 NO CHILDREN INCLUDED IN THE SAMPLE POPULATION

Location on HC website: Summary of Results (Study Population and Participation)

> From these, one person between the ages of 18 and 79 years from each household was randomly selected to participate.

From the *FACT* section of the website: *Why are no children included in the study*?

> A primary objective of the study was to assess the potential impacts that WTN had on measured sleep. Sleep patterns among children are very different from those of adults, making it difficult to identify potential impacts that might be due to WTN exposure. Furthermore, the questionnaire in the study included questions that would not be suitable for a minor to respond to.

Issue: Children, especially very young children/infants/babies are considered a most important and vulnerable population, and Health Canada makes that very clear when they review and approve new drugs for sale in Canada. Children are physically and mentally in varying critical stages of development that might be highly sensitive to sound exposure, including but not limited to, neurological and sensory development, major organ and hormonal development, physical and emotional growth, social development, and others.

WTN has the potential to affect children in as yet unforeseen ways. This observation gives rise to a concern about the general philosophy embedded in the study itself and therefore of its experts. One major weakness with this current HC survey that prevents it from being generalizable in any meaningful way is that it failed to start from the very beginning to ask a pertinent health-related question i.e., to investigate what the potential health risks associated with WTN might be and who is most at risk.

It is customary with an environmental exposure to assess the population broadly for initial signs and symptoms of any disease or dysfunction that in fact the individuals living in the exposed area themselves may be unaware of. By doing so, the researchers achieve a state of equipoise, assuming nothing and understanding that "health" is a broad spectrum that covers wellness in general. Instead, this survey relied on only evaluating the most commonly reported claims and then apparently set out to disprove them. As such, this weakness in study

philosophy/motivation is a critical flaw in the motivation of the researchers. And, it still it fails to explain why children were not included at the very least.

For children, even if only headaches or sleep disturbances were observed, either might easily play a role or signal a problem in CNS health, in cognition and/or in performance. And yet children have been conspicuously omitted from this survey as if they were not important to the researchers or Health Canada in making their claims of "no ill effects" in their "ground-breaking" survey. This fact is deeply concerning in regards to both Health Canada and their expert research panel. It is hardly a secret that Health Canada and ethical researchers advocate the "Precautionary Principle" which means that in the event of any even remotely concerning safety events about any group, especially a vulnerable one like children, they are to undertake rigorous caution especially in the absence of any extremely reliable data, i.e., "do no harm."

The current heavily modelled cross-sectional survey does not qualify as a source of "extremely reliable data" and it remains that children / infants / babies, pregnant women, those with CNS diseases, learning disabilities, etc., should be studied carefully before any conclusions can be made.

13.0 "DISTANCE TO TURBINE" CALCULATIONS COMPLETED EXCLUSIVELY FOR ANNOYANCE
Location on HC website: Summary of Results (Self-Reported Questionnaire Results)

> Results are presented in relation to WTN levels. For findings related to WTN annoyance, results are also provided in relation to distance to allow for comparisons with other studies.

Issue: Broadly speaking, there are three main variables identified by HC in the first paragraph of the HC *Notice to Stakeholders* "Health Canada is working with Statistics Canada …. to design a research study that will explore the relationship between wind turbine noise and the extent of health effects reported by, and objectively measured in, those living near wind power developments". The variables are:

- Wind turbine noise (WTN)
- Health
- Distance to a wind power development

One would therefore expect distance to turbine (one of the primary variables) to be included in the impact calculated for all health outcomes. The selection of subgroups based on distance from the WT is critical to the outcome of the study.

In order to provide some level of certainty with regards to interpretation of results, "results in relation to distance" should have been calculated for all self-reported questionnaire results and objectively measured health outcomes. HC chose to provide this calculation for one health parameter only, for "annoyance."

In other words, in addition to the analysis that was carried out, *all* outcomes should have been analyzed using a subgroup based on *distance from turbines* so that outcomes can be compared using real world data (distance from turbine) as well as the less reliable sound data (modeled sound).

It is interesting to note that the only value (annoyance) that included an analysis linked to distance from turbines is the only value that resulted in a statistically significant association between of the outcome and exposure variable (distance). This is not a spurious or unimportant observation, and it suggests "reporter bias" by the authors of this paper in not analyzing all health outcomes in the same manner. The absence of this distance-based analysis is highly conspicuous.

> The following was found to be statistically associated with increasing levels of WTN:
>
> - Annoyance towards several wind turbine features (i.e. noise, shadow flicker, blinking lights, vibrations, and visual impacts).

To summarize, while we know that the trialists created distance-based bins, which are relevant to the regulations regarding setbacks from wind turbines, they were not included in the calculations for health effects for all parameters. The real problem here is that distance is not at all objective, measurable and thereby a valuable tool in an already weak study design. Instead, the results are presented exclusively by categorical highly-modeled WTN noise levels for all but the annoyance health effect.

This becomes problematic because there are many worrying issues with the "modeling" that went on in this investigation. Their modeling required a number of assumptions to be made and "verification" of these assumptions relied heavily upon relatively few and brief sound samplings from pre-selected areas. In other words, these models are not raw data that actually represent each and every household's ongoing sound levels (A-weighted, low-frequency noise/LFN or infrasound/IS). These assumptions weaken the data. For this reason, a reliance on the actually measurable distance from source bins data would be stronger and most likely more reliable. This then should have been the basis upon which the study objectives were based.

14.0 HC PROVIDES NO INDICATION THAT WHO CLASSIFIES 'ANNOYANCE' AS ADVERSE HEALTH EFFECT AND NO DEFINITION PROVIDED FOR "HIGHLY ANNOYED"

Location on HC website: Summary of Results (Community Annoyance Findings)

> Statistically significant exposure-response relationships were found between increasing WTN levels and the prevalence of reporting high annoyance. These associations were

> found with annoyance due to noise, vibrations, blinking lights, shadow and visual impacts from wind turbines. In all cases, annoyance increased with increasing exposure to WTN levels.
>
> The following additional findings in relation to WTN annoyance were obtained:
>
> - At the highest WTN levels (≥ 40 dBA in both provinces), the following percentages of respondents were highly annoyed by wind turbine noise: ON-16.5%; PEI-6.3%.

Issue: This section as presented does not indicate in any fashion that the World Health Organization (WHO) classifies annoyance as an adverse health effect. Below is from the WHO publication *Burden of Disease from Environmental Noise* published in 2011.

> WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Therefore, a high level of annoyance caused by environmental noise should be considered as one of the environmental health burdens. [19]

A definition of "highly annoyed" must be provided in order to provide a frame of reference for the above point. A much referenced field study in Europe addressed this question as follows: Pedersen et al. (2009) presented the results of a 2007 field study in the Netherlands and related it to an earlier Swedish study. Their cohort was asked to report whether they: did not notice, noticed, were slightly annoyed, rather annoyed or very annoyed. The last two categories were then grouped as annoyed. On this basis, and for the combined studies, the fraction annoyed was 26 ± 5% for the range 40 to 45 dBA. How many annoyance bands did the Health Canada study use? Again, important information that has not been provided.

15.0 INSUFFICIENT DEPTH REGARDING WHO RECOMMENDATIONS

Location on HC website: Summary of Results (Wind Turbine Noise Measurement Results)

> Calculated outdoor A-weighted WTN levels for the homes participating in the study reached 46 dBA for wind speeds of 8m/s. This approach is the most appropriate to quantify the potential adverse effects of WTN. The calculated WTN levels are likely to be representative of yearly averages with an uncertainty of about +/- 5dB and therefore can be compared to World Health Organization (WHO) guidelines. The WHO identifies an outdoor night time average of 40 dBA as the level below which no health effects associated with sleep disturbance are expected to occur even among the most vulnerable people (WHO (2009) *Night Noise Guidelines for Europe*).

[19] http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf

Issue: The first sentence above is unclear. Is 46 dBA the average calculated outdoor A-weighted WTN level for all homes participating in the survey, or is this the maximum dBA calculated and only applicable to "some" homes? How does the calculated dBA relate to the "actual" numbers collected in the summer months? This information is critical.

In addition, while the WHO Guidelines do identify an annual outdoor night time average of 40 dBA as the level below which "no health effects associated with sleep disturbance are expected to occur even among the most vulnerable people" (WHO, 2009, *Night Noise Guidelines for Europe*), this statement must be considered in conjunction with the following from the Executive Summary (emphasis is mine):

> The no observed adverse effect level (NOAEL) is a concept from toxicology, and is defined as the greatest concentration which causes no detectable adverse alteration of morphology, functional capacity, growth, development or lifespan of the target organism. For the topic of night noise (where the adversity of effects is not always clear) this concept is less useful. Instead, the observed effect thresholds are provided: the level above which an effect starts to occur or shows itself to be dependent on the exposure level. It can also be a serious pathological effect, such as myocardial infarctions, or a changed physiological effect, such as increased body movement.
>
> **Threshold levels of noise exposure are important milestones in the process of evaluating the health consequences of environmental exposure.** The threshold levels also delimit the study area, which may lead to a better insight into overall consequences. In Tables 1 and 2, all effects are summarized for which sufficient and limited evidence exists. For these effects, the threshold levels are usually well known, and for some the dose-effect relations over a range of exposures could also be established

Table 1 from the Executive Summary of the WHO *Night Noise Guidelines for Europe* (2009) found below clearly indicates that the Threshold dB for biological effects begins at 32 dB and the medical condition "Environmental Insomnia" begins at the Threshold level of 42 dB. As the HC survey accepts an uncertainty level of +/- 5dB, for annual calculated WTN levels and states that "Calculated outdoor A-weighted WTN levels for the homes participating in the study reached 46 dBA for wind speeds of 8m/s" there is a clear need for further investigation.

Effect		Indicator	Threshold, dB
Biological effects	Change in cardiovascular activity	*	*
	EEG awakening	$L_{Amax,inside}$	35
	Motility, onset of motility	$L_{Amax,inside}$	32
	Changes in duration of various stages of sleep, in sleep structure and fragmentation of sleep	$L_{Amax,inside}$	35
Sleep quality	Waking up in the night and/or too early in the morning	$L_{Amax,inside}$	42
	Prolongation of the sleep inception period, difficulty getting to sleep	*	*
	Sleep fragmentation, reduced sleeping time	*	*
	Increased average motility when sleeping	$L_{night,outside}$	42
Well-being	Self-reported sleep disturbance	$L_{night,outside}$	42
	Use of somnifacient drugs and sedatives	$L_{night,outside}$	40
Medical conditions	Environmental insomnia**	$L_{night,outside}$	42

Table 1 Summary of effects and threshold levels for effects where *sufficient* evidence is available

* *Although the effect has been shown to occur or a plausible biological pathway could be constructed, indicators or threshold levels could not be determined.*

** *Note that "environmental insomnia" is the result of diagnosis by a medical professional whilst "self-reported sleep disturbance" is essentially the same, but reported in the context of a social survey. Number of questions and exact wording may differ.*

Also there is no mention of the WHO recommendation applying to wind turbine noise. There is reference in the WHO document to aircraft, road and rail traffic, industrial and construction noise, neighbours and recreation.

This is significant because wind turbine noise is considerably more annoying than noise from other sources at the same level.[20] While the European field studies found annoyance in 20 to 25% of the population for wind turbine noise at the 40 dBA level, Miedema and Vos measured annoyance in the range 2 to 4% for traffic noise at the 40 dBA level.[21] Both the European field studies and the traffic study were peer-reviewed and published in the highly regarded Journal of the Acoustical Society of America.

[20] Hanning CD and Evans A. 2012. "Wind turbine noise", British Medical Journal **344**, e1527.
[21] Miedema HM, Vos H. 1998. "Exposure response relationship for transportation noise." Journal of the Acoustical Society of America **104** 3432-3445.

The difference in annoyance between noise from wind turbines and other sources of noise is readily understood.[22] The amplitude modulation draws attention to the noise[23] in the same way that the rotating blades draw the eye. There is the thumping associated with the blades rotating in a vertical wind speed gradient and in turbulent air. There is the large low frequency component in the spectrum of the noise. In essence, the periodic thumping of the WT creates a high level of sensory surveillance.

16.0 SUMMARY OF RESULTS RELEASED WITHOUT ANALYSIS OF KEY INFRASOUND DATA
Location on HC website: Summary of Results (Wind Turbine Noise Measures Results)

> Infrasound / Long-term measurements over a period of 1 year were also conducted in relation to infrasound levels.
>
> - Infrasound from wind turbines could sometimes be measured at distances up to 10km from the wind turbines, but was in many cases below background infrasound levels.
> - The levels were found to decrease with increasing distance from the wind turbine at a rate of 3dB per doubling of distance beyond 1km, downwind from a wind turbine.
> - The levels of infrasound measured near the base of the turbine were around the threshold of audibility that has been reported for about 1% of people that have the most sensitive hearing.
>
> Due to the large volume of acoustical data, including that related to infrasound, analysis will continue over subsequent months with additional results being released at the earliest opportunity throughout 2015.

Issue: As infrasound is clearly an important component of this study, it is unclear as to why HC chose to release preliminary results without including some information regarding infrasound. Below is from *Wind Turbines can be Hazardous to Human Health,* Alec N. Salt, Ph.D., Cochlear Fluids Research Laboratory, Washington University in St. Louis. (Updated 4/2/2014)

> Large wind turbines generate very low frequency sounds and infrasound (below 20 Hz) when the wind driving them is turbulent. The amount of infrasound depends on many factors, including the turbine manufacturer, wind speed, power output, local topography, and the presence of nearby turbines (increasing when the wake from one turbine enters the blades of another). **The infrasound cannot be heard and is unrelated to the loudness of the sound that you hear.** Infrasound can only be measured with a sound level meter capable of detecting it (and not using the A-weighted scale). Video

[22] Hanning CD, Evans A. 2012. "Wind turbine noise", British Medical Journal **344**, e1527.
[23] This is why warning sirens are often amplitude-modulated.

cameras and other recording devices are not sensitive to infrasound and do not reproduce it.

You cannot hear the infrasound at the levels generated by wind turbines, but your ears certainly detect and respond to it. The picture shows the **enormous** electrical potentials that infrasounds generate in the ear. The potentials (18.7 mV pk/pk amplitude in this case) are about 4 times the amplitude of sounds in the normal frequency range that are heard. **These measurements show that the low frequency part of the ear is extremely sensitive to infrasound.**[24]

17.0 QUESTIONABLE ASSUMPTIONS REGARDING INFRASOUND

Location on HC website: Updated Research Design and Sound Exposure Assessment (Low Frequency Sound)

> It has been noted in the literature that the effects of infrasound (less than 20 Hz) on people are not well understood (National Research Council, 2007). A survey of all known published results of infrasound from wind turbines found that wind turbines of contemporary design, where rotor blades are in front of the tower, produce very low levels of infrasound (Jakobsen et al., 2005).

Issue: It is not clear how a paper published in 2005 can be considered a reference for "contemporary design." In 2011 Bray and James reported short time interval low frequency sound levels and demonstrated peak sound pressure levels above the threshold of audibility.[25] Furthermore, Moller and Pedersen have demonstrated that modern, larger wind turbines have the sound power shifted to lower frequencies.[26] This again requires a detailed assessment of outcomes analyzed by stratified levels of Infrasound.

18. INACCURATE MODELING OF INFRASOUND

Location on HC website: Updated Research Design and Sound Exposure Assessment (Wind Turbine Sound Characterization and Wind Turbine Sound Measurement)

> Characterization:
> The only cases where measurements would be recommended would be to validate predictions, or in identifying new or unusual situations that occur under proscribed conditions. Consistent with this approach, a limited number of measurements will be used to validate predictions. Also, a more detailed set of measurements will be made to validate low frequency and infrasound predictions. (See "measurement" section below)

[24] http://oto2.wustl.edu/cochlea/wind.html
[25] Bray W, James R. NOISE_CON 2011 (Portland, Oregon, July 2011)
[26] Møller H, Pedersen CS. 2011. Low frequency noise from large wind turbines. J Acoust. Soc. Am. 129, 3727-44.

> Measurement:
> Measurements will be made near the base of the turbines to verify the available sound power level data, and to extend this data down to 6.3 Hz and lower in the infrasound range. On completion of the study, this data will also be requested from the wind turbine manufacturer. Using the same instrumentation, additional measurements will be made at distances up to 10 km from the wind turbines to verify the sound propagation algorithms used.

Issue: The above proposed sound modeling measurement for infrasound does not take into account amplitude modulation, blade vibration, turbulence and wind speed gradient. This will result in inaccurate modeling, which will result in inaccurate application of statistical modeling, which will result in potentially extremely inaccurate and unreliable conclusions.

19.0 METEOROLOGICAL TOWERS UP TO 50KM AWAY FROM TURBINES

Location on HC website: Updated Research Design and Sound Exposure Assessment (Meteorology)

> As appropriate, inputs to the modeling software will include meteorological classes based on the statistics of the meteorological data. These data will be obtained from the nearest Environment Canada weather stations. The Environment Canada data includes hourly reports of temperature, humidity, wind direction, wind speed, and cloud cover. Along with the roughness length estimated from the topographic maps, this data will be used to estimate meteorological classes. This will account for wind and temperature gradients in the propagation calculations.

Issue: The Michaud paper published in the trade publication *Noise News International* states that the meteorological stations can be up to 50 km away. As each wind turbine installations has its own meteorological tower, which would doubtless provide more local / accurate information, it is unclear as to why HC chose to go with the up to "50km away" option.

20.0 THE "OTHER" GOVERNMENT FUNDED RESEARCH ASSERTS STATISTICALLY SIGNIFICANT RELATIONSHIPS BETWEEN IWT AND UNDESIRABLE HEALTH OUTCOMES

It is interesting to note that the unheralded "other" government-funded research addressing industrial wind turbine noise and sleep, does *not* support the findings of the HC *Wind Turbine Noise and Health Study*. Specifically:

- statistically significant relationships were found between Wind Turbine (WT) distance and The Pittsburgh Sleep Quality Index (PSQI)

- statistically significant relationships were found between WT distance and self-reported vertigo
- the relationship between WT distance and self-reported tinnitus approached statistical significance

The five-year Ontario Research Chair (ORC) program in Renewable Energy Technologies and Health (RETH) Program is funded with annual funding of $300,000 from the Ontario Ministry of Environment. The Program commenced at the University of Waterloo in the summer of 2010 with Professor Siva Sivoththaman, PhD, as the Chair.

The ORC program seeks to address important issues in RETs, the program covers Wind, Solar PV, Solar Thermal, Bio energy technologies, and their grid-integration aspects. The ongoing and planned research activities range from in-depth scientific studies, engineering approaches, and health studies to technology solutions, guidelines, and policy recommendations.

According to the *Summary of Activities – Year Three,*[27] "There are two arms of the sleep research component for the project. First an exploration of the impact of industrial wind turbines on sleep among rural Ontario residents was done in the frame of a master's thesis research."

Ms. Claire Paller's Master of Science in Heath Studies and Gerontology thesis entitled *Exploring the Association between Proximity to Industrial Wind Turbines and Self- Reported Health Outcomes in Ontario, Canada*[28] was defended and published in March of 2014. The paper *Wind turbine noise impacting sleep and well-being in Ontario, Canada* is presently in progress for submission to the peer-reviewed journal, *Energy Policy*. This is from the Conclusions section of the thesis:

> Statistically significant relationships were found between ln (distance) and The Pittsburgh Sleep Quality Index (PSQI) and ln (distance) and self-reported vertigo, and the relationship between ln (distance) and self-reported tinnitus approached statistical significance……. Further studies are needed that include a larger number of respondents, especially at the upper end of the dose curve (i.e. the people living closest to industrial wind turbines) before firm conclusions can be made.

A key objective of this cross-sectional survey (with a size sample of 396 individuals) was to determine any association between sleep disturbance and exposures to wind turbine noise at night using sleep diaries, and both actigraphy and the latest wireless sensing technologies for simultaneous sleep and noise measurement. The study design included the comparison of individuals living closer to turbines (group 1– under 1,000 meters and group 2 – between 1,000

[27] http://www.orc-reth.uwaterloo.ca/files/Y3_Summary%20of%20activities.pdf
[28] https://uwspace.uwaterloo.ca/handle/10012/8268

and 1,999 meters) with individuals living further away from turbines (group 3 – 2,000 to 3,999 meters and group 4 – 4,000 meters to 10 km). Further details can be found by following the link to Footnote 4.

It is interesting to note that this research has already resulted in three peer-reviewed publications ([29, 30, 31]) and 6 Posters / Presentations ([32, 33, 34, 35, 36, 37]). These peer-reviewed publications and posters / presentations have-not been the subject of a media blitz by either the Province of Ontario or by Health Canada, as was done with the current HC release.

One of the attributes of an effect that requires assessment to judge causality is *Consistency with Other Investigations* (Henekens, Buring, 1987)[38]. They state first " Since epidemiology is by its nature inexact, and it is never possible to achieve the degree of control possible in a laboratory, perhaps the most persuasive evidence to support a judgment of cause and effect relationship arises when a number of studies, conducted by different investigators at various times using alternative methodology in a variety of geographic or cultural settings and among different populations, all show similar results." They go on to say "A lack of consistency in the evidence concerning a particular hypothesis should result in a high degree of caution in any causal interpretation of the findings".

This lack of agreement between the HC study and the University of Waterloo trial is a concerning.

[29] T. Christidis, C. Paller, S. Majowicz, P. Bigelow, A. Wilson, and S. Jamal, "Creating and Testing a Survey to Assess the Impact of Renewable Energy Technologies on Quality of Life", Environmental Health Review, vol.56 (2013), pp.103-111.
[30] , T. Christidis and J. Law, "Annoyance, health effects and wind turbines: Exploring Ontario's planning processes". Canadian Journal of Urban Research 21 (Suppl.1) 81 – 105 2012.
[31] P. Bigelow, "Wind Power" in Encyclopedia of Quality of Life Research. Ed. A. Michalos, Springer (2013) (in press)
[32] C. Paller, P. Bigelow, S. Majowicz, J. Law, and T. Christidis, "Wind Turbine Noise, Sleep Quality, and Symptoms of Inner Ear Problems", Council of Ontario Universities Symposium on Sustainability (Toronto, ON), October 2013.
[33] T. Christidis, C. Paller, S. Majowicz, P. Bigelow, A. Wilson, and S. Jamal, "The Impact of Renewable Energy Technologies on Quality of Life",ibid.
[34] T. Christidis, "Wind Turbines in Ontario: Examining Annoyance and Opposition" ibid
[35] P. Bigelow, J. Lane, L. Jalali, S. Majowicz, and S. McColl, S, "Impacts of wind turbine noise on sleep: Results of a pilot study and design of a quasi-experimental investigation", International Society for Environmental Epidemiology (Seattle, WA) August 2014.
[36] M. Kamali, S. Sivoththaman, and S. McColl, "Analysis of Models for Audible and Low Frequency Noise Prediction for Wind Turbine Case Studies", Proc 15 Conference on Low Requenqyc Noise LFN 2012 (may 22 – 24, 2012 Warwickhire, UK)
[37] T. Christidis and J. Law, "Challenges to Studying the Health Effects of Wind Turbines among Different Research Designs: Proc. International Conference on Clean and Green Energy (January 2012, Hong Kong), IACSIT Press, Vol 27,pp1 - 5
[38] Hennekens CH, Buring JE, Epidemiology in Medicine, Boston: Little, Brown and Co, 1987.

Additional articles recently published in Peer-reviewed Publications that are of interest are listed in the following footnotes [39,40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54].

[39] C. D. Hanning and A. Evans (2012) "Wind turbine noise", British Medical Journal **344**, e1527.

[40] C. Krogh, L. Gillis, N. Kouwen and J. Aramini (2011) "WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines and the need for vigilance monitoring." Bull. Sci. Tech. Soc. **31** 334-339.

[41] D. Shepherd, D. McBride, D. Welch, K. N. Dirks and E. M. Hill (2011) "Evaluating the impact of wind turbine noise on health-related quality of life", Noise and Health **13**, 333-339.

[42] M. A. Nissenbaum, J. J. Armani and C. D. Hanning (2012), "Effects of industrial wind turbine noise on sleep and health", Noise and Health 14, 237-243.

[43] D. Shepherd, D. McBride, D. Welch, K. N. Dirks and E. M. Hill (2011) "Evaluating the impact of wind turbine noise on health-related quality of life", Noise and Health **13**, 333-339.

[44] Ambrose, Stephen E.; Rand, Robert W.; and Krogh, Carmen M. E. Wind Turbine Acoustic Investigation: Infrasound and Low-Frequency Noise A Case Study DOI: 10.1177/0270467612455734 Bulletin of Science Technology & Society published online 17 August 2012 http://bst.sagepub.com/content/early/2012/07/30/0270467612455734

[45] Bronzaft, Arline L. ,The Noise from Wind Turbines: Potential Adverse Impacts on Children's Well-Being Bulletin of Science Technology & Society 2011 31: 256, DOI: 10.1177/0270467611412548. http://bst.sagepub.com/content/31/4/291

[46] Enbom H and Enbom IM, Infrasound from wind turbines: An overlooked health hazard," Läkartidningen, vol. 110 (2013), pp. 1388-89.

[47] Jeffery, Roy D.; Krogh, Carmen; and Horner, Brett Industrial wind turbines and adverse health effects Can J Rural Med 2014;19(1) http://www.ncbi.nlm.nih.gov/pubmed/24398354

[48] Møller, Henrik and Pedersen, Christian Sejer Low-frequency noise from large wind turbines Section of Acoustics, Aalborg University, Denmark, Acoustical Society of America [DOI: 10.1121/1.3543957] J. Acoust. Soc. Am. 129 (6), June 2011 PACS number(s): 43.50.Rq, 43.28.Hr, 43.50.Cb, 43.50.Sr [ADP] Pages: 3727–3744

[49] Shepherd, Daniel; McBride, David; Welch; Dirks, Kim N.; and Hill Erin M. Evaluating the impact of wind turbine noise on health related quality of life Noise & Health, September-October 2011, 13:54,333-9 DOI: 10.4103/1463-1741.85502 www.noiseandhealth.org

[50] Shepherd, Daniel; Welch, David; Dirks, Kim N.; and McBride, David (March 2013) Do Quiet Areas Afford Greater Health-Related Quality of Life than Noisy Areas? International Journal of Environmental Research and Public Health, ISSN 1660-4601 http://www.mdpi.com/1660-4601/10/4/1284

[51] Seltenrich, NateWind Turbines A Different Breed of Noise? Environmental Health Perspectives, volume 122 | number 1 | January 2014

[52] Nissenbaum, Michael A.; Aramini, Jeffery J.; and Hanning, Christopher D. Effects of industrial wind turbine noise on sleep and health Noise & Health, September-October 2012, Volume 14, p243 www.noiseandhealth.org

[53] Robert Y McMurtry and Carmen ME Krogh Diagnostic criteria for adverse health effects in the environs of wind turbines DOI: 10.1177/2054270414554048 JRSM Open http://shr.sagepub.com/content/5/10/2054270414554048

[54] McMurtry, Robert Y. Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis Bulletin of Science Technology & Society 2011 31: 316, DOI: 10.1177/0270467611415075, http://bst.sagepub.com/content/31/4/316

B - ISSUES WITH OVERALL "PRESENTATION" OF THE DATA / INFORMATION ON HC WEBSITE

Below are some issues with how Health Canada presented its "findings" on the government department's public website.

1.0 ERRONEOUS CLAIMS OF PUBLICATION IN SCIENTIFIC JOURNAL

Location on HC website: Summary of Results (Research Objectives and Methodology)

> Detailed information on Health Canada's *Wind Turbine Noise and Health Study* methodology, including the 60-day public consultation and peer review process is available on the Health Canada website. The detailed methodology for the study is also available in the peer-reviewed literature (*Michaud et al., Noise News International, 21(4): 14-23, 2013*).
>
> The link to "Scientific Journal Publications" in HC Wind Turbine Noise Page takes us to the *Michaud et al., Noise News International* reference.

Issue: *Noise News International* is *not* a peer-reviewed medical journal, or a scientific journal. It is an industry news publication that does not require peer review, although it may well have editorial review. Stating that it is a peer-reviewed publication is in error, and has the effect of lending undeserved legitimacy to the article submitted by Mr. Michaud. The sentence should read, "The detailed methodology for the study is also available in the trade publication, *Noise News International*…." And the reference should be removed from the *Scientific Journal Publications* section of the HC website.

2.0 MISLEADING VERBIAGE

Location on HC website: Summary of Results (Preliminary Research Findings)

- results do not permit any conclusions about causality

Issue: In fact, it is not only the *results* that do not permit any conclusions about causality; it is the *study design* that does not permit any conclusions about causality. The study design selected is an epidemiological cross-sectional survey. Epidemiological studies do not establish causality. They establish association of varying degrees, basically as estimates of risk in the very best case. The above statement erroneously suggests that had the "results" been "different" that causality between health concerns and wind turbine noise could have been established.

The point should read "Retrospective observational epidemiological study designs, including this one, do not permit any conclusions to be drawn about causality".

Here is a definition from Cornell University:

> Epidemiology is the study of diseases in populations of humans or other animals, specifically how, when and where they occur.
>
> Epidemiologists attempt to determine what factors are associated with diseases (risk factors), and what factors may protect people or animals against disease (protective factors). The science of epidemiology was first developed to discover and understand possible causes of contagious diseases like smallpox, typhoid and polio among humans. It has expanded to include the study of factors associated with non-transmissible diseases like cancer, and of poisonings caused by environmental agents.
>
> **Epidemiological studies can never prove causation**; that is, it cannot prove that a specific risk factor actually causes the disease being studied. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation the more certain the association, but it cannot prove the causation.[55]

Entire Report:

> "Wind turbine noise (WTN) levels"

Issue: All references to WTN levels should in fact read "modeled average WTN levels". It needs to be 100% clear that these results are not based on long term sound measurements at homes, but are in fact based on sound modeling that selected the "average". As the 4,000 hours of WTN measurements were conducted at 1,238 homes, this means that each home received a total of 3.23 hours of actual sound measurements, or possibly that a number of homes received no actual sound measurements. This breakdown needs to be provided and should be addressed in the statistical modeling.

3.0 LACK OF ACCESS TO RAW DATA
Location on HC website: Summary of Results (Data Availability and Application)

> Raw data originating from the study is available to Canadians, other jurisdictions and interested parties through a number of sources: Statistics Canada Federal Research Data Centres, the Health Canada website (noise data), open access to publications in scientific journals and conference presentations.

Issue: The Health Canada website has been searched for noise data to no avail. A link should be provided to the appropriate section. The Statistics Canada Federal Research information is only available to individuals affiliated with universities. No raw data is available to the general

[55] Cornell University Epidemiology: http://pmep.cce.cornell.edu/profiles/extoxnet/TIB/epidemiology.html

public at this time, therefore this paragraph is very misleading and should be modified or the data be made available to the public or through the Freedom of Information Act.

4.0 PREMATURE AND PROMOTIONAL STYLE OF RELEASE OF HC STUDY "INFORMATION"
Location on HC website: Summary of Results (Data Availability and Application)

> Detailed descriptions of the above results will be submitted for peer review with open access in scientific journals and should only be considered final following publication.

Issue: It is not acceptable scientific practice to present a summary in a trade publication in order to establish Health Canada's public and media claims prior to publication in a *bona fide* medical journal and certainly not without greater clarity in the research.

In the Michaud paper, a picture is provided within the text of the article that shows a happy, smiling, well-dressed older woman answering the door and reaching for the questionnaire, in a greeting pose with the interviewer. The message is loud and clear: ALL IS WELL. However, in peer-reviewed literature, such heavily biased communications tools as this rosy picture are not allowed. It is surprising and disturbing that anyone on the Expert Panel or at Health Canada would allow this kind of promotion in a supposed scientific article.

The pamphlet is similarly problematic, repeating claims that the survey is "comprehensive" and groundbreaking, while the disclaimer that the findings are preliminary and not peer-reviewed, is located in small type on the second-to-last panel of the publication. Photographs of turbines depict the power generating machines alone on the landscape, with no homes in sight, which is also misleading.

5.0 INCOMPLETE INFORMATION
Location on HC website: "Results" Pamphlet (Key Findings)

> Calculated noise levels were found to be below levels that would be expected to directly affect health (World Health Organization- Community Noise Guidelines [1999]). This finding is consistent with self-reported and measured results of the study.

Issue: Calculated noise levels at what distance to turbines? This statement has no frame of reference. How does this statement reconcile with the following statement found in the Wind Turbine Noise Measurement Results section of the report: "Calculated outdoor A-weighted WNT levels for the homes participating in the study reached 46 dBA for wind speeds of 8 m/s." In fact, the WHO guidelines for night noise recommend less than 40 dBA of annual average (Lnight) outside bedrooms to prevent adverse health effect from night noise.[56]

Location on HC website: "Results" Pamphlet (Key Findings)

[56] [56] http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures

> No evidence was found to support a link between exposure to wind turbine noise and ….

Issue: For all of the issues discussed above, the pamphlet must be substantially edited/corrected. The issues discussed above should be made clear in the pamphlet, at a minimum:

- The information provided so far is preliminary and a great deal more review / interpretation of the data is required.
- The WTN is based on sound modeling that provides dBA that is a yearly *average*
- The epidemiological study design selected is, generally speaking, considered useful for "raising questions", and not designed for "testing a hypothesis"
- The cross-sectional survey fails to meet its stated sample size and target power calculations – resulting in a FAILED study in statistical terms
- 27% of the sample population did not provide any data to be included in the study analysis
- The calculated outdoor A-weighted WTN levels are the results of modeled average WTN

6.0 INCONSISTENT INFORMATION

Location on HC website: Frequently Asked Questions (What was the rationale for measuring sound at some locations but not all?)

> This study included short term field measurements indoors and outdoors at several homes and near the base of the turbines. The purpose of these measurements was both observational and to acquire enough data to support the modelling used to calculate the A-weighted values used in the study. This objective was satisfied with the amount of measures taken.

The Michaud et al. paper states

> "The predicted levels are checked against at least one acoustical and meteorological measurement at each survey location for each model of wind turbine to which the survey subjects are exposed."

Issue: The FAQ statement seems to indicate that not all homes were subjected to field measurements, yet the Michaud paper indicates that each survey location was visited "at least once". Which one is correct? Is there a table available that indicates which homes were "checked"?

7.0 EXPERT PANEL - DISCLOSURE STATEMENTS

It is required in ethical peer-reviewed scientific/medical reporting to include disclosure on the first page with respect to any conflicts of interest that the expert panel and/or

authors/consultants might have to declare. This would include ever having worked for the wind development or turbine industry or for a government to support wind turbine installations, have been given/earned money or other benefits from any sources re: wind turbines companies, etc.

It would appear that such a disclosure statement was not included with the Michaud paper, hence making it quite unusual, especially when Health Canada is involved and are touting the paper as "ground-breaking" work. Such an admission must be made public immediately via media channels by Health Canada or they are doing a disservice to this government department and their authors/consultants. This disclosure will most certainly be demanded of them all in the very near future.

If there is bias present due to conflicts of interest, then the results of the survey will be further discredited, beyond all the reasons cited above, as may some individuals participating in the study, either directly or indirectly. Such disclosures are a common and critical element of ethical, high-grade science.

This review of the information provided by Health Canada pertaining to the HC *Wind Turbine Noise and Health Study* will be updated as HC provides additional data / information. Similarly, any paper published in a peer-reviewed academic journal will be carefully reviewed.

Denise Wolfe[57]
Research
Association to Protect Amherst Island

Note: If you would like a Word version of this document, please send a request to protectai@kos.net, including "HC Word Version" in the subject line. Additional information pertaining to APAI's efforts to prevent the industrialization of this small island in Lake Ontario is available at www.protectamherstisland.ca.

[57] I am a Board member of Wind Concerns Ontario (WCO) and the Association to Protect Amherst Island (APAI). I am employed by a Global Clinical Research Organization as a CRA Manager and have many years of experience as an auditor of clinical trial data. A number of senior medical researchers and scientists have assisted in the review of the preliminary results published on the HC *Wind Turbine Noise and Health Study*.