Response to the Health Canada Wind Turbine Noise and Health Study: Summary of Results

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Introduction

The Health Canada manuscript: "Wind Turbine Noise and Health Study – Summary of Results" has as a primary theme: There is no association between wind turbine noise and self-reported sleep problems, self-reported illness or self-reported stress and quality of life. Yet, the manuscript also speaks to an association between annoyance and wind turbine noise, and between annoyance and self-reported sleep problems, illness, stress and quality of life, as well as measured stress. There is a contradiction here. A serious problem is that there is no data or analysis to review and no reference to other studies that contradict the main theme of the summary. The release of the summary, with no associated data, analysis or peer review, is hasty and premature.

Peer Review

First, it is contrary to established science protocol to publish a summary of a scientific investigation without also presenting the scientific data and analysis upon which it is based. Footnote 2 makes clear that the results will only be considered final following peer review and publication in the scientific literature. There is no analysis and no peer review and yet the summary has been widely circulated and has received enormous press exposure. Some of the large team of federal scientists and senior-level consultants who co-authored the summary must surely know how to present scientific research!

A summary is a summary but without presenting the data and analysis it was important to put the findings into perspective. This means, for instance, how the authors explain their conclusion that there were no associations between wind turbine noise level and self-reported sleep disorders, illness and quality of life, whereas other peer-reviewed and published work does find an association[1].

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[1] C. D. Hanning and A. Evans (2012) "Wind turbine noise", British Medical Journal **344**, e1527.
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.
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.
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.
See also:
Clair Paller (2014), "Exploring the association between proximity to industrial wind turbines and self-reported health outcomes in Ontario, Canada", Thesis, University of Waterloo.
B. J. Frey and P. J. Hadden (2012) "Wind turbines and proximity to homes: The impact of wind turbine noise on health" (unpublished). http://docs.wind-watch.org/Frey_Hadden_WT_noise_health_01Jan2012.pdf
A. Harry (2007), "Wind turbines, noise and health". Report available at:
http://www.wind-watch.org/documents/wind-turbines-noise-and-health/

In asserting that there was no association between wind turbine noise and adverse health effects there needed to be confidence limits. Presumably, these limits will appear in the peer-reviewed publications but meanwhile the assertion is there for the entire world to see.

Annoyance and Adverse Health Effects

The summary includes the statement that the percentages highly annoyed by wind turbine noise at and above 40 dBA[2] were 16.5% and 6.3% in Ontario and PEI respectively. What does the study mean by highly annoyed? 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? We cannot know until the peer-reviewed results are published.

Section 5.2 and 5.3 of the study summary present a real conundrum:

- In 5.2: *"A statistically significant increase in annoyance was found when wind turbine noise levels exceeded 35 dBA."*
- In 5.3: *"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).
- And again in 5.3: *"Wind turbine noise annoyance was found to be statistically related to measured hair cortisol, systolic and diastolic blood pressure."*
- And again in 5.3: *"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."*

So, annoyance increases for turbine noise above 35 dBA and adverse health effects increase with annoyance. We can therefore conclude that increased adverse health effects are related to turbine noise above 35 dBA. As an aside, both the World Health Organization and Health Canada have classified annoyance itself as an adverse health effect.

It is known that calculated turbine noise is a poor predictor of measured turbine noise. There are other variables that influence the actual turbine noise such as wind-speed gradient, turbulence, up-wind or downwind of the wind turbine, temperature gradient. Turning again to section 5.2:

[2] E. Pedersen, F. van den Berg, R. Bakker and J. Bouma (2009), "Response to noise from modern wind farms in the Netherlands", J. Acoust. Soc. Am. **126**, 634 – 643).

- *"Reported wind turbine noise annoyance was statistically higher in the summer, outdoors and during evening and outdoors."*

It is well-known that the wind-speed gradient is significantly higher for summer night-time. In fact, the Ontario wind turbine noise guidelines specify that noise prediction must be made for the summer night-time wind speed gradient. A high wind speed gradient has two effects: masking noise is diminished and the turbine noise is enhanced as the blades turn through the wind speed gradient.

The European field studies of annoyance showed the fraction annoyed among the cohort to jump to 20%, 26% and 28% for the noise ranges 35-40 dBA, 40-45 dBA and >45 dBA respectively, not a large variation. That is, the annoyance was also significant above 35 dBA.

World Health Organization

The Health Canada summary is wrong on two accounts in referring to the WHO night-time noise limit. First, the WHO recommendation is not for an annual average sound pressure level of 40 dB. The WHO recommendation reads as follows[3]:

"For the primary prevention of subclinical adverse health effects related to night noise in the population, it is recommended that the population should not be exposed to night noise levels greater than 40 dB during the part of the night when most people are in bed."

There is no mention of averaging the sound pressure level.

Secondly, there is no mention of the 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 that from other sources at the same sound pressure level.[4] 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.[5] 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.

The difference in annoyance between noise from wind turbines and other sources of noise is readily understood.[4] The amplitude modulation draws attention to the noise[6] 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 acoustic spectrum of the noise.

In the 2012 preamble to the Health Canada study Michaud et al.[7] acknowledge that the WHO Night Noise Guidelines are based on transportation noise sources. They then go on to state,

[3] http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf
[4] C. D. Hanning and A. Evans (2012) "Wind turbine noise", British Medical Journal **344**, e1527.
[5] H. M. Miedema and H. Vos (1998). "Exposure response relationship for transportation noise." Journal of the Acoustical Society of America **104** 3432-3445.
[6] This is why warning sirens are often amplitude modulated.
[7] http://www.hc-sc.gc.ca/ewh-semt/consult/_2012/wind_turbine-eoliennes/research_recherche-eng.php

without attribution, that *"current science shows that the same levels are applicable to noise emitted from wind turbines."* We know of no such current science and none is referenced by Michaud et al. On the contrary, what we do know is that at the same sound pressure level wind turbine noise is significantly more annoying than traffic noise.

Stress Measurement

Hair cortisol measurement is an indicator of stress. However, this measures stress on the short time scale of the order of a few months. Compare this with the time scale of there being no indications of the coming of wind turbines, of the several years of planning and approval process and the year or more of operation. That is, hair cortisol as measured in the Health Canada study cannot be the basis for a longitudinal study. Medical records, however, could be the basis for a longitudinal study.

The opportunity that was missed was to perform a cross-over study.[8] Many people living near wind turbines report how different they feel when they move away. Therefore, where they can, they spend time away: with relatives, at a cottage, camping or trailering, even motels in their desperation. The two-month window for the hair cortisol measurement would have suited the cross-over investigation.

Why were children excluded from the hair cortisol study? Children, along with the chronically ill and elderly, are included in the WHO 2009 recommendations as being especially vulnerable to the adverse health effects of environmental noise.

Calculated and Measured Turbine Noise (Section D1)

The summary document gives almost no useful information on the measured wind turbine noise at homes. To quote:

- *"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."*

What approach? Part of the rationale for the Health Canada study was to test the reliability of predicted noise levels. This needs a comparison between predicted and measured noise. As noted above there are many factors that influence the noise above and beyond those in ISO-9613-2 or similar models. For instance, in compliance tests, measured sound pressure levels have been up to 15 dBA above predicted levels.

- *"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*."

What does "are likely to be" mean? Is this just a guess or a hope? Noise regulations are specified in terms of a defined noise measure such as L_{eq} or L_{90} and with an averaging time such as 10 minutes or one hour. An annual average has no meaning, particularly with an energy source that has an annual capacity factor of the order of 30%. Although uncertainties can be ± 5

[8] C. V. Phillips (2011) "Properly interpreting the epidemiologic evidence about the health effects of industrial wind turbines on nearby residents", Bull. Sci. Tech. Soc. **31** 303-315.

dBA and higher, this has not been accepted yet by the Ontario Ministry of the Environment and Climate Change. The precautionary principle speaks to lowering the noise limit down to 35 dBA when the predicted sound pressure level has an uncertainty of ± 5 dBA.

In discussing low frequency sound and infrasound, the authors have ignored the 2011 work of Bray and James that discovered the volatility of low frequency sound, with short burst of sound above the limit of audibility.[9] One hour averages miss this as they do the amplitude modulation of wind turbine noise.

This section of the Health Canada summary is just one more reason why its release was premature.

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[9] W. Bray and R. James (2011), "Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception". Proceedings of Noise-Con 2011, Portland, Oregon, 25-27 July 2011. Curran Associates, 2011.