BEFORE THE ENVIRONMENT COURT
CHRISTCHURCH REGISTRY

ENV-2011-CHC-090

UNDER	The Resource Management Act 1991
BETWEEN	**MERIDIAN ENERGY LIMITED**
	Applicant
AND	**HURUNUI DISTRICT COUNCIL and CANTERBURY REGIONAL COUNCIL**
	Consent Authorities

Statement of Evidence in Chief of Daniel Shepherd on behalf of Glenmark Community Against Wind Turbines, Inc

30 April 2012

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1.0 INTRODUCTION

Qualifications

1.1 My name is Daniel Shepherd. I hold a PhD in psychoacoustics, a Master of Science degree in experimental psychology, a Bachelor of Science degree in psychology and biology, and a Bachelor of Arts degree in history and politics. My PhD dissertation was a study on the abilities of human observers to discriminate between low level sounds. My Masters thesis investigated a newly emerging paradigm in physics, stochastic resonance, and applied it to the processing of low level sounds in humans.

1.2 Currently I am a Senior lecturer (Above the Bar) at the Auckland University of Technology, lecturing in the areas of psychological assessment, biopsychology, and statistical data analysis at both the undergraduate and postgraduate levels. In 2010 I was named Senior Researcher of the Year in the School of Public Health. Since 2005 I have undertaken substantial supervision of postgraduate students engaged in a range of psychological and health research, including psychophysical topics, and noise and health topics. At the University of Auckland I am an honorary research fellow in the Department of Psychology, an associated staff member in the Department of Chemistry, and have a strong working relationship with members of the Section of Audiology and School of Population Health. In 2008 I co-founded the World Health Organisations' Quality of Life (WHOQOL) field centre in New Zealand.

1.3 The impact of environmental factors on health defines the scope of my research practice. I approach the study of noise and health both descriptively and experimentally, conducting both epidemiological (i.e., in the community) and controlled (i.e., in the laboratory) research. I have published papers on both noise-induced health impacts and the psychophysical measurement of human hearing abilities, and have presented data at numerous international conferences on the topic. Frequently I receive invitations from top-tiered psychoacoustic and health journals to peer-review scientific manuscripts, and from universities to grade research-based masters theses and PhD dissertations.

1.4 In both an official or unofficial capacity, I also contribute to a number of international organisations dedicated to the scientific assessment and mitigation of environmental

noise. I am a scientific advisor for the Society for Wind Vigilance, an international federation of physicians, engineers and medical professionals promoting the development of authoritative international wind turbine guidelines to protect the health and safety of communities. Currently I am in the process of formalising a New Zealand branch of the Noise Abatement Society (http://noiseabatementsociety.com), an organisation dedicated to providing solutions to social and industrial noise issues. In April 2011 I was invited by the European Union, at their expense, to present on the impacts of environmental noise on health at a special think tank convened by the European Union's Science Foundation, and I have been invited to chair a special session dedicated to noise and quality of life in an upcoming European conference next year (INTERNOISE 2013, Innsbruck, Austria).

1.5 Over the last six years I have spent a considerable amount of time in the Manawatu (around four weeks per year), where I have resided in a dwelling located approximately 2.5 kilometres from a major wind turbine installation. During these times I have been exposed to a substantial amount of wind turbine noise, and have regularly visited wind farms in the area to make physical measurements and experience the noise.

Scope of Evidence

1.6 I have been invited by Glenmark Community Against Wind Turbines, Inc to provide an evaluation of the impact of turbine noise on health and well-being. I have accepted this invitation and present findings from research projects I have personally initiated and undertaken in the last five years. Having reviewed all accessible expert opinions available at this time, I opine that the Doctors' McBride and Black hold exclusive expertise in medicine and health amongst the submitters. Thus I do not address health-related comments offered by other expert witnesses on the basis that medicine and health are outside their scope of expertise.

1.7 I have visited the Huruniu district (20/04/2012) and familiarised myself with its layout and character. The area appears to be one of mixed use, consisting of farms and

lifestyle properties. I had the opportunity to speak to a number of individuals residing in the vicinity of the proposed wind turbine installation, some of whom have been in the area since birth.

1.8 Relatively, wind turbines are a new source of community noise, and as such their effects on public health are only beginning to emerge in the literature. The recognition of a new disease, disorder, or threat to health usually follows a set pathway. First, doctors and practitioners attempt to fit symptoms into pre-defined diagnostic categories or to classify the complaints as psychosomatic. Second, as evidence accumulates, case studies begin to appear in the literature, and exploratory research is undertaken to obtain better descriptions of the symptoms/complaints. Third, intensive research is undertaken examining the distribution and prevalence of those reporting symptoms, the factors correlating with the distribution and prevalence of those symptoms, and ultimately to cause-and-effect explanations of why those reporting symptoms may be doing so.

1.9 In my reading of the literature the health effects of wind turbines are only beginning to be elucidated, and is caught somewhere between the first and second stages described above (Paragraph 1.8). The important point to note is that case studies (e.g., Harry, 2007; Pierpont, 2009) and correlational studies (e.g., Pedersen et al., 2007; van den berg, 2008; Shepherd et al., 2011) have already emerged in relation to the health effects of wind turbine noise, and so the possibility of detrimental health effects due to wind turbine noise must be taken with utmost seriousness.

1.10 Noise is a recognised environmental pollutant that degrades sleep, quality of life and general function (WHO, 1999, 2009; 2011). On the basis of data currently available in peer-reviewed scientific publications, it can only be concluded that industrial-scale wind energy generation, involving the saturation of an optimum number of wind turbines in a fixed area, is not without health impact for those residing in its proximity. Based on my experience of wind turbine noise, and my reading of the data available in the scientific literature, I recommend that all turbines displaced at least two kilometres (or more) from any dwelling be consented.

1.11 In this statement I focus on the health impacts of audible wind turbine noise, and I do not focus on issues outside of audible noise. Any valid judgment of noise-induced health impacts necessitates a model from which cause-and-effect relationships can be described and considered. In the context of the proposed Wind Farm I employ a model (see Figure 1) that has been applied to New Zealand rural localities containing wind turbines (Shepherd et al., 2011). This model has been adapted from the aviation context (Shepherd et al., 2010) and has been modified to accommodate a major factor associated with rural / semi-rural living, namely amenity.

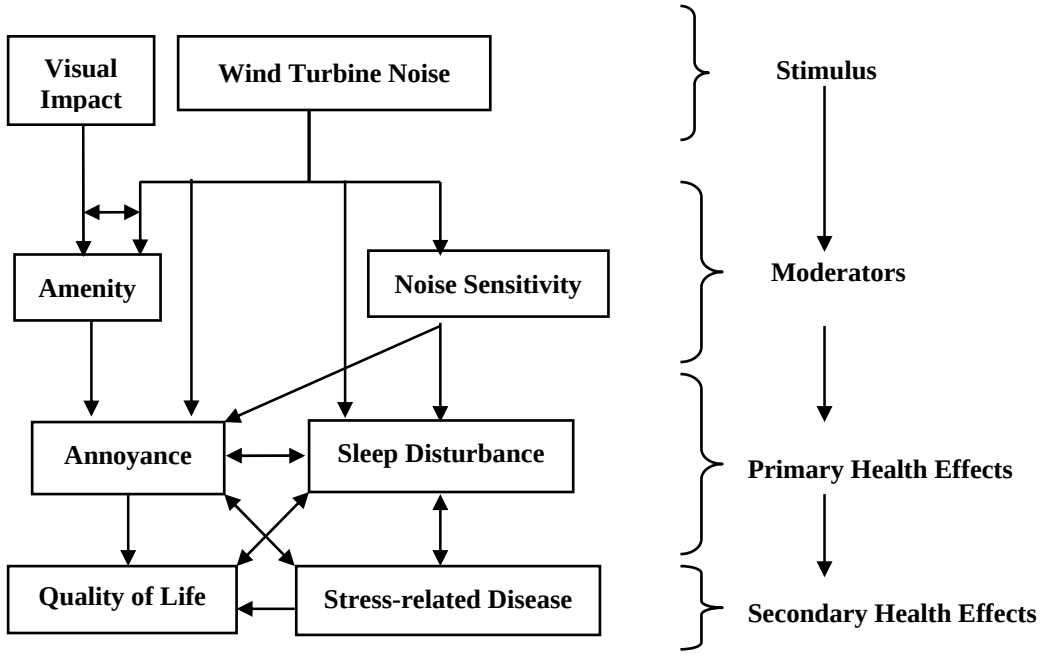

Figure 1: A schematic representation of the relationship between wind-turbines and health in a rural setting, such as that proposed in Project Hurunui Wind. Arrows represent cause-and-effect relationships, which maybe bidirectional. The multiplicity of relationships emerges due to variability in the response of individuals to noise (From Shepherd et al., 2011), and supporting evidence for each relationship can be found in the peer-reviewed literature.

1.12 Figure 1 is a simple model, informed by my own research and that research reported in the literature, demonstrating that, in the rural/semi-rural context, feasible mechanisms exist by which wind turbine exposure can degrade health and wellbeing. In this scheme turbine noise can lead directly to annoyance and sleep disturbance (i.e., direct health effects), or can induce annoyance by degrading amenity (an indirect

health effect). Additionally, the trait of noise sensitivity constitutes a major risk factor, with annoyance and sleep disturbance the likely mediators between noise sensitivity and health (Shepherd et al., 2010). In relation to secondary health effects, it would be expected that quality of life will be affected immediately, while stress-related disease emerges from chronic annoyance and sleep disturbance over time. Contemporary medicine argues that both noise-induced sleep deficits and annoyance can induce stress-related disease. Any object or event that an individual perceives as a threat to their safety or to the resting and restorative characteristics of their living environments can be classified as a stressor. A chronic stress response will also degrade quality of life.

1.13 Having considered the Project Hurunui Wind proposal, relevant high-quality peer-reviewed evidence, and both experimental and epidemiological data collected as part of my own research practice, I structure this statement as per Figure 1. The terminus of this statement coincides with a summary section and a recommendation that consent should be granted for the majority of wind turbines, though not all.

1.14 Throughout the statement I refer to the following peer-reviewed research:

Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. Noise and Health, 13(54), 333 – 339

and attach it as Appendix A.

Code of Conduct

1.15 I confirm that I have read the "Code of Conduct for Expert Witnesses" contained in the Environment Court Consolidated Practice Note 2011. I agree to comply with this Code of Conduct. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions and conclusions I express.

EXECUTIVE SUMMARY

a. The presence of wind turbines within two kilometres of dwellings are of concern from a public health perspective. More likely than not, noise from the proposed Project Hurunui wind farm will degrade amenity for a large proportion of residents, and furthermore, this degradation will result in strong annoyance reactions to wind turbine noise.

b. Highly noise sensitive individuals seek out quiet areas to live, for example, rural and semi-rural areas. Based on New Zealand and international estimates I predict that at least 10 to 15% of residents exposed to noise from the proposed Project Hurunui wind farm will suffer adverse health effects of sufficient severity to force them from the area.

c. Even at 40 $dBA_{outside}$, the probability of sleep disturbance (i.e., awaking) is higher in those with lower spindle rates (characteristic patterns of brain activity during specific stages of sleep). Those with lower spindle rates can be considered "noise sensitive", and thus noise sensitive individuals within the proximity of the proposed Project Hurunui Wind Farm turbines will more likely than not suffer disrupted sleep and the associated decline in health that accompanies sleep disruption.

d. The modulation characteristics of turbine noise appear to induce higher annoyance responses than most other forms of community noise.

e. Currently there is not a single credible research paper in the peer-reviewed literature stating that chronic wind turbine noise is harmless to health. Contra to the assertion that wind turbines have no health-related effects, there is an emerging body of evidence informing us that under certain circumstances wind turbine noise can have substantial physiological and psychological impacts on individuals.

f. New Zealand data links exposure to wind turbines to degraded health-related quality of life and sleep disruption, a finding that is consistent with models described in the literature. The Project Hurunui wind farm proposal is in many ways similar to the

Makara proposal, and so it can be supposed that the erecting of turbines will likewise degrade the Health related quality of life of nearby residents in this area.

g. It is a mistake to judge potential health effects on noise level alone, given that noise level only explains around 15 percent of the variation in the annoyance response across individuals. Instead most weight should be placed on the potential amenity threats and the impact of vulnerable groups in the region, including the elderly and children, those with a clinically-endowed psychological diagnosis (e.g., autism), and noise sensitive individuals.

h. Noise levels, when presented in averages such as dB LA_{eq}, fail to act as guardians of rest and sleep. More meaningful metrics can be related to sleep disturbance, including those metrics which predict maximum levels (e.g., dB LA_{max}) and the number of noise events.

i. Strict compliance with the New Zealand wind turbine noise standard (NZS6808) will not necessarily prevent sleep disruption or other health impacts, due to limitations with modelling and its approach to the relationship between noise and health.

j. Because of probable discrepancies between predicted and actual noise levels it would be prudent to rely on evidence coming from individuals at established wind turbine installations than mathematical models heavily constrained by assumptions. Current epidemiological data suggests a two kilometre buffer zone is a superior guardian of public health.

2.0 WIND TURBINE NOISE

2.1 Noise emissions from modern wind turbines are primarily due to turbulent flow and trailing edge sound, blade characteristics, blade/tower interaction, and to a lesser degree, mechanical processes. The most commonly used description of wind turbine noise is the A-weighted sound pressure level, which is expressed in decibels (notated dBA). The physical analysis of wind farm noise poses distinct challenges, including the identification of acoustic energy that can be directly attributed to the turbines, and the detection of special audible characteristics, including distinct tonal complexes and modulation effects. Generally, wind farm noise is often a broadband low amplitude noise constantly shifting in character ("waves on beach", "rumble-thump", "plane never landing", etc). In this respect wind farm noise is not like, for example, traffic noise or the continuous hum from plant and machinery. The certification of wind turbine noise is undertaken in accordance with the International Standard *IEC 61400-11:2002* (2008) *'Wind Turbine Generators Part 11, Acoustic noise measurement techniques'*. An informative Chapter (Annex A: 2006) to IEC 61400-11, states that:

In addition to those characteristics of wind turbine noise described in the main text of this standard, the noise emission may also possess some, or all of the following: infrasound; low frequency noise; impulsivity; low-frequency modulation of broad band or tonal noise; other, such as a whine, hiss, screech, or hum, etc., distinct pulses in the noise, such as bangs, clatters, clicks or thumps, etc.

2.2 People most frequently describe wind turbine noise as a swishing or lashing sound, or less commonly as thump/throb, low frequency rumble, or a rustling sound (Pedersen & Persson Waye, 2004; Van den Berg et al., 2008). Wind turbines produce noise with an impulsive character (Van den Berg, 2004), and while the actual cause of the swishing or thumping has not yet been fully elucidated, it has been demonstrated that the swishing or thumping pattern is common with larger turbines (Stigwood, 2009), and may result from a fluctuating angle of attack between the trailing edge of the rotor blade and wind, or wind speed inequalities across the area being swept by the rotor blades (Van Den Berg, 2005). It is thought that the swishing sound may be linked to activity in the 2000 to 4000 Hertz band, with the pace of the rotor blades determining

the degree of amplitude modulation (Persson Waye & Öhtrsöm, 2002). Unfortunately, such amplitude modulated sounds are generally attenuated poorly by background noise, especially so in rural areas (Arlinger & Gustafsson, 1988). Overall, it is fair to say that wind turbine noise is neither atheistically pleasing nor relaxing to listen to.

2.3 Further, because human sensory systems behave as contrast analysers (i.e., change detectors), fluctuations in the incoming stimulus field tend to direct attention, and so are more easily detected. Thus amplitude modulated sounds such as wind turbine noise are readily perceived and difficult to filter out, making them especially intrusive (Pedersen & Persson Waye, 2008). The loudness of a wind turbine depends on a number of factors, including wind speed, sound attenuating materials between the turbines and the receiver, other masking sounds, the season, and time of day. The loudness of a modern 2 – 3 MW wind turbine can be compared to a car on a motorway (Pedersen et al, 2008), with a sound power level of 94 to 104 dBA at a windspeed of 8 m/s (Pedersen & Persson Waye, 2007). Wind turbine noise is perceived louder at night and during the summer months, and when the wind is blowing from the direction of the turbines towards the receiver (Pedersen & Persson Waye, 2004, van den Berg et al., 2008).

3.0 AMENITY

3.1 Typically, noise can be quantified by sound exposure levels or audibility, and qualified in terms of unwantedness, annoyance, or loss of amenity. There is an expectation of “peace and quiet” when living in a rural area, and most choose to live in rural areas as they are bastions of tranquillity (Schomer, 2001). The peer-reviewed literature shows that those who live in rural areas have different expectations regarding community noise compared to those living in suburban, urban, or industrial areas. People expect rural areas to be quieter, and consequently exposure to noise will produce a greater negative reaction in rural areas than others (Pedersen & Waye, 2004). It is evident in the literature that community setting is emerging as a powerful predictor of annoyance reactions, and the perceived industrialisation of the landscape following the installation of wind turbines reduces the attractiveness and restorative characteristics of the hosting environment.

3.2 If a proposed wind turbine installation encroaches rural and semi-rural areas populated by residents with a greater expectation for, and value on, peace and quiet, the reaction to the proposed wind turbines are likely to be negative. Amenity values are based upon what people feel about an area, its pleasantness, or some other value that makes it desirable place to live. Noise affects individuals and communities by modifying the extrinsic and intrinsic nature of the environment that attracts and holds people to the locality. The affinity that rural dwellers have to the land is often difficult for their urban and suburban counterparts to comprehend, as too are their responses to unwelcome modification of their environment. Survey-based investigations of wind turbine noise have demonstrated a distinction in self-reported annoyance levels between respondents living in cities and those living in rural areas Pedersen and Waye (2007), and between noisy and quiet areas (Bakker et al., 2012). Because attitudes towards the noise source influence annoyance, then rural residents are likely to exhibit more annoyance than those living in suburban or urban neighbourhoods.

Pedersen and Waye (2007) sum it up:

"*…exposure from wind turbines would be more negatively appraised in an area that is perceived as unspoiled than in an area where several human activities take place … People choose environments that harmonise with their self-concept and needs, and that they remain in places that provide a sense of continuity. When a new environmental stressor occurs, the individual's relationship with her or his place of residence is disrupted. Such a distortion could possibly predispose for an increased risk of annoyance… Expecting the home and its surroundings to be a suitable place for rest and recreation could conversely lead to an appraisal of the sound as threatening personal values. The sound was described as an intrusion into privacy that changed the image of a good home*."

The same report indicated that annoyance was most frequently reported when participants were relaxing outdoors or on "barbecue nights". It can be embarrassing living near sources of community noise, and there is a public stigma that only those in the lower socio-economic bracket live in the vicinity of noise generators

(WHO, 2009). Such feelings discourage residents from inviting guests around to their homes, and thus wind turbine noise can interfere with rest and recreational activities.

3.3 For a variety of reasons wind turbines are placed mainly in rural areas with low background sound levels. The operation of 33 wind turbines within the confines of the proposed Project Hurunui wind farm will undoubtedly produce noise that is incongruent with the natural soundscape of the area. The immediate and long-term effects of industrialising the soundscape will be to degrade amenity and impact upon the responses of a "reasonable person", to the point where they may become "forced emigrants". Pedersen, Hallberg, and Waye (2007) conducted in-depth interviews with 15 people living within close vicinity of wind turbines. Respondents opinions of the turbines and the turbine noise was largely determined by their personal values about the living environment. The feeling of intrusion was associated with feeling a lack of control, subjected to injustice, a lack of influence, and not being believed. Various coping strategies were engaged, such as rebuilding their houses or complaining. Many, however, displayed the "defeat reaction".

3.4 Rylander (2004) describes the characteristics of the defeat reaction after exposure to intrusive noise as increased vulnerability to illness and a depression of mood precipitated by intense sorrow, deep frustration, and defeat. The defeat reaction may in turn be amplified by the presence of turbine noise. A Swedish study (Pedersen & Persson, 2007) reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by wind turbine noise. I have collected data from the Makara Valley in New Zealand marshalling evidence for the defeat reaction in that the Makara sample rated themselves as having significantly more negative feelings such as blue mood, despair, anxiety, or depression than a control sample (Shepherd et al., 2011).

3.5 A 2010 survey undertaken by my colleagues and I included an open-ended question asking *if there been any changes to the better or the worse in their living environment/ neighbourhood during the last year*. Comments from rural areas (including an area surrounding a wind turbine installation (Makara), an area where a turbine installation was proposed (Ohuria / Mill Creek), and a comparison area

unrelated to wind turbines) are presented in Appendix C. Note that peace, quiet, and privacy, and threats thereof, are reoccurring themes emerging from all areas. Furthermore, comments from turbine-free areas indicate that the residents perceive the placement of turbines in their community as a threat to their quiet surrounds and amenity. Overall, the emotional intensity of these comments provides a picture of communities strongly connected with their surroundings. That annoyance responses to wind turbines positioned in "quiet" areas differ to those located in pre-existing "noisy" areas has been well documented in overseas research (e.g., Bakker et al., 2012).

3.6 In the same survey we presented two questions relating to amenity: 1) I am satisfied with my neighbourhood / living environment, and 2) My neighbourhood / living environment makes it difficult for me to relax at home. When compared statistically to the turbine-free area, the Makara sample were less satisfied with their living environment and reported that their living environment made it more difficult for them to relax at home than those in the control sample (see Shepherd et al., 2011). The open-ended responses displayed in Appendix C suggest that these differences may be explained by the presence or absence of wind turbines.

3.7 The visual impact of the turbines can also influence reactions to turbine noise, probably because the visual presence of the turbines act as reminders of the negative impacts that they have had on people's lives and their living environments. In a Danish study, the position of the listener (on a flat landscape) relative to the wind turbine influenced their perception of the noise more than the overall level of the turbine's noise itself (Pedersen & Nielsen, 1994). Other studies (Delvin, 2005) have likewise reported that, as a whole, wind turbines are viewed as eyesores and visual spoilers of the environment (see Figure 2). Pedersen and Persson (2004) hypothesize that, from an aesthetic perspective, those who view the wind turbines as ugly are likely to disassociate them from the landscape, and as a consequence, react more strongly to turbine noise. Their findings have direct relevance to those who value the amenity and restorative features of the area to be occupied by the proposed Project Hurunui wind farm, they state:

"*Wind turbines were described as environmentally friendly, necessary, but also as ugly... Seeing a wind turbine in an otherwise non-industrial environment may reduce the individual's perception of the naturalness of the area and reduce the perception of restoration possibilities.*"

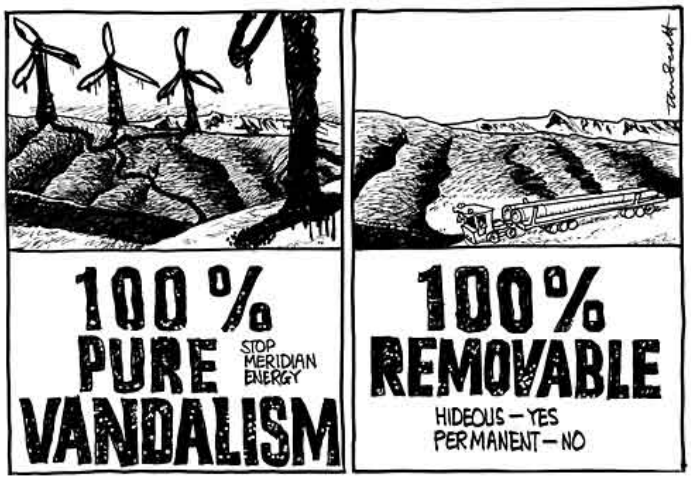

Figure 2: A cartoon from a major daily New Zealand newspaper making fun at wind turbine installation developers (here Meridian energy) and NIMBYs ("Not In My Back Yard") alike (from *www.stuff.co.nz*).

3.8 Thus when built in semi-rural settings, the visual impact of wind farms can also degrade amenity and interact with wind turbine noise to exacerbate annoyance reactions (Pedersen & Persson Waye, 2004), possibly due to a violation of the landscape-soundscape continuum constructed by those who choose to live in these areas (Pheasant et al., 2010). Scrutiny of the comments provided by individuals living in the vicinity of Makara's Westwind installation (see Appendix C2), however, reveals no mention of the visual impact of turbines on the landscape, reinforcing suggestions made by others that wind farm noise is more dominant than their visual aspects, and more likely to compromise amenity (Pheasant et al., 2010).

3.9 Though a high amenity limit is described in the latest version of NZS6808 there seems to be some disagreement as to how it should be applied, as evident in the correspondence below (dated 26/03/2010) from Ruth Paul (community representative) and Stephen Chiles. From Chile's statement (His Paragraphs 8 and 9) it appears that

the interpretation of the amenity clause in the standard differs across individuals (see also Appendix B, email correspondence from Ruth Paul):

From: Ruth Paul [mailto:ruthpaul1@xtra.co.nz]
Sent: Friday, 26 March 2010 9:14 a.m.
To: Stephen_Chiles@URSCorp.com
Cc: Bruce Taylor

Subject: NZS6808 2010 - high amenity noise limit

Hi Stephen and Bruce,

I just quickly wanted to mention an issue I have with the way the new standard is being promoted.
Re the high amenity limit: as discussed previously, and as agreed (I thought), this clause can be read to state that a high amenity limit SHOULD apply where there is a special District Plan noise limit lower than 40 (agreed), and then goes on to ennumerate the specific situations in which the limit would/could apply. It does not say the high amenity limit should ONLY apply where the DP sets a limit lower than 40. In other words, residents or interested groups can and should argue their case if they have the evidence, regardless of the DP.

I note that in the brief that went out with the standard, and in subsequent press interviews, this is not the way it is being portrayed. The District Plan lower limit is being presented as a necessity for applying the high amenity clause. No wonder residents will be unhappy with what they are hearing, as opposed to what I am telling them!

Thanks and kind regards,

Ruth Paul.

PS I've copied this to the committee and a few interested residents.

3.10 Finally, any test for the compromise of amenity (factoring out health) due to noise will almost certainly be audibility, which is a highly individual matter. Therefore the amenity clause in NZS6808 may not necessarily preserve amenity if individuals are still exposed to audible wind turbine noise.

4.0 NOISE SENSITIVITY

4.1 As with other noise sources there is individual variation in the effects of wind turbine noise. However, given identical noise exposures, it is a fallacy to argue that because only some suffer symptoms while others do not then those who claim to be suffering the symptoms must be making them up or that the symptoms are "psychosomatic". In the field of epidemiology the differential susceptibility of individuals are known as risk factors, and assuming that individuals of a population can be represented by the average characteristics of the population is known as the ecological inference fallacy. In terms of wind turbine noise these risk factors are still under study, and one important risk factor is noise sensitivity. Along with collaborators (Shepherd et al., 2010) I recently demonstrated that sleep disruption and annoyance acted as mediators between noise sensitivity and health-related quality of life (a subjective evaluation of health).

4.2 Noise sensitivity, considered a stable personality trait that is relatively invariant across noise level, is a strong predictor of noise annoyance and is correlated with sleep quality. Noise sensitive individuals can be described by two key characteristics. First, they are more likely to pay attention to sound and evaluate it negatively (e.g., threatening or annoying). Second, they have stronger emotional reactions to noise, and consequently, greater difficulty habituating. Unsurprisingly then, noise sensitivity moderates the effects of noise annoyance (see Figure 1), and is not simply the presence of susceptibility to health problems in general (Welch, Shepherd et al., 2011). My own research concurs with international studies estimating the prevalence of severe noise sensitivity to be between 10 – 15 percent of the population. Other studies show that noise sensitivity has a large impact on noise annoyance ratings, lowering annoyance thresholds by up to 10 dB (Miedema & Vos, 1999).

4.3 It should be noted that noise sensitivity is not a symptom of mental illness, but a measurable characteristic that differs in intensity across the population. Research has suggested that noise sensitivity is associated with mental illness. However, this does not mean that mental illness is a necessary prerequisite for reporting high sensitivity

to noise, nor that noise sensitivity is a symptom of mental illness. As a characteristic, noise sensitivity is measured on a continuum from highly noise sensitive to highly noise resistant, and everybody falls somewhere along this continuum:

Highly noise sensitive	Highly noise resistant

4.4 In collaboration with Brain Injury New Zealand and colleagues, I undertook interview-based research attempting to gain further insight into the experiences of living with noise sensitivity (Landon, Shepherd et al., 2012). We chose survivors of traumatic brain injury, as noise sensitivity is the strongest predictor of subsequent post-concussive syndrome, and there is a high prevalence of noise sensitivity in this clinical population. We noted two recurrent themes in the transcripts. First, the inability of current clinical practice to detect or treat the condition, and second, the debilitating effects of high noise sensitivity:

"*For me, I dunno, probably the noise is one of the biggest things; and if you could take one symptom away from me, if I had to choose one thing that I didn't have to have, it would be the noise sensitivity, definitely."*

While we purposively targeted a group with a high prevalence of extreme noise sensitivity, it should be remarked that individuals with similar levels of sensitivity will exist in the general population, that their sensitivity will not necessarily be traced to injury or disease (though it might), and that these individuals will seek quiet areas in which to live and work.

4.5 Most individuals exhibit noise sensitivity in certain situations. Those with noise sensitivity as an enduring trait, however, may try and avoid noisy areas and, if given the choice, will choose to live in quieter areas. In 2010, myself and colleagues from the Universities of Otago and Auckland, collected data in both cities and rural areas across New Zealand, which included self-report noise sensitivity ratings. This data affords a comparison of noise sensitivity prevalence in the countryside and a city, and is presented graphically in Figure 3. Of remark are the disparities evident in the 'none' and 'high' sensitivity categories, that is, by proportion, there are more noise

sensitive individuals in rural areas than urban and suburban areas. Note, however, that the estimates of noise sensitivity in rural areas may be an under-estimate due to the lack of noise and therefore lack of knowledge that one may be in fact noise sensitive. A Scandinavian study on wind turbine noise and annoyance reported that fifty percent of respondents in a rural area described themselves as sensitive to noise (Pedersen & Persson, 2004). The same study estimated the prevalence of noise sensitivity in urban areas to be 20%, suggesting that noise sensitive individuals seek out rural areas for their lower levels of noise.

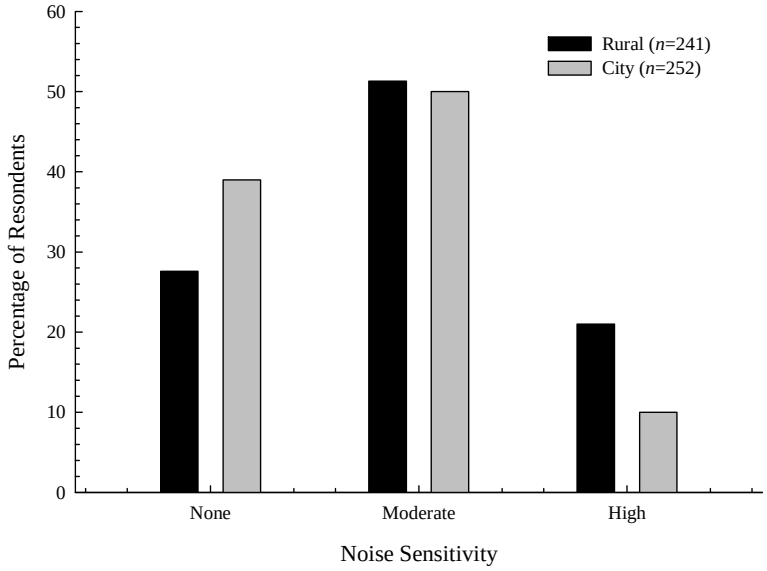

Figure 3: Bar graph plotting percentage of respondents indicating their category of noise sensitivity. Black bars represent respondents from rural areas whilst grey bars represent those living in a city. It is evident that there is a greater proportion (by a factor of 2) of noise sensitive individuals in rural areas than cities.

4.6 There have been calls in the noise and health literature to explore the biological basis of noise sensitivity. Working with researchers at the University of Auckland, I explored whether changes in brain activity following the presentation of annoying sounds was associated with levels of noise sensitivity (Lee, Hautus, and Shepherd, 2012). Annoying sounds were found to induce differing amounts of "alpha desynchronization" (a specific pattern of brain activity) depending on whether an individual was catorgorised as noise sensitive or noise resistant. Noise resistant individuals showed alpha desynchronization only to the most annoying sounds, whilst noise sensitive individuals elicited alpha desynchronization irrespective of how

annoying the sound was rated (see Figure 4). We concluded that noise resistant individuals must have some form of annoyance filter not available to noise sensitive individuals.

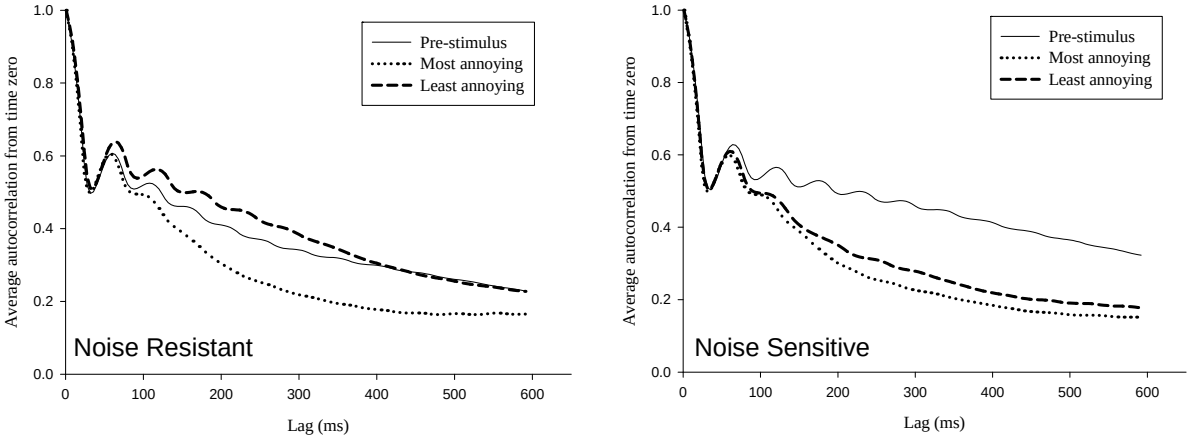

Figure 4: High density electroencephalogram recordings for noise resistant (left) and noise sensitive (right) individuals (*n*=16). The plots (autocorrelation functions) represent alpha desynchronization in three states (very annoying, mildly annoying, silence (termed here *Pre-stimulus*)).

4.7 In further electrophysiological studies we explored the relationship between level of noise sensitivity and the emotional reactions triggered by sounds differing in pleasantness. A difference in mean heart rate deviations between both groups implied that unpleasant and pleasant sounds elicit different physiological responses. Specifically, the noise sensitive individuals show a lack of changes in mean heart rate deviations following the presentation of unpleasant and pleasant sounds. This implies that sounds, irrespective of pleasantness, could be processed similarly. In contrast, a reduction in mean heart rate deviations for the noise resistant individuals suggests that sounds with differences in pleasantness triggered unique physiological responses. This pattern matched skin conductance data that was collected simultaneously.

4.8 Ohrstrom et al. (1990) concluded that noise sensitive individuals have lower thresholds of noise reactivity during sleep than non-sensitive individuals. They

demonstrated that noise sensitive individuals take longer to fall asleep than non-sensitive individuals and that sleep quality is more likely to be compromised by noise in sensitive individuals. Marks and Griefahn (2007) replicated these findings, reporting an association between noise sensitivity and subjective sleep quality, that is, greater sensitivity is linked to worsened restoration, deceased calmness, and difficulty to fall asleep. Finally, a recent study (Dang-Vu et al., 2010) has shown that subjects with fewer sleep spindles (electro-physiological markers characteristic of shallow sleep) are more easily aroused by noise (Figure 5), a marker of sleep-related noise sensitivity. Sleep spindles are small bursts of brain activity occurring during sleep, and are thought to regulate the brain's response to external stimuli (e.g., noise). Sleep spindles are taken as a marker of sleep stability, and provide a physiological marker of sleep quality.

4.9 In conclusion, noise sensitivity explains much of the variation in annoyance responses across individuals, though should not be considered a deficit of character or a symptom of mental illness, but rather a unique trait differing across individuals that has a neurological basis.

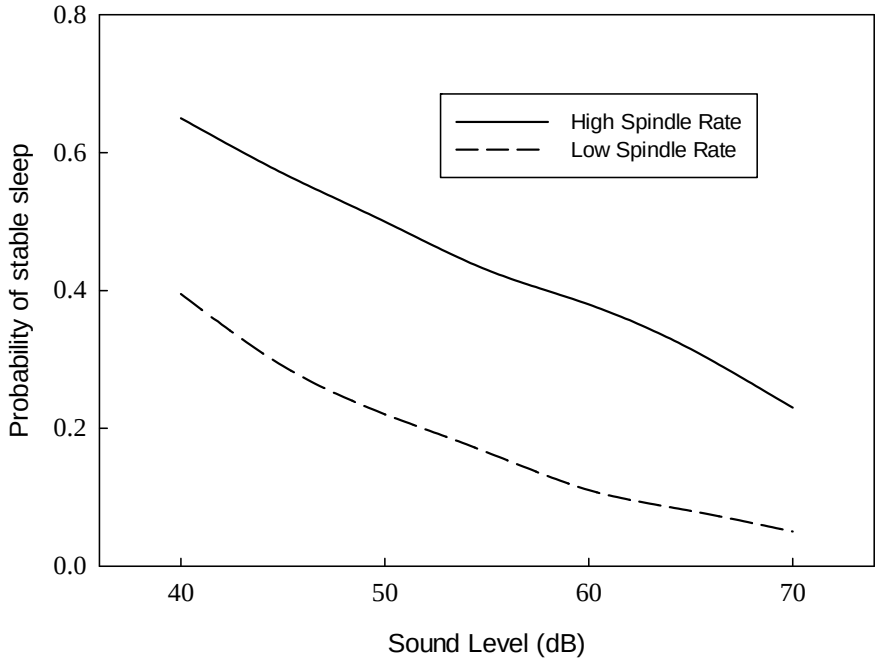

Figure 5. Sleep stability as a function of sound level for noise resistant (high spindle) and noise sensitive (low spindle) groupings. Estimated from Dang-Vu et al., 2010.

5.0 ANNOYANCE

5.1 The word annoyance is often misinterpreted by the general public as a feeling brought about by the presence of a minor irritant. The medical usage, in contrast, exists as a precise technical term and defines annoyance as a mental state capable of degrading health. Suter (1991) presents a formal definition of annoyance:

"*Annoyance has been the term used to describe the community's collective feelings about noise ever since the early noise surveys in the 1950s and 1960s, although some have suggested that this term tends to minimize the impact. While "aversion" or "distress" might be more appropriate descriptors, their use would make comparisons to previous research difficult. It should be clear, however, that annoyance can connote more than a slight irritation; it can mean a significant degradation in the quality of life. This represents a degradation of health in accordance with the World Health Organization's (WHO) definition of health, meaning total physical and mental well-being, as well as the absence of disease*."

5.2 Noise level is that measure of sound which we associate with the perception of loudness. Figure 6 demonstrates that, for equivalent noise levels, people judge wind turbine noise to be of greater annoyance than aircraft, road traffic, or railway noise (Pedersen et al., 2004). The most recent research to hand (van den Berg, 2008; Janssen et al., 2011) has confirmed the relationship reported in Figure 6, and I have added van den Berg's (2008) data to the figure. The lack of equivalence across noise sources evident in Figure 6 is likely due to the unique characteristics of turbine noise, that is, clusters of turbines present a cumulative effect characterized by a dynamic or modulating sound as turbines synchronise. Note the differences between those receiving no economic benefit, and individuals benefiting financially from the turbines. Van den Burg (2008) reports this depreciation in annoyance of those benefiting economically can be explained by the control they have over the wind turbines, such that they can impede their operation if noise levels increase as they largely had the turbines placed on their own property. Thus perceived control of the

turbines, coupled with the ability to regulate their output, also explains individual differences in response to turbine noises.

5.3 Van den Berg et al., (2008) analysed data from 725 Dutch nationals who were exposed to calculated outdoor noise levels between 24 and 54 dB(A). Approximately 60% of the sample could hear the turbines outdoors, while 33% reported that they could hear the wind turbines indoors. Of the 45% (*n*=231) who noticed the sound of the rotor blades, 24.7% were not annoyed, 25.8% were slightly annoyed, 19.5% were rather annoyed, and 29.9% were very annoyed. The sound level explained approximately 25% of the variability in annoyance scores, and those who compared the noise to an amplitude modulation (i.e., swishing or lashing) were more likely to be annoyed, though this is not a novel finding (Hayes & McKenzie, 2006; Pedersen & Waye, 2008).

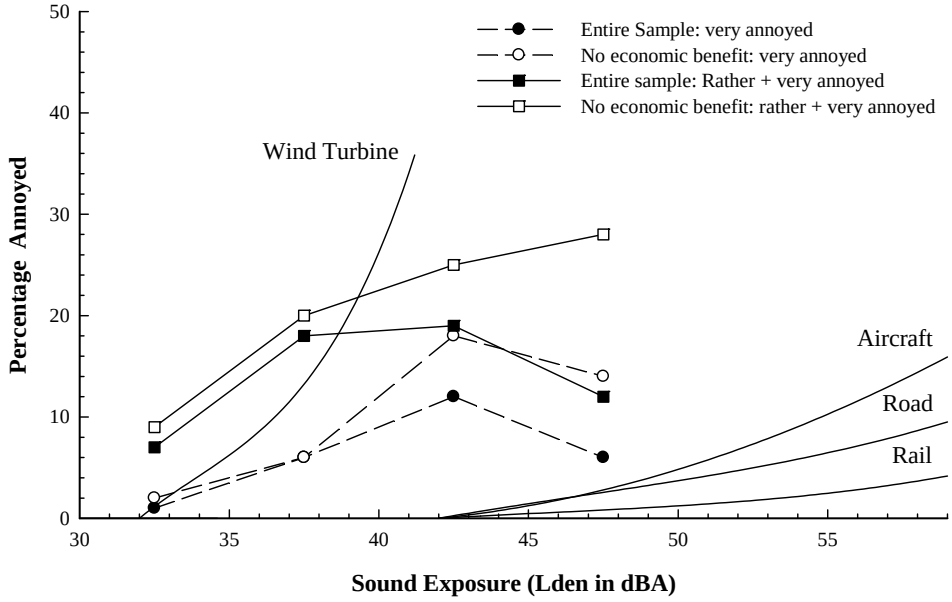

Figure 6: Annoyance plotted as a function of noise level for four theoretical models (rail, road, air: Miedema and Oudshoorm, 2001; wind turbines: Pedersen et al., 2004) and four sets of data obtained from van der Berg et al., (2008). For the data, closed symbols are for the entire sample, while open symbols are for those who identified that they had no economic interest. Circles represent the percentage of "very annoyed" responses whilst squares represent the sum of "very annoyed" and "rather annoyed" responses.

5.4 Pedersen and co-workers have undertaken a series of investigations examining the relationship between wind turbine noise and health. In a study involving 351 respondents, Pedersen and Waye (2004) explored the importance of individual and contextual factors alongside noise parameters, and the danger in generalising findings from other sources of community noise (e.g., road, rail, aircraft) to the wind turbine context. In a 2007 paper, this time reporting data collected from 754 individuals, Pederson further explores these individual and contextual influences. They noted that those living in rural areas are more likely to be annoyed than those from suburban areas, and that those living in complex terrain (e.g., hills or rocky terrain) were more likely to be annoyed than those living on flat ground. The study found a strong association between annoyance and both lowered sleep quality and negative emotions. Pedersen and Waye, 2008 reanalysed pre-existing turbine noise and annoyance data from 1822 individuals and concluded that turbine noise can impede health, especially for susceptible individuals. The paper also discussed the dangers of using noise level as a sole predictor of annoyance, and the strength of noise sensitivity measures in predicting annoyance.

5.5 Pedersen and colleagues (2009) reported that annoyance increased with increasing sound levels, both indoors and outdoors. Although the authors (Pedersen et al., 2009) do not seek to recommend minimum sound levels, they do note that turbine noise was more annoying than other sources, and was more noticeable and annoying at night, when they can't be seen at night, replicating earlier studies (van den Berg, 2008). Reported associations between annoyance and symptoms of stress (headache, tiredness, tension and irritability) confirmed that "annoyance" is more than irritation and is a marker of impaired health. They conclude:

"...night time conditions should be treated as crucial in recommendations for wind turbine noise limits."

Nevertheless, it is clear from their analysis that external predicted turbine sound levels should be less than 35 dB(A)to reduce effects on nearby residents to acceptable levels, less than those currently proposed.

5.6 van den Berg (2008) and colleagues (Bakker et al., 2012) from the University of Groningen in the Netherlands have recently published a major questionnaire study of residents living within 2.5km from wind turbines. Outdoor noise exposure ranged between 24 and 54 dB(A). It is worth noting that the wind industry was approached for assistance in the research but refused. The research team concluded that *"Sound was the most annoying aspect of wind turbines"* and was more of an annoyance at night. Interrupted sleep and difficulty in returning to sleep increased with calculated noise level as did annoyance, both indoors and outdoors. Even at the lowest noise levels, 20% of respondents reported disturbed sleep at least one night per month. Figure 7 is taken from van den Berg's tables, and presents not only annoyance but also detectability. At a calculated noise level of 30-35 dB(A), 10% were rather or very annoyed at wind turbine sound, 20% at 35-40 dB(A) and 25% at 40-43 dB(A). van den Berg concluded also that, contrary to industry belief, road noise does not adequately mask turbine noise and reduce annoyance and disturbance. Similarly, Bolin (2009) has shown that vegetation noise (e.g., leaves moving in the presence of wind) does not mask turbine noise as well as expected.

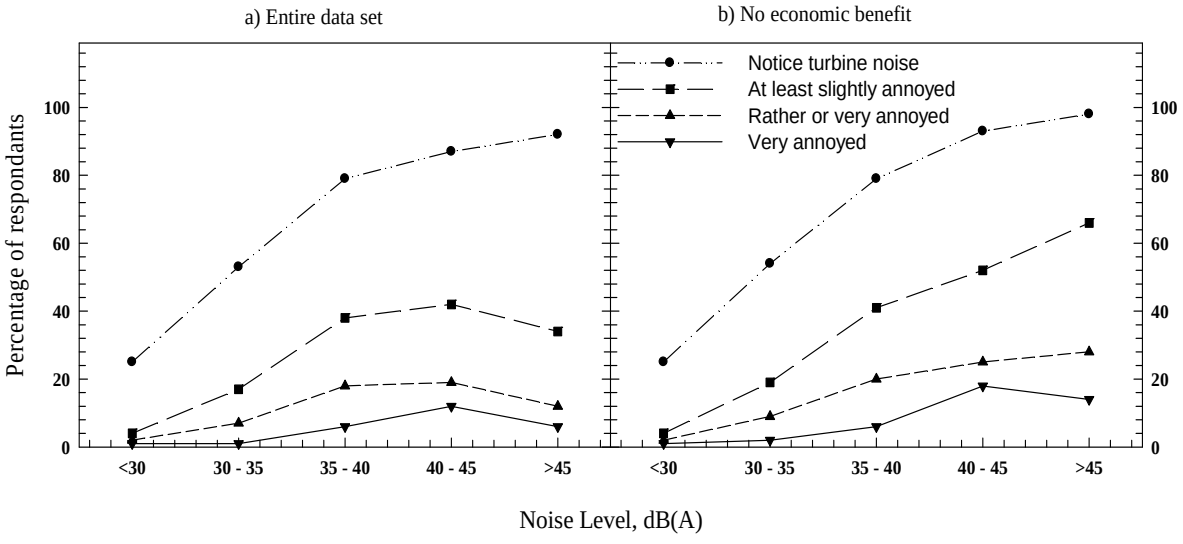

Figure 7: Data from van den Burg et al., (2008), plotting outside wind turbine noise levels as a function of annoyance and detectability.

5.7 Perceived procedural unfairness is a non-acoustical factor that must be considered when judging potential annoyance. Case studies show that anger can arise when a person feels that they no longer have control of their environment, stress results, and if chronic, feelings of disempowerment will gradually give way to feelings of depression, low self-worth due to an inability to control the noise, and further stress (Maris et al., 2007). The resulting sense of anger that people experience when they feel a lack of control can significantly increase noise annoyance responses. Dealings between the community and wind farm developers are extremely sensitive, and I understand that residents will present descriptions of perceived procedural unfairness to the court.

5.8 For the most part, the acceptable noise limits recommended by noise standards are derived from WHO guidelines (WHO 1999, 2009, 2011). However, as Figure 6 demonstrates, using recommended noise levels from guidelines based on transport data risks exposing the population to unacceptable levels of noise. It follows that the he Ldn (the 'day-night' level in the United States) or Lden (the 'day-evening-night' level in Europe) measures, derived from the measured LA_{eq} sound level and based on transport data, should not be applied to the wind turbine context. Inspection of Figure 6 suggests that, relative to transport guidelines, at least a 10 dBA penalty should be placed on wind turbine noise.

5.9 The differences in annoyance ratings between wind turbine noise and transport noise maybe accounted for by amplitude modulation, the typical location of wind farms (e.g., rural areas), or the over-representation of noise sensitive individuals. A recent meta-analysis of three epidemiological studies revealed a consistent trend in wind turbine noise exposure and annoyance (Pedersen, 2011). On the basis of her analysis, Pederson recommends that outdoor levels should not exceed 40 dBA, though this level could be more-or-less depending on situational factors, that is, ambient noise levels or the building's construction materials. When noise is continuous, the WHO (1999) stipulate an indoor limit 30 dBA, though for noises containing lower frequencies (e.g., wind turbine noise) a lower limit still is recommended. Thus, careful examination of the lower end of the frequency spectrum is important when judging appropriate exposure to wind turbine noise, and the use of dBC or spectral

analysis in one third octave bands is necessary. On this point I defer to the evidence of William Leslie Huson.

5.10 Considering the preceding sections above and my discussions with residents I conclude that noise from any industrial source will likely induce severe annoyance reactions due to a combination of acoustic and non-acoustic factors. First, and taking William Leslie Huson's statement as evidence, the noise will likely be modulated and low frequency. Second, the noise is incongruent with the natural soundscape and will at times dominate it, and therefore be intrusive and distracting. Third, there are noise sensitive individuals living in the area, who should be considered high risk. Lastly, belittlement, and a lack of sympathy and respect from local authorities and others can further exacerbate feelings of disempowerment, and induce greater annoyance.

6.0 SLEEP

6.1 The deleterious effects of noise on sleep and the consequences of sleep loss are well documented and are a major concern for governments (WHO, 2004). In comparison with road, rail and aircraft noise, there is little research on the effects of wind turbine noise on sleep. One of the earliest studies (*n*=128) reported that approximately 16% of respondents living at calculated outdoor turbine noise exposures exceeding 35 dB LA_{eq} stated that wind turbine noise disturbed their sleep (Pedersen & Persson Waye, 2004). The largest wind turbine noise study to date, "Project WindfarmPerception" (van den Berg, 2008), concluded that turbine noise was more of an annoyance at night, and that interrupted sleep and difficulty in returning to sleep increased with both indoor and outdoor calculated noise levels. Even at the lowest noise levels, 20% of 725 respondents reported disturbed sleep at least one night per month. In a meta-analysis (Pedersen et al., 2009) of three European datasets (*n*=1764) there was a clear increase in levels of sleep disturbance with dB L_{Aeq} in two of the three studies. In one study an increment in self-report sleep disturbance occurred between 35-40 dBA, while in the other it occurred between 40-45 dBA. Finally, Bakker et al., (2012) present data from turbine-containing "noisy" areas showing that though individuals were not annoyed at turbine noise levels *per se*, there was a strong correlation

between sleep disruption and annoyance. This can be taken as evidence that turbine-induced sleep disruption can lead to annoyance, as per Figure 1 above.

6.2 It is unfortunate that noise from wind turbines are often at their loudest and most disturbing at night due to an increase in atmospheric stability. In other research directly related to wind turbines one study reported that sixteen percent of respondents experiencing 35 dBA or more of noise suffered sleep disturbances due to turbine noise, with all but two respondents sleeping with an open window in summer (Pedersen & Persson , 2004). Pedersen & Persson (2007), studying the effects of wind turbine noise on sleep, showed that 36% of respondents who were annoyed at wind turbine noise also reported that they suffered disturbed sleep (compare 9% for those not annoyed). Closer to home, a study undertaken in the Makara Valley (Shepherd et al., 2011), indicated that, compared to matched-control areas, satisfaction with sleep is significantly less in turbine areas than non-turbine areas.

6.3 More recent research into wind turbine noise and sleep are two studies reported by Nissenbaum (2011). In the first, a pilot study, a structured questionnaire was administered to 22 subjects living 370-1100 meters from 28 1.5mW turbines and a control group (n=28) living at least 4.5 kilometres from the nearest turbine. The turbine group had clinically and statistically worse sleep disturbance when compared to the control group. The second study, also using pre-validated questionnaires, administered the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Score (ESS) and Short-form health survey (SF36) to 79 subjects living between 375 and 6600 metres from two wind farms. Those living within 375-1400 metres reported worse sleep, and as a result felt sleepier. Modelled dose response curves of sleep scores against distance from nearest turbine (Figures 8a and 8b) were significantly related after accounting for gender and age. There was a sharp decrease in sleep quality between one and two kilometres. While the sample size is modest (n = 78), it is convincing evidence that wind turbine noise adversely effects sleep and health for those living within 1.5 kilometres of turbines. The sleep measures used in Nissenbaum's (2011) study (i.e., ESS and PSQI) are average scores, determining sleepiness and sleep quality respectively over a period of weeks. Thus occasional sleep disturbance would not alter scores as the sleep loss would have been compensated quickly over one or two nights.

6.4 Mechanisms explaining the effects of wind turbine noise on sleep have been considered, but would benefit from further empirical support (Hanning, 2011). Noise of any description can interfere with sleep by preventing the onset of sleep either at sleep initiation or at the return to sleep after a spontaneous or induced awakening. The amplitude, character and associations of the noise are all important as is the noise sensitivity of the individual and their psychological response to the noise. In this respect, wind turbine noise seems to be particularly annoying, possessing an impulsive nature with short bursts of low frequency sound, making it audible 10-15 dBA below background level (Bolin, 2009; Nelson, 2007). Nocturnal atmospheric stability ensures that wind turbine noise is maintained while ground level ambient noise diminishes. Indoor noise levels for most noise sources can be reduced by closing windows, however the low frequency content of wind turbine noise means that it may be more audible indoors than outdoors (*re*: Les Houston's statement). Additionally, during warmer months windows are more likely to stay open to control thermal parameters, whence the inability to control or modify wind turbine noise will contribute to the annoyance and, presumably, the effect on sleep onset (Pedersen & Persson Waye, 2007).

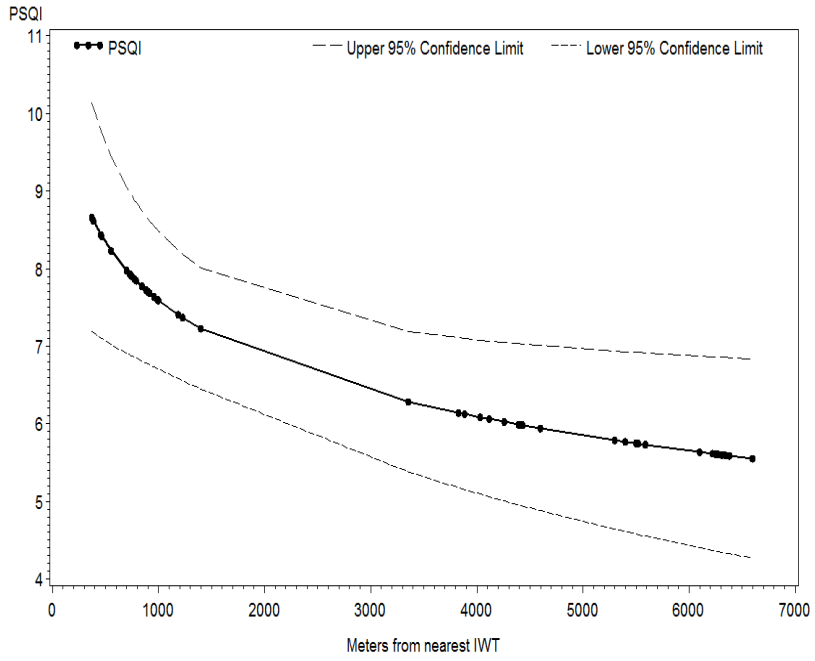

Figure 8a: Mean Pittsburgh Sleep Quality Index (PSQI) scores as a function of setback distance. The dashed lines are 95 % confidence intervals. From Nissenbaum et al. (2011).

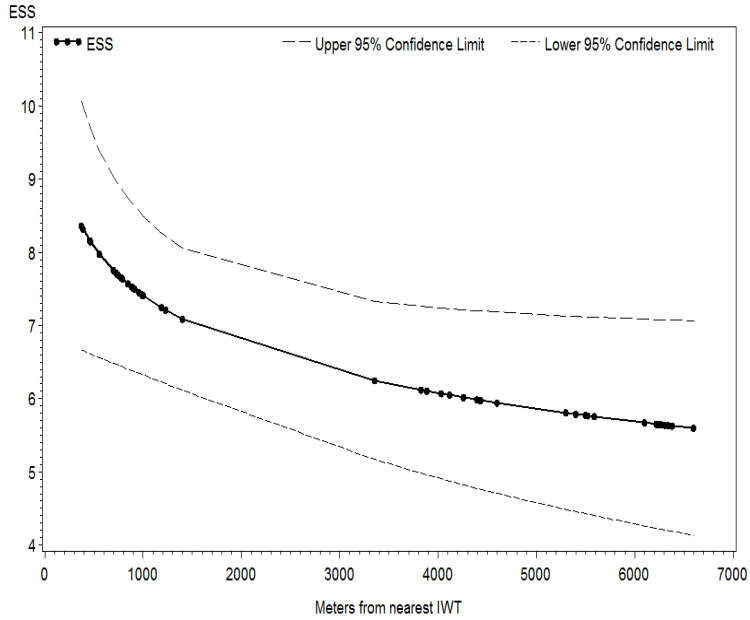

Figure 8b: Mean Epworth Sleepiness Scale (ESS) scores as a function of setback distance. The dashed lines are 95 % confidence intervals. From Nissenbaum et al. (2011).

6.5 The WHO (Europe) has attempted to categorise different bands of noise levels in relation to health impact, specifically sleep disturbance. They set out to establish a "No Observed Effect Level" (NOEL) and a "Lowest Observed Adverse Effect level" (LOAEL) for noise and various measures of health. The WHO's (2009: Table 5.4) description of the relationship between noise level (Lnight, outside) and health are repeated in Table 1:

Table 1: WHO Europe (2009) night time guidelines.

30 dB Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed.
30–40 dB A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. Lnight,outside of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise.
40–55 dB Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
>55 dBThe situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

6.6 There are a number of important points to be read from these figures, which are expanded on in the WHO guidelines. First, the WHO recognizes the existence of vulnerable groups and acknowledges the existence of individual differences in noise sensitivity. Second, health begins to be degraded between 30 and 40 $dBA_{outside}$. Third, 30 dB is the level that can be considered "safe". Last, 40 dB and above can be considered "unsafe". It is interesting to note that the originally WHO noise working party (2007) originally stipulated 30 dB, but in the 2009 publication 40 dB was stipulated. As originally drafted the WHO noise working party (2007) recommendation read thus:

"*The review of available evidence leads to the following conclusions...For the primary prevention of subclinical adverse health effects in the population related to night noise, it is recommended that the population should not be exposed to night noise levels greater than 30 dB of Lnight,outside during the night when most people are in bed. Therefore, Lnight,outside 30 dB is the ultimate target of Night Noise Guideline (NNGL) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise."*

6.7 The approach of the WHO (2009) is useful in some respects, but limiting in others. The NOEL / LOAEL values were developed primarily with aviation and road annoyance data. Reference to Figures 10 and 11 below indicates that a universal criterion is likely to fail unless additional factors are taken into account. Additionally, both NOEL / LOAEL values will not be constant across a defined population, as subgroups of that population will be more vulnerable to the effects of noise than others. While the WHO does acknowledge the existence of vulnerable groups, the 2009 levels nevertheless rest on aggregate data that for the most part do not distinguish vulnerable from non-vulnerable groups. Such an approach constitutes an ecological inference fallacy as described above.

6.8 While the noise contours presented by the representatives of Meridian Energy Limited claim to represent a "worst-case scenario" I note that they do not represent maximum

noise levels, which are more likely to disturb sleep, and studies have consistently demonstrated that sleep disturbance is related to maximum noise levels rather than aggregated measures such as dB LA_{eq}. It is for this reason that the WHO, in the 2009 Night Noise Guidelines, recommends that sleep disruption and sleep interruption be related to dB $LA_{max,\ inside}$. Nor does the "worst-case scenario" consider mechanical malfunction noise, which I have experienced myself on occasions. I defer to the statement presented by William Leslie Huson as to why the estimates supplied by the appellant should not be taken on face value, and restate again that noise levels themselves are of limited utility when predicting human response to noise.

7.0 HEALTH AND WELLBEING

7.1 Elucidating a causal mechanism between an environmental event and health is a complicated undertaking, and noise effects are commonly "indirect" as oppose to "direct". A direct health effect implies a direct pathological relationship between an environmental parameter (e.g., noise level) and a target organ or biological process (see Figure 9a). If sleep is classified as a biological process in its own right, then noise effects (*viz* dB LA_{max}) can be considered to directly cause impairments to health (see Figure 1). Irrespective, the biomedical approach has largely been discredited in the fields of health and medicine, due to, for example, its inability to account for diseases associated with lifestyles.

7.2 An alternative approach (Figure 9b) distinguishes between direct health effects and psychosomatic illness, the latter indicting that any physiological illness coinciding with the onset of wind turbine noise is caused by a negative evaluation of the noise, and not the noise *per se*. Thus anxiety or anger in the presence of wind turbine noise induces stress and strain that, if maintained, can eventually lead to adverse health effects. Some argue that a fear of impaired health resulting from turbine noise is sufficient to impair health, or put another way, *all we have to fear is fear itself*. A counter-argument to this approach is that some individuals are simply more susceptible to noise than other individuals, which fits with the general concept of biological and physical variation. A second challenge to the psychosomatic approach comes from documented instances of individuals who initially welcomed wind turbines into the community, but who later campaigned to have them removed due to

undesirable noise exposure (e.g., Martin, 2008). Lastly, the veracity of psychosomatic arguments lessens in the face of feasible biological mechanisms describing the relationship between health and noise (e.g., Lercher, 2006; and Figure 1 above), and for reasonable individuals, this argument is not accepted by the WHO as an explanation for noise-induced health impacts.

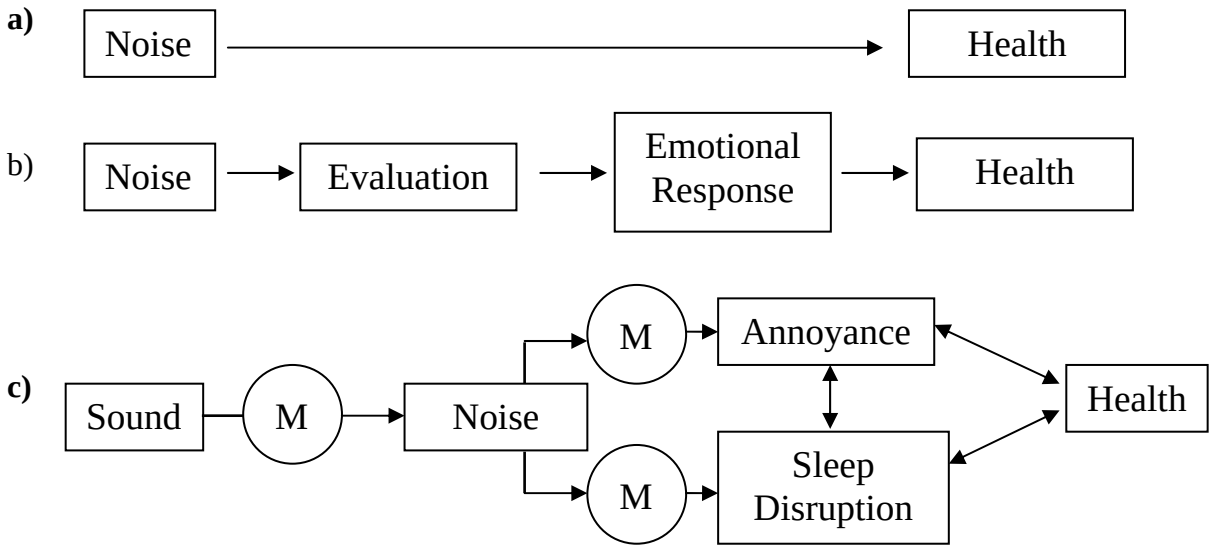

Figure 9: Three models representing the relationship between noise and health. The biomedical model (a) stipulating a direct casual relationship, and indirect models (b and c) containing moderators and mediators.

7.3 An alternative and generally accepted approach to health is the World Health Organizations (1948) definition of health (20): "*A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*". The WHO's definition states that optimal human functioning is determined by the interplay of biological, environmental, psychological, and social factors. Figure 4c displays a model consistent with the WHO's approach, in which the impact of noise is moderated by environmental, psychological, and social factors. A context-relevant model proposed by van den Berg and colleagues (van den Berg, 2008), based on previous wind turbine literature, takes a similar shape to that presented in Figure 9c. They dichotomise moderators (denoted "M" in Figure 9c) into environmental moderators (e.g., degree of urbanisation, house type, and ambient sound level), or

psychological and social moderators (e.g., age, gender, education, employment status, attitudes to wind energy, noise sensitivity, and whether the individual receives a monetary return from the turbines). Other models linking wind turbine sound and health have been proposed (Shepherd et al., 2011), but can be considered extensions of that presented in Figure 9c.

7.4 As a new source of noise, the impact of wind turbine noise is understandably understudied relative to aviation and road traffic noise. Consequently, little data exists with which to assess the impacts of wind turbine noise on health, a state of affairs compounded by rapid development of wind turbine technology, in which data collected for smaller and less powerful turbines are not generalisable to larger, more modern turbines (Van Den Berg, 2004; Møller & Pedersen, 2011). To date, there have been two approaches to collecting wind turbine noise impact data, either epidemiological studies employing surveys in which responders are blinded as to purpose, or clinical case studies (Pedersen, 2011). Both approaches typically focus on the emotional impacts of noise (i.e., annoyance), upon sleep disruption, and/or the degradation of wellbeing and increases in stress that arise from sleep disturbance and annoyance. Irrespective of approach, however, case studies (e.g., Harry, 2011; Pierpont, 2009, Krogh et al., 2011), and epidemiological studies (e.g., Pedersen & Persson Waye, 2004; van den Berg et al., 2008, Shepherd et al., 2011), have provided evidence that, like road traffic and aviation noise, wind turbine noise can be associated with negative health outcomes.

7.5 A variety of outcome measures have been reported in the literature to assess the impacts of noise, including annoyance, sleep disturbance, cardiovascular disease, and wellbeing. One approach to health assessment involves a subjective appraisal of Health-Related Quality of Life (HRQOL), a concept that measures general wellbeing and wellbeing in domains such as physical, psychological, social, and environmental wellbeing. The WHO (1999; 2009; 2011) reports that noise-induced annoyance and sleep disturbance can, when chronic, compromise positive wellbeing and quality of life. The WHO (2009) Noise Guidelines (Europe) likewise supports the use of quality of life measures (p. 92):

"*The effects of noise are strongest for those outcomes that, like annoyance, can be classified under 'quality of life' rather than illness. What they lack in severity is made up for in numbers of people affected, as these responses are very widespread*".

7.6 To determine if wind turbine noise degrades quality of life in a manner consistent with road and aviation noise a team of New Zealand researchers undertook exploratory research in the Makara Valley, a confined rural setting in which wind turbines have been operating for the past year. We used an appropriate epidemiological design, and measured HRQOL from residents in the Makara Valley and those living in a matched comparison area. The response rates, 31% and 34% respectively, can be considered high for this type of research (compare to van den Berg and colleagues (2008) 37% response rate). Each house received two copies of the questionnaire, which utilised a WHO tool to measure HRQOL, a neighbourhood satisfaction survey designed to mask the intent of the study, and questions on amenity, noise annoyance, and noise sensitivity. This research has been peer-reviewed and published in an academic journal (Shepherd et al., 2011).

7.7 Statistical analysis revealed some differences and some similarities between the two areas in terms of HRQOL. First, the Turbine sample reported significantly lower physical HRQOL, and they were also less satisfied with their sleep than those in control areas. Second, the Turbine sample reported lower environmental HRQOL, a domain that correlates highly with amenity. Third, there were no statistical differences between the two areas in relation to social or psychological HRQOL, although the latter was close to significance. Finally, when rating overall HRQOL there was again a statistical significant difference between the two areas. Interestingly, there was no difference between the two areas in terms of self-assessed health, a finding that replicates many others in the health literature, including turbines (Bakker et al, 2012), and likely resulting from the lay conceptualisation of health as being either terminal illness, disability, or infectious disease.

8.0 MITIGATING THE EFFECTS OF TURBINE NOISE

8.1 There are multiple ways in which to reduce the impacts of audible and inaudible wind turbine noise. The first, and often the most effective, method is to control audible noise at the sound source. Thus mechanical solutions invite technologies designed to attenuate wind turbine noise, or to shift its spectral character in order to eliminate salient tonal characteristics. To safeguard health is more difficult, however, because wind turbine noise is largely aerodynamic in origin (Pedersen & Persson Waye, 2004) and it is not possible to obtain solutions that completely attenuate the noise at its source. Having minimised the noise through the implementation of technology, other approaches are often required, normally involving the application of noise standards to limit exposure levels, or the determination of 'safe' setback distances to mitigate noise impact. Still other approaches involve the positioning of wind turbines around pre-existing noise generators (Pedersen et al., 2010), in remote areas away from human habitations, or using social processes to determine wind turbine location (Gross, 2007; Maris, 2007).

Standards, noise limits and NZS6808

8.2 Permissible or 'safe' exposure levels are often set in national noise standards, which may or may not be specific to wind turbine noise. These standards may serve one of two purposes, or sometimes both, with noise compliance guidelines naturally emerging from the two. The first purpose relates to methodologies for the physical quantification of the noise. This may involve standardised procedures for measuring noise from pre-existing wind farms, or detailing accepted mathematical models affording noise predictions of a planned wind farm. The second purpose is to determine what exposure levels can be considered safe, and to clearly state criteria to this effect. However, there are a number of flaws inherent in wind turbine noise standards, including the metrics used to represent the noise, over-simplified modelling approaches that yield unrealistically low predictions of noise levels representing "best case" conditions (e.g., IEC 61400-11, 2002), or stimulus-orientated approaches that fail to account for human factors (Thorne, 2011).

8.3 Most noise standards utilise noise level as an acceptable correlate of health. In fact noise level is actually a very poor predictor of the human response to noise, and its role in health is commonly over-emphasised. Indeed, over 40 years of laboratory and epidemiological research has discredited this stimulus-orientated approach to noise effects, or flagged other more important characteristics of the noise (e.g., modulation) as important. For this reason noise standards promoting only noise level as the metric to assess health impacts should be approached with caution.

8.4 Noise standards, even those advocated by the WHO in the past, are based on the dose-response curve. The dose-response curve plots noise annoyance (or some other outcome measure such sleep disturbance) as a function of noise level. Users of a dose- response curve define a level of annoyance that they are willing to accept and then, either graphically or numerically, determines the level of noise that yields the predefined annoyance level. Figure 10 illustrates an actual equation-based dose-response curve used to determine acceptable levels of aviation noise.

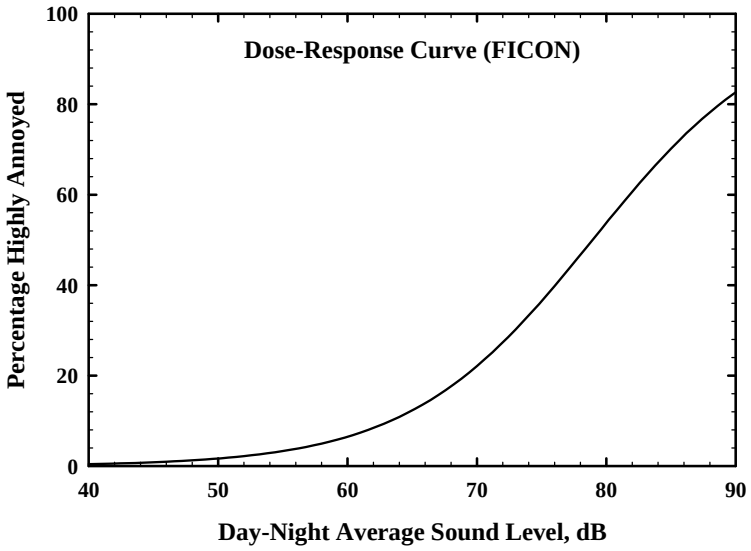

Figure 10: A theoretical curve formulated to model the relationship between noise level and annoyance to aviation noise.

8.5 Figure 11 is the same curve but with a shortened x-axis (now from 57 to 68 dB) accompanied by actual measurements of noise annoyance from numerous studies reporting annoyance to aviation noise. Note the incompatibility of the theoretical

curve (solid curve) and the empirically derived data points. Scrutiny of Figure 11 reveals that annoyance reactions to noise vary substantially and do not appear to be correlated with noise level. It can be concluded that the high variability between individuals and groups makes it difficult to model the relationship between noise and annoyance. Regrettably, formulas such as that in Figure 10 are still used to determine noise standards.

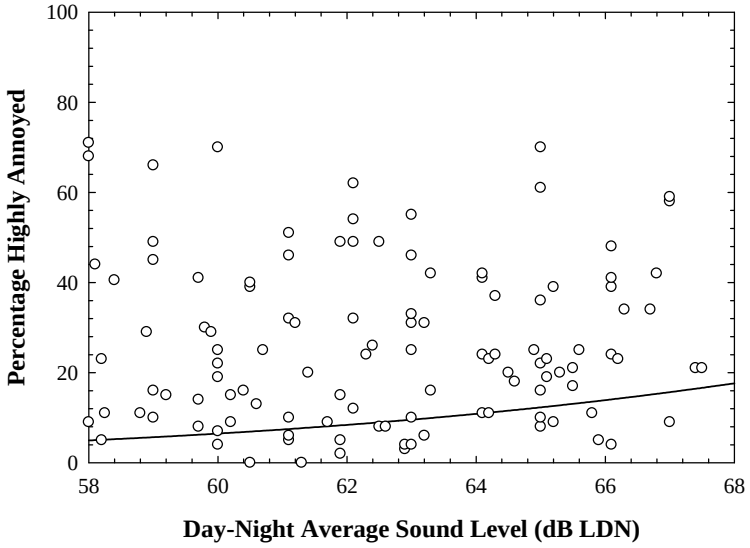

Figure 11: Percentage highly annoyed at aircraft noise plotted as a function of noise level. The solid curve is a portion of that presented in Figure 3, while the scattered points represent real measurements (data from Fidell, 2003: used with permission).

8.6 A further handicap of noise level approaches, including NZS6808 (2010), is the use of the dBA metric. Eberhand Zwicker (1999), a recognised global authority on noise measurement and noise abatement, questions the "enthronement" (p. 66) of the dBA scale in noise measurement practice. He demonstrates that, frequently, dBA measures are of no intrinsic use, and can produce misleading measurements. He also warns against the exclusive use of physical sound measures such as dBA in noise control situations, and one of his statements is worth repeating here (p. 67):

"*It is definitely not the simple dB(A) measuring equipment which is annoyed by the noise, but individuals and their hearing organs that have to endure the noise whether they like it or not!*"

Degrees of annoyance to noise cannot be measured by sound level meters; instead it can only be described by the listeners themselves. Thus, the response of the individual to the sound is just as important as the acoustic properties of the sound wave. The "people" side of noise is commonly absent from acoustics reports, where acousticians have a tendency to treat a spectrum analyzer or a free field microphone as equivalent to a human being. In one example, Zwicker (1999: p.70) uses motorbike noise to demonstrate how the dBA scale can produce meaningless values. Here he presents data in which a motorcycle was modified to produce 3 dBA lower noise levels, while actually being 25% louder.

8.7 There exists, in respect to levels-based noise standards, disagreement as to the relevance of physical measures such as dBA to human response (Fidell, 2003), not only for wind farm noise (Pedersen, 2008) but also traffic and aviation noise. Of the few parametric studies that have been published (e.g., Pedersen & Persson Waye, 2004, van den Berg et al., 2008), only marginal dose-response relationships between wind turbine noise intensity and health measures have emerged. For example, Pedersen (2011) noted that stress was not related to wind turbine noise level but rather noise annoyance. Persson Waye and Ohrstrom (2002) reported that annoyance ratings varied for five distinct recordings of wind turbine noise, even though all five had equivalent noise levels. Others note that both laboratory and field studies have consistently found that the equivalent dBA measure fails to account for the relationship between wind turbine noise and annoyance (Pedersen & Persson Waye, 2008).

8.8 It is accepted that both the physical parameters of the noise and the psychological characteristics of the listener combine to produce noise annoyance (Lee et al., 2011). On the physical side, the relatively high annoyance levels elicited by wind turbine noises (e.g., swishing or thumping) may be explained by the increased fluctuation of the sound, up to 4 to 6 dB for a single turbine operating in a stable atmosphere (van den Berg, 2005). Individuals are also highly sensitive to changes in frequency modulation variations of approximately 4 Hz or greater (van den Berg, 2005). Noting that amplitude modulated sound is known to be more annoying than un-modulated sound, Lee et al., (2011), in a laboratory setting, demonstrated that amplitude modulated wind turbine noise was consistently judged more annoying than its un-modulated counterpart. Thus the dominant acoustic driver of annoyance is likely to be noise

dynamics rather than noise level, and Lee et al., recommend that standardised metrics based on the modulation depth spectrum be developed and used in conjunction with sound levels. Other approaches to measuring amplitude modulation have existed for some time (Ando & Pompoli, 2002; van den Berg, 2005) but have yet to be seriously applied to the wind turbine noise context. In *Appendix B: Special Audible Characteristics*, NZS6808 (2010) recommends a subjective-assessment in some circumstances, but the description of a standardised objective assessment would have been more appropriate.

8.9 In presenting at the 2011 Wind Turbine Noise conference in Italy I took the opportunity to attend other talks and to discuss the issues around modelling with acousticians whom, unlike myself, could be considered experts in this area. Nearly all concur that wind farm noise modelling in its current state lacks scientific credibility, which this has been known for some time, and that significant development needs to be undertaken in the area. Table 2 contains a number of important factors that need to be accounted for in noise modelling. Arguably, the first two factors are sufficiently accounted for in NZS6808 (2010), the third factor partly (for wind speeds up to five metres per second, and the remaining factors not at all. It was further evident from the pace of development in this area that NZS6808 (2010) cannot be considered up-to-date. For example, the NZSS6808 revision committee used the WHO Guidelines for Community Noise (1999), already a decade old, and not the WHO Night Noise Guidelines for Europe (2009), which were fortified with updated research demonstrating that aspects of the 1999 Guidelines were in need of review, including a lowering of noise threshold levels associated with health impacts.

Table 2: Factors effecting the prediction of wind farm noise levels at a receiver. A conservative set of noise predictions should take all factors into account.

- The true sound power level of the turbine(s) at the specified wind speed
- The reduction in sound level due to ground effects
- The increase or reduction in sound level due to atmospheric (meteorological) variations and wind direction
- The variation due to modulation effects from wind velocity gradient
- Increase and reduction in sound levels due to wake and turbulence modulation effects due to turbine placement and wind direction
- Increased sound levels due to synchronicity effects of turbines in phase due to turbine placement and wind direction
- Building resonance effects for residents inside a dwelling.

8.10 Mr Stuart Camp, in his statement dated 12/08/2012, has repeated some modelling and confirms that the calculations have been correctly undertaken, this being an important process in quality control. However, he does not offer a critique of the general approach or methods contained within NZS6808, an important task as the modelling has not been independently validated or tested. Wind farm noise impact modelling to the wind farm standard (NZS6808:1998) has been found deficient in a wind farm hearing (Te Rere Hau) currently before the Environment Court (re: ENV-2010-WLG-000114). The 1998 standard has been found to be deficient in Victoria, Australia, and is currently subject to review for the Environmental Protection Agency in that state. It is understood that Dr Chiles, the author of the 2010 standard, is involved with the preparation of updated guidelines, suggesting that the standard in its current form is inadequate.

8.11 Broadly, in my opinion, both Te Rere Hau and Victoria confirm that the basic problems with NZS 6808 1998 and 2010 are that the "standards" (1) fail to provide an accurate prediction methodology that reflects the physical operation of a wind farm with different wind speeds, wind directions, turbulence and other meteorological and topographic factors; (2) fail to provide a definitive assessment protocol to clearly define wind turbine sound contribution within ambient sound; (3) fail to provide a definitive assessment protocol for special audible characteristics and, most importantly, (4) fail to recognise the adverse human perception of the sound from the wind farm turbines. Currently, there is no epidemiological evidence available to prove that the so-called "acceptable" criteria in the standard is acceptable to anyone in the receiving environment.

8.12 That NZS6808 (2010) is not necessarily definitive is further demonstrated by the lack of agreement that exists amongst experts. The quarrelling surrounding the revision of the New Zealand standard for acceptable wind turbine noise (NZS6808) is testament to this (see, for example, the September 2010 Edition of the NZ Acoustical Society Journal, New Zealand Acoustics). The fact that the revision panel's two university representatives (Dickinson and Dodds) failed to endorse the revised standard (NZS6808:2010), and that the community representative (Ruth Paul) likely would not have voted positively given subsequent interpretations of the revision (see Appendix

B), relegates the standard to a tool developed by, and for, the wind industry and associate interests. As such, it is very difficult to argue the credibility of the standard.

Set-Back Distances

8.13 In my opinion NZS6808 (2010), like many noise standards, fails to protect public health by failing to correctly conceptualise the relationship between noise and health, a deficiency perhaps brought about by a lack of thorough research. In adopting averaged noise levels as a marker of compliance, NZS6808 (2010) bypasses much of the knowledge found in the scientific literature, and misapplies knowledge presented by agencies such as the WHO. An alternative approach to the use of noise levels are buffer zones or "*set-back distances*".

8.14 Setback distances may be based on noise level, which, as discussed in the preceding section, is not a valid approach. Instead, a better approach may be to link setbacks to turbine type. Møller and Pedersen (2011), investigating the detection and annoyance of lower frequency sound emitted from wind turbines, suggest that, for flat terrain, the minimum set back distance for modern turbines (2 to 3.6 MW) should be between 600 to 1200 meters. The United Kingdom Noise Association acknowledges that ill-effects may be experiences up to 1-1.5 miles (1.6 to 2.4 kilometres) of large wind turbines. In Australia the 2 kilometre set-back has already been adopted by the state of Victoria, while New South Wales and South Australia are currently considering it. Additionally, some states in the US currently specify a 2 kilometre buffer, as does the Scottish Planning Policy SPP6 (Renewable Energy), though on a case-by-case basis. One German wind turbine manufacturer (RETEXO) states that "*Buildings, particularly housing, should not be nearer than 2 km to the windfarm*".

8.15 Other approaches rely on the establishment of dose-response curves relating a health outcome variable (e.g., annoyance or disturbed sleep) and distance (e.g., Nissambuam, 2011). Nissenbaum's Figures 8a, 8b, & 12, clearly demonstrates that adverse effects are substantially greater below two kilometres. Some medical professionals have proposed setback distances of 2.4 kilometres (Harry, 2007; Pierpont, 2009) or 1.5 kilometres (Hanning, 2011). Other research recommends a

minimum of two kilometres if wind turbines are cited in rough terrain (Thorne, 2011; Shepherd et al., 2011), including my own (Shepherd et al., 2011). Thus at the current time there is sufficient epidemiological data to recommend a set-back distance, which for the prevention of adverse health effects, should be no closer than two kilometres to any non-consenting dwelling.

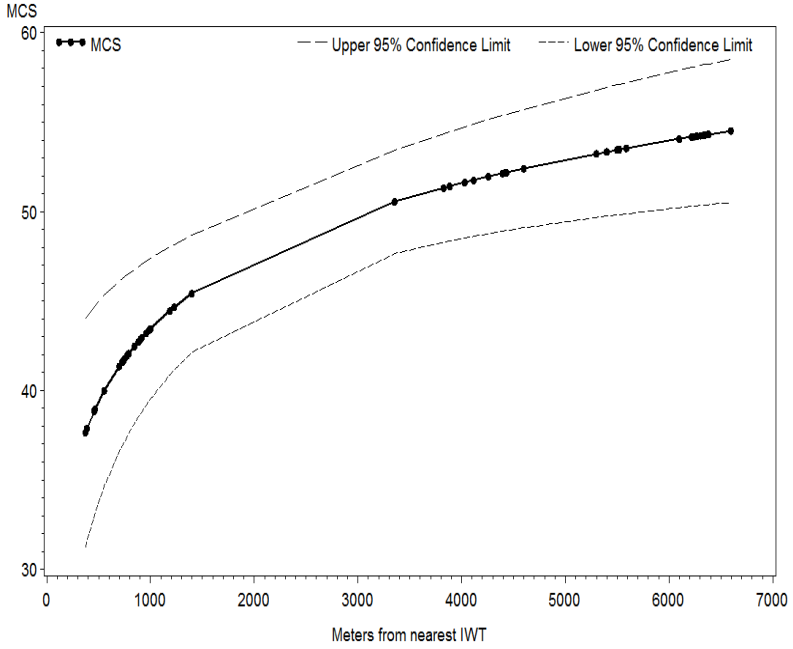

Figure 12: Mean Mental Component Score (MCS) as a function of setback distance. The dashed lines are 95 % confidence intervals. From Nissenbaum et al. (2011).

8.16 For European dwellings, Bakker et al., (2012) report that at distances of 2.5 kilometres it would be expected that wind turbines would no longer be audible indoors, though still audible outdoors in certain conditions (e.g., wind direction). However, the authors did assume that wind turbines were situated on flat terrain, and thus negated topographical effects.

8.17 I argue, therefore, that rather than relying on NZS6808(2010), that a set-back distance be applied. This will minimise monitoring, and noise measurements can be undertaken on an as-needed basis for houses within the proximity of the boundary. To protect health I would to recommend a minimum of a two kilometre set-back, though the court may wish to further consider the issue of amenity and extend this perimeter.

In his statement to the court, David Meares provides estimated distances of dwellings from the 33 proposed wind turbines in his statement of evidence, and these can be considered and referenced to determine which of the 33 turbines should be granted consent.

9.0 RECOMMENDATIONS

9.1 In formulating recommendations I note that the control of unreasonable noise is central to the Resource Management Act. Section 16 describes a "Duty to avoid unreasonable noise", while Sections 322 to 324, and 326 to 328, of the Act empower local authorities to issue an abatement notice containing the prescribed particulars to an occupier of land from where "unreasonable noise" is emanating. Additionally, in relation to public health, Section 5(2) states:

"*managing the use, development and protection of natural and physical resources in a way, or a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety*."

9.2 Thus the decision-making processes utilised by local and regional authorities must account for the health and wellbeing of those impacted by their decisions and policies. Noise is recognised by the World Health Organisation, as a degrader of health and wellbeing (1999, 2011), and thus authorities should, as directed by statute, consider noise when developing policy and making decisions.

9.3 Noise impacts individuals predominantly by inducing stress (the term "annoyance" is used in the noise context) or disrupting rest and sleep. By this definition noise can be considered a "nuisance". *Noise nuisance* is defined by the New Zealand's Health Act (1956) as follows (Section 23, Paragraph K only):

"…where any noise or vibration occurs in or is emitted from any building, premises, or land to a degree that is likely to be injurious to health."

and though this definition does not apply if another statute is more specific (e.g., the RMA) it is useful to document instances of noise policy within New Zealand legislation.

9.4 In helping me prepare my evidence for this Hearing, I refer to Judge Panckhurst, (Langdon v Bailey, AP3-00: Timaru Registry) who defined nuisance as

"…a repetitive activity which causes damage to the plaintiff's land or his enjoyment of it."

9.5 The two common themes emerging from legal definitions of noise nuisance are degraded amenity (i.e., "enjoyment") or insult to health (i.e., "injurious"). However, these two themes are not mutually exclusive. The world's highest authority on health, the World Health Organisation, defines health thus:

"*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*."

where physical, mental and social well-being are themselves dependent upon restorative environments, that is, environments high in amenity. Figure 1 above demonstrates how nuisances such as noise can be quantifiably unreasonable and directly injurious to health, or indirectly injurious to health by degrading amenity.

9.6 The test as to the amount of annoyance necessary to constitute an unreasonable noise differs according to jurisdiction. Two tests of unreasonable noise are generally encountered, with the first test involving the use of noise standards. Critical analysis of the current New Zealand standard NZS6808 (2010) leaves me in no confidence as to whether noise from the proposed Project Hurunui wind farm can be judged as reasonable or unreasonable. A second, less quantitative approach in judging nuisance involves asking a question of the sort:

"*Would a person of ordinary sensibilities regard the noise as an interference materially affecting their physical comfort to a degree which would constitute an unreasonable noise*?".

Having interviewed numerous residents whom will potentially be exposed to noise from the proposed wind farm I assert that a) they can be considered to have ordinary sensibilities, and b) working with the definitions and Acts presented in paragraphs 9.3 and 9.4 above, their loss of amenity and levels of annoyance will likely result in the noise to be considered unreasonable and, potentially, an objectively quantifiable nuisance in the future.

9.7 It should be acknowledged that not all potentially exposed residents can be considered, on the basis of current psychiatric diagnostic criteria, to be of "ordinary sensibilities. I understand that there exists several individuals within the area that have been diagnosed with autistic spectrum disorder. For these individuals noise level is a relevant metric, and would be difficult to relate to an individual with autism. The WHO (1999, 2009) warns that special consideration needs to be given to vulnerable groups, including children and those with psychopathology. Historically, many have stated that you measure the degree of civilization of a society by how it treats its weakest members, and I note New Zealand has ratified the United Nations Convention on the Rights of Persons with Disabilities. As a society then we should give special consideration to our weakest members, though they may be outside the normal population distribution and considered "abnormal". In medicine, one section of the modern translation of the Hippocratic oath asserts:

"I will remember that I remain a member of society with special obligations to all my fellow human beings, those sound of mind and body as well as the infirm."

and the potential effects of noise on vulnerable individuals should be appropriately considered during this hearing.

9.8 In considering vulnerable individuals it may be useful to enact the precautionary principle. A European Commission (2000) Communication on the Precautionary Principle notes:

"*The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU*".

Preliminary scientific evidence indicates that like other noise sources, wind turbine noise is disruptive to sleep and health, and when compared at equivalent noise levels, may be even more toxic than other sources (see Figure 6). Thus we should be mindful also of the precautionary principle and that absolute certainty may not be required in order to take action to prevent harm, especially to vulnerable individuals. Another section from the modern translation of the Hippocratic oath reads:

"*I will prevent disease whenever I can, for prevention is preferable to cure."*

Conclusion

9.9 The introduction of audible wind turbine, in transforming a semi-rural/rural environment into a semi-industrialised environment, will likely impede the residents' ability to enjoy the surrounds. In the worst-case scenario health may be degraded due to sleep disruption and annoyance.

9.10 The NZS6808 (2010) is not fit for purpose, it should not be used as an integral part of the proposed consent conditions, and will not provide the required degree of certainty affording a guarantee that noise effects will be no more than minor.

9.11 The adoption of a two kilometre buffer zone and giving consent to wind turbines beyond two kilometres from a dwelling represents the best possible compromise between community and wind turbine developer. It will also simplify compliance processes.

9.12 Finally, acceptable quantities of noise exposure are ultimately a societal and not a scientific decision. That decision is made by individuals choosing how best to distribute their resources relative to their needs, that is, by choosing where they live. Those choosing to live in quiet areas should only have their locality compromised by industrialisation if it can be shown that the change is vital to the health and existence of the nation. As I understand it, such judgments are core decisions to be made by the Environment Court.

Dated this day of April 30, 2012

Daniel Shepherd

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APPENDIX A

Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. Noise and Health, 13(54), 333 – 339

See separate file: 11a. Appendix A - Statement of Evidence of Dr Daniel Shepherd.pdf

Appendix B

Communication with Ruth Paul

From: Ruth Paul [mailto:ruthpaul1@xtra.co.nz]
Sent: Tuesday, 24 April 2012 2:09 a.m.
To: Daniel Shepherd
Subject: Re: NZS6808 2010 - high amenity noise limit - this time?

1. NZS6808 2010

It concerns me that the application of the High Amenity Limit at 5.3.1 of the Standard is being misinterpreted.

5.3.1 states that a high amenity limit 'should' be considered where a District Plan specifies a noise limit lower than 40dB. I agree, it should.

5.3.1 does not say the high amenity limit 'should only' apply where the District Plan sets a limit lower than 40dB. The 'should' of 5.3.1 is explicitly different in the scheme, than the 'should only' of 5.3.2. This is intentional. As in a legal document, 'should' is quite different from 'will' and sits in the same territory as 'may'.

The commentary of 5.3.1 enumerates the specific situations in which the limit would/could be considered for application. In other words, residents or interested groups can and should argue their case for application of the High Amenity Limit if they have the evidence, regardless of District Plan noise specifications.

The wording in 6808 was hammered out very carefully and with much input from all committee members. I was only able to vote positively for the Standard as a community representative knowing that affected parties who wanted to put their case for a living in a High Amenity area were able to do so.

Another area where the wording was very carefully considered was 5.3.2. Justification for 6m/s (at the windfarm) as the threshold speed for the High Amenity Limit came from data collected at Westwind. This data was commercially sensitive so was not presented to the committee. In other words, the committee saw no evidence to support this being the appropriate threshold. It is therefore important to consider seriously the final sentence which states that '*…An alternative wind farm wind speed threshold may be applied where justified on meteorological, topographical, and acoustical grounds'*. This should be combined with C5.3.2 where it says that '*… The wind farm developer will collect, analyse, and provide the data according to this Standard to justify that their proposed wind farm wind speed threshold is appropriate'*.

There are other areas of NZS6808 that I believe are a big improvement on the previous Standard and I would be happy to offer my view on their intent and purpose if requested by the committee.

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APPENDIX C

Responses to an open-ended question in the Wellbeing and Neighbourhood Survey**.**

Respondents were invited to share comments on the final page of the survey and were instructed thus:
If you would like to share any comments relating to your neighbourhood or this survey then please do so in the box below. For example, have there been any changes to the better or the worse in your living environment/ neighbourhood during the last year

Comments were elicited from respondents in three areas: the control areas (C1) which were demographically matched to the Makara Valley, the turbine-containing Makara Valley (C2), and the Ohariu Valley (C3), an area currently being considered for turbines.

Table C.1: Comments from the Wellington rural control area

C1.1	I live in a rural setting. Approx 8 minutes by car to nearest shop. I have neighbours but probably not as close as town. Ave 20-50 metres.
C1.2	The idea of potential wind farms is horrifying
C1.3	We live on a lifestyle block and we love the peace and quiet. We have a variety of animals and pets.
C1.4	Where I live is fairly rural. Would have more issues if I lived in the 'burbs.
C1.5	Q8: The drug 'P' is what makes me feel most afraid as it is in every neighbourhood. Neighbours children are incredibly noisy, screaming and yelling all the time.
C1.6	Live in semi rural area 6km from Upper Hutt. More traffic from subdivision of blocks of land. More trees planted in what was once pasture so in future lack of views. Horse riders/cyclists who think they own the rural roads.
C1.7	I live in a rural environment. Subdivision of nearby farms is leading to a wee bit of over-crowding (i.e.; curtails some shooting and stock movement). But has advantages of meeting interesting people.
C1.8	Too much sub-division of rural land
C1.9	Problem with boy racers, but healthy environment, friendly neighbours who are not too close. Road has recently been widened, which has worsened the boy racer situation
C1.10	*Extensive comments regarding housing development without providing infrastructure to support it, examples of problems caused were provided.*
C1.11	A council introduced recycling programme is good. Housing development without upgrading the roads is putting too much pressure on the neighbourhood, making it unsafe for pedestrians, cyclists and horse riders.
C1.12	Council has a long-term plan to develop the area into high density, affordable housing. Community is concerned about social problems, noise and pollution affecting quality of life and desire to remain in the neighbourhood.
C1.13	Happy with rural lifestyle after moving from city to get away from bad neighbours, in-fill housing, over-crowding and lack of privacy
C1.14	Problems with mentally ill neighbours
C1.15	We don't know our neighbours
C1.16	Neighbours pets/hand reared animals are allowed to roam free into our property and eat our gardens. Our young son has been confronted by the animals and now doesn't cope well with those animals elsewhere.

C1.17	No buses in rural areas, and no street lights. The roads are dangerous without them
C1.18	Since council relinquished local landfill to private ownership, roadside & park litter increased dramatically
C1.19	Inconsiderate groups cyclists who won't pull over to let cars past, and sport-based road closures which don't take into account that people need to take children to school, or travel to work etc.
C1.20	Semi-rural environment getting more populated causes earth works, less privacy, and increased problem in narrow roads. Council also reduced recycling efforts which causes rubbish build-up
C1.21	Increase in fast traffic
C1.22	Environmental pollution of wind turbines. The proposed placement would expose us to noise pollution
C1.23	Large increase in traffic since I moved here 3 years ago
C1.24	Would like to know outcome of survey, Deanne Gabita thegabites@xtra.co.nz Neighbour has burgled them several times, affects quality of life.
C1.25	Wind turbines would be the only reason I would ever want to leave here.
C1.26	A lot of theft in our area lately.
C1.27	As long as there are no wind farms build along side us I think we'll spend the rest of our lives here!
C1.28	Joy-riding traffic is a problem in our rural area, especially for the people walking, riding bicycles, and horses.
C1.29	The roads are not safe for the amount of traffic. Bikes, children, horses and pedestrians sharing the road with cars, trucks, farm vehicles etc.
C1.30	No wind turbine was a great relief for everyone. Motorcross drivers & logging trucks are dangerous on the roads. Lack of broadband is frustrating.
C1.31	Poor quality dangerous roads, & poor public transport. Commute is too long
C1.32	A walkway has just opened up, which has spoilt our seclusion
C1.33	The community is under threat by potential wind farms
C1.34	Feel threatened by the wind farm destroying their peace
C1.35	Local council is investing in the neighbourhood with things like roads, library art-work, rubbish & recycling. I feel as though my rates are benefiting me.
C1.36	Rural setting means little or no services from council such as lighting/footpaths
C1.37	Neighbours dogs constant barking
C1.38	Council don't consider local residents, and can't seem to agree with regional council
C1.39	Subdivisions mean more people, roads not up to it. Too narrow and winding. Pesky road cyclists who think they own the road.
C1.40	Subdivisions have caused friction between neighbours
C1.41	Roading can't cope with population growth in neighbourhood
C1.42	Vandalism from kids who don't live in the area, and people dumping rubbish who don't live in the area

Table C.2: Comments from Makara Valley

C2.1	I live in Makara which is a rural community. The Westwind farm has been commissioned in the last 12 months. This has had a considerate or great affect on

	my way of life, and has changed the way I live and also deprived me of my greatest interests and activities.
C2.2	Installation of wind turbines have had a negative effect on my environment
C2.3	There is only 1 issue in our neighbourhood that causes concern and that is the building of an industrial wind generation site called Westwind by Meridian, an SOE. In many ways it has brought this community closer together to fight the common foe. The problem is not the visual. The problem is the noise generated by the wind turbines. We are concerned about the adverse health effects and sleep deprivation that is caused by them. Well over 1000 complaints have been logged on the 0800 complaints line, but little has been done to improve the situation, the wind industry noise standard NZS6808 is not adequate to protect residents when the turbines are built with no consultation with residents. We didn't want them there, and the Government and their SOE rode roughshod over our concerns.
C2.4	We live in Makara, have been here 6 years, moved here for the quiet life plus having more land to enjoy. We enjoy being outside working on our land. I work full time in the CBD so look forward to coming home to the quiet, but unfortunately in the last two years we have had turbines installed. We see twelve of them from our home. When I sit in my chair in the living room, this is alright but when they get noisy this is what I get upset about. You go to bed to sleep and the noise is there, it sounds like a plane that keeps going around and around and does not fly away, or it is the vibration we feel. I have not had a decent night's sleep in that time. I can wake up to about six times in the night so my quality of life has changed for the worse. Nobody wants to know. Basically we are left to get on with it. If we complain we are a pack of whiners or whingers. Our rural lifestyle is horses, no transport, no lighting, but we do have a café.
C2.5	We live in a rural village – access to shops, medical, public transport etc in a 10/15 min drive over a winding road up a steep hill. We have been inflicted by a wind farm with visual and noise pollution, completed late last year.
C2.6	Not in the last year, but previously. Turbines have been built behind our property causing grief, lack of sleep and lack of stress in family harmony.
C2.7	Wind turbines have spoilt the district.
C2.8	I live on a lifestyle block on the fringe of Wellington city.
C2.9	I live within 2.3 of 5 turbines. They are to the North + Northwest (prevailing wind) of me + some to the south. I live on the valley flat. The sound is noticeable during the day BUT at night it bothers me when I am a) trying to go to sleep b) if I wake up.
C2.10	It is not a loud noise but it is a vibration. I admit it probably meets sound conditions of the resource consent BUT this says more about what is allowable under resource consent than about what is reasonable and comfortable. Without adequate sleep or with disturbed sleep I begin to feel anxious and stressed and it is hard to separate out what is contributing most to the stress I experience. I have just returned from 5 days away in the South Island. I had a fantastic trip so probably my ratings reflect that.
C2.11	Power station wind farm has destroyed the recreational and tranquillity of the region with unexplained vibrations and noise pollution. People working outside are effectively bombarded with frequencies with cause headaches, dizziness, and motion sickness. This is amplified at night when sleeping.
C2.12	The biggest change in my living environment has come from the direct impact of the wind farm built in our district despite strong opposition from residents. I now

	have 11 visible turbines in my direct line of sight – the closest is 1.2 KMs ranging to 2.9 kms. I am disturbed by noise, sight, vibration, flickering shadows and red lights on top of turbines. My sleep is disturbed. I live in a rural environment for its peace, lack of housing, beauty, relaxed lifestyle. The wind farm has changed all that, we are not compensated nor draw any direct benefit from them (unless of course I include some notion of a reduction of green-house gasses and global warming etc etc)
C2.13	As far as my community is concerned, this questionnaire would have great relevance and significance if it were to study the extremely harmful effects of living within a short distance of wind turbines. Overseas studies are beginning to show how people and communities in general are suffering. To apply pressure on the government and energy suppliers, they need to see a properly conducted survey that hopefully would stop wind turbines being sited so close to people's homes. All universities and the NZ WHOQOL group could make a significant contribution. Please think seriously about doing this.
C2.14	Meridian Energy has completed construction of "West Wind" wind farms in our quiet rural area. It at times produces noise into the environment that dominates the background noise levels and sounds. Residents have no compensation for their changed living environment. Most consumers of power don't think about the consequences of their usage – our quality of life is effected.
C2.15	The biggest change has been the building and operating of the wind farm. I have had to de-tune my ears and senses to the noise created by the turbines. Generally I sleep all night and the turbines have woken me on several occasions, and I have not been able to sleep. The generally absolute silence we loved living here has gone. Sydney – Balmain is quieter than our property now.
C2.16	Our living environment has changed dramatically in the last year or so. Meridian Energy has built 'West Wind', a wind power station with turbines along the ridges that face our homes. The turbines are too close to homes; there are around 125 private homes within 2km of the turbines. Many homes lie downwind from the turbines – the prevailing wind flows over the power station site towards homes. As we said, this carries the noise for greater distances. The company told the general public that: "the turbines will not be noisy for the residents of Makara" – and so got the general public to support their proposal. Now it is noisy for us, the company says they always said there would be some noise!! The trucks started at 3:30am every morning except weekends (when on Saturday it was 6am) – during construction. The background sound levels at my home have been measured at 14.1dba at night – so the traffic woke me up, and then I could not get back to sleep. Meridian assured the court construction traffic would not start until 6am. It took six months to get the 3:30am start stopped – by that time I was exhausted (and my husband too) with the lack of sleep. My husband's work also suffered. The power company has treated our community with utter disdain – as if we do not exist even. They did not carry out the background noise testing that they were supposed to have carried out – they get away with whatever they want – leaving the community powerless and with a completely changed – for the worse – environment. This is unjust, as they have profited from their dishonesty and cavalier disregard while the community has suffered, yet the community was always honest in it's claims. Meridian has stopped access to the Makara Farm/Terawhiti which we have always been able to access in the past to go over the hill to access the coast further south, so considerably restricting recreation opportunities that used to abound in our

	environment. Our landscape has been changed from an outstanding natural landscape to a vast and kinetic industrial landscape. What we used to enjoy and appreciate has been lost. We cannot avoid seeing turbine blades from our deck and the garden around our home which faces towards the NW to catch our sun. We have spent most weekends away from Makara and our home, to escape.
C2.17	We have a good neighbourhood (rural). Meridian West Wind project has caused all sorts of issues – initially, we had a mutual enemy that brought us together. However, now, the reverse seems to be happening – with some people taking what they can from Meridian and others who have serious noise issues find that attitude obnoxious – so the turbines are causing rifts that were never there when we moved out to Makara. Endless giant piloted truck movements through our formally quiet rural roads to fix broken turbines is annoying. The council doesn't really care.
C2.18	Before the turbines were built, there was no loss of sleep, nausea and headaches. Within three months of their construction the symptoms started. It's terrible now when the wind comes from the north of northwest. The quality of life is gone. How the government and the city council have allowed this to be built is completely beyond my comprehension.

Table C.3: Comments from Mill Creek

C3.1	Many changes for the worse, more houses being built, neighbours closer (sounds travel in the countryside), townies with no idea of animal control and pest control, and consideration, and fencing issues etc. Don't respect boundaries, animals straying, more traffic – speeding, boyracers, motorbikes, ATVs. People cutting down trees and not replanting. Damage and silt affecting streams and running off neighbourhood properties. Rubbish along the road – dumped from vans and cars. Windfarm issues – changed whole wellbeing feeling of the neighbourhood and split families etc. Some positives, some people planting trees, native bush: more birds. Some going organic, reducing spray use and fencing off streams from stock.
C3.2	The proposal of a windfarm in our neighbourhood has had an extremely negative impact on our local/neighbourhood community. It goes to the environment court late in the year.
C3.3	Problem, erecting windmills, luckily we still fight. Neighbours, great, quiet, pleasant. Bugger all street lights – thank god!
C3.4	We live in a rural area, now fighting wind farm. Too many houses and subdivisions being allowed with little or no consideration to existing landowner house sitings. This is putting huge pressure on the quality of life in this rural area and seems the "rules" for subdivision are not being followed at all.
C3.5	We live on a lifestyle block in Takara Gorge Road, Ohariu Valley. We have noticed an increase in road traffic over the last year. This is in part due to improved road surfacing encouraging more users, especially in the weekend. Speed and noise is a constant issue and concern, especially with our community foot traffic on the road, ie house/children + also cyclists being unsafe as a result. Since west wind turbine installations have become fully operational we can hear the turbines and we are more than 8 km from them. We don't hear them every day but it is concerning that we hear them at all. Many of our neighbours can hear them and are suffering disturbances to their sleep and quality of life. We are deeply concerned about the proposed mill creek wind turbine installation which

	will be much closer to our home.
C3.6	Some levels of stress related to proposed windfarm (Mill Creek). Stress related to neighbours not getting on so well (those for vs those opposed to wind farm). Worry over potential effects of noise and how this may affect our quality of life. Currently we can not really hear the turbines at Makara – just occasionally and not too intrusive.
C3.7	Road into the valley has got busier with more trucks and general traffic. Our outlook to the south (Makara) is now dominated by 20 – 30 turbines. We were visited by Meridian's landscape expert earlier this year as our property has been identified as being significantly affected by their proposed Mill Creek wind farm. Photo simulations show that most of the windfarm is potentially visible from our property. During their visit they commented that we could be surrounded by turbines. We find this very distressing as our surroundings are very important to us and we put our heart and soul into creating a special environment for our family. It has been a shock for our community that (80%) to learn that our homes have no protection and we have no representation and support from the council or government. In the past year we have installed solar hot water and solar panels which provide all the electricity we need with any excess going into the grid. This has not caused any disturbance to our neighbourhood!
C3.8	The main problem is the divide in the community about the proposed turbines, which would very much affect our household with visibility, noise, glare, and vibrations. Otherwise we enjoy the peace, tranquillity, and privacy and that's why we choose to live in this area.
C3.9	We have a peaceful rural lifestyle that we relish and I feel this contributes to a high sense of wellbeing, having a sanctuary to return to at the end of the day.
C3.10	Traffic and the road seem busier. Community discussion centred around proposed wind farm. This causes mistrust and tense feeling where before there was none. Lack of protection and representation is a big issue. Destruction of community is a possibility if wind farm goes ahead. People value their lifestyle and appreciate amenity values in the valley. We can see 20-30 turbines from Makara when we were told that we would see none by the developer – this has caused us to question motives and honesty.
C3.11	Loss of community spirit due to small section of community seeking to establish a wind farm on the nearby hills.
C3.12	Our neighbourhood was the ideal rural lifestyle that we wanted and moved into the valley for, however, in the last year Project Westwind has caused some noise nuisance and the possibility of the Mill Creek wind farm proceeding is extremely concerning to us as we would be less than 2k from the nearest proposed turbines. The experiences of the residents at Makara are of grave concern regarding noise and health affects from the turbines not to mention loss of property value. The court processes over the proposed Mill Creek has divided the community, previously it was a very strong and close rural community, now it is divisive. I worry about our future if Mill Creek gets consent, whether we will be able to live in our houses, if it will devalue, I am very noise sensitive and worry about how I will deal being that close to turbines. This is a very real concern to myself, my husband, and many residents in the community. I am not adverse to change, technology, wind farms in general or green alternatives, but I strongly object to having my quality of life in my own home reduced by noise, vibration, visual disturbances and possible health effects on the basis of "its all for the greater

	good of the nation".
C3.13	We live in a beautiful rural environment however the threat of wind turbines coming into our environment has caused stress in the community and great fear of loss at our unique environment.
C3.14	We live 6-8 km from the new west wind industrial turbine complex. Since it started we have been woken and prevented from sleeping. There has been tinnitus, developing headaches, lack of concentration and disturbing feelings that courses through the body, difficulty breathing and tightness in the chest. We feel disempowered as no government minister or councillor will even meet us let alone discuss and are actively supporting plans to extend closer still to our homes.
C3.15	We are very fortunate to live in a rural area, approx 6 km from Johnsonville. We have 6 children aged between 7-17 yrs. I believe our environment has affected our children and ourselves in a positive way. Everyone is keen to stay home more and enjoy the surroundings. However, there is a lot of discord in our area due to proposed wind turbines being installed next year. We have not entered into the argument or discussions surrounding the issue.
C3.16	Since project west wind was commissioned we have had numerous occasions when we could hear them. Until Meridian fixed the special audible characteristic problem they could be heard as a distant rumbling noise in N'Westly wind conditions but on top of that noise was a clear mechanical noise like a distant aeroplane. The noise would come and go. Since SAC has been 'removed' by Meridian, the noise disturbance has reduced but on occasion it can still be heard as a distant rumbling. On one night in early June (frosty) I could hear blade swish. These turbines are 6.7 km to the west of us. We are faced with the prospect of another 31 turbines (Project Mill Creek) also a Meridian Energy Project. I am extremely anxious that the noise from these turbines will dominate our living environment here on Takarau Gorge road. The nearest 4 turbines will be between 1.7 and 2.0 km away from us in the North West if Meridian are granted consent for Mill Creek. I have visited properties that are furiously affected by noise from Makara on the lower Takarau Gorge road and on the South Makara Road. These properties are between 1.4 and 2.0 Km away. The residents are suffering noise disturbance and their sleep is affected. I know and understand these consequences. There are many families in the Ohariu Valley that refuse to believe these affects. I am concerned that they will suffer as well.
C3.17	I live a semi-rural area that has changed slowly over the last 50 yrs. The changes are currently escalating due to proposed wind turbines to be placed quite close to residences and a marked upgrade in socio-economic residents.
C3.18	Ohariu Valley has been an unspoiled part of New Zealand's history until Meridian desecrated the Makara area with 68 wind turbines. Unaware of the true disturbances these turbines would create due to the total mis-information supplied by Meridian and the lies fed to the Ohariu Valley residents by Meridian and the directors of windcorp, the residents unfortunately did not support the Makara community as we should have to stop the west wind project from going ahead. The true ill-health effects of turbines of this size situated so close to people's homes have been documented world wide and proven to be true yet Meridian chose to ignore them and up to now the courts have not taken seriously the extent of the effects. This has to change and these wind farms stopped in closer than at least 15 ks from the nearest home. People's lives are being ruined for a short-lived monetary gain by the likes of Meridian Energy.

C3.19	We are currently fighting a proposal to build a wind farm being erected in our gorgeous valley. This is a major stress both emotionally and financially on ourselves, our family, and our community. It will be resolved in the Environmental court this October. I suggest you repeat your survey after the outcome is known, That might teach you all a lot more!
C3.20	We now have an industrial wind farm less than 2kms away from our farm. Not only is this a noise issue but also with consent given for another wind farm to be put in on yet another lot of hills to the north of us, they (wind turbines) will also be a visual problem as well, caught in between industrial sites. No pleading from our community, re noise conditions has made any difference at all! No compensation for loss of property value, simply lack of consideration for a very unique small community that doesn't have a chance against a power company.
C3.21	I have lived in a quiet rural environment for 11 years by choice. 1. Because it is quiet. 2. Because it offers a life style choice (Horse care/farming on 62 acres). 3. Because it is close to the city where I can get part time work if needed. 4. Neighbours are too far away to be a problem. I live a comfortable, busy, rewarding life. I am now threatened by Meridian and 5 other 'neighbours' by a proposed 31 industrial wind farm less than 3 km's from my paradise. I get sleep disturbance from West Wind (West farm) at Makara – 6-8 kms away that has already been commissioned. I'm extremely anxious about: a) my property value. b) my community polarisation over this issue. c) The cost to me personally fighting to preserve my neighbourhood.
C3.22	Wind Turbine Centres. We live 4.5 km away from Makara Westwind Wind Energy Centre and I'm woken sometimes by a low frequency grinding noise, 3 – 4 am. There is another Meridian project planned 1.3 km from our house (Mill Creek) & we know that the noise will be unacceptable. The big drive behind these so called green projects comes from the E.T.S & the govt, council are hell bent on pushing them through. We're not heard by the general public as they have been brainwashed & the turbines aren't in their faces. The media, TV, Newspapers won't air our complaints as executives on their boards are also on Meridian's – ie Fairfax etc.
C3.23	Mill Creek wind farm proposal by Meridian has split the community into 2 divisive halves. Those supporting it ie farmers that have leased land & their friends + people not concerned or informed about the potential noise and health impacts & those that are concerned. The proposition has halted much of the real estate activity which is a classic demonstration that everyone want green power but not in their backyard ie lifestyle blocks were very much sought after until announcement if the wind farm came thru. Seems that it is the locals that must pay for the greater good of green energy…
C3.24	The last 2.5 years have been incredibly difficult with the proposed wind farm. The stress of your living environment potentially changing & confrontation from people proposing change has been very intimidating and as a result at times it has been difficult to sleep.
C3.25	In our neighbourhood there is a proposal to build a wind farm within 2.5 km of our home. This is of grave concern to my family due to the industrialisation of our countryside, our view from our home and the potential noise disturbance. This has caused stress and concern to us.
C3.26	Since the build and start up of the turbines in Makara I have found them visually offensive (I can see approx 20 from my home) and when they were first being built I was reduced to tears on more than one occasion. They have turned my

	rural views to a industrial abomination. The noise produced by these turbines (approx 8 – 10 km distant I estimate) has caused me physical distress, sleep disturbance and a funny feeling of pressure – my ears in certain wind conditions. The combination of these plus having to fundraise/put my life into a holding pattern to fight the progress of destroying Ohariu Valley with more turbines has caused some stress in my relationship both at home and at work. Ohariu Valley was one of the most loving, supportive communities I have ever living in and turbines have completely split this community into a number of groups with all the associated distrust, lies, and backstabbing as those who want the turbines (they are getting money from Meridian) try to undermine and destroy the rival group. A woman's support group that was very strong – this valley for more than 50 years is now falling apart as various woman from both sides will no longer mix socially based on their opinions of the turbines.
C3.27	This neighbourhood in Ohariu Valley used to be a wonderful, friendly, peaceful place to live. Not now: people are at war: Families have fallen out with each other, marriages broken down, & neighbours not being nice to each other all over money = the cause = wind turbines. Five families are getting millions of dollars &a almost 100-200 other families have to live with the noise, vibration, property devaluation + sleep deprivation. We are looking for somewhere else to live – but will cost a fortune to move & we would have to degrade. My life right now is not pleasant for my family and our quality of life is not good. This reflects in our daily output which is reduced. This is more than sad – it is destructive to the community = fatal for society.
C3.28	Since the greedy farmers in the valley put up wind farms they have split the community into two. The loving peaceful valley that I moved into will never return. They have destroyed the peace and harmony that has existed for over 100 years. Having the wind farm proposal going through concert has put our life on hold and even if we wanted to sell we will sell for a lot less than what we purchased it for.
C3.29	A couple of points that may (or may not) be relevant. 1) I have been recently widowed and this has affected / lowered some of my satisfaction results which would previously have been higher. 2) I live rurally so many of the issues of are non-issues. 3) The peace / tranquillity / satisfaction with my neighbourhood is threatened by a potential wind farm within the immediate vicinity. I am sensitive to noise so if this were to go ahead it would change some answers I am sure.

I **Daniel Shepherd** state:

1. I reside at 50 Camp Road, Mount Wellington, Auckland

2. Dated this day of 2012

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D Shepherd