

IN THE MATTER

of the Resource Management Act
1991

AND

IN THE MATTER

of applications to the **WAIKATO
DISTRICT COUNCIL** and
WAIKATO REGIONAL COUNCIL
by **WEL NETWORKS LTD** for
resource consents to authorise the
establishment, operation and
maintenance of 28 wind turbines for
the generation of electricity and
associated activities on the
Wharauoa Plateau near Te Uku

FURTHER STATEMENT OF EVIDENCE OF DR DAVID BLACK

1. INTRODUCTION

Qualifications and experience

- 1.1 My name is David Russell Black. My qualifications and experience and commitment to adhere to the Code of Conduct for Expert Witnesses were set out in the evidence which I presented to the Committee on 21 November 2007.
- 1.2 The Hearing Committee has indicated that it would like to receive further evidence on potential adverse effects on public health arising as a result of the Te Uku Wind Park project, in light of evidence presented by submitters.

Purpose and scope of further statement

- 1.3 The purpose of this further statement is to assist the committee by commenting on health issues raised by submitters and to respond to criticisms of my evidence in evidence presented by submitters. Submitters who particularly raised issues in that regard were:
- (a) Mr Cox – who was critical of my description of the physics of wind generation, which I used as a basis of the evidence which followed, and who raised issues in relation to subsonic noise.
 - (b) Dr Bolden – in relation to health issues relevant to the local community.
 - (c) Ms Penfold – in relation to the effects of noise on health and wellbeing.

- 1.4 In light of the committee's request for further material, I propose to address the following:
- (a) The outcome of a peer review which was commissioned in relation to my comments on the physics of wind turbines (Section 2);
 - (b) Community health issues (Section 3); and
 - (c) Noise and health, including subsonic noise and vibro-acoustic disease (Section 4).

2. **PEER REVIEW OF MY EVIDENCE IN RELATION TO THE PHYSICS OF WIND TURBINES**

- 2.1 Mr Cox made submissions at the first part of this hearing in November to the effect that my understanding of the way that wind turbines work is incorrect and that, as a result, my evidence was misleading or should be disregarded. Such an assertion is of concern to me and I therefore arranged for an experienced and academically qualified mechanical engineer, Duncan McMillan, who is known to me from both his work at the University of Auckland and his current commercial activities, to critically peer review my evidence.
- 2.2 Mr McMillan has developed a statement of evidence in relation to his peer review. I will make some brief remarks.
- 2.3 I wish to emphasise that, given that I am a physician, I did not intend to give evidence as a wind turbine engineer or aerodynamicist. Rather, as is my normal practice, I summarised my understanding of the physics and mechanics of wind generation technology and its interaction with the environment at the level of understanding required and expected of an environmental medicine specialist as a preamble to discussing possible health effects.
- 2.4 Mr McMillan has reviewed my evidence in that light and, in particular, considered whether my descriptions of the physics and mechanics of wind turbines and their interaction with the environment are generally correct and reflect a reasonable understanding of that technology for the purpose of presenting my evidence. Mr McMillan has also explained the technology in more concise engineering and physical terms.

Terminology

- 2.5 In particular, Mr McMillan concisely summarises the principle of a horizontal axis wind turbine ("HAWT") referring to my clause 4.5. His description is not

fundamentally different from my understanding as described in my evidence, any differences being mainly in the terminology I have used.

- 2.6 Mr McMillan discusses my clause 4.8, making the point that the term “laminar flow” (at least in professional aerodynamic engineering) has a more exact meaning than I have accorded it.
- 2.7 I use the term “laminar” and “turbulent” because they are commonly understood in the context of airfoils such as sails and aircraft wings and I have used these terms to represent degrees of smooth and disturbed flows of air. Having discussed this with Mr McMillan, I understand that in the context of aerodynamics, the term “laminar” is generally used only when the flow is smooth and steady. I tend to think in terms of “relatively laminar” flow and I have conveyed this in my evidence. Mr McMillan does not agree with the use of the term “laminar”, I accept that advice and recommend the hearing prefer it.
- 2.8 Mr McMillan also makes the point, referring to clause 4.12, that the term “wind turbine” should be preferred to the terms “wind generator” or “wind generated turbine”.
- 2.9 Mr McMillan is in general agreement with the principles I have outlined in clauses 4.13 and 4.14 although provides more precise wording.
- 2.10 At clause 4.16 Mr McMillan found a typographical error, the words “angle of” had been inadvertently included. He is correct that this should read “the tip velocity is relatively fast”.
- 2.11 With regard to clause 5.2, whereas I say “*any change in air pressure or flow is insignificant*”, Mr McMillan confirms that there is no change in the flow rate of air referring to the mass flow rate due to the principle of mass flow continuity which he has described.
- 2.12 At clause 7.2 on the second line, I note there is a typographical error which has replaced the word “from” with “form”.
- 2.13 At clause 7.7 there is a transcription error which misquotes Mr Cox’s evidence. He was referring to air pressure variation “*above 0.02mPa (milli pascals) with a frequency of less than 15Hz*” not “*air pressure levels drop below 15Hz*” which makes no sense.
- 2.14 I am grateful to Mr McMillan for his review, and his expansion on my general explanations. However, I consider that the descriptions and explanations contained

in my original statement of evidence are generally appropriate insofar as they reflect the way that I would describe the technology in a university teaching situation as I am called to do on a day-to-day basis. Mr McMillan has confirmed that the understanding conveyed in this way is generally correct. However, now that Mr McMillan is available to the hearing, his explanations of these matters should be preferred to mine if they convey a different meaning or better understanding as he is eminently qualified and experienced in this exact area.

Significance in terms of my evidence

- 2.15 In my view, none of the points raised by either Mr Cox or Mr McMillan have identified any significant misunderstanding of the principles of a horizontal axis wind turbine or of the physics behind the interaction of air with the turbine and the potential generation of noise and vibration. Furthermore, and of paramount importance, nothing arising out of this review has in any way altered my conclusions which are based on the understanding I outlined. My views are formed from my wider consideration in a public health context that there are no adverse health effects which would be expected directly arising from this proposal to construct a wind park at Te Uku.

3. COMMUNITY HEALTH

- 3.1 Dr Fiona Bolden is the local general practitioner for the Raglan and Te Uku area (and beyond). Her evidence addressed concerns about the potential impacts of the wind park on her patients. I have confirmed that Dr Bolden is a registered medical practitioner with vocational registration in general practice which is the full and appropriate qualification for the work she undertakes. Since she works in the Whaingaroa/Raglan area and cares for 4,000 patients her opinion and concerns are important and are of interest to me. Dr Bolden qualifies her opinion by saying that she is not a specialist in wind farms and, with all due respect, I must make the point that she is not qualified or registered as a specialist in environmental medicine or public health either.
- 3.2 Dr Bolden has had substantial exposure to an earlier generation of wind generators in Southern England in her childhood, however, these are hardly comparable with the present proposal as the nature of this technology particularly with regard to noise and efficiency has changed radically in the last decade.

Potential mental health effects

- 3.3 I agree with the general statement that mental disorders do have a high prevalence in the New Zealand population, as they do in most modern societies. Any

impression that this is increasing is partly if not entirely due to improved recognition and diagnosis. The 23% quoted by Dr Bolden for her patients in Raglan would be reasonably typical of practices elsewhere in the country of similar character. I have retrieved and read the paper she cites from NZ Medical Journal 116 (Magpie Study) which is actually an evaluation of the Wellington Mental Health Liaison Service and is only relevant in confirming that a minority of people seek help for mental health problems and those that do seek help usually go to their GP. I accept that, but if anything it indicates an underlying problem rather than evidence of any environmental cause.

- 3.4 Dr Bolden lists ways in which she considers mental health may be affected by the wind farm proposal. These are *sleep deprivation* (due to mechanical noise from the turbines), *annoyance from daytime noise levels*, *the effects of low frequency noise* and *visual impacts*. She is also concerned about *disruption during the building process* and *difficulty with selling houses and falling property values* in the area.
- 3.5 From a professional public health point of view, the valuation matters are for others to consider. Disruption during the building process will be managed by council appropriately. Thus, these two points (Dr Bolden's 5 and 6) are outside of the scope of my evidence.
- 3.6 With regard to the effects on sleep, Dr Bolden quotes WHO Guidelines noting that these require indoor noise levels to be less than 30dBA. These matters have been covered in detail by Mr Hegley and I note that Dr Bolden's main concern is for "*the accuracy of the predictions for our area and how these will vary with the strong winds we have here*".
- 3.7 Dr Bolden quotes from a 1987 article on the difficulties encountered in measuring broadband noise from early wind turbines in 1987. There has been enormous progress in both the machines and measurement and modelling technology since then and this article is only of historical interest.
- 3.8 I expect that the calculations undertaken for WEL will be accurate as they have been undertaken by experts using well established and proven methods. However I would also note that the effect of any other noise (such as that from weather) would tend to mask the turbine noise. On the basis of Mr Hegley's evidence, I do not agree that there is any likelihood of adverse effects from either daytime noise or sleep deprivation from night time noise.
- 3.9 Dr Bolden goes on to discuss the potential annoyance of turbine noise not because the levels are loud (indeed they will be barely perceptible) but because of

characteristics which are peculiar to these generators. I have already raised in my original evidence the problem for people who become stressed by noise or other sensations which trigger their awareness of the presence of the facility and escalates their concern about harm. However, as I said in my original evidence, these usually arise when there are misconceptions about the effects in the first place.

- 3.10 There is the possibility, which is often seen in environmental medicine, of initial concerns resulting in distress leading to sensitivity and hypersensitivity in which this psychological phenomenon becomes a problem in itself out of all proportion to any direct harm. In some cases, the basis of this may be a real hazard.
- 3.11 I will illustrate this by way of a common real life example. Over the last few years, it has become well accepted that diesel fumes are having a small but significant adverse effect on public health. The impact on a population is small, but nonetheless important. The magnitude, taking into account the likelihood of an impact on an individual is probably insignificant having regard to the overall risks of living. Nonetheless, the New Zealand Government has recently decided to effectively ban importation of used diesel vehicles in order to arrest the escalation of this genuine problem. If an individual was worried about this risk, they might become stressed every time they detected the presence of a diesel vehicle, such as hearing a bus go past, which might be regarded as a rational concern. However, it would not be reasonable to worry about this. In fact, this rarely happens because the presence of such vehicles is so ubiquitous because it is not new or novel and is already accepted. However, the appropriate public health response would be to deal with the problem at source and this has been done proactively.
- 3.12 When such an approach has to be applied to new or novel proposals such as wind generators, the first priority in terms of developing an appropriate response, is to make an assessment of the possibility of actual direct harm, including theoretical possibilities for such harm and, if these exist, identify appropriate measures for mitigation.
- 3.13 This has been done in the case of the Te Uku Wind Park and there is no case for hypothesising or expecting any direct harm. I suspect Dr Bolden's genuine concern is that people who do not understand or accept this assurance may still find the presence of the wind park threatening and that might cause, in some people, escalating fear and anxiety which can build on itself to the point where it becomes a diagnosable mental disorder.

- 3.14 I accept that is a possibility. However, the only way of managing it is to deal with the misconceptions in the first place as there is no part of this proposal which will cause actual harm. It would also be reasonable to minimise this risk by, as far as is possible, reducing the prominence and of the wind park by measures such as appropriate choice of colours, avoidance of effects of shadow flicker and glare and minimisation of noise. As I understand it, all such measures which can practicably be applied are proposed to be adopted and my assessment is that the facility is likely to become an accepted feature of the environment in due course.
- 3.15 Typically, installations of this type are initially noticed but soon become a normal part and feature of a landscape of little relevance to adjacent communities. When the technology involved has no demonstrable risk of harm, the most effective means of addressing public health issues is to ensure that any misconceptions in relation to potential health effects are addressed. Thus, a paramount consideration in managing or addressing concerns of the nature raised by Dr Bolden is ensuring that those of us, such as public health and general practitioners on whom a community relies for medical advice and warnings of potential threats to health, give accurate and evidence based information and that the people we care for are not misled into misunderstandings causing them to expect likely effects. If this does happen, doctors and other health professionals trusted by communities can become part of, or even the cause of, the problem rather than the solution.
- 3.16 I have experience of a number of cases when this has happened. A well known case involved the proposal by Telecom New Zealand Limited to establish a mobile telephone base station adjacent to Shirley Primary School in Christchurch. I was a witness in that case. Unsubstantiated concerns about health effects on children in the school were raised by members of staff, these were escalated by the school taking a coordinated position against the proposal which included the provision of misleading information to children and parents in the school community with regard to ideas of harm which were hypothesised to arise from mobile telephone sites.
- 3.17 Ultimately the matter was heard in the Environment Court in which this process which had occurred became evident to the Judge and those in positions of responsibility were substantially criticised for their misleading role.

Precautionary approach

- 3.18 One reason often put forward for raising these type of unsubstantiated concerns is that it involves adopting a “precautionary approach”. However, that does not represent a valid interpretation of the “precautionary principle” which is well understood and described in both health and legal context and is properly

applicable only when there is the potential for actual harm. Even then, any response has to be of established potential benefit and proportionate to the risk. The idea of taking a precautionary approach in advance of an effect which is not reasonably expected or established has been substantially criticised both in scientific literature and in legal decisions.

3.19 In the same context of the *Shirley* case (a mobile telephone base station), in 2006 that exact scenario was the subject of a case heard by the Environment Court in New South Wales, presided over by Preston CJ, known as the *Telstra*¹ case. I was retained as a court appointed witness in this case. In fact, the proposal which was for a mobile telephone base station in a suburban area did include substantial precautionary approaches even though there is no evidence that these would be of any direct health benefit. Evidence of this was presented and accepted by the Court, however, the decision made it clear that such an approach had no merit when the evidence was quite clear that there was no possibility of any adverse effect in the first place and that the degree of certainty about this exceeded any threshold expected by the Court. (I do not presume to discuss legal decisions in my evidence, that is a matter for Counsel, I mention the cases Shirley and Telstra because I was involved as an expert witness in both matters.)

3.20 In this Te Uku case, there is a significant parallel to *Telstra*. After extensive care and research, there is no expected effect and so any anxiety which might arise in the community of the type envisaged by Dr Bolden, could not be mitigated by any means other than correcting misunderstandings and misapprehensions about the true impact of the wind park proposal. WEL have put a lot of work and resource into both achieving engineering based controls and communicating these to the people.

4. **NOISE AND HEALTH**

4.1 In this section of my evidence I will address other noise related health issues raised by submitters.

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Telstra Corporation Limited v Hornsby Shire Council [2006]
NSWLEC 133

Effects of noise on health and wellbeing

- 4.2 I have read the evidence of Jenny Penfold. Much of her concern about noise generation by the turbines is covered by Mr Hegley.
- 4.3 I accept that many health authorities, including the World Health Organisation have become interested in the effects of noise on health and wellbeing. However, this is in the context of significant issues such as traffic and aircraft noise and these concerns are advanced as evidence for providing effective curfews against significant noise nuisance particularly during hours where people are sleeping.
- 4.4 As Ms Penfold mentions in her evidence, the chronic night time noise levels of concerned WHO are of the order of 50dB and above. I have no doubt that compliance with the New Zealand standard as is proposed in this case will eliminate any such risk.

Subsonic noise and vibro-acoustic disease

- 4.5 The possibility of subsonic effects, such as vibro-acoustic disease has been raised by several submitters. I addressed this in some detail in my evidence and nothing I have heard or read at or as a result of this hearing has altered my view.
- 4.6 Firstly, it is unlikely that there is significant subsonic vibration from these horizontal wind axis wind turbines as assured by Mr Hegley. Circumstances in which harm can arise from subsonic vibration are all together different with magnitudes of vibration some 50dB or hundreds of thousands of times greater than those which arise from a modern wind turbine. It makes no sense to consider that these high levels of energy would be generated and transmitted back to air by a device which attempting to harness the energy of moving air. Concerns about diseases resulting from subsonic vibration do not extend below levels of 85dB and even at that level are only tentative. The threshold for acute damage from noise is 140dB.
- 4.7 The difference in pressure magnitude that I have referred to is huge. 50 db is a logarithmic way of expressing a ratio of 10^5 , which is one hundred thousand. Such levels of sonic and subsonic energy hundredths of thousands of times higher than those predicted could even then only raise the beginnings of concerns about vibro-acoustic disorders. Such maladies have been described in people working and confined to living in adverse industrial environments for long periods (such as in constantly airborne military aircraft) but never in a setting like that proposed at Te Uku.

- 4.8 In addition, I would not expect such levels to be compatible with the survival of the wind turbine machines.
- 4.9 I have seen ideas of vibro-acoustic harm raised in a very limited way in published scientific literature although never established as occurring and it is only discussed in the context of machines in the immediate vicinity of a living environment.
- 4.10 There is no doubt that the physics of the aerodynamics of driving wind turbines is well enough understood and refined to ensure that, by design, wind turbines of this type will not transmit subsonic energy of any significant magnitude.

5. **SUMMARY**

- 5.1 In summary, I have considered the points raised by Mr Cox in criticism of my evidence but, particularly after Mr McMillan's review, do not accept that this represents any misunderstanding of the nature of the technology or the physics involved. I confirm that I am satisfied that my understanding of these matters is sufficient to enable me to form the expert environmental medicine and public health opinion which I have presented.
- 5.2 I understand and acknowledge Dr Bolden's concern about the potential of a significant project like this for causing anxiety in the community but respectfully suggest that careful representation of evidence based analysis of real potential effects by those of us with public and professional responsibility to do so is the most useful means of prevention.
- 5.3 In contrast, the perpetuation of invalid technical, scientific and medical analysis suggesting harm, which can occur because of genuine misunderstanding or as a deliberate surrogate for concern about other issues (such as valuation) is likely to cause significant harm in itself and must be avoided or countered.
- 5.4 The issues of subsonic noise and health effects such as vibro-acoustic disease have been considered and the certainty that these could not occur is confirmed by a factor of literally hundreds of thousands in the margin of sound pressure level at subsonic frequencies.
- 5.5 I have revisited my previous literature search of health conditions caused by exposure to audible sound and subsonic vibration. This has strengthened my view that these conditions arise in altogether different circumstances and are irrelevant to any conceivable environmental effects or possible health effects of this proposal. The most striking factor which makes this conclusion inescapable is the huge difference in energy level - of the order of 50dB – hundreds of thousands of times-

between the maximum levels expected from this wind park and harmful levels of broadband sonic and subsonic energy.

- 5.6 After reading and seriously considering the points made and references cited in these submissions to the hearing, I confirm my view that that this wind park proposal does not represent any threat or risk to public health in the surrounding communities.

David Black
January 2008