

IN THE MATTER of the Resource Management Act
1991

AND

IN THE MATTER of a Board of Inquiry appointed
under s146 of the Resource
Management Act 1991 to
consider an application by Mighty
River Power Limited for resource
consents to construct, operate,
and maintain a wind farm at
Turitea

REBUTTAL EVIDENCE OF CHRISTOPHER WILLIAM DAY

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1 QUALIFICATIONS AND INTRODUCTION

- 1.1 My qualifications and experience are as stated in my principal evidence.
- 1.2 I confirm that I prepared this rebuttal brief of evidence in accordance with the Environment Court Code of Conduct for Expert Witnesses (July 2006). As stated in my principal evidence, I have relied on the expertise of Ms Siiri Wilkening from my firm, for the noise modelling analysis for this project.
- 1.3 I am providing this rebuttal evidence to comment on and respond to some of the evidence in chief that relates to noise effects of the Turitea Wind Farm. In particular this evidence relates to the evidence in chief of:
 - (a) Mr Nigel Lloyd, for Palmerston North City Council (PNCC);
 - (b) Mr Alan Baker, for PNCC;
 - (c) Mr Douglas Pringle, on his own behalf; and
 - (d) Mr Robert Thorne for Tararua Aokautere Guardians and Friends of Turitea Reserve.

2 EVIDENCE OF MR NIGEL LLOYD

- 2.1 I have read the evidence of Mr Nigel Lloyd and comment as follows.
- 2.2 In paragraph 16 of his evidence, Mr Lloyd states that neither Hegley Acoustic Consultants (HAC) nor Marshall Day Acoustics (MDA) believe that the quiet background noise limit is required. He refers to the secondary noise limit set out in the Draft Standard DZ6808:2009 (DZ6808 or Draft Standard) which has not yet been released. In my opinion this lower noise limit is not justified and the standard that refers to it is still in draft and may undergo changes prior to public release.
- 2.3 Mr Lloyd further states at paragraph 16, that for background noise levels below 25 dBA, when wind turbines are more than 10 decibels above such background noise level, then the noise will be “unduly audible”. However, as is accepted by Mr Lloyd in his paragraph 36, the assessment criterion is not audibility but sleep disturbance.
- 2.4 In paragraph 21, Mr Lloyd notes that there is a discrepancy between predictions made by HAC and Marshall Day Acoustics MDA, and that HAC’s predictions are more conservative, possibly because of different calculation models and input data.
- 2.5 The difference between the predictions is due to the utilisation of different prediction methods and in my opinion, small differences are to be expected. While HAC’s predictions may be seen as more conservative (higher noise

levels), MDA used ISO 9613, which is referenced in the current Standard NZS6808:1998, (NZS6808) and has been recommended as suitable prediction method in the DZ6808. The ISO 9613 method is representative for downwind conditions and also for well developed inversion conditions, and takes into consideration ground and atmospheric effects. It has been shown to be more accurate for large distances (of more than 800 metres) between source and receiver, and for significant terrain, as is the case for Turitea.¹

- 2.6 The MDA terrain data uses five metre contours, and the HAC data uses 20 metres contours as stated by Mr Hegley in paragraph 4.8 of his evidence. This may also account for some of the differences. In any case, the more important point is that two calculation models have been applied and correlated and that makes for more robust noise predictions.
- 2.7 Mr Lloyd states in paragraph 30 of his evidence that both HAC and MDA have under-estimated the number of affected dwellings. As is generally the case for wind farm noise assessments, the potentially most affected dwellings have been assessed. Achieving compliance with relevant limits at those dwellings will then ensure compliance at other, more distant dwellings as well. This can be seen on figure 43 of Mr Hegley's evidence which shows predicted noise contour lines.
- 2.8 In paragraphs 31 and 32 of his evidence, Mr Lloyd states that the Turitea wind farm site is not a "*typical industrial site*" but is next to the "*currently quiet*" Tararua Ranges where people move to escape the close confines of residential living. The Turitea wind farm site is located in the Rural Zone, which is a production zone. Normal rural activities include: aircraft for spraying, cattle, tractors, machinery, often starting early in the morning (4.00 am in summer). Therefore, it is misleading to say that the site is quiet. This has also been confirmed by the HAC ambient noise measurements which show that for some positions, the noise levels are relatively high.
- 2.9 I also note that the District Plan does not apply especially low noise limits to this area, which would indicate that the area deserves additional protection. Indeed, night time noise limits of 40 dBA L₁₀ are applied by the District Plan.
- 2.10 Mr Lloyd states in paragraph 33 of his evidence, that it is appropriate to have a specific standard that deals with wind farm noise (NZS 6808:1998). I note that while in this instance Mr Lloyd acknowledges the appropriateness of NZS 6808, elsewhere in his evidence he chooses to apply only parts of the standard and re-write other parts to fit into his assessment. Given NZS6808 is specifically referenced in the District Plan as being applicable, I consider that a different or amended standard could only be applied if there were compelling

¹ Stakeholder Review and Technical Comments, NZWEA and EECA, May 2007, 6 Summary of Findings, Topic 1: Noise Propagation Modelling.

reasons to do so. In my opinion, those reasons are not provided by Mr Lloyd. The only reason given for changing the requirements of the existing NZS 6808 (and the new unreleased DZ 6808) are that this has been done for other wind farms and should therefore apply for Turitea as well. I do not consider that justifies overriding the clear provisions of the District Plan.

- 2.11 In paragraph 34 of his evidence, Mr Lloyd states that in the new and as yet unreleased DZ 6808, secondary noise limits **would** apply at times of quiet background sound. However, I note that DZ 6808 states that the secondary noise limit “*should be considered*” (5.3.1) and “*the secondary noise limit is likely to be justified*” (C5.3 1e). Accordingly, the application of the secondary noise limit is only a recommendation, it is not a requirement.
- 2.12 I also note that the secondary noise limit, as set out in the Draft Standard, requires a number of conditions to be met before it may be considered. Those conditions are, that the limit may only be applied:
- for evening and night time periods;
 - when the wind speed at hub height is less than 6 m/s and when the average background noise level (obtained via regression curve) is 25 dBA L₉₀ or less and the wind turbine noise level more than 8 decibels above the background noise level; or
 - if the relevant District Plan specifically recommends the application of lower noise limits, thus indicating that an area deserves special protection.
- 2.13 In paragraph 36 of his evidence, Mr Lloyd states that audibility is not a design criterion, but “*I do believe that the primary noise level of 40 dBA L₉₅ is too lax when background sound levels are low*” and then wind farm noise will be “*unduly audible*”. This is Mr Lloyd’s personal belief, however no scientific reason is given to support the opinion. The noise limit in a Rural Zone is 40 dBA.
- 2.14 In paragraph 47, Mr Lloyd states the special audible characteristics penalty applicable to the Te Rere Hau wind farm makes it complicated to undertake a cumulative assessment of noise from both wind farms for the dwellings in the area. I note that modern computer noise modelling software is capable of dealing with effects such as this, and therefore making such an assessment is not at all complicated. Mr Hegley deals with the Te Rere Hau wind farm in his rebuttal evidence paragraph 4.1.
- 2.15 In paragraphs 50 to 52 of his evidence, Mr Lloyd states that there are “*significant differences between the results of acoustic reports*”. The differences of prediction are 3 decibels for MP20 and 4 decibels for MP 60. In my opinion these levels are not significant. The greatest difference occurs for MP07, which is an accessory building 94 metres from the closest turbine.

- 2.16 Mr Lloyd states that MP07 and MP60 are close to the turbines and that ISO9613 is likely to over-predict noise levels. He does not provide a reason for this assumption. I note that by calculating the noise level from the closest turbine to MP07 using a simple formula (as is appropriate for such a close source-to-receiver distance), shows that the predictions are accurate.
- 2.17 In paragraph 54 of his evidence, Mr Lloyd states there are uncertainties with the data used and that that HAC predicts higher levels than MDA, except where HAC assumes additional screening. I am unclear what is meant by this. HAC does not 'add' screening, and all screening occurs from terrain formation which is inherent in the model. As noted above, the models used by HAC and MDA are directly comparable in their data input, only their calculation methods differ. Indeed, the same terrain model was used in both computer models and is accurate to 5 m vertical distance, an accuracy which is suitable for a project of this size.
- 2.18 In paragraph 55, Mr Lloyd states that MDA does not state which ground attenuation factors were used for its predictions. The computer model used soft ground which I considered to be accurate, as most of the surrounding land is rural meadow. I note, however, that the effects of ground attenuation are reduced due to the height of source.
- 2.19 Mr Lloyd is correct in his statement in paragraph 56 of his evidence, 51 out of 75 positions are within 2 dB of the HAC predictions.
- 2.20 As further support of these noise prediction studies, Dr Thorne (discussed later in this evidence) has also carried out noise predictions using different modelling software again. His study predicts noise levels that are lower than the HAC predictions except one position.
- 2.21 In paragraph 57 of his evidence, Mr Lloyd states that where the wind farm noise level is 15 decibels above the background noise level, then the "*secondary noise limits are necessary for those times*". In my opinion, Mr Lloyd has not understood the intention of the Draft Standard which includes strict conditions on when the secondary noise criterion is to be considered. This is discussed earlier in my rebuttal evidence in paragraph 3.12.
- 2.22 In paragraphs 58 & 22 of his evidence, Mr Lloyd states that he considers the recommended noise conditions based on the Te Uku Wind Farm are inadequate. Mr Lloyd does not give a reason for this opinion, but recommends the use of conditions similar to those imposed on the Motorimu Wind Farm. However, Mr Lloyd does not comment as to why he thinks such conditions are more appropriate.
- 2.23 In my opinion, the Motorimu conditions are overly complicated and unnecessarily lengthy. They were agreed to by caucusing in that particular case and this process can lead to some parts that are agreed to for

expediency. The agreement involved a small number of people. The Te Uku conditions basically refer to the procedures laid out in NZS6808 which were developed after wide consultation with a large number of experts. These procedures do not change significantly in DZ6808.

- 2.24 In paragraph 68 of his evidence, Mr Lloyd recommends the imposition of a secondary noise limit in accordance with DZ 6808, but considers that the precondition of 6m/s wind speed at hub height (as set in DZ 6808) is not appropriate for Turitea. In my opinion, an unreleased draft standard should not be used as there is a long way for this standard to go before it is finalised. Applying parts of an unreleased standard to the Turitea wind farm is in my opinion, even more inappropriate. Should conditions be imposed on Turitea which do not reflect either NZS 6808 or the Draft Standard, but something entirely different again, the Draft Standard would be undermined even before it is released. Mr Lloyd has had an opportunity to provide a submission on the Draft Standard and should allow that submission process to determine the standard rather than reframing it in an ad hoc manner as suggested.
- 2.25 I consider that, either NZS6808 or the Draft Standard, as it is currently available, should apply to this application. I do not consider some amalgam of the two, with further amendment is an appropriate 'Standard' to apply to the Turitea wind farm.

3 EVIDENCE OF JEFFREY ALAN BAKER

- 3.1 I have read the evidence of Mr Baker and comment on the noise issues raised as follows.
- 3.2 In paragraph 48 of his evidence, Mr Baker accepts that the assessment of noise effects from wind turbines is a highly technical field. Nevertheless, Mr Baker comments extensively on perceived noise effects.
- 3.3 In paragraph 49 of his evidence, Mr Baker states that the difference in prediction results of HAC and MDA is problematic, and that no explanation is provided by Mr Hegley or me. Both Mr Hegley and I discuss the differences in prediction results in our evidence and reports. Further, the Section 4 of MDA report (Turitea Wind Farm – Acoustic Peer Review, dated February 2009), deals extensively with the differences, limitations and suitability of the prediction methodologies utilised by MDA and HAC.
- 3.4 In paragraph 51 of his evidence, Mr Baker states that the wind turbines that are predicted to cause exceedance were not identified in HAC or MDA evidence. The wind turbines which are predicted to exceed the derived noise limits have not been identified in the MDA or HAC evidence because detailed design has not been completed and turbine type and placement may change prior to installation. However, the exceedances predicted are small (one to four

decibels) and can be managed by de-rating turbines or placing them in a different position. The Noise Management Plan recommended in condition ix of the HAC report would provide detailed information on those management techniques and would be based on final turbine selection and placement.

- 3.5 However, in order to provide the requested information, the following turbines would contribute (in order of effect) to the predicted exceedance at identified receiver positions:

Position MP60: WTG82, 86, 87, 85 and 88

Position MP13: WTG132, 133, 130, 131

Position MP20: WTG82, 86, 87, 88, 85

Position MP58: WTG133, 132, 131, 130

Position MP63: WTG90, 92, 88, 89

- 3.6 Nevertheless, it needs to be borne in mind that the predicted exceedances are generally small, and slight adjustments to the position, turbine type or noise limit (for those positions where the background noise levels have not been specifically measured), are likely to alleviate any potential non-compliance.
- 3.7 In paragraph 52 of his evidence, Mr Baker states that in his opinion there would be a high level of management needed to comply with Mr Lloyd's conditions. I am in agreement with Mr Baker's comments and consider that the conditions put forward by Mr Lloyd are unreasonably detailed. Many of the issues addressed in specific conditions are already contained in NZS 6808 and would therefore, be adequately dealt with by referencing the Standard, as has been proposed by both Mr Hegley and myself.

4 EVIDENCE OF DOUGLAS ROGER SCOTT PRINGLE

- 4.1 I have read the evidence of Mr Pringle as regards to noise and comment as follows.
- 4.2 In paragraphs 2.9 – 2.11 of his evidence, Mr Pringle states that Survey Position 2 is shown in different places in the HAC and MDA evidence. While the initial HAC report (December 2008) showed an indicative circle on a large scale map which was neither intended nor suitable for reading exact co-ordinates, the co-ordinates provided by HAC in Mighty River Power's section 92 RMA response, and used by MDA in the predictions, are within 50 metres of each other. This separation distance is of no consequence in relation to predicted noise levels.
- 4.3 In paragraph 2.14 of his evidence, Mr Pringle states correctly that the sound levels are calculated using a logarithmic scale. However, he then goes on to state that a noise level increase of 9 dBA represents an increase of three times the sound pressure level. This is incorrect and misleading. It is widely accepted amongst noise experts, that an increase of nine decibels will subjectively sound

about twice as loud. I note that similar errors are made repeatedly in paragraphs 2.14 and 2.16 of Mr Pringle's evidence.

- 4.4 In paragraph 2.23, Mr Pringle assumes that residences at higher topographical level than MP15 would receive higher noise levels as they are less shielded from the proposed wind farm. This is not the case, as position MP15 receives no terrain shielding for those wind turbines which control the predicted noise level at MP15. Noise levels predicted for the surrounding sites are between 38 and 41 dBA, similar to the level predicted for MP15.
- 4.5 I note that currently, the noise limit for MP15 has been determined based on the survey data of Site 2, which is a considerable distance from MP15 (980 metres). Therefore, the noise limit should be addressed with caution as the noise environment at MP15 could well be different, and ambient background noise level higher than that measured at Site 2. Additional noise surveys are proposed to be undertaken once detailed design has been completed, the results of which will then be used to set the specific noise limit.
- 4.6 In paragraph 3.9 of his evidence, Mr Pringle states that NZS 6808 allows noise levels considerably higher than those recommended by the World Health Organisation (WHO). In my opinion, Mr Pringle's statement is not correct. Section 4.4.1 of NZS 6808 states that:
- "...in order to provide a satisfactory level of protection against the potential adverse effects of WTG sounds, this Standard recommends an upper limit of WTG sound levels outdoors at the residential locations of 40 dBA L₉₅. This has been based on an internationally accepted indoor sound level of 30 to 35 dBA L_{eq} commonly used as a design level to protect against sleep disturbance."*
- 4.7 Mr Pringle appears to confuse external and internal noise levels, and has omitted to take into consideration the reduction of noise level from outside to inside, which is approximately 15 decibels with windows open.
- 4.8 The paper cited by Mr Pringle (WHO, *Noise and Health, Night noise guidelines*, May 2009) confirms that sleep disturbance occurs in adults at around 40 dBA (internal noise level) and that children are more sensitive. Therefore, I consider the 30 dBA internal noise level set out in NZS 6808 is a suitable level to protect residents from sleep disturbance.
- 4.9 In paragraphs 4.7 to 4.10 of his evidence, Mr Pringle discusses the secondary noise limit contained in the Draft Standard. He considers that the secondary noise limit of 35 dBA should be applied to the subdivision he lives in because it is a residential subdivision which should invoke higher protection, and because the background noise levels are low. As I have set out above, should the Draft Standard be adopted, the secondary noise criterion would only be applicable if the measured and averaged background noise level during evening and night time is less than 25 dBA, for wind speeds of less than 6 m/s at the wind farm

site. Mr Hegley's analysis of the measurement data at Site 2 shows that this is clearly not the case (refer HAC S92 response). The regression line for wind speeds below 6 m/s never drops below 26 dBA.

- 4.10 In paragraphs 4.11 to 4.13 of his evidence, Mr Pringle discusses the prediction of wind turbine noise levels and refers to NZS2608:1998 (sic) and the simple prediction method. He then goes on to discuss DZ 6808 and comments on the fact that the draft standard does not specify a prediction method for wind turbine noise propagation. As the draft standard states (in section 6.1.3), there is currently no standardised sound propagation calculation method directly applicable to wind turbines. Therefore, the standard reference is ISO 9613, as this has been shown to provide good agreement between measured and predicted noise levels. The draft standard therefore enables the adoption of a more specific calculation method, should one become available prior to the next review of the standard.
- 4.11 In paragraph 4.17 of his evidence, Mr Pringle assumes that the prediction, in accordance with ISO 9613, does not take into consideration individual frequencies, and therefore underestimates low frequency noise levels travelling over large distances. This is not the case. The prediction in accordance with ISO 9613, as set out in section 6.1.4 of the Draft Standard, clearly requires the assessment for individual octave bands from at least 63 Hz to 4 kHz.

5 EVIDENCE OF ROBERT THORNE

- 5.1 I have read the evidence of Mr Robert Thorne, (as regards to noise issues) and comment as follows.
- 5.2 Dr Thorne's evidence is repetitive, and raises a large number of issues that lack cohesion which makes it difficult to determine their relevance to Turitea. The few key issues that emerge appear to be Dr Thorne's opinion that:
- wind turbine noise contains a 'special audible characteristic' that deserves a 5dB penalty;
 - wind turbines create low frequency sound and vibration which is an issue;
 - 30dBA is a 'reasonable objective' for wind turbine noise as against 40dBA used in the NZ Standard, which Dr Thorne considers will create "severe sleep disturbance";
 - a number of 'frontage' turbines should be removed to reduce noise levels to 30dBA;
 - the noise prediction techniques used by MDA & HAC are deficient; and
 - the proposed noise monitoring conditions are difficult to implement.

- 5.3 I will address each of these issues under those headings and one or two others matters raised by Dr Thorne. Due to the overall length of the evidence and its variable relevance to this wind farm, I have not addressed all issues raised in Dr Thorne's evidence and that should not be taken to mean I agree with them.

Special Audible Characteristic

- 5.4 At paragraph 5.29, Dr Thorne proposes that wind turbine noise exhibits significant modulation in sound (variation in level – sometimes referred to as the 'swishing' sound of the blades) and that a 5 dB penalty for Special Audible Characteristic (SAC) should be applied in accordance with the New Zealand Standard.
- 5.5 In paragraph 6.13, Dr Thorne asserts "*sound modulation causing annoyance and sleep disturbance.*" However, Dr Thorne provides no evidence to support this assertion.
- 5.6 In paragraph 6.14 Dr Thorne states there are known adverse effects of noise including "... *increased noise from turbines operating in phase*". This is technically incorrect. Modern wind turbines do not operate in phase. Individual turbines operate independently and have different speeds and radiation characteristics at any particular time. This 'out of phase' behaviour ensures the overall sound from a wind farm (as against a single turbine) is relatively steady in level. The variation in level is approximately 3 dB in practice.
- 5.7 Dr Thorne disagrees with this in paragraph 6.30 of his evidence, where he notes that his Manawatu ambient monitoring evidence suggests that the 1.5 dB to 2.5 dB difference between L_{eq} and L_{95} (quoted in the Standard) is not what happens in practice.
- 5.8 A very recent summary paper by Leventhall et al (Institute of Acoustics Bulletin, March/April 2009) disagrees with Dr Thorne. Leventhall et al state (at paragraph 3.6); "*From the information currently available our view is that the relationship between L_{A90} & L_{Aeq} for wind turbines stated in ETSU-R-97 (2dB diff) remains valid.*" Mr Leventhall is regularly referred to by Dr Thorne in his evidence and this paper is an "*Agreement about relevant factors for noise assessment from wind energy projects*" reached between the key noise consultants working on wind farm noise in the UK.
- 5.9 In my opinion, the modulation described by Dr Thorne is apparent (but not necessarily offensive) at distances less than 100m but from further away than 1000m is insignificant. The noise from wind farms is broad-band aerodynamic noise (in that it contains all the frequencies) and is in my opinion, inoffensive in character.
- 5.10 I am not aware of the SAC penalty being applied for the assessment of any other wind farm in New Zealand. I understand that some specific turbines have

had tonal problems with gear boxes and that they are being rectified. The application of SAC for this wind farm is, in my opinion, inappropriate.

Low Frequency Noise & Vibration (Topic I)

- 5.11 Low frequency noise and infrasound is an emotive topic that is often alluded to by lay people in respect to wind farms. In Topic I, Dr Thorne refers to some investigations he is currently carrying out in this field. I have great difficulty understanding most of the explanations but a number of technical errors appear immediately.
- 5.12 Firstly, in paragraph I.5 of Topic I, he describes a machine called an SpectroAudioMeter (SAM) which he states has a measurement range from 20Hz to 20,000Hz (paragraph I.5). It is interesting to note that he then quotes 'seismic noise' measurements in Figure I.1 down to 1.6Hz i.e. outside the range of his instrumentation.
- 5.13 Secondly, the same figure I.1 shows the largest difference between 'Quiet' and 'Noisy', out of a number of samples, as being 6dB – hardly a significant finding.
- 5.14 Finally, the proposition in paragraph I.22 of Topic I that "Heightened Noise Zones' occur due to the phase of the turbine blades is technically flawed. Modern wind turbines (including the V90) are variable speed and operate independently. This variable speed characteristic means the turbines will not create phase related peaks and troughs.
- 5.15 I dispute Dr Thorne's comments regarding the effects of low frequency and vibration. I note that in the same paper referred to above, by Leventhall et al, the forth topic within the paper is titled 'Vibration and Low Frequency Noise'. The final paragraph of the whole paper concludes:

"From examination of the studies referred to above, and other reports widely available on internet sites, we conclude that there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, generally has adverse effects on wind farm neighbours."

30dBA Noise Objective

- 5.16 In paragraph 5.28 and 5.39 of his evidence, Dr Thorne claims "...severe risk of sleep disturbance or annoyance at 40 dBA L_{95} " outside. I find this claim extraordinary. If this were true, most of New Zealand would be experiencing 'severe sleep disturbance' and virtually all District Plan noise controls around the country are specifically providing for 'severe sleep disturbance' as they specify either 40 dBA (or 45 dBA) as their night-time noise limit.
- 5.17 Dr Thorne also states in the same paragraph, that there is "low risk of sleep disturbance at 30 dBA" outside. This 30 dBA suggestion is 15 dB more stringent than the WHO guidelines. The WHO guidelines recommend an **internal** objective of 30 dBA. The reduction of noise from outside to inside,

with windows open, is 15 dBA. Thus the WHO objective is 45 dBA outside. To suggest 30 dBA outside is required to protect sleep disturbance, as Dr Thorne has, is completely out of line with accepted practice overseas and in New Zealand.

- 5.18 If a geothermal power station or hydro-electric power station were being proposed at this location, the development would have to comply with 40dBA at night and 50 dBA during daytime. While wind farms present difficulties of measurement during windy conditions, I am not aware of any research that shows the noise from wind farms is any more disturbing than noise from these other industrial activities. I see no justification for noise limits lower than 40dBA in normal situations.
- 5.19 In paragraph 6.25 Dr Thorne concludes that “... *at least for some homes, the Turitea wind farm will not comply with NZS6808.*” This is correct. Both Mr Hegley and I conclude that (excluding MP07) the noise limit may be exceeded at four houses by one decibel and at one house by four decibels. These exceedances are small and can potentially be alleviated with engineering solutions at the detailed design stage.

Monitoring

- 5.20 In paragraphs 6.21 and 6.26 Dr Thorne suggests that the conditions proposed are difficult to monitor and asks “...*how does the consent ... authority gain access to background sound levels 24/7...*” I do not envisage problems of access for monitoring. If people want the sound level monitored at their residence, then they would allow an automatic data logger to be located there for a period.
- 5.21 In paragraphs 6.26 and 6.28 of his evidence, Dr Thorne suggests that accessing real time monitoring data and compliance assessment is problematic. I disagree. The monitoring and analysis procedures provided in NZS6808 have been developed by the body of experts on the Standards Committee. The monitoring and assessment of such a major facility of national significance needs to include significant data over a period of time to assess compliance. The Draft Standard includes similar procedures.
- 5.22 In paragraph 6.29 Dr Thorne states that the application of the analysis techniques specified in Condition 17 is difficult. However, in my opinion, consultants experienced in the measurement and analysis of noise will be able to separate the sound levels required by Condition 17 without undue difficulty.

Topics A & B – Prediction of Sound Levels

- 5.23 In Topics A and B, Dr Thorne goes into considerable detail discussing technical aspects of the noise propagation modelling used to calculate noise levels from

wind farms. There appears to be no clear conclusion from his discussion of the various prediction techniques used, although he does appear to be casting aspersions on the methods used by HAC and MDA.

- 5.24 Under Topic A, Dr Thorne discusses in detail the variation in noise level due to different wind and temperature conditions during daytime versus night-time. In Table B.1.1 he sets out the noise levels calculated at various “receptor” positions during four different meteorological conditions (day versus night and north-west wind versus south-east). Having stated in paragraph A.3.12 that *“This presents a possible variation of – 3 dB to + 10 dB over the ‘nominal calculated level’ for sound level predictions at 1,000 metres,”* it is somewhat surprising that the levels quoted in Table B.1.1 show a variation of only 1 dB for the four very different meteorological conditions calculated. This lack of variation suggests there is something wrong with Dr Thorne’s modelling procedure.
- 5.25 This error may be due to a lack of understanding of how meteorological conditions affect the propagation of noise which becomes apparent in his paragraph A.3.21. The variation in noise propagation under different meteorological conditions occurs due to the change in air temperature with altitude. In the first bullet point of A.3.21, Dr Thorne has described the change in temperature with altitude, completely the wrong way round – air temperature decreases with height during overcast conditions, not increases as stated by him.
- 5.26 Of interest Dr Thorne’s analysis shows predicted noise levels at the HAC measurement positions (MP 14 to MP 98) are lower than the HAC predicted levels in all positions, except MP 58 (where Dr Thorne’s level is 2 dB higher). Thus, the HAC predictions are more conservative (higher noise levels) than Dr Thorne’s own predictions (see bottom of Table B.1.1).
- 5.27 On this basis, I would expect Dr Thorne would accept the higher noise levels of Mr Hegley’s procedure as being reasonable. In any event it shows the noise predictions of HAC to be conservative.

Other Issues

- 5.28 In paragraph 5.34 of his evidence, Dr Thorne correctly defines background sound as *“the environment in the absence of the sound in question”*. However, he then misuses this term throughout his evidence when referring to the ‘background sound’ of the turbines. For example at paragraph 5.27 he states: *“A wind farm sound level of 40 dBA measured as the background level...”* Further, at paragraph 6.29 he refers to *“background sound due to the wind farm”*. The term background sound cannot be used in respect of turbine sound.

5.29 In paragraphs 7.1 to 7.4 of his evidence, Dr Thorne states that construction vehicles will cause significant noise for two years, but does not provide any data or technical evidence to back up this opinion.

6 CONCLUSION

6.1 I have reviewed the evidence prepared by Nigel Lloyd, Alan Baker, Douglas Pringle and Robert Thorne and remain of the opinion that the proposed Turitea Wind Farm project can be designed and managed to achieve compliance with NZS 6808:1998 and ensure the activity does not exceed a reasonable level of noise at the surrounding residences.

Christopher W Day

5 June 2009