

BEFORE THE PALMERSTON NORTH CITY COUNCIL

UNDER The Resource Management Act
1991 (RMA)

AND

IN THE MATTER of a review under s 128(1)(c) of the
conditions of consent applying to
the Te Rere Hau Windfarm, North
Range Road, Palmerston North

SECTION 42A REPORT BY TOM EVANS

Dated: 17 August 2017

Introduction

- [1] My name is Thomas Ross Evans. I am associate director of Resonate Consulting Pty Limited (Trading as Resonate Acoustics) and I reside in the state of Victoria, Australia. I am the author of reports dated 27 October 2016 and 15 March 2017 in relation to revised conditions for the Te Rere Hau Windfarm to address effects identified as a result of incorrect information supplied in the original application. I also provided recommendations to ensure the conditions reflected contemporary standards for operation of the Te Rere Hau Windfarm. My background and professional qualifications are summarised in detail in Appendix B – CV of my report dated 27 October 2016.
- [2] I am experienced in acoustic assessment of windfarms in Australia and am familiar with the New Zealand standards applied to the assessment and management of windfarm noise. Palmerston North City Council (“**PNCC**”) consulted with New Zealand Windfarms Limited (“**NZWL**”) (also the “**consent holder**”) concerning the appointment of an independent consultant to assist PNCC with the process. I was one of the nominees and was subsequently appointed. I have had no prior relationship with either the consent holder or PNCC. My role was to independently review the historical material and the data obtained on the operation of the Te Rere Hau Windfarm and make recommendations as to the appropriate conditions to monitor and control noise effects of the existing WTGs and any further WTGs authorised by the existing consent.
- [3] I have visited the site and the detail of my site visit is contained in my report dated 27 October 2016.

Code of conduct

- [4] I have read the Environment Court code of conduct for expert witnesses 2014, and I agree to abide by it. I have prepared this

report in accordance with that Code. I have not omitted to consider material facts known to me that alter or detract from the opinions I express in this report. I have acknowledged the material used or relied on it forming my opinions and in the preparation of this report.

Conclusions reached in the Resonate reports attached to the notice of review

- [5] The reports attached to the notice of review are included on PNCC's website. There are two reports. The first is the report dated 27 October 2016 and the second is dated 15 March 2017. The latter report addresses some specific issues identified by the consent holders (NZWL's) acoustic consultant, Miklin Halstead in relation to my report dated 27 October 2016. I confirm that those reports represent my professional opinion except to the extent that I have made any modifications or changes to this s 42A report.
- [6] I have worked with PNCC's planner, Craig Auckram, in the setting of conditions in the notice of review. In a separate part of this report I address the question whether or not any additional modifications to the conditions are required.
- [7] The main purposes of my report, dated 27 October 2016, were to review the available information relating to noise emissions from the windfarm and to advise on suitable noise-related consent conditions given both this information and current regulatory requirements for windfarm noise in New Zealand. The information reviewed in relation to the windfarm at this time is summarised in my report and included both the noise compliance assessment, which was undertaken by Marshall Day Acoustics (MDA) and summarised in their report Rp008 R03 2011095W dated 18 February 2014 (MDA Report), and a spreadsheet summarising noise-related complaints received by PNCC from 2009 through until 2016 regarding the windfarm. I highlight

these two items as they relate to the summary of my findings I provide below.

- [8] In determining appropriate noise-related conditions for the windfarm, I was asked to consider the site as a new proposal, and therefore subject to the current Palmerston North District Plan and current New Zealand requirements for wind farm noise assessment, as well as to consider knowledge of the noise generated by the existing site. This includes the noise monitoring results presented within the MDA Report and the agreement of all parties that the wind turbine generators (WTGs) installed at the windfarm produce special audible characteristics (SACs) in the near field.

Complaints register

- [9] In my report, I provided a summary of the complaints PNCC has received regarding noise from the subject windfarm. While complaints are, on their own, not confirmation that the site is non-compliant with reasonable noise-related conditions nor are they a reason for the imposition of specific noise-related conditions, they do provide important information on the nature of noise experienced by residents around the windfarm.
- [10] The PNCC complaints log I reviewed indicates that, from May 2009 until August 2016, 1722 complaints were received from a total of 32 different locations. The residents of some locations lodged a relatively small number of complaints, while considerable complaints (greater than 40 in number) have been received from nine locations.

- [11] In reviewing the complaints received by PNCC, I have concluded that the complaints did not necessarily relate to downwind conditions, when noise from the windfarm would be expected to be louder. Most complaints also appeared to be related to lower wind speeds, rather than medium or strong winds.
- [12] Additionally, many of the complaints received referred to the character of the noise rather than simply the level of noise. These complaints describe the noise in terms that could describe tonal or amplitude modulation SACs, and this is supported by the descriptions of the windfarm noise in the resident affidavits.

Overall noise limits and consideration of High Amenity areas

- [13] The key change in noise-related conditions for windfarms in New Zealand that has occurred since the windfarm was originally constructed is that the 1998 version of New Zealand Standard 6808 has been superseded by New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise* (NZS 6808:2010). It is clear that any new noise-related conditions for the Te Rere Hau Windfarm will need to make reference to regard to NZS 6808:2010. However, certain aspects of NZS 6808:2010 are unclear as to how they would apply to the wind farm, and will therefore need to be supplemented with additional conditions.
- [14] The overall noise limits for windfarms that apply in most situations are defined in Section 5.2 of NZS 6808:2010, with the noise limit at noise sensitive uses being 40 dB(A) or the background noise level plus 5 dB, whichever is the greater. The noise limit will vary with wind speed as, for wind speeds where the background noise level is greater than 35 dB(A), the noise limit will be higher than 40 dB(A). Section 5.1 of NZS 6808:2010 notes that these noise limits are appropriate for protecting the health and amenity of residents for

most noise sensitive activities, but also notes that compliance with the noise limits does not mean that windfarm noise will be inaudible at noise sensitive locations.

- [15] A key aspect of NZS 6808:2010 that differs from the 1998 version is that the 'background noise level' is defined to be the noise level measured in the absence of any noise from windfarms, whether that be the noise from other stages of the subject windfarm or a separate site. The MDA Report relied upon background noise levels measured during windfarm shutdowns but was not clear as to whether the background levels measured were influenced by noise from other windfarms, including the Te Rere Hau Extension on Tararua District Council Land and the neighbouring Tararua Wind Farm. This will need to be clarified, and the background noise measurements repeated if necessary, as part of the future compliance assessment required under the new conditions imposed on the subject windfarm.
- [16] The exception to the noise limits stated in [10] is provided in Section 5.3 of NZS 6808:2010 which states that more stringent noise limits should be considered where a District Plan promotes a higher degree of protection of amenity for the acoustic environment of a particular area. NZS 6808:2010 refers to such areas as High Amenity areas. This is relevant to the application of noise-related conditions for Te Rere Hau Windfarm as change decision 15A-H to the Palmerston North District Plan recently identified particular sections of the Rural Residential Zone that surrounds the site as 'High Amenity' with specific reference to NZS 6808:2010.
- [17] Where residences are located in a High Amenity area, then NZS 6808:2010 states that the minimum noise limit for evening and night time periods should be reduced to 35 dB(A). Section 5.3.2 of the Standard restricts the application of this reduced limit to lower wind speed periods, below a defined wind speed threshold. It

recommends that the wind speed threshold should be 6 m/s, but that 'an alternative wind speed threshold may be applied where justified on meteorological, topographical, and acoustical grounds.'

[18] In my first report, I recommended that the wind speed threshold for the High Amenity limits be increased to 8 m/s in the case of the subject windfarm. I consider this increased justified in this case as:

- (a) The measured background noise levels at two residences within the defined High Amenity are low (less than 30 dB(A)) for wind speeds of up to 8 m/s. For example, the background noise levels at 48 Ridgeview Road presented in the MDA Report are 26-27 dB(A) up to 8 m/s for most of the considered wind directions. This provides justification on acoustical grounds as required by NZS 6808:2010.
- (b) Additional acoustical justification is provided when the potential for SACs from the windfarm is considered. It is agreed that the WTGs installed at the windfarm produce SACs in the near field, and this presents a risk that these SACs may be detectable at residences in an area designated as requiring high acoustic amenity. While this may not be a reason on its own to extend the wind speed threshold to 8 m/s, I am of the opinion that it provides additional justification for the extension of the threshold to ensure reasonable protection of acoustic amenity to the designated High Amenity areas.
- (c) The topography around the windfarm is such that residences in the High Amenity areas may be shielded when the wind is blowing in particular directions, potentially increasing the difference in wind speed between the windfarm (at which the wind speed is measured and used for the assessment against NZS 6808:2010) and the residence. Therefore, I consider there

is justification to consider a higher wind speed threshold on topographical grounds.

- (d) In relation to (c) above, and based on my discussions with PNCC and review of the complaint register, some complaints received about the windfarm refer to situations where it is operating but there is little or no wind at the house to provide background masking noise. Given that the WTGs at the windfarm only commence operation at 5.5 m/s, a high wind speed threshold of only 6 m/s may not adequately address this situation.

I note that the extension of the wind speed threshold does not necessarily mean that the High Amenity limit will apply in all cases up to 8 m/s. Rather it means an investigation needs to be undertaken comparing the operational noise levels to the background noise levels for those residences within High Amenity areas, in accordance with Section C5.3.1 of NZS 6808:2010. An average difference of at least 8 dB between the operational and background conditions is required for the High Amenity limits to be justified.

- [19] Based on the above, I have summarised the various noise limits applicable to the windfarm under NZS 6808:2010 in Table 1. The time periods are as per the standard time periods from New Zealand Standard 6802 *Acoustics – Environmental noise*.

Table 1 NZS 6808:2010 noise limits applicable to windfarm

Time period	Windfarm noise limit
All areas: Day, 7 am – 7 pm	40 dB(A) or background + 5 dB, whichever is greater
High Amenity areas*: Evening / Night 7 pm – 7 am	35 dB(A) or background + 5 dB, whichever is greater
Other areas: Evening / Night 7 pm – 7 am	40 dB(A) or background + 5 dB, whichever is greater

* Noise limits for “other areas” apply to residences in High Amenity areas if High Amenity limit is deemed to not be justified following assessment in accordance with C5.3.1 of NZS 6808:2010.

[20] In measuring and assessing overall noise levels from the windfarm for assessment against the noise limits in Table 1, the proposed conditions impose additional specific requirements as follows:

- (a) Operational and background noise levels are to be assessed based on measurements conducted for the night time period, which, for the purpose of this condition, is defined as the period from one hour after sunset to one hour before sunrise. This definition is as per the measurement specification that was jointly developed prior to the monitoring results detailed in the MDA Report. I consider it appropriate for the compliance assessment to be based on night-time data as this will provide a conservative assessment of windfarm noise levels given the lower background noise levels that typically occur at night. The definition of night in this instance is appropriate as it will ensure that measurements avoid the influence of extraneous noise, such as bird noise, which can occur within the standard night time period of 10 pm to 7 am.
- (b) The assessment is to be separately conducted based on four defined wind directions. I consider this an appropriate approach as wind farm noise levels can vary with wind direction and the defined wind direction sectors adequately address the predominant wind directions that occur at the site, as well as the different conditions under which complaints have occurred.
- (c) Restrictions are included on the operational conditions of the windfarm that can be considered in the assessment. This is to ensure the exclusion of measurements taken when a sufficient number of WTGs are offline for maintenance or due to failure that it may noticeably reduce the noise levels at residences.

- (d) A minimum number of valid data points for the different wind direction sectors. This is required to provide a robust assessment of the different direction sectors.

Special Audible Characteristics (SACs)

- [21] Another relevant consideration for the windfarm and the application of NZS 6808:2010 in noise-related conditions is the assessment of SACs, namely tonality and amplitude modulation. While it is agreed that the WTGs produce SACs, specifically tonality, in the near field, it has not been demonstrated whether these SACs occur at residences, at least at a level that would require the application of a penalty to the measured wind farm noise level. Given the knowledge of the near field SACs and the fact that complaints from residents often describe the character of the windfarm noise in terms that suggest potential SACs, I consider it important that a rigorous assessment of SACs from the windfarm be required by the consent conditions.
- [22] Assessments of potential SACs at residences were documented within the MDA Report but had limitations that I addressed within my first report. Additionally, I note that the assessment will need to be updated to address the objective assessment methodologies of SACs required by NZS 6808:2010 and other recent guidance.
- [23] For tonality, Appendix B of NZS 6808:2010 is clear that the assessment methodology for tonal noise at a residence should be in accordance with the Reference Method from Annex C of International Standard ISO 1996-2:2007 *Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels*. Annex C of ISO 1996-2:2007 details a methodology for determining the tonal audibility of a measurement and recommends a penalty scheme. Where the tonal audibility is less than 4 dB, no penalty is applied. Where the tonal

audibility is above 4 dB, the penalty is the audibility less 4 dB up to a maximum penalty of 6 dB.

- [24] The main problem that arises with respect to the application of the ISO 1996-2 penalties for tonal audibility in the case of the windfarm is that NZS 6808 applies an approach to wind turbine noise assessment whereby a large number of 10-minute data points are correlated with wind speed and then averaged to determine the windfarm noise level for each wind speed. However, the audibility of any tones from the windfarm at a residence will be related to variable factors including the wind speed and direction at the WTGs, and the background masking noise in the specific frequency range around the tone at the residence. Therefore, it is quite possible that, if the windfarm produces audible tones at residences, these tones may only be subject to a penalty as a SAC for a limited percentage of the collected 10-minute data points.
- [25] Appendix B of NZS 6808 suggests that penalties for any tonal characteristics may only be applied to the individual 10-minute data points in a complete dataset, and the overall wind farm noise level should then be recalculated from the adjusted dataset. However, I have a significant concern that NZS 6808 does not adequately consider a situation where a WTG is known to produce a tonal SAC in the near field but where this characteristic may only be detected at residences under certain conditions. In this case, the application of a penalty to individual 10-minute data points will not always adequately reflect the potential annoyance caused by a characteristic.
- [26] To illustrate the discussion in [25] above, I provide the hypothetical example of a tonal noise that would attract a penalty of 5 dB under ISO 1996-2 that occurs for 20 percent of the time at a residence. This corresponds to an annoying tone that occurs with reasonable

regularity, and depending on weather conditions may occur constantly for several consecutive nights. If the 5 dB penalty were to only be applied to 20 percent of the 10-minute data points, the overall average noise level would only increase by approximately 1 dB. I do not consider this to reflect the potential annoyance of the SAC in this instance. A 1 dB penalty is unlikely to significantly alter a compliance assessment for such a windfarm and therefore, from a regulatory perspective, there is unlikely to be any incentive for the operator to rectify the tone or otherwise reduce noise levels. Additionally, I note that the tonal penalties from ISO 1996-2 can also be applied to other industrial noise sources in New Zealand, under NZS 6802, and I would expect a higher tonal penalty than 1 dB would be applied to an industrial noise source were it to produce an annoying characteristic for 20 percent of the time.

- [27] An additional consideration regarding tonality from windfarms is the assessment time for individual samples. The proposed conditions around tonality include a requirement that tonality is assessed in two-minute periods rather than 10-minute periods, even though 10-minute measurements are the basis of NZS 6808. Where a tonal SAC is detected, then the highest penalty for any two-minute period within that 10-minute period is applied. I have recommended this approach as, in my experience, the level of tonal audibility can vary quite markedly over a 10-minute period. Unlike the windfarm noise level, which typically remains fairly steady over a 10-minute period, the level of audibility of a tone can vary due to changes in both the level of the tone from the windfarm and the level of the background masking noise. Therefore, the level of tonality assessed over a 10-minute period may not be suitably representative of the level of annoyance that could occur within that time. I have recommended that the level of tonal audibility, if any, is determined in two-minute periods to address this potential variability. I note that a two-minute

assessment period is longer than the minimum one-minute period required by Annex C of ISO 1996-2.

[28] For amplitude modulation, NZS 6808 notes that some amplitude modulation will always be present in audible wind turbine noise and advises that an amplitude modulation SAC is only deemed to be present when excessive amplitude modulation occurs. Appendix B of the Standard details an 'interim test method' for the assessment of excessive amplitude modulation but states that 'it is envisaged that appropriate objective tests for modulation special audible characteristics will be developed in future' to replace the interim test method.

[29] Given the interim nature of the amplitude modulation test method detailed in NZS 6808, I consider that it is appropriate for the conditions to make reference to the recent amplitude modulation assessment methodology developed by the UK Institute of Acoustics, as recommended in a 2016 review released by the UK Department of Energy & Climate Change (DECC). The DECC review was specific to windfarm amplitude modulation and included a recommendation for a penalty to be applied to the measured noise level where the modulation exceeded a peak-to-trough level of 3 dB. The penalty that could be applied where this occurred ranged from 3 dB up to a maximum penalty of 5 dB.

[30] I note that the amplitude modulation penalty scheme recommended in the UK DECC report is clear that any penalty applies to individual 10-minute data points only, but is not clear as to what number of 10-minute data points incurring a penalty should be considered unacceptable, rather stating that the 'frequency and duration of breaches' should be considered, as well as the coincidence of the breaches with conditions causing complaints. Where the number of data points with penalties for amplitude modulation that result in

breaches of the noise limit is considered unacceptable, it recommends that the windfarm operator should be required to implement mitigation. However, I do not consider this approach consistent with the approach taken to SACs in NZS 6808.

[31] To adequately address the application of penalties for SACs for the subject windfarm, proposed Condition 8 requires the following approach:

- (a) 10-minute periods which have undergone an analysis for SACs (tonality and amplitude modulation) are grouped into 1 m/s-wide wind speed bins for each wind directions.
- (b) If a tone is detected that attracts a penalty and is a result of the windfarm, then the applicable penalty is applied to that period. A separate penalty is applied if excessive amplitude modulation is detected.
- (c) If both tonal and amplitude modulation SACs are detected in an individual period, the penalties are arithmetically summed. However, the maximum penalty applicable to any 10-minute period is 6 dB in accordance with Appendix B of NZS 6808.
- (d) If less than 10 percent of the data points in a particular wind speed and direction bin attract a penalty for SACs, then the penalty is applied to the individual 10-minute data points only, and the overall wind farm noise level is recalculated in accordance with NZS 6808.
- (e) If 10 percent or more of the data points in a particular wind speed and direction bin attract a penalty for SACs, then the arithmetic average penalty for those penalised data points is determined and applied to the overall measured wind farm noise level for that wind speed.

I consider that the above approach adequately addresses the question of the threshold at which intermittently-occurring SACs should be considered to be a regular feature of the windfarm noise. If a SAC, such as a tone, occurs infrequently (less than 10 percent of the time) then the effective penalty will be relatively small due to the averaging approach applied by NZS 6808. However, if the SAC occurs more than 10 percent of the time, then it is considered to occur with reasonable regularity and an appropriate penalty is applied. I consider the threshold of 10 percent appropriate, and note that the same threshold has been applied in recent windfarm noise guidelines issued in Australia, namely the New South Wales *Wind Energy: Noise Assessment Bulletin*, dated December 2016, and the Queensland *State code 23: Wind farm development – Planning Guideline*, dated July 2017.

Requirement for a compliance noise monitoring report

[32] Proposed Condition 10 details the requirements for a compliance noise monitoring report to be submitted to PNCC to demonstrate compliance, or otherwise, with the consent. The condition details specific requirements for the report that I consider are necessary for a robust assessment of noise from the windfarm. In my report, I noted that it may be possible for this compliance assessment to use the existing noise measurement data already collected for the site (as documented in the MDA Report) but noted that:

- (a) It would need to be confirmed that the ‘background noise levels’ measured during the windfarm shutdowns was unaffected by noise from other stages of the windfarm and other windfarms. If this cannot be confirmed, then additional shutdowns will be required to confirm the background noise level in accordance with the 2010 version of NZS 6808.

- (b) Tonality and amplitude modulation assessments will need to be undertaken using the relevant objective methodologies detailed in the conditions. The MDA Report utilised methodologies that, while originally considered adequate for the situation under which that assessment was undertaken, have now been superseded.
 - (c) The tonality assessment in the MDA Report used tonality results collected in the near field (i.e. at the WTGs) to filter the results in the far field. While I consider this a valid approach in principle, the near field tonality assessment was only carried out in the downwind direction over a limited wind speed range. I consider it important that any near field assessment of tonality consider different wind speeds and directions that are representative of the orientation of residences under a suitable variety of wind speeds and directions. This is based on my prior experience that turbines may radiate tones in other directions that are not detected immediately downwind of the turbine, and the PNCC register of complaints which demonstrates that a considerable number of complaints are received under light winds where residences do not appear to be directly downwind of the windfarm.
 - (d) Other, relatively minor, alterations would be required to update the assessment such that it addresses the requirements of the 2010 version of NZS 6808.
- [33] Condition 11 requires the compliance noise monitoring report to be independently peer reviewed by an acoustic expert acceptable to PNCC. I consider this condition necessary due to the technical nature of windfarm noise assessment, in particular the assessment of potential windfarm SACs at residences. The technical nature of the

assessment means that expertise is required to provide confidence that the compliance assessment has addressed the requirements of the consent.

Stage 4 of the windfarm

[34] Stage 4 of the windfarm is yet to be constructed and, if NZWL do decide to construct it, then it will be necessary for a number of conditions to be met. These are detailed in proposed Condition 12 and require that compliance is first demonstrated for the 65 currently installed WTGs prior to the installation of any further WTGs. The proposed Condition also states that a predictive acoustic assessment will need to be submitted to PNCC for approval, with the compliance monitoring data collected for the current form of the windfarm used to validate the predictions for Stage 4.

Second report issued 15 March 2017

[35] My second report, dated 15 March 2017, provided a response to comments on my original report from Miklin Halstead of MDA. In certain cases, I agreed that Mr Halstead's suggested changes to the proposed noise-related conditions were reasonable and these changes are incorporated in the current proposed noise-related conditions. For two items, however, I disagreed with Mr Halstead's suggestions; namely the wind speed threshold at which the High Amenity condition should apply and the process for the application of penalties for special audible characteristics, particularly tonality. My reasons for this disagreement are summarised above in paragraph [18] for the high amenity threshold and paragraphs [23] to [31] for the application of SAC penalties.

Proposed conditions

[36] I confirm that the proposed noise-related conditions presented for this Hearing incorporate the recommendations of my report and, other than where I have provided additional recommendations within this Statement, reflect my professional opinion.

Differences in opinion between me and the consent holder's acoustic consultant

[37] Following my initial report dated 27 October 2016 PNCC, in accordance with a memorandum of understanding with the consent holder, provided the consent holder with the opportunity to comment on that report. The comments were received from Mr Halstead. Generally speaking, Mr Halstead agreed with the conclusions reached in the report dated 27 October 2016, but there were some matters of difference.

[38] Certain matters of difference were in relation to the wording of the High Amenity condition (other than the wind speed threshold) and the conditions under which data points were to be considered valid. I considered that the suggestions provided by Mr Halstead on these aspects were appropriate and these suggestions have been incorporated into the proposed conditions.

[39] Following my discussions with Mr Halstead, the main area of disagreement is that Mr Halstead does not believe that there is justification to increase the high wind speed threshold above 6 m/s, whereas I consider that there is justification to increase it to 8 m/s.

[40] In our discussion, Mr Halstead stated that, in his view, justification for increasing the wind speed threshold for high amenity would only be justified where background noise levels were very low (< 25 dB(A)) and did not show a strong relationship with wind speed. He did not

consider that these conditions were met at the subject windfarm based on his assessment of the background noise data his company had collected.

- [41] Via email, Mr Halstead provided an example of a background noise dataset at another site where he would consider the application of a higher High Amenity wind speed threshold to be justified. The dataset showed a trendline level below 25 dB(A) up to approximately 8 m/s, with the trendline level only increasing by a relatively small amount with increasing wind speed.
- [42] In response to Mr Halstead's view on the High Amenity wind speed threshold, I note that Section 5.3 of NZS 6808 does not state that it excludes sites where there is a relationship between wind speed and background noise level from consideration of higher wind speed thresholds for the High Amenity limit.
- [43] The High Amenity definition in NZS 6808 states that its aim is to protect sensitive land uses in defined High Amenity areas under conditions in which the windfarm may be operating but the background noise level is low. The only definition it provides around this is that a High Amenity limit may be justifiable where there is an 8 dB difference between the windfarm noise level and the background level. Given that the background noise levels at residences within the High Amenity area are 27 dB(A) or less at wind speeds of up to 8 m/s under certain wind directions, allowing a windfarm noise level of 40 dB(A) would have the potential to result in a difference in operational noise levels of 13 dB or more. Therefore, I consider it appropriate to increase the High Amenity wind speed threshold to 8 m/s in this case to ensure that, where there may be an increase in noise level of 8 dB or more above background, the overall windfarm noise level does not exceed 35 dB(A).

- [44] I also consider that the other factors identified earlier in my statement, namely the potential difference in wind speed at the windfarm and the residence due to topographic shielding, and the risk of audible SACs at residences, provide additional justification for an increased High Amenity wind speed threshold in this instance.
- [45] I do not view it as necessary to extend the wind speed threshold beyond 8 m/s as typically the background noise levels extend beyond 30 dB(A) by 10 m/s. However, I do acknowledge that this may lead to increases of more than 8 dB above background at some residences within the High Amenity area under specific wind conditions. Overall, I consider that its application up to 8 m/s will ensure that appropriate acoustic amenity is maintained for those conditions where it is most likely that the windfarm will be operating but there will be a low background noise level at the residences within the defined High Amenity area.
- [46] One additional difference of opinion between Mr Halstead and myself was that Mr Halstead stated that, in his view, NZS 6808 was clear that penalties for SACs should only be applied to individual 10-minute periods rather than to the overall measured windfarm noise level.
- [47] While I agree that this is the strict interpretation of NZS 6808, I consider that the Standard does not adequately consider or address the situation where a windfarm produces intermittent SACs at a residence as per my earlier points raised in this statement. The potential annoyance of such SACs does not, in my view, align with the penalty that would be applied if those penalties are only applied to a percentage of the data points.
- [48] Therefore, the proposed penalty scheme sets a bar for particular wind conditions where, if less than 10 percent of data points contain

a SAC, then the NZS 6808 approach may be applied. However, if more than 10 percent of data points contain a SAC, then the penalty should be applied to the overall wind farm noise level determined via a trendline, rather than the individual data points.

[49] In support of the above, I note that recent windfarm noise assessment guidance in New South Wales and Queensland also uses a 10 percent level as a trigger for the application of the penalty to the trendline rather than individual data points.

[50] It is also stated in the UK amplitude modulation guidance that, if a certain percentage of data points attract a penalty that results in a breach, then mitigation should be required. This reflects the same approach, whereby a small number of SACs may be considered to be adequately reflected by a small penalty, but that, at a certain point, applying those penalties only to individual data points within a large dataset does not adequately reflect the annoyance.

[51] I also note that the requirement for the SAC assessment to be grouped into specific wind speed and direction sectors will enable targeted mitigation by NZWL should SACs be detected that result in an exceedance of the noise limits. In my experience, SACs are highly dependent on wind speed and direction and this will allow practical mitigation options, should they be required, to be developed and targeted to those wind conditions under which the SACs occur.

Consideration of submissions

[52] I have considered the submissions filed in response to the notice of review. I provide a response to those that raised specific aspects related to windfarm noise that may impact on the proposed consent conditions.

Submissions 3 and 5

[53] Two of the submissions (Submission 3 and Submission 5) state that the submitter is not able to hear any noise from the windfarm at distances of 1 to 1.5 kilometres from the site, while another submission (Submission 7) stated that the windfarm noise is minimal at their residence. I accept that not everyone will be able to hear the windfarm at all times, with audibility depending on a number of factors including both the level of windfarm noise and the level of background noise. However, I note that the proposed noise-related consent conditions are based on objective measures of the windfarm noise level, including objective measures of SACs, that are consistent with good practice for windfarm noise assessment in New Zealand and elsewhere. If the windfarm can operate in compliance with these conditions, then, from an acoustic perspective, it would be able to be operate as such.

Submissions 6, 8 and 10

[54] Submission 6, 8 and 10 all raised concerns regarding periods when wind speed at the windfarm was sufficient for the WTGs to operate but wind speed at the residence was very low, such that there was reduced natural masking of the windfarm noise. At any windfarm site, it is possible that these conditions will occur from time to time. My experience has been that they are more likely to occur at night time, when the difference between hub height and ground level wind speed tends to be higher and there is less noise generated by human activity, and under specific wind directions where there may be greater shielding of wind at the residence due to the topography. Therefore, I am satisfied that the proposed conditions address this issue appropriately as they require separate assessments to be carried out for each of the predominant wind directions at the site, and they require the assessment to focus on the night-time period. I

acknowledge that there will be times when the background noise level will be low and the windfarm will be producing audible noise at residences, but note that NZS 6808 does not recommend that windfarms be required to achieve inaudibility at noise-sensitive locations.

- [55] Submission 8 also raised a concern that it was difficult to interpret the meaning of the NZS 6808-based noise limits. It was suggested that these should be viewed as the target but that it was the noise experienced and reported by residents that should be considered in compliance. I note that the appropriate approach to the regulation of windfarm noise in New Zealand is to apply objective noise limits in accordance with NZS 6808, and this is acknowledged within the Palmerston North District Plan. I note that Conditions 16 to 20 of the proposed conditions relate to the implementation of a Contact and Complaints Procedure by NZWL that will require consideration be given to information received from residents.

Submission 9

- [56] Submission 9 raised a concern regarding potential deliberate manipulation of wind turbines during compliance noise monitoring, by altering the pitch of the blades to reduce noise emissions. While I am not aware of any site where this has occurred, I note that the compliance assessment submitted to PNCC will need to be independently peer-reviewed. If determined necessary by the appointed peer reviewer, it may be appropriate for the electrical output data from the WTGs over the monitoring period to be provided for the review.
- [57] Submission 9 also expressed significant concerns with respect to potential amplitude modulation from the WTGs installed at the windfarm. This included a concern that the specified amplitude

modulation assessment methodology in the proposed conditions was not sufficiently accurate in detecting amplitude modulation. In response to this, I note that it is not possible to comment on the unpublished research referred to in the submission regarding the Institute of Acoustics amplitude modulation methodology but note that this methodology has undergone extensive testing, and has been published by the peak body for acousticians in the UK. In my opinion, I consider the Institute of Acoustics methodology to be the best available assessment methodology for amplitude modulation of wind turbine noise.

[58] It was also recommended by Submission 9 that the SAC penalty of 6 dB be applied in full regardless of any SAC testing. I do not consider this appropriate and it is not consistent with the approach required by NZS 6808. SACs have been shown to occur in the near field of the WTGs but, to date, have not been objectively identified at residences. Given the occurrence of SACs in the near field, I am of the opinion that a robust SAC assessment methodology is required at relevant residential locations, and consider that the methodology required by the proposed conditions is such a methodology.

[59] A final concern of Submission 9 was the need for verifiable compliance testing and, as requested in the submission, ongoing 'live' or real-time testing of the windfarm. With respect to the need for verifiable testing, I agree that an independent peer review of any compliance testing is required and note that this is conditioned in the proposed consent. However, I do not consider that there is a need for ongoing 'live' or real-time monitoring of windfarm noise. My reasons for this are:

- (a) 'Live' monitoring of windfarm noise is not feasible as the NZS 6808 assessment methodology, as specified in the proposed conditions, requires a sufficient number of 10-

minute data points to be collected and analysed for an assessment to be considered valid. The assessment is not of a single 10 minute period.

- (b) The signal-to-noise ratio of windfarm noise at residences and at a distance from the windfarm is often relatively low, with the windfarm noise level at or close to the background noise level. Therefore, in my opinion, 'live' monitoring systems for windfarms are likely to be subject to significant interference from extraneous noise, and will likely return a high number of false 'exceedances'.
- (c) In my experience, windfarm noise levels remain relatively steady (for a given wind speed and direction) over many years. However, if there is a reason to believe there has been a change in noise levels, I consider that the proposed conditions enable noise emissions to be managed into the future.

Submission 11

[60] Submission 11 summarised a detailed analysis of resident logs and complaints that had previously been undertaken by the submitter. It concluded that complaints referred primarily to the wind direction sectors identified in the consent conditions and typically when wind speed at the wind farm is in the region of 8 – 10 m/s in the southeast, and 6 – 8 m/s in the northeast. As per my review of complaints, the review identified that complaints do discuss noise from the windfarm in terms that suggest potential SACs.

[61] I note that the proposed consent conditions will require that a detailed SAC assessment will be undertaken to address the wind speed and directions identified in Submission 11.

[62] The proposed conditions impose a High Amenity limit on certain residences for the lower wind speed range of up to 8 m/s. As per my earlier statements, I do not consider it reasonable, based on the available background noise data, to extend the High Amenity limit up to the 10 m/s referenced in Submission 11. However, I note that the assessment of windfarm noise, including SACs, will need to extend to wind speeds of up to 15.5 m/s. Therefore, I consider that the application of the conditions will require assessment of those periods where the vast majority of complaints have been received from the residents.

Submission 12

[63] Submission 12 raised a number of suggested changes to the proposed resource consent conditions, and I have responded to the suggestions that impact on the noise-related conditions below.

[64] The first suggestion is that the wind conditions as measured at the windfarm mast will be different to that at the residences. My experience tells me that it is likely that there will be a difference between the wind at the mast and the wind at the residences. However, I note that NZS 6808 requires wind speed measurements to be taken within the wind farm and at the WTG hub height, and therefore the nominated western mast location is an appropriate measurement location. I refer to my response in paragraph [54] as to other measures incorporated into the conditions to address periods of low wind speed at residences in particular.

[65] Submission 12 also states that all residences on Ridgeview Road should be considered High Amenity areas. I note that the definition of High Amenity Areas is a matter for PNCC but that, as the windfarm will be required to comply with the High Amenity condition at some residences on Ridgeview Road, noise levels at other residences will

also effectively be controlled to the same condition due to the relatively close proximity of these residences. Therefore, I do not consider that the extension of the High Amenity overlay in the PNCC District Plan to all residences on Ridgeview Road would have any noticeable effect on noise levels from the windfarm.

[66] A request was made that the wind sectors specified in the conditions 'should be checked so that they match the natural distribution of the wind'. I confirm that I have reviewed annual wind data collected at the wind farm mast for both 2014 and 2015 and the nominated wind direction sectors address the vast majority of conditions that occur at the site. There will be periods that fall outside of the nominated sectors during any assessment period but these appear to be very limited in number and it would not be appropriate to conduct a compliance assessment on that occasional occurrence of different wind directions.

[67] Suggestion H of the Submission is that Condition 7.4 should be amended to require WTGs to be generating, rather than 'online and available for generation', for a data point to be considered valid. The reason for the current definition is that there will be periods at the lower end of the defined wind speed range where WTGs will be online but the natural variation of wind speed across the site will mean that the wind speed at the WTG will not have reached cut-in. As this is part of the natural operation of the site, I am satisfied that the current condition is appropriate but note that:

(a) Given that there may be data points at 6 m/s where WTGs are not operating due to local wind speed (below 5.5 m/s), bin analysis of the data would be preferable as per C7.4.2 of NZS 6808. This would ensure that the result at higher wind speeds would not be influenced by any of these data points at 6 m/s.

(b) I would expect that the compliance noise monitoring report required under Condition 10 would consider the generation of the site during the monitoring and, if NZWL opt not to operate certain WTGs under particular conditions, that this would be identified in the report as a condition that the noise monitoring results were collected under. I would also expect that the peer review of the report required under Condition 11 would consider this.

[68] Suggestion I of Submission 12 states that Condition 7.5.2 should be amended to define a minimum number of data points for each of the SSE and ESE wind direction sectors. The condition has been documented as such to allow timely reporting of results, in line with other conditions of consent, and I am satisfied that it, along with the requirements for the assessment of SACs across the range of wind speeds and wind directions defined, will result in an adequate assessment of windfarm noise.

[69] Suggestion J of Submission 12 suggested an approach to the assessment of tonal sound that, based on my understanding of the submission, is equivalent to the methodology already required by NZS 6808. Annex C of ISO 1996-2 requires that the tonal energy is determined and then the masking/background energy in the frequency band immediately around the tone is determined. The difference between the two is used to determine the audibility of the tone. This methodology has been determined based on the outcome of subjective listening tests and I consider it an appropriate methodology for the determination of tonality and tonal audibility.

[70] Suggestion K of Submission 12 requests consideration of On/Off testing. On/Off testing is defined in Section 7.7 of NZS 6808. In my experience, On/Off testing can be inconclusive as it is subject to the specific short term background noise and operational conditions at

the time of the test. I consider the longer term testing required by the proposed consent conditions to provide a more robust assessment methodology, particularly for SACs which are highly dependent on the background noise at the measurement location. Longer term testing provides a clearer indication of the occurrence of SACs as it provides measurement over a wider range of conditions.

[71] Suggestion L of Submission 12 states that there is a lack of clarity around the timeframes in the proposed conditions, particularly with respect to the assessment of noise during the daytime and the definition of the evening period. Upon review of the currently proposed conditions, I agree that these aspects should be better defined and have provided recommendations to address this at the end of this statement.

[72] Suggestion M of Submission 12 states that mitigation should be implemented to address the complaints of residents. From an acoustic perspective, I do not agree this is necessary. That is, if the windfarm can operate in accordance with the proposed consent conditions then I would consider it to provide an appropriate acoustic outcome.

[73] The final request of Submission 12 is for a condition related to the measurement of infrasound from the windfarm. Infrasound is sound at very, very low frequencies and, due to the high hearing threshold at these frequencies, typically well below the threshold of hearing. Modern windfarms do produce infrasound but, in my experience, the level of infrasound that occurs at residences, and indeed even at the WTGs themselves, is well below the threshold of perception. NZS 6808 does not require the assessment or measurement of infrasound, and it is not appropriate to classify it as a SAC, and therefore I do not consider it appropriate to include the suggested condition. Additionally, based on my experience, I do not consider it

necessary to include such a condition because the level of infrasound at residences is likely to be significantly lower than the threshold of perception. I note that none of the complaints lodged with PNCC refer to the windfarm in a way that indicates potential infrasound, with the complaints clearly referring to audible noise.

Recommended conditions

[74] In reviewing the proposed conditions of consent in the PNCC Notice of Review, I have noted some recommended changes below. These are a result of specific concerns raised by submissions received on the review.

[75] Firstly, I recommend that the last paragraph of Condition 4 be reworded as follows (change **bolded** for emphasis):

*This condition only applies twelve months after the conditions have been amended pursuant to PNCC's review under RMA, s 128(1)(c), **from 7 pm to 7 am**, up to a hub height wind speed of 8 m/s and where the difference between operational and background noise levels is greater than 8 dB(A) in accordance with Section C5.3.1 of NZS 6808:2010, otherwise condition 5 applies.*

[76] I consider this change important because, as identified by Submission 12, there is potential confusion around the definition of evening and night time given the definition of night given in Condition 7.2. The time definitions given above are consistent with the standard definitions of evening and night time under NZS 6802 (as referenced by NZS 6808) but I consider that the specific definition of times in this condition provides additional clarity to the time at which the High Amenity limits may apply.

- [77] For the same reason as the above, I recommend that Condition 7.2 be reworded as follows to assist with clarity (change **bolded** for emphasis):

*The operational and background noise levels are to be assessed for the **period from 1 hour after sunset to 1 hour before sunrise only.***

The removal of the phrase “night time” from this condition reduces potential uncertainty with varying definitions of this term.

- [78] My final recommended change is to address the concern that, as the assessment only requires assessment during the evening and night time period, it is not clear how any exceedances during daytime would be addressed, should they occur. It is quite possible that an exceedance would only occur at night time, due to higher background noise levels during the daytime and less stringent noise limits for residences in High Amenity areas, but this needs to be demonstrated by the consent holder.

- [79] Considering the above, I suggest the following additional condition (Condition 10.7) be added to the consent:

If any mitigation measures are identified within the compliance noise monitoring report, then evidence shall be provided that these measures have been applied at all times of day, unless justification is provided within the compliance noise monitoring report as to why the mitigation measures should be limited to specific times of day.

- [80] I consider that the above suggested condition would address the concern around daytime noise levels, requiring the consent holder to justify why any mitigation should only apply during specific periods. This justification will need to be included in the compliance noise monitoring report and will therefore be subject to the peer review required under Condition 11.

Conclusion

[81] With the incorporation of my recommendations above, which I understand have been made into the proposed conditions presented by PNCC, I consider that the proposed noise-related conditions are appropriate based on my site visit, the information I have received and reviewed regarding the current site, and on current regulation of windfarm noise in New Zealand.

Date: 17 August 2017



Tom Evans