

**Before the Hearings Commissioners
At Palmerston North**

In the matter of the Resource Management Act 1991

And

In the matter of an application by NZ Windfarms Limited for landuse, stormwater discharge and contaminants discharge consents required to establish the proposed Te Rere Hau Eastern Extension

Between **NZ Windfarms Limited**

Applicant

And **Horizon Regional Council**

And **Tararua District Council**

Consent Authorities

And **Submitters on the application**

Submitters

Statement of Evidence of Michael Miklin Halstead

Introduction

Qualifications and experience

1. My name is Michael Miklin Halstead. I am an Associate with Marshall Day Acoustics Limited (**MDA**).
2. I have the following qualifications and experience relevant to the evidence I shall give:
 - (a) I hold a Bachelors degree in Industrial Engineering;
 - (b) I am a member of the New Zealand Acoustical Society and the Resource Management Law Association;
 - (c) I have had 21 years experience assessing and advising on the environmental sound effects of various projects, including wind farms, gas production plants, electricity substations and roading projects for industrial and public sector clients;
 - (d) My experience with wind farms includes consenting for the Te Apiti and Waitahora wind farms, measurements for Tararua 3 and West Wind, and research on propagation of wind turbine noise; and
 - (e) I served as Chair of the NZS6801-6802 (noise measurement and assessment standards) revision committee, and I am a member of the NZS6808 (wind farm noise) standard revision committee.
3. I confirm that I have read the 'Code of Conduct for Expert Witnesses' contained in the Environment Court Consolidated Practice Note 2006. My evidence has been prepared in compliance with that Code in the same way as I would if giving evidence in the Environment Court. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Scope of evidence

4. My evidence will cover the following areas:
 - (a) Compliance measurements performed by MDA;
 - (b) Analysis of resident complaints in terms of wind conditions and noise levels;
 - (c) Assessment of tonality performed by MDA; and
 - (d) Peer Review of the Malcolm Hunt and Associates (**MHA**) Assessment of Environmental Effects – Noise (**Noise AEE**).

Summary of conclusions

5. Compliance measurements have been taken in accordance with the requirements of the conditions of consent for the existing Te Rere Hau Wind Farm (**TRH**).
6. Complaints received during the past several months have been examined, and have been shown to occur over a range of wind directions and wind speeds. The conditions during which complaints have occurred are not necessarily the loudest periods, but include quieter periods where windfarm sound is more exposed.
7. Tonality has been assessed as required in NZS6808:1998 but using the techniques of the Joint Nordic Method (**JNM**) as incorporated in the relevant international standard IEC-61400-11. This combination of standards references has given rise to some conflicts of interpretation as to the intended position of measurement, but when assessed at numerous residential locations, no penalty for tonality is indicated.
8. A review of the methods of assessment conducted by MHA has been carried out. I agree with the use of NZS6808:1998 as a means of assessment, and I agree with the conclusion that noise effects will be acceptable.

Compliance Measurements

9. MDA was engaged by New Zealand Windfarms Ltd (**NZWL**) to perform noise measurements in the vicinity of the TRH wind farm. These measurements consisted of long-term monitoring of broadband background noise levels at five positions (for approximately two weeks at each position), as well as short term attended narrowband measurements to assess noise tonality. These measurements were conducted by my colleague at MDA Mr Alex Barker. I have reviewed all of the measurements and analyses conducted by Mr Barker.
10. I also conducted further measurements at the 104 Harrison Hill Road position between 26 August and 7 September. This followed two attempts to gather this data between 15 July and 19 August, during which time our sound meters failed.
11. In the process of tending to the noise measurement devices, I had the opportunity to make a number of visits to the wind farm and to various residential locations, to gain an understanding of the noise character at these locations.
12. The report submitted to NZWL on 26 June 2009 provides the results of the measurements conducted between 12 May and 8 June 2009. All measurements were carried out in accordance with the TRH conditions of consent and with NZS6808:1998, so that they could be incorporated into compliance reporting by NZWL.
13. Initial long term noise monitoring was conducted over two periods at the following locations:
 - Stewart Residence, 662 Pahiatua Track;
 - Parlane Residence, 96 Harrison Hill Road;
 - Irvin Residence, 38 Ridgeview Road;
 - NZWL Property, 104 Harrison Hill Road; and

- Anderson Residence, 81 North Range Road.

14. Wind speeds were measured during the monitoring period and supplied to MDA in 10 minute averages synchronised with the 10 minute noise measurements. The wind speeds were measured at two locations: a 10 metre mast situated adjacent to the monitoring position at 104 Harrison Hill Road, and a 30 metre mast situated on the wind farm, in the vicinity of turbine T85.
15. Due to its closer proximity to the monitoring positions and residences, data from the 10 metre wind mast was correlated with the noise measurements for the monitoring period 12 – 25 May. An instrumentation failure on the 10 metre mast necessitated the use of data from the 30 metre mast for the period 26 May – 8 June.
16. The raw measurement results (and correlations of sound level to wind speed for the May – June measurements) have been provided to MHA, and have been presented as part of Mr Hunt's evidence.
17. I offer the following comments regarding the measured noise levels at these sites. These comments are derived from Mr Barker's field notes which I have reviewed, from my own visits to the site, and from my review of the processed data.
18. The relationship of wind speed to noise level at the residential sites investigated showed a high degree of correlation. This indicates that wind effects were primarily responsible for the noise received at these locations.
19. There is little indication of significant clusters within the data. When such effects are present it can indicate that under some wind conditions there is less wind effect than under others.
20. My visits to the site indicated that during strong downwind conditions in particular, there is a strong contribution of noise from the trees on the hills near the wind farm which are at similar distances to the residential locations as the turbines. My impression was that this provides significant masking to the wind farm sound under conditions which would normally be the most

significant for wind farm propagation. This may explain why complaint frequency is not highly dependent on wind direction (as will be discussed in the following section of my evidence).

Analysis of Complaints

21. Residents living in the vicinity of TRH wind farm were asked by NZWL to keep a log of their impressions of wind farm noise for the duration of noise monitoring. Residents were also asked to keep a record of their level of annoyance due to wind farm noise on a four-point scale (none, low, medium or high) and to self-report the wind conditions at the time.
22. I have examined the wind conditions and noise levels present at the times when complaints were recorded, in order to understand the conditions which gave rise to the complaints.
23. Figure 1 below shows a comparison of reported levels of annoyance with reported wind direction during the annoyance. All of the complaint logs which were submitted are from residences situated from west to south-west of the wind farm. Thus a reported direction of East – Northeast ($45^{\circ} - 90^{\circ}$) would represent downwind conditions, where noise propagation from the wind farm would be expected to be most efficient.

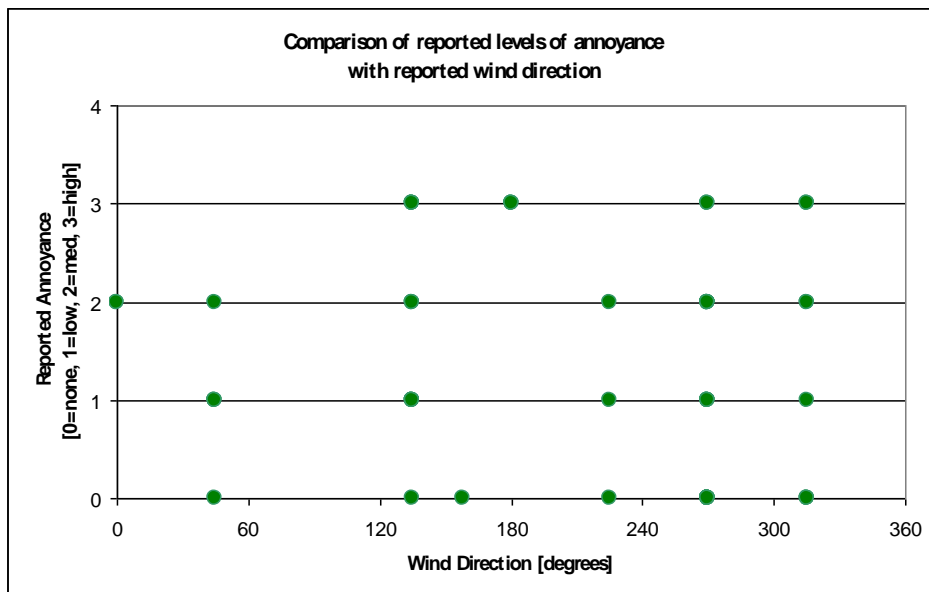


Figure 1: Reported levels of annoyance and reported wind direction.

24. Complaints were received during a variety of wind directions, and were in fact least prominent during the conditions which would be considered “downwind”.
25. Figure 2 below shows a comparison of the measured background noise levels during the late-May period of monitoring, with reported levels of annoyance from the resident noise logs.

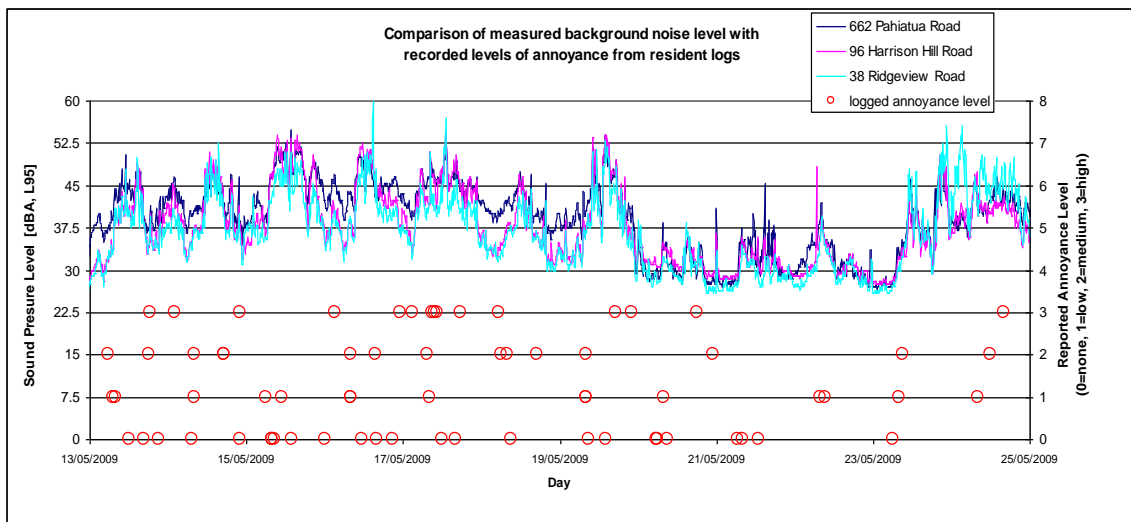


Figure 2: Background noise levels and recorded levels of annoyance – May 2009

26. As with wind direction, it can be seen that complaints were received both during noise periods and during quiet periods. The noise levels indicated by the graphs are total noise, including both turbine and non-turbine sources.
27. It is reasonable to expect that turbine noise may be more audible when overall noise levels are lower. This is because when other sources of noise diminish they do not mask turbine noise as thoroughly.
28. Toward the end of the lull in wind activity on 21-23 May this year there is a general reduction in reported levels of annoyance. This correlates with a period of low wind speeds during which the turbines are likely to have operated less regularly.
29. It should be pointed out that some complaints are occurring when the measured sound level in the vicinity of the residences is less than 40dBA. At

such times, the contribution by the turbines to the overall noise level is significantly less than 40dBA.

30. I have also reviewed a summary of logged complaints provided to me by NZWL, for the period of my August – September noise measurements. I have plotted the times of the complaints against the measured noise levels at 104 Harrison Hill Road, and indicated the direction of wind in Figure 3.

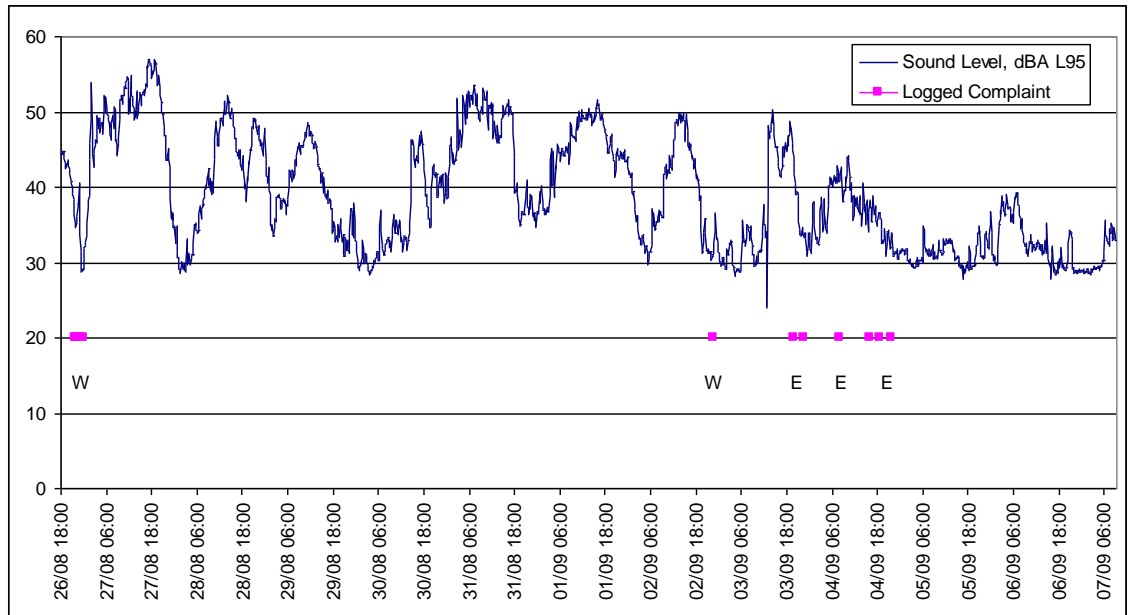


Figure 3: Background noise levels and recorded annoyance events – Aug-Sept 2009.

31. These noise measurements were taken at 104 Harrison Hill Road, which is in the general vicinity of the residences from which most of the complaints originated. An exception to this is the complaint received from the Malley residence, which is generally to the North of the wind farm.
32. Complaints were received during both upwind and downwind conditions. As with the previous measurement period, many of the complaints occurred during periods of low sound level rather than high sound level.
33. From the above I conclude that complaints are not due necessarily to periods of high noise level. It is likely that complaints occur instead when other noise subsides and the turbine activity can be more readily distinguished from other sounds.

Assessment of Tonality

34. Tonality is one of several types of 'special audible characteristics' which can arouse negative reactions at lower noise levels than sound without such characteristics.
35. Tonality may be described in general terms as a sound which has a clearly audible pitch. Sounds which possess this characteristic may be penalised in a noise assessment by adding a value to the measured sound level; effectively requiring such noise source to comply with a more stringent limit.
36. Most sounds possess some degree of tonality, and the challenge in deciding whether to impose a penalty is finding a threshold of audibility above which a tone can be considered to have 'special audible character'.
37. The most basic assessment of tonality is carried out by an experienced and trained listener, who may decree a certain sound to be tonal. In some cases this is sufficient. For instance, the sound of surf is commonly considered not to have tonality, while the sound of a circular saw is considered to be tonal.
38. A subjective assessment of tonality is more contentious for sounds with less clearly defined purity of pitch, and for this reason various objective methods have been devised to establish clear thresholds for the application of a penalty. A reasonably simple implementation of such a test may be found in New Zealand Standard 6802:2008. Here, measurements are made in one-third octave bands, and tonality is confirmed when one such band exceeds that of its immediate neighbours by a certain amount.
39. However this method fails to assess tonality in some cases, such as when several tones are present in adjacent bands, and may offer a false positive when sound energy occurs at several places within a single frequency band.
40. To provide further certainty in relation to the assessment of tonality, the Joint Nordic Method (JNM) has been developed. This method assesses frequencies in very fine detail, with the characteristics of the human hearing system in mind. With the second revision of this method, (**JNM-II**), a sliding penalty scale is introduced which avoids the difficulty of the entire 5-decibel

penalty being imposed at one threshold. Rather it offers a penalty from zero to six decibels based on the degree of audibility of the tone or tones.

41. The method defined in JNM-II has been adopted in several more specific methods of tonality assessment, including the standard for assessing Wind Turbine Generator sound power level, IEC 61400-11. The IEC standard gives specific requirements for measurement position and measurement times which are appropriate for the purpose of determining whether the sound power spectrum of a turbine (the total effective sound emission) contains special audible character. Specifically, measurement is to take place at a distance from the base of the turbine which is equal to the turbine mast height plus the turbine rotor radius.
42. However the more general JNM method is referenced by the New Zealand Standard NZS6808:1998 as an appropriate means for establishing the presence of tonality at an assessment position; typically a residence.
43. Relevant to the issue of which method of tonality assessment should be used for the existing TRH wind farm — the one stated in NZS6808 (JNM) or the one stated in IEC61400-II:2002 — are the conditions of consent. Condition 5(a) states that measurements should be taken at the notional boundary of a particular dwelling; while condition 5(l) requires that the assessment technique contained in the IEC standard be used.
44. The entirety of Condition 5 relates to measurement of noise received at a residential site, and accordingly I interpret the intent of condition 5(l) as a requirement to use the JNM method, with a sufficiently short averaging time to capture the most audible tonality; but to apply this test at the residential site mentioned.
45. I do not believe that the intent of condition 5(l) is to impose the penalty for tonality if it is present within 100 metres of the turbine, if it does not meet the threshold for tonal audibility at the residential location.
46. To assess tonality at the required location and other residential locations, we conducted attended measurements using a Brüel & Kjær 2260 sound level

meter, which includes software for tonality assessment according to the JNM-II method.

47. Measurements were conducted during conditions under which the tone which has been identified near to the turbines could be detected at the residential locations. Measurements excluded interference by local or distant wind effects, traffic noise, and other environmental noises to as great an extent as possible.
48. Weather during the measurements was clear, with minimal cloud cover and an Easterly wind blowing. Wind speed over the course of the measurements ranged from 7.5 – 13 m/s, with the direction of wind ranging from 81 – 99 degrees.
49. The majority of turbines were observed to be operating during all measurements. It is expected that the conditions were representative of those during which the greatest amount of turbine noise is received at most measurement positions, as the wind speed was above the turbine cut-in speed of 6 m/s, but below speeds that cause high levels of wind and foliage noise.
50. Measurement positions included 104 Harrison Hill Road, 38 Ridgeview Road, a position opposite 96 Harrison Hill Road, and 7 other positions along Ridgeview Road, Harrison Hill Road, Pahiatua Aokautere Road and North Range Road. The locations of each measurement position are shown in **Appendix A**.
51. While there was a perceptible tone around 1 kHz at many of the measurement positions, none of the measurements reached the threshold of audibility requiring an adjustment for tonality.

Peer Review of AEE Report and Hunt Evidence

52. I have reviewed the Noise AEE, and the evidence of MHA. The scope of my assessment has not included detailed digital terrain modelling as would be required to accurately predict sound level, but I have considered the inputs to

the model used by MHA including the sound power level of the wind turbines and the distances between the wind farm and the residences.

53. In my opinion the methodology used in this assessment, which is described in NZS6808:1998, is the correct methodology for the assessment of this wind farm.
54. I have been involved with the revision of NZS6808, and can confirm Mr Hunt's statement that the issues raised during its revision process do not substantially change either the means of noise assessment or the recommended noise limits which should be applied.
55. I also support Mr Hunt's opinion that low frequency noise, infrasound and ground-borne vibration are not significant factors in wind farms using turbines such as the Windflow 500.
56. I have not conducted a full re-assessment of the numerical predictions in Mr Hunt's report. However I have calculated the noise level from the TRHE turbines to several residences using the NZS6808:1998 prediction method, excluding any terrain shielding effects.
57. I note that in my opinion it is appropriate to include terrain shielding effects, and this is supported by the present edition of NZS6808 and the Draft Standard 6808. However to do so requires significant investment in analysis which is beyond the scope of the peer review I was engaged to conduct. I would therefore expect that my predictions would produce a higher value than those in the AEE where terrain shielding was considered.
58. I have performed these calculations using the same sound power level as Mr Hunt, of 104.5 dBA, which I understand relates to a hub height wind speed of 10 metres per second.
59. My predictions at the Anderson and Day residences are within 1 decibel of those given in Mr Hunt's evidence. At the Poff residence I predict a significantly higher sound level (35 dBA instead of 25 dBA) but following discussion with MHA I understand that the MHA modelling demonstrated a significant amount of terrain shielding which would account for this difference.

60. I note in the Noise AEE that the Wind Flow 500 turbine produces a sound power level of 106.2 dBA when the wind speed at 10 metres above ground level is 10 metres per second. This presumably relates to a hub-height wind speed of between 11 and 12 metres per second.
61. In my opinion it would be appropriate to include this wind speed in the assessment of noise effects, which would increase the predicted maximum reported noise level by 1.7 dB. At the most affected property, the Day residence, this would elevate the predicted sound level to 39 dBA, which still complies with the recommended noise limit.
62. The predicted cumulative noise levels at the Day property indicate that the existing turbines do not contribute significantly, and thus I would conclude that the cumulative effects of the existing turbines and the TRHE turbines, taking into account the 1.7 dB increase I have suggested in the previous paragraph, would comply as well.
63. To summarise my review of the MHA assessment of noise effects, I agree with the conclusion that noise effects have been appropriately assessed, except that in my opinion the noise at all wind speeds at which the turbines operate should be assessed. I concur that the noise predictions carried out in the Noise AEE indicate that the wind farm will comply with the NZS6808 recommended noise limits, and that this will also be the case if wind speeds of 10 metres per second at 10 metres above ground level are considered.

Submissions and Planners Report

64. The noise related issues raised in submissions and the planners report are addressed by Mr Hunt in his evidence.
65. The only noise matter raised in submissions on which I comment further are the points made in C and N Wallace's submission (Submission 72) which relate to the MDA report. Specifically I comment on sections 2.4 and 2.5 in this submission.
66. The submitter notes that the MDA report does not comment on the number of turbines running during the period of our measurement. I have not been

provided with operational data for the May – June measurement period. However this information has been provided for the period during which I carried out additional compliance measurements in August – September. During this period up to 47 turbines were operational, depending on the wind speeds encountered at each turbine.

67. Paragraphs 2.4.A and 2.4.B of the submission conclude that more assessment points should be considered when assessing the noise effects of the wind farm. In my opinion the sites considered in the MDA report are reasonable representations of the noise environment. On the basis of my visits to the site I would expect that 104 Harrison Hill road would receive similar or higher noise levels than at neighbouring properties, and thus would be a good conservative indicator of compliance.
68. I accept that the audibility of the wind farm could be different at different sites, and that the relationship between audibility and wind conditions could vary from site to site. However my assessment, and indeed any assessment of any noise, is focussed on the level of noise, considering audibility only where special audible character is identified.
69. In paragraphs 2.4.C and 2.4.D the submission presents the opinion that the logging of noise complaints could form a basis for considering a more stringent noise limit, and suggests that a limit of 30 dBA should be implemented.
70. I accept that at this site, the sound from the turbines is audible at relatively low noise levels. However in my opinion the most reasonable and fair way to assess wind turbine noise is by applying the same general tests as we apply for other noise sources such as industrial noise or outdoor air conditioners or noise from highways. This is to consider the sound level of the noise sources, corrected if necessary for special audible characteristics, in relation to a noise limit in a district plan, and with regard to any pre-existing elevated noise environment. Adding a consideration for the audibility of a sound would be a departure from this method.
71. It is not uncommon for noise complaints to arise from noise sources which are deemed 'reasonable' by noise standards. It is also common for noise at a

given level to affect different people in different ways. For these reasons we restrict our assessment of noise effects to judging the level of sound against a standard.

72. However I agree with the submitter that the subjective observations are a valuable line of communication between the community and NZWL and would encourage such communication to continue.
73. The Tararua District Council Planners Report includes a review of the AEE noise report. The points in general have been considered by Mr Hunt in his evidence, but I have considered the peer reviewer's concerns regarding the potential for special audible characteristics to be present at the nearest residence (the Day residence), causing the noise limit to be exceeded.
74. The MDA assessment of tonality has demonstrated that the tone which is assessed to be audible near the turbine is not considered sufficiently audible to impart special audible character on the wind farm sound when considered at 'residential distances'.
75. The nearest turbine to the Day residence is approximately 1.6 km from the nearest turbine. I expect that wind farm sound at this distance will experience the same shift in spectrum and masking by the local noise environment as was experienced at houses we have assessed, such that tonality is not likely to be sufficiently audible to warrant a tonality penalty.

Conclusions

76. I am satisfied that the compliance monitoring of TRH was undertaken in accordance with the relevant standard and that the tonality assessment of TRH indicated that a penalty for tonality was not required.
77. The complaints received in relation to TRH occur at differing wind speeds and levels of background noise. Provided TRH is complying with its consent conditions and the applicable standard (which I understand it is), I see no need for any more stringent conditions on the proposed extension.

78. I have reviewed the Noise AEE as well as Mr Hunt's evidence and on the basis of the full assessment in that report, I agree with his conclusion that the noise effects from the TRHE will be acceptable.
79. On the basis of the above, I see no noise related reason not to grant consent.

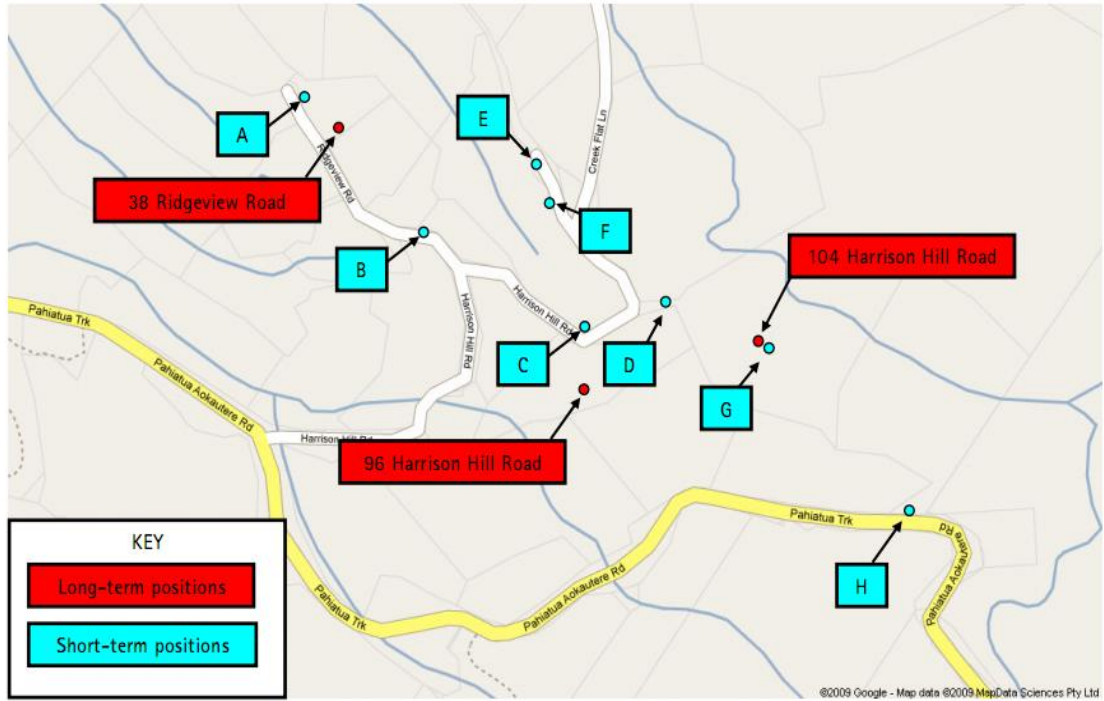
Miklin Halstead

30 September 2009

Appendix A

Measurement Positions for Tonality Assessment

Map 1:



Map 2:

