

Salt Creek Wind Farm

Noise Compliance Test Plan

January 2019

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Noise Compliance Test Plan

MOYNE PLANNING SCHEME

THIS PLAN IS ENDORSED PURSUANT TO
PLANNING PERMIT No. **PL06/304.01**
SUBJECT TO THE CONDITIONS OF THE PERMIT AND
PROVISIONS OF THE MOYNE PLANNING SCHEME

Delegate: *Michelle Gage* Page 1 to 13 inclusive
Date: 29/7/2020

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Noise Compliance Test Plan
S5168C2
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GLOSSARY

A weighting	Frequency adjustment representing the response of the human ear.																						
Ambient noise level	Noise level in the absence of the noise from the wind farm.																						
Background Noise Assessment	GL Garrad Hassan Background Noise and Compliance Limit Assessment for the Salt Creek Wind Farm Document Number 45539/PR/01																						
dB(A)	A weighted noise level measured in decibels.																						
Intermediary Position	A monitoring location between the turbines and a receptor which operates at the same time as the residential logger and assists in determining the contribution of noise from the wind farm.																						
Intermediary Graph	The graph based on correlation of the Intermediary Position noise level minus the Propagation Loss against the hub height wind speed.																						
L _{A90}	The A weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. The L _{A90} measured over a 10 minute time period is commonly termed “background sound level” and “post-installation sound level” with respect to wind farms.																						
L _{Aeq}	The A weighted equivalent continuous noise level – the energy-average of noise levels occurring over a measurement period.																						
Propagation Loss	The reduction in the noise level associated with the wind farm from the Intermediary Position to the Residential Logging Location.																						
Re-correlation Graph	The graph based on re-correlation of the noise data at the residential logging location with wind speed after filtering using the Propagation Loss and the Intermediary Position data.																						
Residential Logging Locations	The following proposed locations where noise logging will be conducted at residences: <table border="1" data-bbox="427 1512 1377 1729"> <thead> <tr> <th rowspan="2">DNVGL Monitoring Location ID</th> <th rowspan="2">Tilt House ID</th> <th rowspan="2">Monitoring Location ID</th> <th colspan="2">Monitoring Location Coordinates (UTM WGS84 54H)</th> </tr> <tr> <th>Easting</th> <th>Northing</th> </tr> </thead> <tbody> <tr> <td>H3</td> <td>H1</td> <td>M1</td> <td>653789</td> <td>5801058</td> </tr> <tr> <td>H12</td> <td>H8</td> <td>M8</td> <td>658150</td> <td>5804184</td> </tr> <tr> <td>H22</td> <td>H6</td> <td>M6</td> <td>658336</td> <td>5801780</td> </tr> </tbody> </table>	DNVGL Monitoring Location ID	Tilt House ID	Monitoring Location ID	Monitoring Location Coordinates (UTM WGS84 54H)		Easting	Northing	H3	H1	M1	653789	5801058	H12	H8	M8	658150	5804184	H22	H6	M6	658336	5801780
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The Permit	Moyne Shire Council Permit Number PL06/304.01																						
NZS6808:2010	New Zealand Standard NZS 6808:2010 Acoustics – The assessment and measurement of sound from wind turbine generators																						

1 PLANNING PERMIT CONDITIONS

The Permit provides conditions for the operation of the Salt Creek Wind Farm. The noise related conditions are detailed below:

12. *The operation of the wind energy facility must comply with New Zealand Standard 6808:2010, Acoustics – Wind Farm Noise (the Standard) in relation to any occupied dwellings existing on the land (other than the site) at 8 May 2007, to the satisfaction of the responsible authority. In determining compliance with the standard the following requirements apply:*

- a. *The sound level from the wind energy facility, when measured outdoors within 10 metres of a dwelling at any relevant nominated wind speed, must not exceed the background level (L90) by more than 5dBA or a level of 40dBA L90, whichever is the greater.*
- b. *Compliance at night must be separately assessed with regard to night time data. For these purposes the night is defined as 10.00pm to 7.00am. For sleep protection purposes, a breach of the standard set out at Condition 12a), for 10% of the night, amounts to a breach of the condition.*
- c. *Where special audible characteristics, including tonality, impulsive sound or enhanced amplitude modulation occur, as assessed in accordance with Appendix B of the standard, the noise limit will be modified by applying a penalty of up to + 6dB L90 in accordance with Section 5.4 of the standard.*

This condition does not apply if the operator of the wind energy facility has entered into an agreement with the landowner under which the landowner acknowledges and accepts that the noise standards in this condition may be exceeded at the landowner's dwelling(s). Evidence of this agreement must be provided to the satisfaction of the responsible authority, and must be in a form which runs with the land for the life of the wind energy facility.

13. *If Condition 12 is determined to have been breached, the Responsible Authority shall notify the wind energy facility operator with a request that steps be taken to rectify the breach, which may include, ascertaining the relevant meteorological circumstances at the time of the breach and requiring the operator to noise optimise the operation of the relevant wind turbine or turbines if such meteorological circumstances occur again. If a further breach is determined to have occurred in similar meteorological circumstances and at the same receptor location, the Responsible Authority shall notify the wind energy facility operator, with a request to selectively reduce or modify the operation of the relevant wind turbine or turbines in such meteorological circumstances. If a third breach occurs in the same meteorological circumstances and at the same receptor location, notwithstanding the procedures outlined above, the Responsible Authority may take further action, as appropriate.*

14. *An independent post-construction noise monitoring program must be commissioned by the proponent within 2 months from the commissioning of the first turbine and continue for 12 months after the commissioning of the last turbine, to the satisfaction of the Responsible Authority. The independent expert must have experience in acoustic measurement and analysis of wind turbine noise. The program must be carried out in accordance with New Zealand Standard 6808:2010 Acoustics -Wind Farm Noise. The permit holder must pay the reasonable costs of the monitoring program.*

15. *The results of the post-construction noise monitoring program, data and details of compliance and non-compliance with the New Zealand Standard must be forwarded to the Responsible Authority within 45 days of the end of the monitoring period. The results must be written in plain English and formatted for reading by laypeople.*

16. *Before the use begins, the proponent must prepare a detailed noise complaint evaluation and response plan in consultation with the Department of Sustainability and Environment, the Environment Protection Authority and the Moyness Shire Council. The plan must be submitted to, and approved by, the Responsible Authority. This plan must include the following elements:*
 - a. *A toll free noise complaint telephone service;*
 - b. *The erection of a small sign on site advising of the complaints telephone number;*
 - c. *Minimum recording requirements for noise complaints (that is: date, time, noise description and weather conditions at the receptor);*
 - d. *A process for determination of whether the noise complaint is a breach of Condition 12 or not;*
 - e. *A response protocol for confirmed breaches including, but not limited to:*
 - i. *Determination of the meteorological circumstances at the time of the breach and the operational status of the turbine(s) at that time;*
 - ii. *Noise optimisation of the relevant wind turbine(s) under the same meteorological circumstances as occurred at the time of the breach;*
 - iii. *In the event of a further breach the selective shut down of the relevant wind turbine(s) or turbines in the same meteorological circumstances; and*
 - iv. *Where under the same meteorological conditions subsequent confirmed noise breaches occur, the decommissioning of the relevant turbine(s).*
 - f. *A register of complaints, responses and rectifications which may be inspected by the Responsible Authority; and*
 - g. *Provision for review of the complaint and evaluation process, including review of the process 12 months after commencement of the operation of the wind energy facility.*
17. *A management plan for any proposed blasting shall be prepared and any relevant licenses obtained. If blasting is undertaken it shall:*
 - a. *Not exceed 115dB (Lin Peak) for more than five percent of the total number of blasts over the period of any relevant licence.*
 - b. *Not exceed 120dB (Lin Peak) at any time.*



2 NEAR FIELD AND INTERMEDIARY TESTING

Near field and intermediary testing is proposed for the purpose of determining the character of the noise from the turbines and enabling noise from other sources to be excluded from the noise at Residential Logging Locations.

The near field measurements will be conducted:

- between 100m and 200m from the closest turbine;
- for two representative turbines;
- over the range of wind speeds from cut-in to greater than rated power;
- with a ground board and windshield dome (in accordance with IEC61400-11) to minimise any noise from wind on the microphone;
- in one-third octave bands; and;
- in 10 second intervals and correlated with the hub height wind speed over the same time period (in accordance with IEC61400-11).

The correlations will be used to determine the wind speed at which the highest noise level is emitted from the turbines. If the noise at Residential Logging Locations continues to increase at wind speeds above the wind speed of highest noise emission, this will indicate that the noise is from sources other than the turbines (most commonly wind in trees for high wind speed conditions). The 1/3 octave band data would also be used for the first stage of tonality testing.

Loggers will be placed at Intermediary Positions between the turbines and receptors. These loggers would operate at the same time as the residential loggers and would assist in determining the contribution of noise from the wind farm, providing a calibration point to validate noise modelling and a second stage of tonality assessment.

3 NOISE COMPLIANCE TESTING

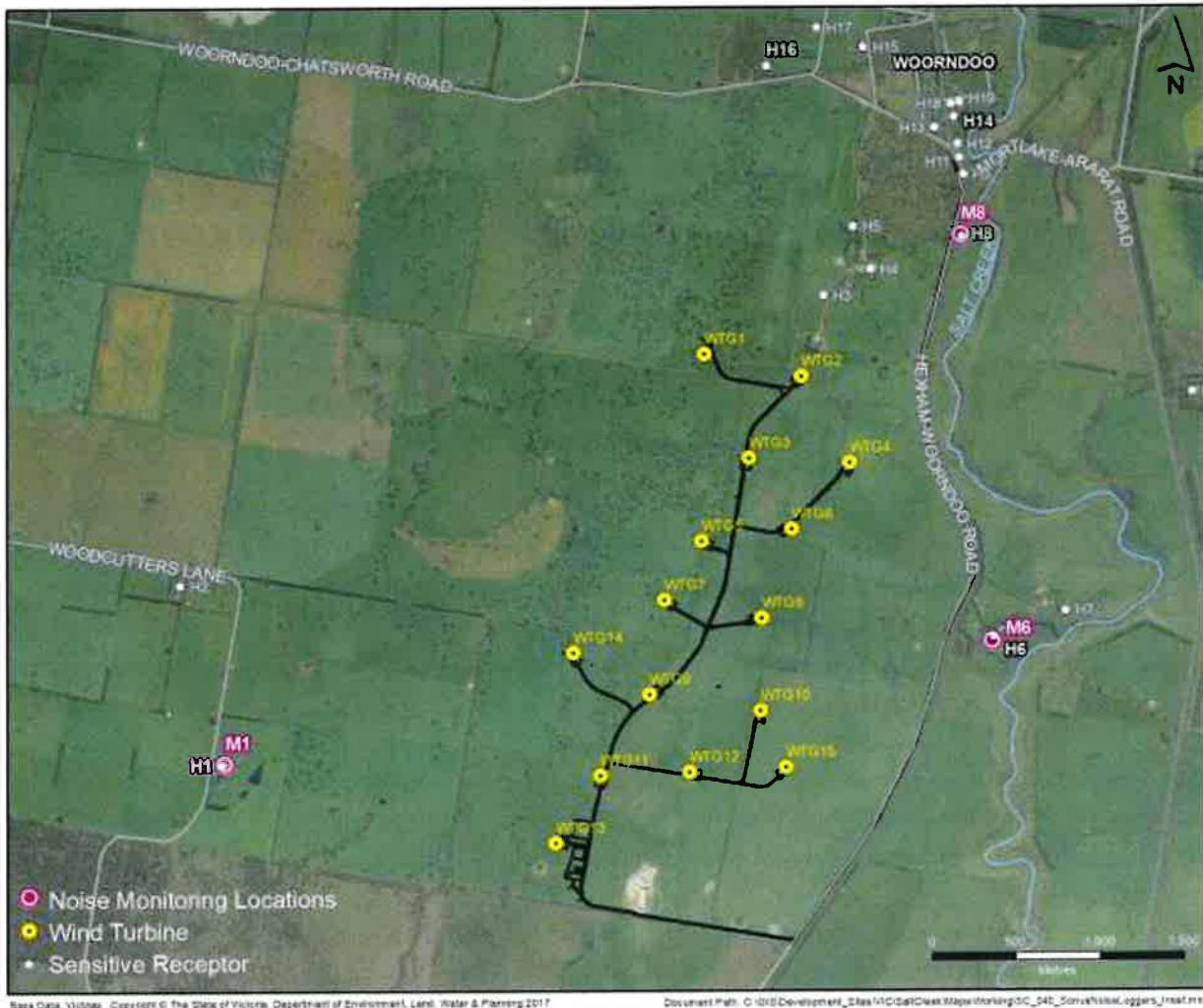
The following provides the proposed methodology to be used to satisfy the operational noise related Permit Conditions.

3.1 Residential Logging Locations

Compliance testing will be conducted at the following three locations where background noise level data were measured prior to the wind farm being constructed, subject to access being granted by the landowner:

DNVGL Monitoring Location ID	Tilt House ID	Monitoring Location ID	Monitoring Location Coordinates (UTM WGS84 54H)	
			Easting	Northing
H3	H1	M1	653789	5801058
H12	H8	M8	658150	5804184
H22	H6	M6	658336	5801780

The Residential Logging Locations, relative to the wind farm are shown on the aerial photograph below:



The location of the equipment will be generally consistent with the positions documented in the Background Noise Assessment, subject to landowner approval and any changes to the local conditions that might result in modified results such as the construction of structures, change in vegetation or the installation of pumps or air conditioning units. Where the location is greater than 10m from a dwelling, it will be on the wind farm side of the dwelling. The changes will be documented and the rationale provided for any alternative location.

3.2 Equipment

Sound level meters with a noise floor no greater than 20 dB(A) will be used. The equipment will be either Class 1 or Class 2 sound level meters in accordance with the Australian Standard AS 1259-1990 *Acoustics – Sound Level Meters* and IEC 61672.1-2004 *Electroacoustics – Sound Level Meters* as relevant.

A wind shield with a diameter of at least 100mm will be used to minimise wind noise on the microphone. A calibrated reference sound source will be used before and after the compliance testing regime.

3.3 Data

The compliance testing will collect L_{90} data made continuously over 10 minute intervals.

Data filtering may remove time periods:

- (i) affected by rain, hail or wind based on a weather logger placed at representative location to one of the noise loggers. Data are adversely affected where precipitation occurs in a 10 minute period or where a wind speed greater than 5 m/s is exceeded for 90% of a 10 minute period;
- (ii) when the wind farm is not operating; and
- (iii) considered abnormal by the Independent Noise Consultant, such as during local construction or maintenance activities or related to local extraneous noise sources.

Further data filtering will remove time periods where:

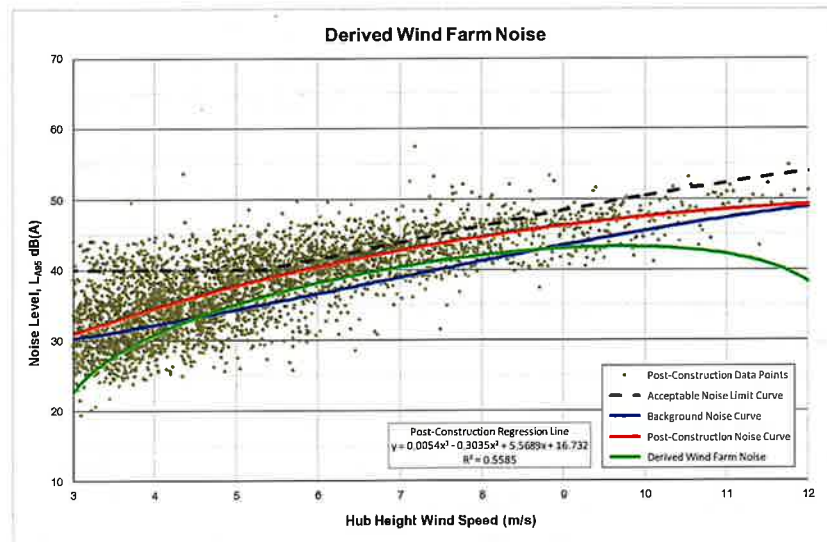
- Noise data collected at an Intermediary Position confirms that the source of the noise at a receptor is not the wind turbines. For example, noise data collected in a particular 10 minute interval at a receptor may be removed if the noise measured in the same period at the intermediary position (closer to the turbines) is at a lower level.
- The noise continues to increase as the wind speed increases above the wind speed of highest noise emission (determined from near field testing).

Following removal of adverse data and application of applicable penalties for special audible characteristics (refer below), all of the remaining noise data for the full monitoring period will be correlated with the corresponding hub height wind speed data for each monitored dwelling.

In addition to the correlation of data collected over the full 24 hours each day, a separate correlation will be performed for filtered data collected between the hours of 10:00pm and 7:00am. Condition 12b requires an assessment of the worst case 10% of the night period. Therefore, only the 10% of data points collected when the wind direction is closest to downwind (the direction from the closest turbine to the noise logger) will be used in the night time correlation. This will provide the 10% of data points where the contribution of noise from the wind farm is highest. Further explanation is provided in Appendix A.

If the intermediary position has not been used to remove data points, the wind farm noise contribution at the dwelling will be derived by logarithmically subtracting the background noise curve from both curves generated by the compliance testing data correlation.

An example of a wind farm noise contribution line derived from the post-construction measured noise regression line and background noise curve is shown in the figure below.



The primary test method of NZS6808:2010 cannot be used in all circumstances to demonstrate compliance. This is primarily related to changes in local conditions or extraneous noise sources when compared to the conditions and noise sources that existed at the time of the original testing regime.

Where the primary test method of the Standard cannot be used to demonstrate compliance, an alternate analysis incorporating *on/off* testing and the intermediary noise logging data will be conducted.

The analysis will be conducted as follows:

- At dwellings (and associated intermediary location) where the primary test method cannot be used to demonstrate compliance;
- For integer wind speeds where the primary test method cannot be used to demonstrate compliance;
- With the noise monitoring equipment at the same position where the primary test had been conducted, or if that position is considered to be a factor in the inability of the primary test to demonstrate compliance, at an equivalent position with respect to turbine noise at the dwelling, but which has a higher turbine to background noise level ratio (noting that the *on/off* testing will assist in determining if the primary test position can ultimately be used);
- Conducted under a downwind condition. A downwind condition is defined as the wind direction at the relevant wind mast being within 45 degrees of the direct line from the closest turbine to the dwelling;
- Over part (to exclude intermittent noise) or all of a minimum interval of 10-minutes with the wind farm operational and the same interval with the wind farm shut off to obtain the background noise level;
- Monitoring the wind speed and direction over the measurement intervals to identify the comparable *on* and *off* measurements.

- Where there is a sufficient difference between the *on* and *off* noise measurements, the contribution of noise from the turbines at the dwelling and intermediary position will be determined by logarithmically subtracting the *off* measurement from the *on* measurement.
- The difference between the contribution of noise from the turbines at the dwelling and intermediary position will be deemed the Propagation Loss for the specific wind speed.
- The Propagation Loss will be used for further filtering of the collected noise logger data prior to re-correlation of the noise data with the wind speed (the Re-correlation Graph). That is, noise data will be removed where the noise level at the dwelling is higher than the corresponding noise at the Intermediary Position less the Propagation loss. The assessment of compliance for the dwelling will then be made based on the Re-correlation Graph.
- If the further data filtering (described above) results in insufficient data for a correlation to be performed, this will demonstrate that the noise at the dwelling is dominated by noise other than the wind farm. In these circumstances, the noise at the dwelling will be determined as the noise at the Intermediary Position, less the Propagation Loss. That is, a correlation will be performed of the noise at the Intermediary Position minus the Propagation Loss against the hub height wind speed (the Intermediary Graph). The assessment of compliance for the dwelling will then be made based on the Intermediary Graph.

The supplementary *on/off* test method provided by NZS6808:2010 cannot be used in all circumstances to determine the Propagation Loss. This would occur where it is not practicable to consistently achieve comparable wind conditions between the *on* and *off* conditions or when there is not a sufficient difference in noise level between the *on* and *off* conditions. In these circumstances, the Propagation Loss will be determined from *on/off* testing at a lower wind speed or by reference to a noise model.

3.4 Special Audible Characteristics – Tonality

The tonality testing will be conducted in general accordance with Appendix B2.2 of NZS6808:2010. The testing will be conducted in two stages, with the first stage conducted in the near field location, and the second stage conducted at a residence if required.

Stage 1

The first stage will be conducted by using the near field noise measurements in one-third octave bands between 25Hz and 10,000Hz at the two representative turbines.

Stage 2 testing shall be conducted where the noise level at any hub height integer wind speed, in any one third octave band exceeds the arithmetic average of the adjacent bands by:

- **5 dB or more** if the centre frequency of the band containing the tone is in the range 500Hz to 10,000Hz;
- **8 dB or more** if the centre frequency of the band containing the tone is in the range 160 to 400Hz; and/or
- **15 dB or more** if the centre frequency of the band containing the tone is in the range 25Hz to 125Hz

In other cases, no penalty for tonality shall be applied and no further testing is required.

Stage 2

Where required, Stage 2 testing shall be conducted at two intermediary positions. The equivalent noise level (L_{eq}) shall be measured in one third octave bands in 10 minute intervals for a period of at least 3 weeks.

A 10 minute interval shall be deemed to be tonal where a one third octave band identified as tonal in Stage 1 for the equivalent hub height wind speed exceeds the arithmetic average of the adjacent bands by:

- **5 dB or more** if the centre frequency of the band containing the tone is in the range 500Hz to 10,000Hz;
- **8 dB or more** if the centre frequency of the band containing the tone is in the range 160 to 400Hz; and/or
- **15 dB or more** if the centre frequency of the band containing the tone is in the range 25Hz to 125Hz and there is no evidence (such as an audio recording) that the tone is from a source unrelated to the wind farm.

For each 10 minute period where tonality is identified, an adjustment of 6 dB(A) will be added to the measured noise level at this intermediary position. A correlation with wind speed will be conducted with and without the tonal adjustments being applied. Where the addition of the tonal adjustment increases the overall noise at any wind speed by 1 dB(A) or more, stage 3 testing shall be conducted.

In other cases, no penalty for tonality shall be applied and no further testing is required.

Stage 3

Where required, Stage 3 testing shall be conducted at the closest non-associated residence where the landowner has granted permission to place the equipment for noise compliance testing. The equivalent noise level (L_{eq}) shall be measured in one third octave bands in 10 minute intervals.

A 10 minute interval shall be deemed to be tonal where a one third octave band identified as tonal in Stage 1 for the equivalent hub height wind speed exceeds the arithmetic average of the adjacent bands by:

- **5 dB or more** if the centre frequency of the band containing the tone is in the range 500Hz to 10,000Hz;
- **8 dB or more** if the centre frequency of the band containing the tone is in the range 160 to 400Hz; and/or
- **15 dB or more** if the centre frequency of the band containing the tone is in the range 25Hz to 125Hz and there is no evidence (such as an audio recording) that the tone is from a source unrelated to the wind farm.

For each 10 minute period where tonality is identified, an adjustment of 6 dB(A) will be added to the measured noise level at this residence, prior to correlation with wind speed. Where the addition of the tonal adjustment increases the overall noise at any wind speed by 1 dB(A) or more, this increase will be applied to other non-associated residences (at the same wind speeds), unless there is evidence that the tone(s) are not audible at the other residences.

3.5 Special Audible Characteristics – Amplitude Modulation

An objective test for amplitude modulation has not been established by NZS6808:2010 or in any Australian jurisdiction. An “interim test method” was provided in NZS6808:2010 in the absence of a more robust method. The testing procedure for “special” amplitude modulation is based on the interim method in NZS6808:2010 and will be conducted as follows:

- At the dwelling with the highest predicted noise levels;
- At the integer wind speed where the difference between the predicted noise level and the project criteria is the least;
- Conducted under a downwind condition;
- Over a minimum interval of 2-minutes with the wind farm operational;
- Collecting at least 5 measurement intervals where the amplitude modulation of the wind farm is audible;
- Reviewing the overall noise level time trace for amplitude modulation at the blade pass frequency;
- Comparing the results against the objective criteria for the overall A-weighted noise level in Section B3.2 of the NZS6808:2010.

Where the comparison indicates a measurable amplitude modulation trace at the blade pass frequency that exceeds the objective criteria in Section B3.2 of the NZS6808:2010 for the overall A-weighted noise level, longer term testing at the nearest dwelling will be conducted over the same period as the compliance testing.

For each 10 minute period where “special” amplitude modulation is identified, a 5 dB(A) penalty will be added to the measured noise level in that 10 minute interval prior to correlating the noise data with the corresponding wind data as detailed above.

Where the addition of the amplitude modulation adjustment increases the overall noise at any wind speed by 1 dB(A) or more, this increase will be applied to other non-associated residences (at the same wind speeds), unless there is evidence that the amplitude modulation is not audible at the other residences.

It is recognised that the methodology outlined in NZS6808:2010 is an “interim test method”. Should a more widely accepted methodology become available prior to the above testing period, then subject to approval by the responsible authority, the framework outlined above might be superseded.

3.6 Testing Schedule

Testing will commence within 2 months of the commissioning of the first turbine and will continue for 12 months after the commissioning of the last turbine. Results will be determined based on the data collected in the 12 months after commissioning of the last turbine.

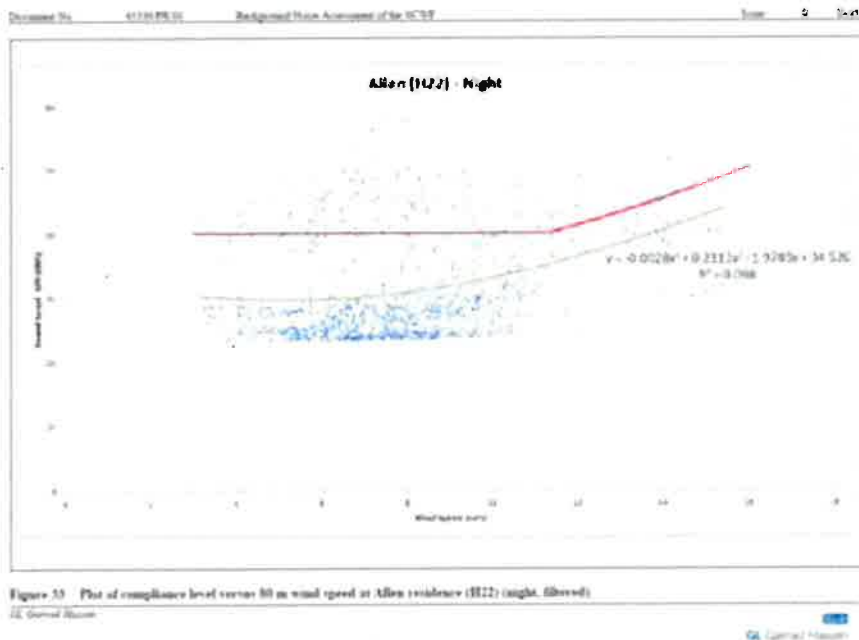
A final noise compliance report will be provided within 45 days of the completion of the testing.

APPENDIX A COMPLIANCE WITH CONDITION 12 b

Condition 12 b states:

Compliance at night must be separately assessed with regard to night time data. For these purposes the night is defined as 10.00pm to 7.00am. For sleep protection purposes, a breach of the standard set out at Condition 12a), for 10% of the night, amounts to a breach of the condition.

There is no standard or procedure for assessing the 10% requirement. One interpretation could be to count the percentage of points above the night criterion in the correlation graph. The graph below is from noise measurements conducted prior to the construction of the wind farm. Each blue dot represents a 10 minute data point, the green line is the regression curve and the red line represents the night time criteria. The graph indicates that there are already more than 10% of the data points above the red line. That is, if this interpretation is taken, a breach would occur without any contribution of noise from the wind farm.



Rather than consider the highest 10% of measured noise levels (which are most likely to be from sources other than the wind farm), the NCTP includes a filtering process to consider the 10% of data points where the contribution of noise from the wind farm is highest. The noise from a wind farm at residential separation distances is highest when the wind is blowing (downwind) from the turbines to the residences. Therefore it is proposed to represent the highest contribution of noise from the wind farm by the 10% of noise measurements which are closest to downwind.

