

Marshall Day Acoustics Pty Ltd  
A.C.N. 006 675 403  
6 Gipps Street  
Collingwood 3066  
Victoria Australia  
Telephone: +61 3 9416 1855  
Facsimile : +61 3 9416 1231  
mdamelb@marshallday.com.au  
www.marshallday.com

**REPORT No.:** 2006293 001 R02

**PROJECT:** HEPBURN COMMUNITY WIND PARK  
NOISE ASSESSMENT

**CLIENT:** Future Energy Pty Ltd  
PO Box 2007  
Richmond Vic 3121

**ATTENTION:** Mr David Shapero

**DATE:** 10 October 2006

**MARSHALL DAY ACOUSTICS**

A handwritten signature in black ink, appearing to read 'P. Fearnside', with a horizontal line underneath.

Peter Fearnside  
Managing Director

A handwritten signature in black ink, appearing to read 'C. Delaire', with a vertical line underneath.

Christophe Delaire  
Consultant

**TABLE OF CONTENTS**

	Page No.
1.0 OVERVIEW .....	1
2.0 WIND TURBINE NOISE CRITERIA IN VICTORIA.....	2
3.0 WIND SPEED MEASUREMENTS .....	2
4.0 SELECTION OF RESIDENCES FOR ASSESSMENT.....	3
4.1 Prediction of noise impact using ISO9613-2:1996	
4.2 Residences to be assessed	
5.0 BACKGROUND NOISE MEASUREMENTS.....	5
6.0 OUTDOOR NOISE LEVEL CRITERIA USING NZS6808:1998.....	6
6.1 House 7	
6.2 House 18	
7.0 NOISE PREDICTIONS USING NZS6808:1998 .....	8
7.1 Sound power of a WTG with changing wind speed	
7.2 Comparison of predicted levels with noise limits	
8.0 CONCLUSION .....	12
9.0 SUMMARY OF PARAMETERS.....	12
APPENDIX A SITE LAYOUT	
APPENDIX B ACOUSTIC TERMINOLOGY	
APPENDIX C METHODOLOGY OVERVIEW	
APPENDIX D ONE-THIRD OCTAVE BAND SOUND POWER SPECTRUM FOR THE REPOWER MM82-2MW	
APPENDIX E NOISE CONTOUR MAPS AT 9 M/S USING ISO9613-2:1996	
APPENDIX F PHOTOGRAPHS OF LOGGER LOCATIONS	
APPENDIX G MEASURED BACKGROUND NOISE LEVELS AND WIND SPEED	
APPENDIX H PREDICTED NOISE VS NOISE LIMITS	
APPENDIX I SUMMARY OF PARAMETERS	

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Revision	Purpose	Date delivered
-	Draft issued to client	25 August 2006
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## 1.0 OVERVIEW

This report, commissioned by Future Energy Pty Ltd, details the results of a noise assessment of the proposed Hepburn community wind park.

The assessment has been performed in accordance with the requirements of New Zealand Standard 6808:1998 – *Acoustics – The assessment and measurement of sound from wind turbine generators*, which is applicable in Victoria. The standard states that the noise level from a wind turbine generator or wind farm at a residential site should not exceed the background noise level ( $L_{A95}$ ) by more than 5dBA or a level of 40dBA  $L_{A95}$ , whichever is greater.

Limits are therefore set using these criteria based on noise measurements of existing ambient levels at a range of wind speeds. Noise predictions are compared to these limits in order to confirm compliance or not, with the standard. Noise predictions in the New Zealand standard are based upon a simple equation that may be conservative and independent of sound spectrum, but requires the choice of an air absorption coefficient that suits the spectral content of the turbine.

The Hepburn community wind park will consist of two (2) Repower MM82-2MW wind turbine generators (WTG) with a hub height of 69m. Sound power data used to predict noise impact of these turbines has been taken from an independent test report prepared by Windtest Kaiser-Wilhelm-Koog GmbH. The test was carried out in Germany between February and March 2004 with a fully operational Repower MM82-2MW wind turbine generator.

Using the spectral sound power level of the wind turbines, an assessment was carried out using the ISO9613-2:1996 standard as implemented in SoundPLAN noise prediction software. This method includes effects of terrain, worst-case meteorological effects and ground effects and includes spectral propagation. Fourteen (14) residential sites were initially identified as potentially sensitive to noise impact. These properties were defined as any properties that have a predicted noise level of 35dBA or higher. These residential properties are the closest to the wind park. Residential sites further away will comply with the NZS6808:1998 noise limits.

Background noise monitoring was undertaken at two (2) study sites deemed representative of all the other nearest affected residential properties for a period of 14 days. Noise limits determined for the two (2) study sites can be applied to a further twelve (12) properties in close proximity, and with similar adjacent vegetation.

The method described in NZS6808:1998 has been used to calculate the predicted noise level at each residential site due to the presence of WTGs. This method requires the use of an air absorption coefficient suggested in the standard to be typically 0.005dB/m. This value can, in fact, vary according to the spectral content of the wind turbines that are being assessed. Using the initial analysis of the noise impact of the wind park carried out with ISO9613:1996 standard, it was found that an air absorption coefficient of 0.005dB/m was acceptable for predictions carried out using NZS6808:1998. This standard is already conservative in nature in that it does not include ground absorption effects, or screening effects due to terrain or buildings, and contributions from every wind turbine is included.

Comparison of the predicted noise levels and the noise limits indicates that all residential properties will comply with the NZS6808:1998 noise limits.

The site layout for the proposed wind park is presented in Appendix A.

Acoustic terminology used throughout this report is described in Appendix B.

An overview of the methodology used for this noise assessment is provided in Appendix C.

## 2.0 WIND TURBINE NOISE CRITERIA IN VICTORIA

Guidelines from the Victorian Government state that wind farms in Victoria must be assessed in accordance with New Zealand Standard 6808:1998. The Standard states that the noise level from a WTG or wind farm at a residential site should not exceed the background noise level ( $L_{A95}$ ) by more than 5dBA or a level of 40dBA  $L_{A95}$ , whichever is greater. This should be valid for a range of wind speeds that cover the operation of the wind farm.

The Standard requires a minimum of 10 days continuous background noise monitoring at selected affected sites, together with simultaneous wind speed measurements every ten minutes.

A regression analysis is then performed to describe the relationship between the background noise level and the wind speed.

## 3.0 WIND SPEED MEASUREMENTS

Measurements of wind speed were taken at a tower situated on site with wind anemometers at heights of 20m and 50m and provided to us by Future Energy. Wind speed increases with height above ground, and is dependent on the shape of the velocity profile. Measurements at two or more heights can determine the shape of this profile.

For the purposes of standardising measurements and avoiding confusion regarding whether wind is measured at hub height or any other height, *NZS6808:1998* as well as most noise specification reports for WTGs use data standardised to wind speed at a height of 10m AGL.

In order to convert wind speeds measured at a height of  $x_2$  to that of a height of  $x_1$ , AGL, the following equation which describes a velocity profile in a turbulent boundary layer, is used:

$$V(x_1) \text{ m/s} = \frac{V(x_2)}{\ln(x_2 / Z_0) / \ln(x_1 / Z_0)} \text{ m/s} \quad \text{Equation (1)}$$

$Z_0$  is the roughness factor which is dependent on the terrain and atmospheric stability. The wind data shows that a roughness factor of 0.2 is reasonable for this site.

Noise impact of a wind farm varies with wind speed and therefore it is also usual to choose a single wind speed as a starting point for comparison between noise impacts at different sites. In this case, the maximum impact of the wind turbines occurs at the single wind speed of 9m/s, 10m AGL where sound power of the MM82-2MW with a hub height of 69m, is at its maximum. Selection of residences for inclusion in the study is therefore based upon worst-case noise impact at a wind speed of 9m/s, 10m AGL.

For the purposes of brevity and to avoid confusion, all references to values of noise impact in this report from this point onwards, are for those that occur at a wind speed of 9m/s calculated at a height of 10m AGL, using equation (1).

#### 4.0 SELECTION OF RESIDENCES FOR ASSESSMENT

Implicit in the New Zealand Standard NZS6808:1998, is that residences with an expected noise impact of 35dBA or more should be included in the noise assessment. The standard has a simple non-spectral prediction methodology based on hemispherical spreading and an air absorption coefficient, presumed to typically be 0.005dB/m.

However, as turbines have become larger, this value of air absorption coefficient can be too high, particularly for turbines with the greater proportions of low frequency sound power. This may result in under-predicting wind farm noise emissions. For this reason, an initial investigation using the *ISO 9613 – 2 "Acoustics – Attenuation of sound during propagation outdoors –Part 2: General method for calculation (1996)"* has been carried out to identify likely affected properties, as it incorporates a spectral air absorption algorithm.

This method uses the sound power spectrum of the turbine, and calculates propagation for each frequency band and sums the total predicted sound levels at each receiver. An outcome of this initial investigation is that a more suitable choice of air absorption coefficient can then be applied to the method in the standard to be used in the final assessment.

#### 4.1 Prediction of noise impact using ISO9613-2:1996

The ISO9613-2:1996 method has the scope to take into account a range of factors affecting the attenuation of sound, including:

- The magnitude of the noise source in terms of sound power
- The distance between the source and receiver
- The presence of obstacles such as screens or barriers in the propagation path
- The presence of reflecting surfaces
- The hardness of the ground between the source and receiver
- Attenuation due to atmospheric absorption in one-third octave bands
- Worst-case wind affects that increase noise level.

Sound power data used to predict noise impact of these turbines have been taken from an independent test report prepared by Windtest Kaiser-Wilhelm-Koog GmbH. The test was carried out in Germany between February and March 2004 near Reußenköge with a fully operational Repower MM82-2MW wind turbine generator. The one-third octave band sound power spectrum of the MM82-2MW turbine at wind speed of 9m/s is presented in Appendix D.

A noise contour map of the wind park has been produced using proprietary sound level prediction software, SoundPLAN. The prediction algorithm used to calculate the noise contours was ISO9613-2:1996. Calculations were performed using one-third octave bands from 25Hz to 10kHz. Each turbine was modelled as a point source at hub height. All noise predictions use a receiver height of 1.5m above the local ground level. The ground was modelled as 50% hard ground. The noise contour map for the Hepburn community wind park is presented in Appendix E.

The hardness of the ground between the sources and the receivers needs to be defined in ISO9613-2:1996. 100% hard ground is considered to be fully reflective as would occur with concrete or asphalt, while 100% soft ground would be considered to absorptive and be appropriate for fields and grass. Our experience is that in country Victoria it is appropriate to assume that the ground is 50% hard/50% soft.

#### 4.2 Residences to be assessed

All of the assessable properties can be identified as those within the 35dBA noise contour presented in Appendix E. Table 1 presents these assessable properties as well as the predicted levels according to ISO9613-2:1996. The "S" next to the reference indicates the property is owned by a stakeholder in this wind park project.

**Table 1**  
**Residential sites to be assessed**

Reference	Easting	Northing	Distance to nearest turbine (m)	Predicted noise level according to ISO9613 at 9m/s (10m AGL)
1	245594	5853056	776	36dBA
2	245228	5853160	699	38dBA
3	245174	5853228	656	39dBA
4	244937	5853331	653	38dBA
5	244870	5853553	519	40dBA
6 (S)	244801	5854130	509	40dBA
7 (S)	244795	5854153	525	39dBA
10	244538	5854359	850	35dBA
11	244815	5854504	747	36dBA
13	244923	5854558	738	36dBA
14	245265	5854666	769	36dBA
16	245456	5854466	606	39dBA
17	245511	5854753	895	35dBA
18	245695	5854351	589	39dBA

## 5.0 BACKGROUND NOISE MEASUREMENTS

Background noise monitoring was undertaken between 5-20 September 2006 at the two (2) selected residential properties.

Table 2 lists these two (2) sites selected for background noise monitoring, as well as the remaining twelve (12) indicative sites that will share common limits.

**Table 2**  
**Background monitoring sites**

House	Address	Indicative of houses
7	Ballan-Daylesford Road	1, 2, 3, 4, 5, 6, 10, 11, 12 and 13
18	Leonard Hill-South Bullarto Road	14, 16 and 17

Environmental Noise Loggers Type EL-316 and Rion NL21 were used to conduct 24 hour ambient noise level measurements. Measurements were taken at 10 minute intervals over a period of at least 14 days.

Noise loggers were placed at least 5m from the nearest dwelling in positions that were representative of the general ambient noise environment.

Photographs of logger positions are presented in Appendix F.

Daily rainfall data collected by Bureau of Meteorology at the Ballarat Station were reviewed and where rainfall is likely to have occurred, these data points were removed from the analysis. Appendix G shows the background noise and wind vs time for each study site.

## 6.0 OUTDOOR NOISE LEVEL CRITERIA USING NZS6808:1998

The measurement of noise from a source in the environment is normally undertaken at wind speeds below 5m/s in order to reduce the influence of windborne noise on the measurement itself. However, by the very nature of wind farms, the noise produced by turbines occur in a windy environment, at wind speeds consistently greater than 5m/s. For this reason, NZS6808:1998 was developed especially for this type of acoustic problem. The parameter  $L_{A95}$  is chosen as the compliance parameter, because it is statistically more representative of the type of noise a wind farm produces, and can take into account the background noise levels due to wind.

The New Zealand Standard NZS6808:1998 states that the background noise level at any residential site caused by a WTG or wind farm should not exceed a limit of the pre-wind farm background ( $L_{A95}$ ) plus 5dBA or 40dBA, whichever is greater. The lower level of 40dBA is based upon an internationally accepted indoor level of 30-35dBA  $L_{Aeq}$  when there is no wind and assumes a reduction from outdoors to indoors, of typically 10dB with windows open.

Wind turbine noise is usually most noticeable in the lower wind speeds of 6-8m/s when the sound level produced can be comparable or greater than, the background noise generated by the wind. At greater wind speeds, the background noise due to the wind itself can mask the turbine noise, rendering it inaudible. For this reason it is important to observe the relationship between the background noise levels and wind speed, particularly at lower wind speeds.

The background sound pressure levels described in Section 5.0 are plotted against wind speed in this section. To determine the noise limits, a regression analysis of the background noise vs wind speed is performed. An investigation of a suitable regression analysis was carried out using linear, second order or third order polynomial curves. It was found that a third order polynomial had the highest correlation coefficient thus providing the best representation of the background noise levels.

Presented in the following sections are the graphs used to derive the noise limits for each of the two (2) study sites. The solid red line represents the background noise line of best fit and the solid black line represents the noise limits derived in accordance with NZS6808:1998. The equation of the line of best fit is noted on each graph as is the correlation coefficient. Both sites are surrounded by farming properties and background noise levels are likely to have been affected by farming activities. House 7 is also in close proximity to the Ballan-Daylesford Road and traffic noise is likely to have affected the background noise levels.

Wind speed can vary greatly with height above the ground. To avoid confusion, it has become an industry standard to refer to turbine operating conditions as specified at a single height of 10m above ground level (AGL). For consistency, all reference to wind speed from this point forward, refers to that at a height of 10m AGL.

### 6.1 House 7

The following graph shows the derived noise limits for House 7. Limits at this site also apply to other residential properties located close to the Ballan-Daylesford Road (Houses 1, 2, 3, 4, 5, 6, 10, 11, 12 and 13).

Photographs of the logger position at House 7 are presented in Figures F1 to F4 of Appendix F.

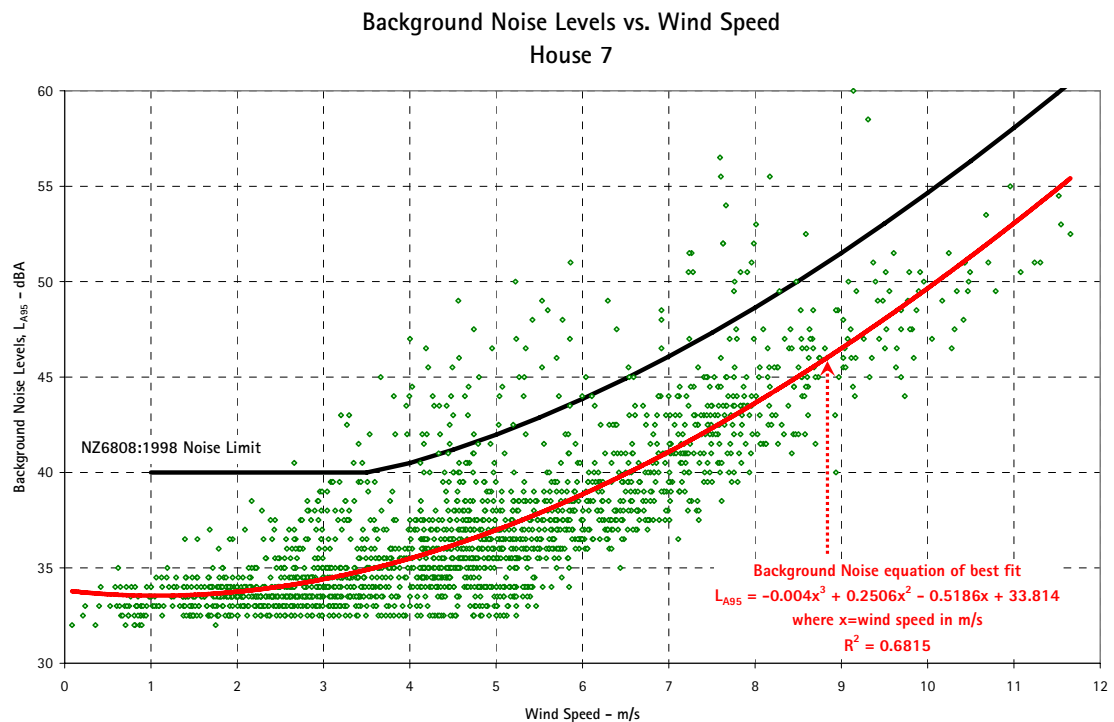


Figure 1: Noise limits at House 7

### 6.2 House 18

The following graph shows the derived noise limits for House 18. Limits at this site also apply to the remaining residential properties located further away from the Ballan-Daylesford Road (Houses 14, 16 and 17).

Photographs of the logger position at House 18 are presented in Figures F5 to F8 of Appendix F.

Background Noise Levels vs. Wind Speed  
House 18

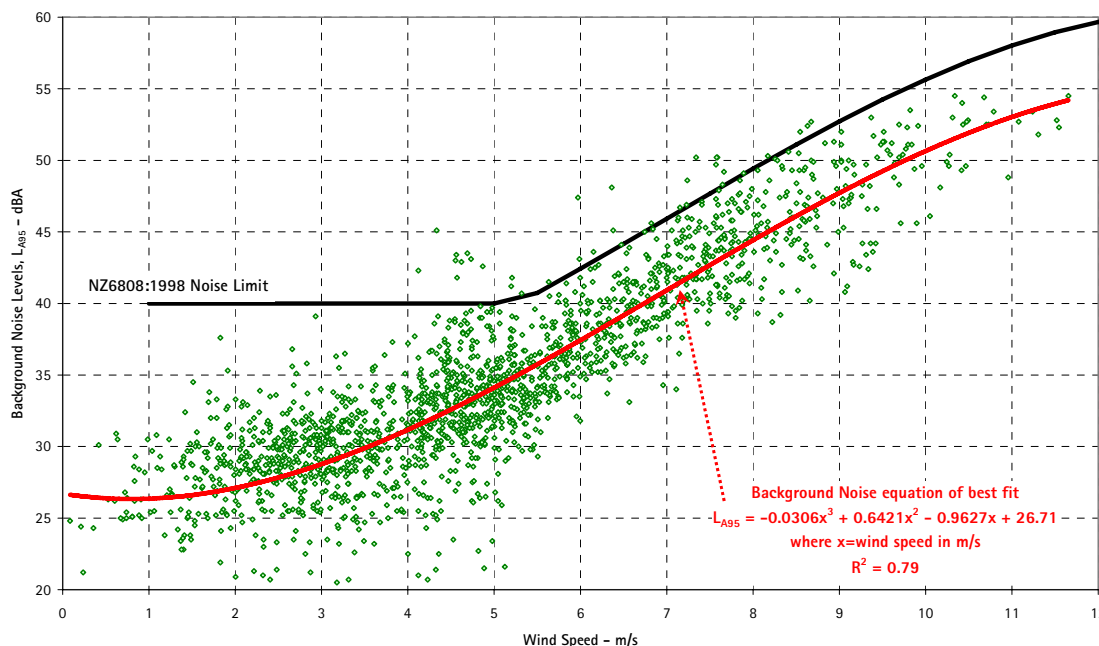


Figure 2: Noise limits at House 18

## 7.0 NOISE PREDICTIONS USING NZS6808:1998

Section 4.3.3 of NZS6808:1998 sets out an equation for predicting noise levels which is generally accepted as being slightly conservative (ie, over-prediction of the sound levels) and is the same as that used in International Electrotechnical Commission document IEC 1400-11. Section 4.3.3 of NZS6808:1998 which states:

*"Equation 1 is based upon hemispherical spreading of the sound from the source and does not take into account attenuation due to screening effects, i.e. where there is no line of sight between the WTG and receiver locations. Acoustic absorption and reflection effects due to vegetation and ground cover are also ignored. The sound level ( $L_R$ ) predicted at a distance ( $R$ ) is that at 1.2m – 1.5m above the local ground level, which is assumed non-reflective. Thus, a good estimate can be derived when predicting sound propagation through free space (e.g. across open gullies), and a conservative estimate (i.e. over-prediction), for propagation across flat locations where ground absorption may be significant. For instances where the WTG is not in line of sight from the observation point, there may be an additional attenuation of up to 12dBA. The degree of attenuation will depend upon a number of factors influencing the direct and indirect sound paths between source and receivers."*

The following equation is used to calculate the sound pressure levels at the residential sites as required by NZS6808:1998:

$$L_R = L_w - 10 \log(2\pi R^2) - \Delta L_A$$

where:

$L_R$  = the sound pressure level from a single WTG at 1.2m to 1.5m above local ground level in dBA at distance R

$L_w$  = the sound power of the WTG at 10m above ground level (AGL) in dBA.  
Measured according to IEC 61400-11

$R$  = the distance between source and receiver in metres

$$\Delta L_A = \alpha_a R$$

$\alpha_a$  = attenuation of sound due to air absorption, in dBA/m for broadband sound which is typically 0.005dBA/m as suggested in NZS6808:1998.

As mentioned in Section 3.0, the prediction method outlined in NZS6808:1998, does not consider the spectral content of the WTG noise emissions. Spectral content can be important as some larger modern WTGs emit noise with significant low frequency content. Low frequency sound attenuates at a relatively slow rate in air; hence the initial proposed atmospheric absorption coefficient of 0.005dBA/m may be too high.

Therefore, in order to derive a more appropriate atmospheric absorption coefficient, predictions from NZS6808:1998 method are rerun using a reducing value of air attenuation until the predicted levels are similar to those from results using ISO9613-2:1996 as presented in Section 3.1. It was found that for this project, a value of  $\alpha_a = 0.005$ dBA/m gave good agreement between NZS6808:1998 predictions and ISO9613-2:1996.

Results for predicted noise levels according to NZS6808:1998 for assessable residences are shown in Table 3; with comparison levels calculated using ISO9613-2:1996. The noise levels calculated from the NZ Standard will be used in the comparison with the NZS6808:1998 noise limits.

**Table 3**  
**Predicted noise levels for assessable residences at reference conditions using ISO9613-2:1996 and NZS6808:1998**

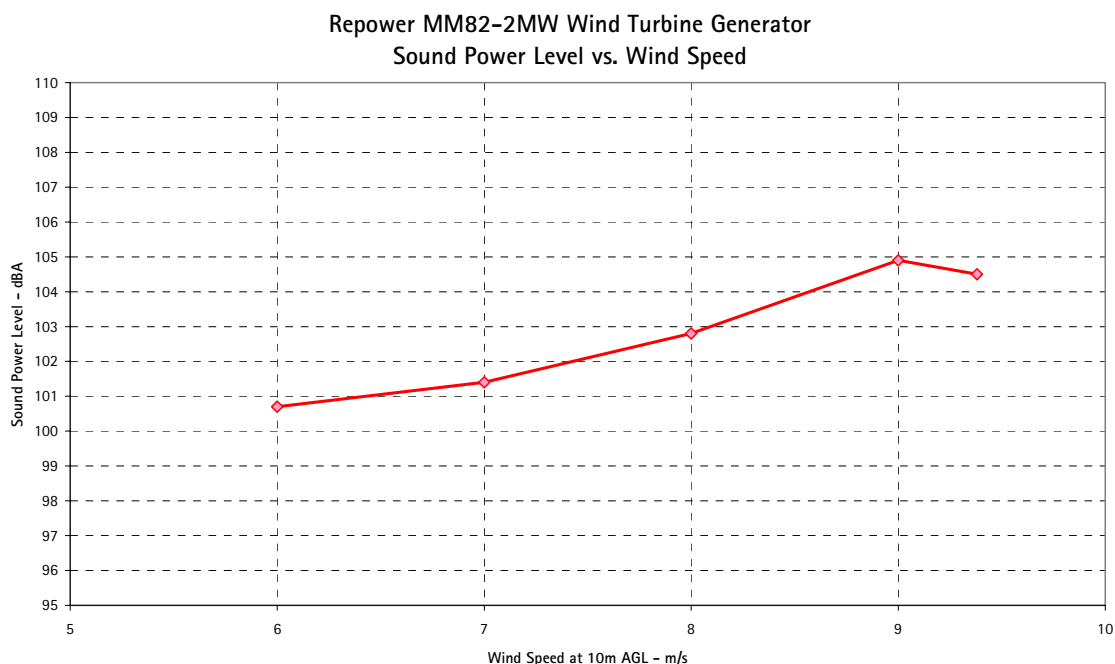
Reference	Predicted noise level according to ISO9613-2 at 9m/s (10m AGL)	Predicted noise level according to NZS6808, 0.005dBA/m at 9m/s (10m AGL)
1	36dBA	37dBA
2	38dBA	39dBA
3	39dBA	40dBA
4	38dBA	40dBA
5	40dBA	42dBA
6 (S)	40dBA	42dBA
7 (S)	39dBA	41dBA
10	35dBA	36dBA
11	36dBA	37dBA
13	36dBA	38dBA
14	36dBA	38dBA
16	39dBA	41dBA
17	35dBA	36dBA
18	39dBA	41dBA

We can see from Table 3 that the correlation between ISO9613-2:1996 and NZS6808:1998 is good to within 1-2dB, with NZS6808:1998 being the more conservative method in all cases where there is a difference.

### 7.1 Sound power of a WTG with changing wind speed

In order to carry out a thorough analysis of the impact of the wind park, predicted noise levels must be calculated for the full range of wind speeds. Once the noise impact of the WTGs is calculated for one wind speed, the "power profile" represented in Figure 3 is applied across the range of wind speeds to give a solution.

The sound power vs wind speed has been sourced from an independent test report prepared by Windtest Kaiser-Wilhelm-Koog GmbH. The WTG sound power levels are only available slightly above 9m/s which is the speed at which 95% of the power output is produced.



**Figure 3: Sound power level vs wind speed for the Repower MM82-2MW**

Sound power levels in Figure 3 have been measured for a hub height of 59m. The proposed hub height of the selected WTG is 69m. The WTG sound power levels at 10m AGL for this hub height will only increase marginally compared to those presented in Figure 3 and will not affect the outcome of the assessment.

## 7.2 Comparison of predicted levels with noise limits

Table 4 shows the comparison of predicted noise levels calculated according to NZS6808:1998 compared with lowest possible noise limit at the reference wind condition of 9m/s at 10m AGL.

A plot of predicted noise levels against the NZS6808:1998 noise limits at each of the two (2) study sites are presented in Figures H1 and H2 of Appendix H for the range of wind speeds over which the wind park is operational. Compliance occurs if the line of predicted noise levels remains below the limit line and non-compliance occurs when the predicted noise level line rises above the limit line.

**Table 4**  
**Predicted noise level at reference conditions at assessed residences**

Reference	L <sub>Aeq</sub> level due wind park	Noise limit	Compliance
1	37dBA	52dBA	✓
2	39dBA	52dBA	✓
3	40dBA	52dBA	✓
4	40dBA	52dBA	✓
5	42dBA	52dBA	✓
6 (S)	42dBA	52dBA	✓
7 (S)	41dBA	52dBA	✓
10	36dBA	52dBA	✓
11	37dBA	52dBA	✓
13	38dBA	53dBA	✓
14	38dBA	53dBA	✓
16	41dBA	53dBA	✓
17	36dBA	53dBA	✓
18	41dBA	53dBA	✓

Note: ✓=compliance ✗ = non-compliance

All residential properties comply with the NZS6808:1998 noise limits.

## 8.0 CONCLUSION

In this report, suitable noise limits were determined for the external noise level of each of the fourteen (14) assessable residential sites near the proposed Hepburn community wind park. Using the New Zealand Standard for wind farms (NZS6808:1998) noise limits were set depending on the relationship between measured existing (pre-wind farm) background noise levels and wind speed.

The predicted noise levels at each residential site were calculated in accordance with NZS6808:1998 and confirmed using a more complex spectral method found in ISO9613-2:1996. These predicted levels were compared with the appropriate noise limits. This comparison was made over a range of wind speeds.

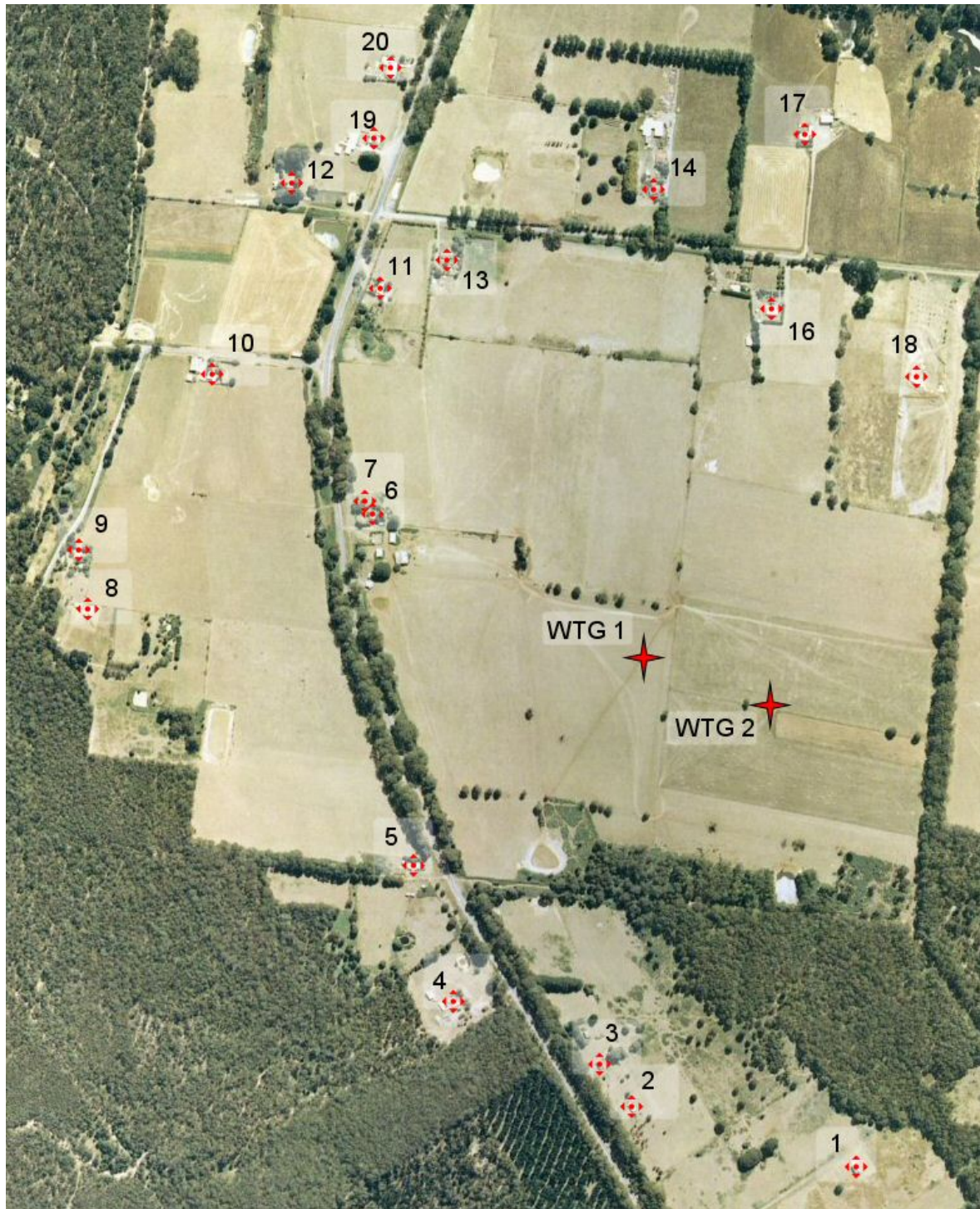
It was found that all residential sites complied with the NZS6808:1998 noise limit.

## 9.0 SUMMARY OF PARAMETERS

Documentation of relevant parameters as required by NZS6808:1998 is contained in Appendix I.

APPENDIX A

SITE LAYOUT



## APPENDIX B

### ACOUSTIC TERMINOLOGY

- dBA Unit of overall noise level, in A-weighted decibels. The A-weighting approximates the average human response over the entire frequency range.
- $L_{eq}$  Continuous or semi-continuous noise levels are described in terms of the equivalent continuous sound level ( $L_{eq}$ ). This is the constant sound level over a stated time period which is equivalent in total sound energy to the time-varying sound level measured over the same time period. This is commonly referred to as the average noise level and is generally measured in dBA.
- $L_{Aeq}$  The "A" weighted equivalent continuous sound level.
- $L_{95}$  Background noise levels are described in terms of the level exceeded for 95% of the measurement period ( $L_{95}$ ). This value can be referred to as the minimum level and is generally measured in dBA. Note that the New Zealand Standard here uses the slightly more conservative  $L_{95}$  rather than  $L_{90}$  which is more commonly used in Australia. By definition,  $L_{95}$  is slightly lower than  $L_{90}$ .
- $L_w$  Sound power level. The measure of acoustic power radiated by a sound source.

## APPENDIX C

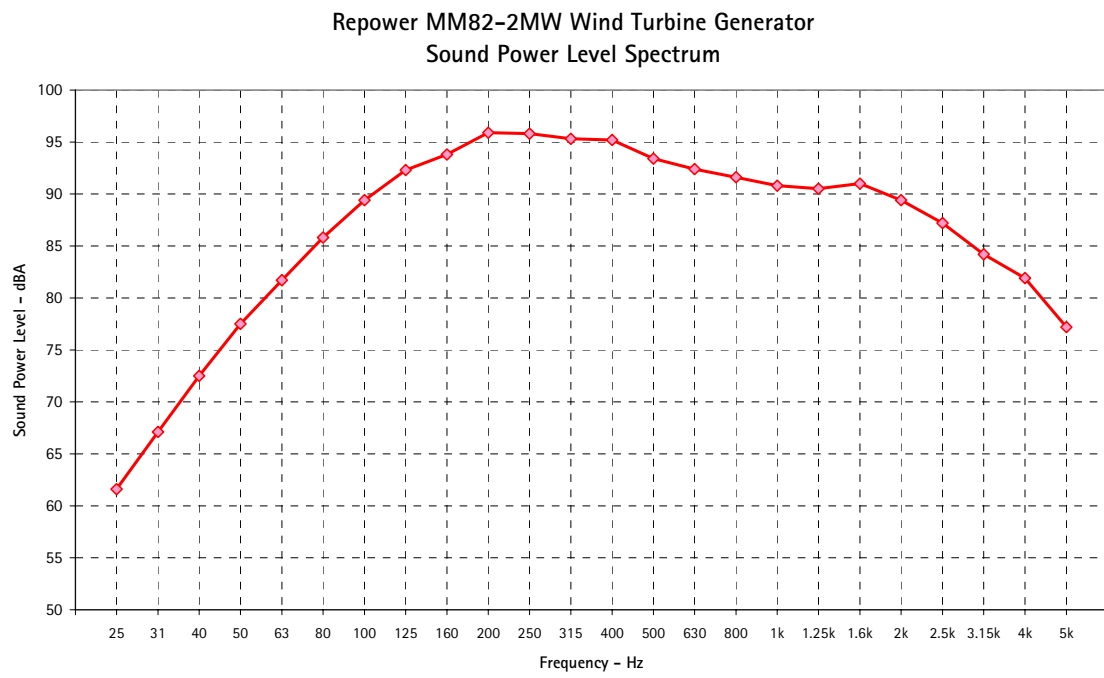
### METHODOLOGY OVERVIEW

The methodology used for this noise assessment is composed of the following:

- Identification of noise-sensitive residences
  - Wind farm noise predictions using ISO9613-2:1992
  - Implicit in NZS6808:1998, noise compliance is achieved automatically for residential properties below 35dBA.
- Determination of the noise criteria
  - Background noise monitoring for a minimum of 14 days
  - Correlation of background noise levels with wind speed
  - Noise levels from a wind farm should not exceed the background noise level by more than 5dBA or a level of 40dBA, whichever is the greater over a range of wind speeds covering the operation of the wind farm.
- Prediction of the wind farm noise emissions
  - Use of ISO9613:1992 and NZS6808:1998 predictions to determine appropriate air absorption value
  - Predict wind farm noise emissions in accordance with NZS6808:1998 to assess compliance with the noise limit.
- Assessment of compliance.
- If compliance is not achieved, recommendation of ways to achieve compliance.

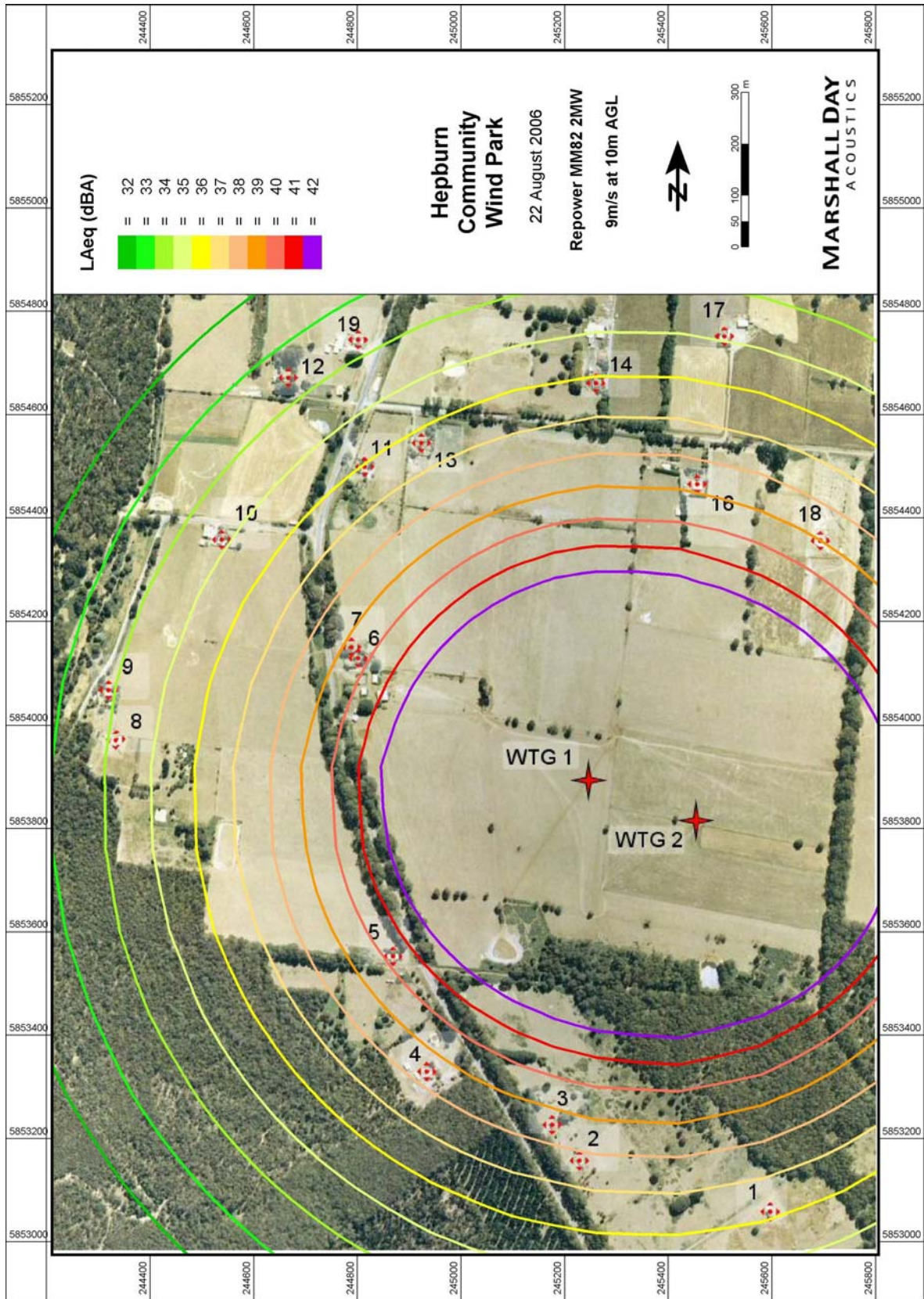
## APPENDIX D

### ONE-THIRD OCTAVE BAND SOUND POWER SPECTRUM FOR THE REPOWER MM82-2MW



APPENDIX E

NOISE CONTOUR MAPS AT 9M/S USING ISO9613-2:1996



APPENDIX F

PHOTOGRAPHS OF LOGGER LOCATIONS



Figure F1 – Photograph of logger location at House 7, North



Figure F2 – Photograph of logger location at House 7, East



Figure F3 – Photograph of logger location at House 7, South



Figure F4 – Photograph of logger location at House 7, West



Figure F5 – Photograph of logger location at House 18, North



Figure F6 – Photograph of logger location at House 18, East



Figure F7 – Photograph of logger location at House 18, South



Figure F8 – Photograph of logger location at House 18, West

# APPENDIX G

## MEASURED BACKGROUND NOISE LEVELS AND WIND SPEED

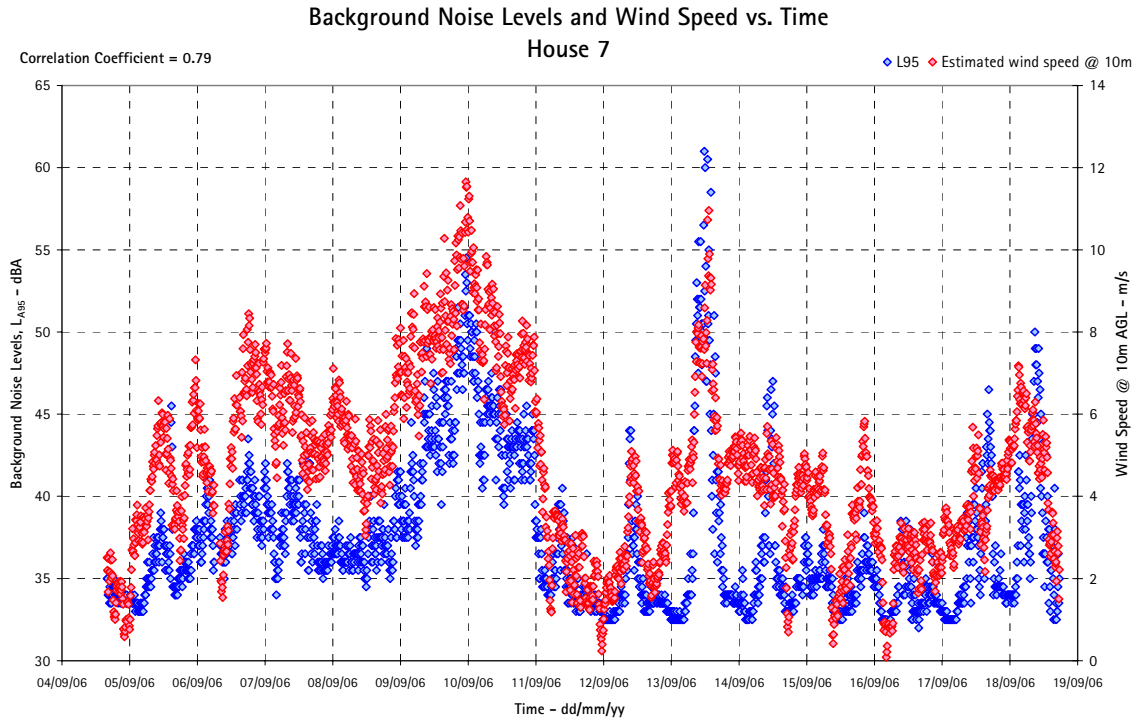


Figure G1 - Background Noise Level and Wind Speed vs Time – House 7

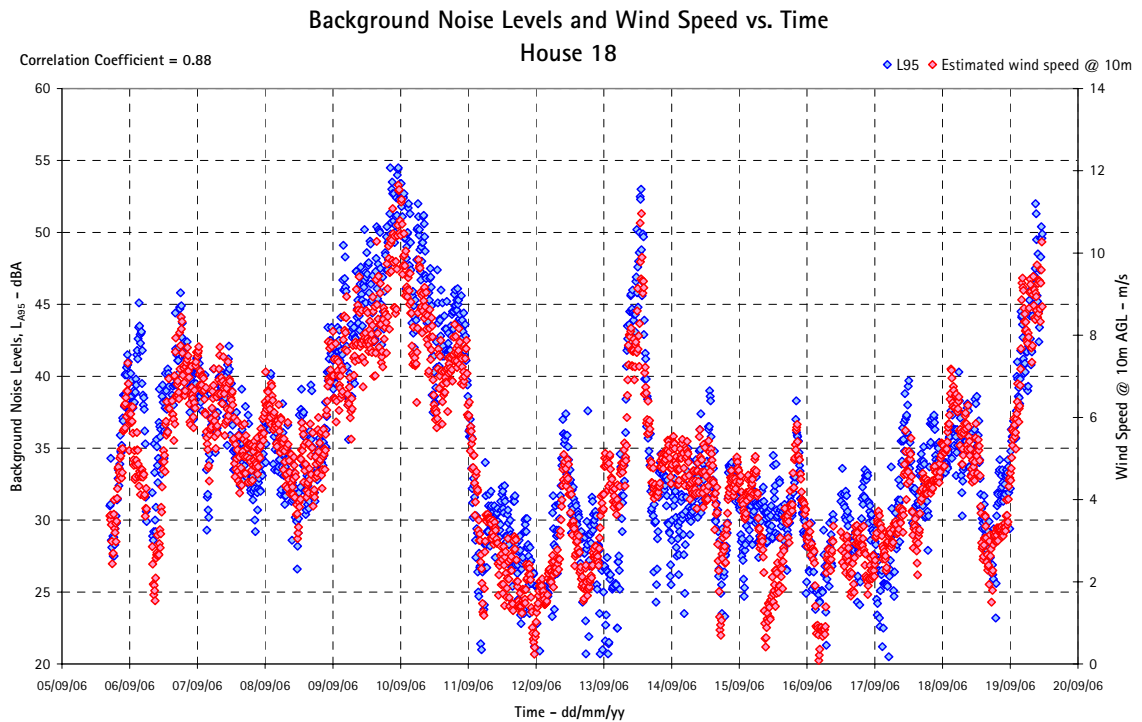


Figure G2 - Background Noise Level and Wind Speed vs Time – House 18

# APPENDIX H

## PREDICTED NOISE VS NOISE LIMITS

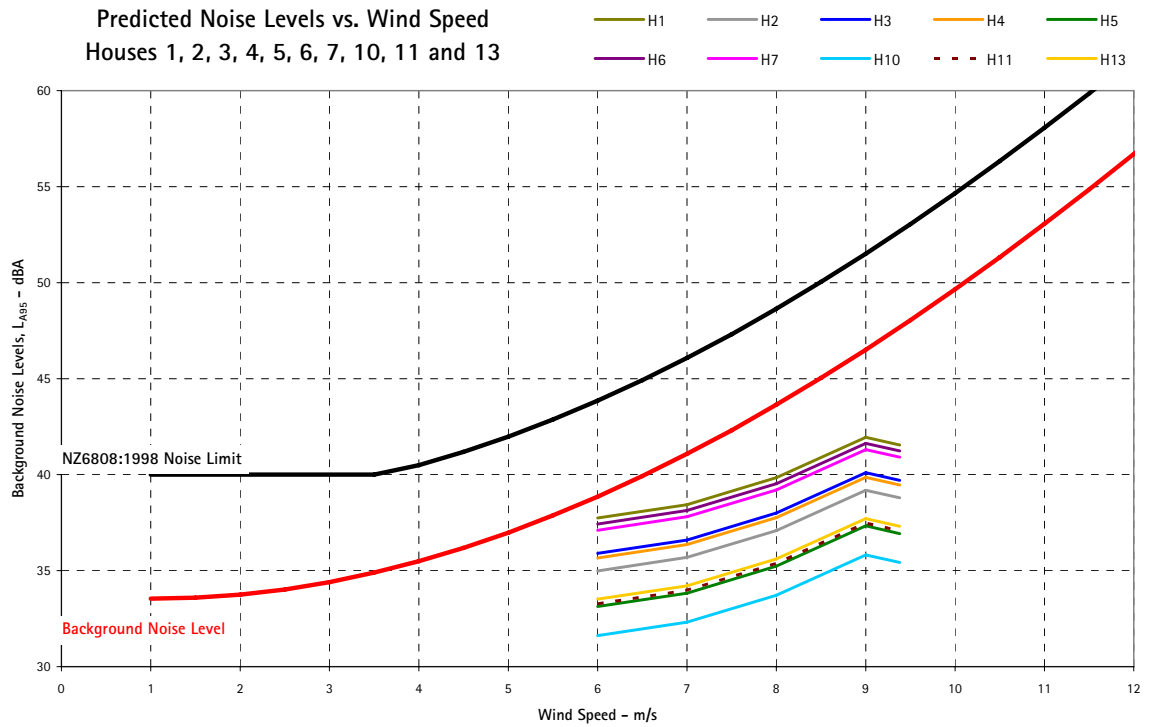


Figure H1 - Predicted WTG noise vs noise limits at House 7

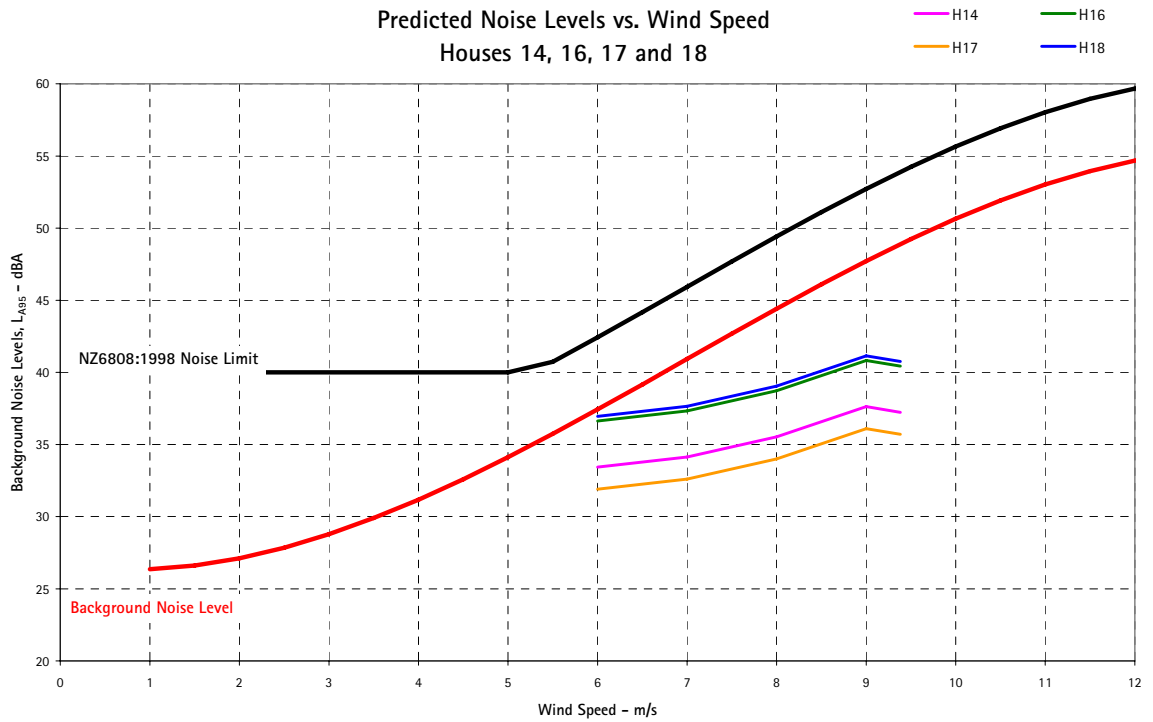


Figure H2 - Predicted WTG noise vs noise limits at House 18

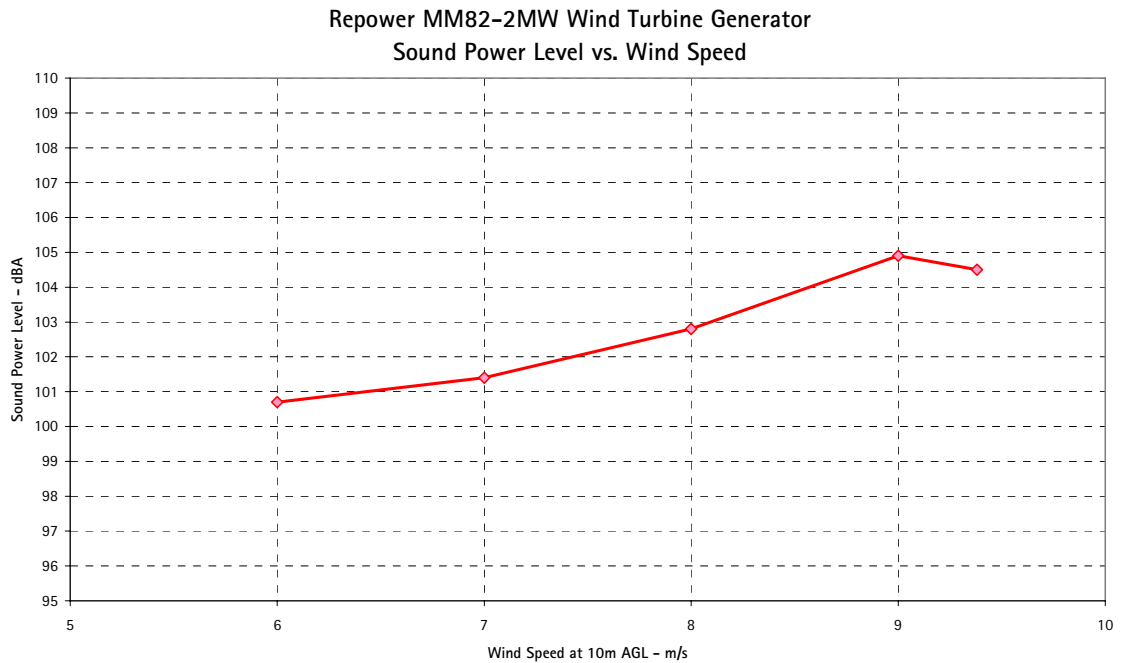
## APPENDIX I

### SUMMARY OF PARAMETERS

Parameters are summarized in accordance with documentation specification shown in Section 6 of NZS6808:1998.

#### Parameters for noise prediction

(a) WTG sound power level at 10m AGL



- (b) Air absorption model: ISO9613-1:1996,  $\alpha_a = 0.005\text{dBA/m}$
- (c) Sound Attenuation due to screening – nil absorption due to screening
- (d) Source and method of calculation – NZS6808:1998
- (e) Make and model of WTG – Repower MM82-2MW
- (f) Hub height of WTG – sixty nine (69) metres
- (g) Coordinates – MGA94 Zone 55.

#### WTG coordinates

WTG	Eastings	Northings
1	245250	5853900
2	245457	5853817

### Residential site coordinates

Reference	Eastings	Northings
1	245594	5853056
2	245228	5853160
3	245174	5853228
4	244937	5853331
5	244870	5853553
6	244801	5854130
7	244795	5854153
8	244335	5853974
9	244317	5854066
10	244538	5854359
11	244815	5854504
12	244666	5854673
13	244923	5854558
14	245265	5854666
16	245456	5854466
17	245511	5854753
18	245695	5854351
19	244805	5854747
20	244835	5854858
21	245049	5855439
22	245041	5855470
23	245054	5855624
24	245157	5855432

### Parameters for background measurement

- (a) Monitoring equipment - Environmental Noise Loggers Type EL-316 and Rion NL21 were used to conduct 24hr ambient noise level measurements.
- (b) Anemometry equipment - Calibrated Riso P2546A anemometers and Vector instruments W200P wind vanes @ 20m and 50m AGL
- (c) Location of monitoring equipment - more than 5m from existing residence in accordance with NZS6808:1998, see photos in APPENDIX F.
- (d) Atmospheric conditions - see wind data, APPENDIX G.
- (e) Time and duration of measurement - Measurements were taken at 10 minute intervals over a minimum period of 14 days.

(f) Averaging period – 10 minute intervals for all measurements, coordinated on the hour.

(g) Position of wind speed measurement AGD66 Zone 55H

Eastings	Northings
245146	5853703

(h) Number of data pairs = approximately 2000 for each site

(i) Regression analysis – Least squared third order polynomial regression

(j) Regression analysis graphical outputs: see Section 6.0