Capital II Wind Farm - Noise Impact Assessment

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EXECUTIVE SUMMARY

A noise impact assessment has been performed of the proposed Capital II Wind Farm (CWFII) project near Tarago, New South Wales. This modelling was performed to determine the noise generated by a proposed 53 to 57 Wind Turbine Generators located at the site.

The likely noise impact of the proposed wind farm configuration has been predicted for a range of operational and wind scenarios using an accurate Predictive Noise Model (based on the accepted Concawe algorithm for meteorological conditions and the ISO9613 standard). The algorithms used in the model take into account the likely effects of atmospheric absorption, ground absorption/reflection, diffraction and attenuation by topographic features, screening effect of barriers and the propagation effect of wind speed and direction.

The proposed wind farm configuration will consist of 53 to 57 Wind Turbine Generators (WTGs) distributed in an array along the eastern shore of Lake George.

There are a total of approximately 28 residential premises (receivers) that are between 2 and 5 km of the proposed wind farm only of which only four are relevant receivers.

The background noise levels and criteria for Capital II Wind Farm have been previously measured for the Capital I Wind Farm (CWFI) project.

The noise model was run for the maximum power WTG setting, for neutral and wind-affected propagation conditions. The model was run for the worst case wind conditions for the range of wind speeds from 4 to 10 ms^{-1}. At the time of modelling, the turbine type for the CWFII project has not been fixed, however a number of turbine types have been investigated. Therefore for the purposes of this assessment, to represent the highest impact scenario we have used the highest sound power level of the Suzlon S88 2.1MW WTG and the Sinovel 3MW WTG at each integer wind speed.

The predicted levels were assessed against the SA EPA *"Environmental Noise Guidelines: Wind Farms"*. The predicted L_{Aeq} noise levels for worst case wind propagation conditions range between about 13 and 36 dB(A) (except at two sites, where the noise levels can range up to 42dB(A)) at the nearest relevant receivers, however achieve the selected criteria at all sites except E02 and E03 (which are non-relevant receivers for the CWFI project).

Capital II Wind Farm development is adjacent to the Capital I Wind Farm and Woodlawn wind farm developments, and therefore the cumulative noise impact of both wind farms was also investigated. It was found that at some relevant receivers (for CWFII project) the cumulative noise impact of both wind farms exceeded the noise criteria, however it was found that the noise levels at these receivers were dominated by CWFI WTG noise (or combined levels would not have an adverse impact, and exceed WHO guidelines for sleep disturbance), and would have standing noise agreements with the wind farm owner for these levels.

The cumulative impact of Stages I and II of the wind farm as well as Woodlawn Wind Farm therefore meet the selected criteria where CWFII turbines are dominant (or meet the WHO noise guidelines for sleep disturbance at the sites with noise agreements). Mitigation measures are therefore not required for the criteria to be met. As a contingency measure, if levels higher than those predicted eventuate, then mitigation could be easily applied in the form of modifying sound power levels by de-rating turbines or applying wind sector management to the turbines.

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1. INTRODUCTION

This report outlines a noise impact assessment of the proposed Capital II Wind Farm (CWFII) development near Tarago, New South Wales. Noise modelling was performed to determine the noise generated by a proposed 53 to 57 Wind Turbine Generator layout on the site.

The likely noise impact of the proposed wind farm configuration is predicted for a range of operational and wind scenarios using a noise model and accepted noise propagation algorithms.

Predicted noise levels are assessed against the SA EPA *"Environmental Noise Guidelines : Wind Farms"* (Ref [1]).

2. REFERENCES

[1] "*Wind Farms: Environmental Noise Guidelines (interim)*", SA Environment Protection Authority, SA Government, Dec 2003.

[2] Concawe Report No. 4/81: "*The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*", Manning C.J., 1981

[3] International Standard ISO 9613 *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*, 1996

[4] *Background Noise Monitoring Report, Capital Wind Farm*, Vipac Document No. 505608-TRP-017528-00, Vipac Engineers & Scientists, 27 April 2005

[5] "Capital Wind Farm: Noise Impact Assessment Report" 10 February 2006. Reference: 505608-TRP-018284-02

[6] "Capital Wind Farm - Addendum Noise Impact Assessment" 15 October 2008. Reference: 50B-04-5608-TRP-423213-2

[7] WTG layout for Capital II Wind Farm provided by Chris McGrath (Infigen Energy) 1 June 2010

[8] *"Guidelines for Community Noise",* World Health Organization (WHO), Geneva, Switzerland, 1999.

[9] Sinovel 3MW WTG sound power data provide by Laura Dunphy (Infigen Energy) 14th September 2010

[10] Capital Wind Farm Director General requirements (3 September 2010)

3. NOISE CRITERIA GUIDELINES

The primary criteria to be used for wind farm developments in South Australia are provided in the SA EPA *"Environmental Noise Guidelines : Wind Farms"* [Ref :[1]].

The EPA guidelines state that: "The predicted equivalent noise ($L_{Aeq\ 10mins}$), adjusted for tonality in accordance with these guidelines, should not exceed 35dB(A) or the background noise ($L_{A90\ 10mins}$) by more than 5 dB(A), whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG."

The EPA guidelines [Ref : [1]] also state all noise measurements are to be taken outdoors at 1.2 to 1.5 metres above the ground and within 20 metres of a noise sensitive premises (and at least 5m from any major reflecting surface). The background noise monitoring survey should be carried out (for representative sensitive or relevant receivers within 1.5km of the wind farm) over a period of at least 2 weeks to ensure the

collection of at least 2000 valid data points. All wind speed measurements are to be taken at, or adjusted to, 10m AGL.

In addition, in accordance with the EPA guidelines, an adjustment of 5dB(A) should be added if tonality, impulsiveness or low frequency components are present in the noise generated by the wind farm.

The criteria for this proposed wind farm (for relevant receivers) are determined from the background noise measurements at the site (see section 5). Corrections for the influence of wind-induced background noise are determined from the application of regression techniques described in [Ref : [1]] and [Ref : [4]].

For non-relevant receivers (associated with the wind farm), the World Health Organisation (WHO) criterion level for unreasonable interference or sleep disturbance is applicable [Ref :[8]].

A glossary of acoustic terminology is provided in Appendix A.

4. PROJECT AND SITE DESCRIPTION

The proposed wind farm near Tarago is situated in proximity of Map Grid of Australia (MGA) reference 6,116,000 m N, 734,000 m E. The wind farm area is in the southern tablelands area of New South Wales. Note that the coordinate system used throughout is MGA (equivalent to UTM WGS84).

The site is located on the eastern side of Lake George, New South Wales. In this area, the Great Dividing Range runs in an approximately north-south direction. The general area of the wind farm site comprises a mix of pasture and open farming properties. The aspect of the landscape is open, with significant hills and occasional trees and other obstructions.

The area would be classified as mainly rural with some agricultural industry and party industrial zoning. The land use in the area mainly comprises intermediate-sized farming.

The wind farm configuration will consist of up to 57 Wind Turbine Generators (WTGs) distributed in an array along Lake George. Adjacent to this proposed wind farm is the existing Capital I Wind Farm (CWFI), which consists of 69 Suzlon S88 2.1MW wind turbine generators (hub height of 80m). Additionally, to the North East of CWFI is the planned Woodlawn Wind Farm, which will consist of approximately 20 Suzlon S88 2.1MW Wind Turbine Generators.

At the time of modelling, the turbine type for the CWFII project has not been fixed, however a number of turbine types have been investigated. Therefore for the purposes of this assessment, to represent the highest impact scenario we have used the highest sound power level of the Suzlon S88 2.1MW WTG and the Sinovel 3MW WTG at each integer wind speed. The WTG type is likely to be a three-bladed rotor with a hub height of up to 100m. Rotation speed will likely vary up to a maximum of 16 rpm. The cut-in wind speed is assumed to be 4ms^{-1} (at 10m AGL), and the assumed rated power at 12 ms^{-1} (at 10m AGL).

5. BACKGROUND NOISE MEASUREMENTS AND CRITERIA

The existing environment is defined from background noise monitoring that has been carried out within the vicinity of the proposed site and is detailed in Ref [4]. We note that no specific background noise monitoring has been undertaken for CWFII project as any noise monitoring undertaken will have influence from nearby CWFI. Therefore the background measurements and criteria selection as used in the Capital I Wind Farm (CWFI) Noise Impact Assessment, will also be used in the CWFII Noise Impact Assessment.

There are a total of approximately 29 residential premises (receivers) that are within 5 km of the proposed wind farm, of which only four are non-relevant receivers. The nearest associated dwelling (non-relevant) is approximately 960m away from the nearest CWFII wind turbine, and the nearest non-associated (relevant) dwelling is approximately 1.2km away from the nearest CWFII wind turbine. The receivers are listed, with details, in Appendix C. The residences associated with the wind farm (“windfarmers”, with wind turbines on their properties) are also noted in Appendix C.

Background noise monitoring was undertaken for the CWFI project [4] and can be used as the background noise for the receivers. The background noise levels at six receiver sites in the vicinity of the proposed wind farm have been measured (Ref [4]) continuously over a period of two to three weeks in accordance with [1]:

- Luckdale (G2)
- Euroka (G7)
- Sunnybrook1 (G8)
- L'Orizon (E2)
- Currandooley (H2)
- Wyoming (E1)

Therefore these sites are available surrounding the wind farm site which can be used for the assessment of the wind farm's noise impacts.

It is expected that other residential sites will have background levels similar to those monitored, depending on location and degree of exposure to prevailing meteorological conditions. Therefore, the following background criteria are considered appropriate (majority of these are shown in [4]):

- Luckdale (G2) : G3, G4
- Euroka (G7) : G5, G6
- Sunnybrook1 (G8) : G9, G10, G11, G12, G13, G14, G15, G16, G17, G18, H3
- L'Orizon (E2) : E3, E6
- Currandooley (H2) : E4, E5, E7, H1
- Wyoming (E1): none other

For residential sites which have WTGs on their property, the criteria above are not strictly applicable to the noise from CWFII. These residences are classified as "windfarmers" or non-relevant receivers and are identified in Appendix C.

The results of the analysis of the noise and wind monitoring are given in Ref [4]. These monitoring results have been performed in compliance with the 2003 SA EPA Wind Farm Noise Guidelines (Ref [1]). From these results we have observed that there is small disparity between day time and night time results. The difference between individual day time and night time noise levels with the total regression is generally within 1dB. We note however that as there is not a statistically robust data set to determine both day time and night time noise levels separately (more than 2000 data points, as prescribed to use to define wind farm noise criteria (Ref [1])), this gives only a general indication of the noise levels, taking this into consideration we deem this difference to be not significant. For higher wind speeds (greater than $8ms^{-1}$ at 10m AGL), the night time noise levels were generally higher than the day time noise levels. The selection with the criteria has been undertaken using and adhering to industry best practices, specifically the 2003 SA EPA Wind Farm Noise Guidelines (as required by [10]).

The adopted criteria for this project has been adopted from the criteria used to assess noise levels at the same sites from the CWFI and Woodlawn Wind Farm projects, which have been previously accepted by the Department of Planning, and follow the prescriptions of the 2003 SA EPA Wind Farm Noise Guidelines.

A recommended wind farm noise compliance level at each of the seven monitored sites and the rest of the sites has been based on the background noise levels measured. The noise criterion levels at each wind speed (10mAGL) from Ref [4] are as follows:

Table 5-2: Resultant noise criteria for each site

Monitored Site	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Luckdale (G2)	35	36	38	39	41	42	43
Euroka (G7)	35	35	35	36	37	38	40
Sunnybrook 1 (G8)	35	35	35	36	37	39	40
Torokina (G18)	35	35	36	37	38	39	40
L'Orizon (E2)	35	35	35	38	40	43	45
Currandooley (H2)	35	35	35	37	38	39	40
Wyoming (E1)	35	35	35	36	37	39	40

The residences with wind turbines on their properties (identified in Appendix C) are not relevant receivers and the above criteria are not applicable. Predicted levels are provided for these sites and referenced to the World Health Organisation (WHO) relevant guideline level of 45 dB(A) [Ref: [8]]. This applies to Lakoona (G04), Luckdale (G02), Panhandle (G01) and Ellenden (G04) residences.

6. NOISE MODEL PREDICTIONS

An accurate Predictive Noise Model has been constructed using the validated and accepted Concawe algorithm ([Ref: [2]]) for noise propagation in different meteorological conditions, with a ground absorption factor set to partially reflective (30% reflective, with ground factor set to G=0.7). The standard ISO9613 algorithm [Ref : [3]] was also used, with a ground absorption factor set to fully reflective. The noise model has been constructed using the widely recognised SoundPLAN proprietary software package.

The algorithms used in the model take into account the likely effects of atmospheric absorption, ground absorption/reflection, diffraction and attenuation by topographic features, screening effect of barriers and the propagation effect of wind speed and direction. The accuracy of the noise model is likely to be at least ± 2 dB(A) and up to the order of ± 5 dB(A).

Two layouts were presented to be modelled, one consisting of 53 WTG's, and another with an additional 4 WTG's, the modelled 57 WTG layout provides a worst case noise scenario for the nearby sensitive receivers. These layouts are represented graphically in Appendix B, and in tabular format in Appendix D. We note that for each WTG location, the actual placement site of the turbines can vary up to 200m at each placement. Therefore the noise model was constructed with each WTG being moved 100m closer to the closest residence, to create a worst case scenario for the WTG layout.

The model incorporates the proposed locations of WTG arrays at a hub height of 80m above the ground level (although we are aware the hub height of the proposed WTGs is to be 100m, we have modelled 80m hub height for conservatism, as the modelling was undertaken before final hub height selection was made). The van den Berg effects, have not been accounted for, as for wind speed profiles given for CWFI project, there has been no evidence for stable van dan Berg effects found.

At the time of modelling, the turbine type for the project has not been fixed, however a number of turbine types have been investigated. Therefore for the purposes of this assessment, to represent the highest impact scenario we have used in our model the highest sound power level of the Suzlon S88 2.1MW WTG and the

Sinovel 3MW WTG at each integer wind speed. Additionally, the spectra of the sound power levels at each integer wind speed was modelled using the spectral shape of the S88 2.1MW WTG.

The WTG sound power data is given in Appendix E. The sound power output, measured at 10m AGL (in accordance with IEC 61400-11), as well as the sound power levels used in the modelling are given in Table 6-1. Note that the numbers of WTGs and the WTG layout in the model was based on a smaller turbine type (lower power, lower hub height) for added conservatism, and that if a larger turbine (e.g. Sinovel 3MW) is chosen later this would not be practical and there would be fewer turbines required in the WTG layout.

Table 6-1: Sound Power Levels of WTG Types

Wind Speed (10m AGL)	S88 2.1MW Overall Sound Power Level, dB(A) re. 10^{-12}W	Sinovel 3MW Overall Sound Power Level, dB(A) re. 10^{-12}W	Used Sound Power Level (Max of S88 and Sinovel SWL) dB(A) re. 10^{-12}W
4ms^{-1}	103.2	103.9	103.9
5 ms^{-1}	103.6	103.9	103.9
6 ms^{-1}	103.0	103.9	103.9
7 ms^{-1}	103.7	104.7	104.7
8 ms^{-1}	104.3	103.9	104.3
9 ms^{-1}	103.6	103.5	103.6
10 ms^{-1}	103.6	103.8	103.8

There was limited published data from the manufacturers outlining any detectable tones or any other significant characteristics such as impulsiveness, modulation or low frequency components in the sound power spectrum. We have assumed for conservatism the highest impact sound power levels for the installed WTGs, if the published maximum sound power levels for the selected WTG model is greater than the levels provided in Table 6-1 or noise measurement data for the proposed WTG model displays any tonality or other characteristics, remodelling will be required and the noise impact be reassessed, otherwise these noise predictions presented in this report provide a conservative estimate.

We expect that in the close vicinity of a WTG there is a slight swish-like modulation resulting from the rotor blade passing through the air and past the support tower in addition to a slight hum emanating from the WTG generator. These minor effects diminish rapidly over distance and, for an array of WTGs, are randomly mixed to form low-level background white noise.

The psycho-acoustic response or annoyance levels to a new noise source is subjective and will vary from person to person but is unlikely to be significant with wind farm noise and particularly so with increasing separation distance between the turbines and the residences. Current wind turbine designs are not a significant source of low frequency noise or infrasound – even nearby (less than 500m), any infrasound is well below the threshold of human perception and would not cause health effects.

6.1. 53 Turbine Layout

The noise model was run for the maximum power (104.7 dB(A)) setting for all of the WTGs. The model was run with these sound power settings for neutral and wind-affected propagation conditions from 4 to 12 ms^{-1}.

Predicted L_{Aeq} noise levels (rounded to the nearest 0.5 dB(A)) have been determined for all non relevant and relevant receivers and are tabulated in Table 6-2 and Table 6-3 respectively for the worst case wind scenario at 8 ms^{-1}. The criterion level which would be applicable is also given in the table. The relevant World Health Organisation (WHO) guideline level of 45 dB(A) for unreasonable interference or sleep disturbance [Ref :[8]] is also given in the table.

Table 6-2: 53 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Non-Relevant Sites at 8ms^{-1} wind speed

Receiver	Criteria, dB(A)	ISO9613 Meteorological Conditions - 8m/s, dB(A)	CONCAWE Worst Case Meteorological Conditions 8m/s, dB(A)
G01 (Panhandle)	45	40.5	40
G02 (Luckdale)	45	36	34.5
G04 (Lakoona)	45	42.5	42
E04 (Ellenden)	45	31	36.5

Table 6-3: 53 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Relevant Sites at Different Wind Speeds Using Concawe Worst Case Noise Conditions G = 0.7.

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Criterion : Luckdale (G2)							
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*
Kullingrah (G03)	**36**	36	36	37	37	36	36
Gundry	15.5	15.5	15.5	16.5	16.5	15.5	15.5
Roth	27	27	27	28.5	28.5	27	27
Criterion : Euroka (G7)							
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*
Bernallah (G5)	31.5	31.5	31.5	32.5	32.5	31.5	31.5
Widgemore (G6)	29	29	29	30	30	29	29
Euroka (G7)	9	9	9	10	10.5	9	9
Criterion : Sunnybrook 1 (G8)							
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*
Sunnybrook 1 (G8)	19	19	19	20	20	19	19
Sunnybrook 2 (G9)	21	21	21	22.5	22.5	21	21
LaGranja (G10)	20.5	20.5	20.5	21.5	21.5	20.5	20.5
G11	15.5	15.5	15.5	16.5	16.5	15.5	15.5
Narine Green (G12)	20	20	20	21.5	21.5	20.5	20.5
G13	10	10	10	11	11.5	10	10
G14	15.5	15.5	15.5	16.5	16.5	15.5	15.5
G15	15	15	15	16.5	16.5	15.5	15.5
G17	13.5	13.5	13.5	14.5	14.5	13.5	13.5
Criterion: Torokina (G18)							
Criterion	*35*	*35*	*36*	*37*	*38*	*39*	*40*
Torokina (G18)	20	20	20	21	21.5	20	20
Criterion: L'Orizon (E2)							

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Criterion	*35*	*35*	*35*	*38*	*40*	*43*	*45*
L'Orizon (E2)	**41.5**	**41.5**	**41.5**	**42.5**	**42.5**	41.5	41.5
Criterion: Currandooley (H2)							
	35	*35*	*35*	*37*	*38*	*39*	*40*
Currandooley (H1)	31.5	31.5	31.5	32.5	32.5	31.5	31.5
Currandooley (H2)	31	31	31	32	32	31	31
E03	**41**	**41**	**41**	**42**	**42**	**41**	**41**
E05	34.5	34.5	34.5	35.5	35.5	34.5	34.5
E06	32.5	32.5	32.5	33.5	33.5	32.5	32.5
E07	35	35	35	36	36	35	35
Criterion: Wyoming (E1)							
	35	*35*	*35*	*36*	*37*	*39*	*40*
Wyoming (E1)	34.5	34.5	34.5	35.5	35.5	34.5	34.5

The predicted noise levels at most relevant receivers achieve the appropriate criteria at all wind speeds. Colour noise contour plots have been generated for the maximum power setting (at $8ms^{-1}$ wind speed for ISO9613 and CONCAWE wind propagation scenarios), covering the surrounding area. These are shown in Appendix G.

6.2. 57 Turbine Layout

A noise model was constructed for the original 53 WTG layout, as well as 4 additional WTGs. This layout is given in Appendix B.

The noise model was run for the maximum power (104.7 dB(A)) setting for all of the WTGs. The model was run with these sound power settings for neutral and wind-affected propagation conditions from 4 to 12 ms^{-1}.

Predicted L_{Aeq} noise levels (rounded to the nearest 0.5 dB(A)) have been determined for all non relevant and relevant receivers and are tabulated in Table 6-4 and Table 6-5 respectively for the worst case wind scenario at 8 ms^{-1}. The criterion level which would be applicable is also given in the table. The relevant World Health Organisation (WHO) guideline level of 45 dB(A) for unreasonable interference or sleep disturbance [Ref :[8]] is also given in the table.

Table 6-4: 57 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Non-Relevant Sites at $8ms^{-1}$ wind speed

Receiver	Criteria, dB(A)	ISO9613 Meteorological Conditions - 8m/s, dB(A)	CONCAWE Worst Case Meteorological Conditions 8m/s, dB(A)
G01 (Panhandle)	45	42	42
G02 (Luckdale)	45	41	41
G04 (Lakoona)	45	42.5	42
E04 (Ellenden)	45	31	36.5

Table 6-5: 57 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Relevant Sites at Different Wind Speeds Using Concawe Worst Case Noise Conditions G = 0.7.

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Criterion : Luckdale (G2)							
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*
Kullingrah (G03)	**39**	**39**	**39**	**40**	39.5	38.5	38.5
Gundry	15.5	15.5	15.5	16.5	16.5	15.5	15.5
Roth	27	27	27	28.5	28.5	27	27
Criterion : Euroka (G7)							
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*
Bernallah (G5)	31.5	31.5	31.5	32.5	32.5	31.5	31.5
Widgemore (G6)	29	29	29	30	30	29	29
Euroka (G7)	25	25	25	26	26	25	25
Criterion : Sunnybrook 1 (G8)							
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*
Sunnybrook 1 (G8)	23.5	23.5	23.5	24.5	24.5	23.5	23.5
Sunnybrook 2 (G9)	22	22	22	23	23	22	22
LaGranja (G10)	23	23	23	24	24	23	23
G11	22.5	22.5	22.5	23.5	23.5	22.5	22.5
Narine Green (G12)	24.5	24.5	24.5	25.5	25.5	24.5	24.5
G13	21	21	21	22	22	21	21
G14	22	22	22	23	23	22	22
G15	22	22	22	23	23	22	22
G16	19.5	19.5	19.5	20.5	20.5	19.5	19.5
G17	21	21	21	22	22	21	21
Criterion: Torokina (G18)							
Criterion	*35*	*35*	*36*	*37*	*38*	*39*	*40*
Torokina (G18)	21.5	21.5	21.5	22.5	23	21.5	21.5
Criterion: L'Orizon (E2)							
Criterion	*35*	*35*	*35*	*38*	*40*	*43*	*45*
L'Orizon (E2)	**41.5**	**41.5**	**41.5**	**42.5**	**42.5**	41.5	41.5
Criterion: Currandooley (H2)							
	35	*35*	*35*	*37*	*38*	*39*	*40*
Currandooley (H1)	31.5	31.5	31.5	32.5	32.5	31.5	31.5
Currandooley (H2)	31	31	31	32	32	31	31
E03	**41**	**41**	**41**	**42**	**42**	**41**	**41**
E05	34.5	34.5	34.5	35.5	35.5	34.5	34.5
E06	32.5	32.5	32.5	33.5	33.5	32.5	32.5
E07	35	35	35	36	36	35	35
Criterion: Wyoming (E1)							
	35	*35*	*35*	*36*	*37*	*39*	*40*
Wyoming (E1)	35.5	35.5	35.5	36.5	36	35	35

The predicted noise levels at most relevant receivers achieve the appropriate criteria at all wind speeds. Colour noise contour plots have been generated for the maximum power setting (at $8ms^{-1}$ wind speed for ISO9613 and CONCAWE wind propagation scenarios), covering the surrounding area. These are shown in Appendix G.

6.3. Model accuracy

We acknowledge that the 95% confidence level of the Concawe model used in the SoundPLAN programme under high propagation conditions may be in the order of ± 4 to 5 dB(A). However, we note the following issues and assumptions made in the use of the Concawe model for the noise assessment of the Capital Wind Farm II:

- In our experience, we have found that the Concawe model can over-predict sound pressure levels by up to approximately 3 to 4 dB(A) in some situations (compared to measurements).
- The WindPro software which would otherwise be used is oversimplistic, as it does not take into account ground absorption or the barrier effect of topographical features. The WiTuProp software is also simplistic and has been validated for nearby receivers less than 500m away; the algorithm often greatly underpredicts at distances greater than about 500m.
- The standard ISO9613 algorithm is also simplistic with limited accuracy; it should only be used to provide predictions in neutral (no wind) conditions, as we have done in this study.
- The Concawe algorithm model in combination with the capabilities of the recognised SoundPLAN software offer a far more accurate estimate of environmental noise levels and, importantly, provides estimated wind effects on noise propagation.
- In South Australia and elsewhere, the use of the Concawe model has been validated for its application to wind farms. Post-compliance data and information suggests that the model provides reasonably accurate (and slightly conservative) predictions of wind farm noise levels.
- The noise prediction model for the Capital Wind Farm II assumes a steady or uniform wind field; however, this does not happen in reality and therefore the real noise propagation from the installed turbine array is likely to be less than that modelled, and the model is therefore likely to be slightly conservative.
- For the above reasons, the Concawe model should incorporate enough built-in conservatism to account for any possible inaccuracies.

7. NOISE IMPACT ASSESSMENT

We note that the criteria are exceeded at sites G03, E02 and E03. We note however that these sites are non-relevant receivers for the CWFI project, and noise levels from the CWFI turbines may be higher and more dominant than from the CWFII turbines.

7.1. Cumulative Impacts

Capital I Wind Farm

We note that CWFI and Woodlawn wind farm is located to the East of the proposed CWFII. Cumulative impacts of the noise from all three adjacent wind farms are assessed in this section of the report.

7.1.1. 53 Turbine Layout

Table 7-1 and Table 7-2 provide a cumulative impact of CWFI, CWFII and Woodlawn Wind Farm turbines on the residences closest to CWFII with the 53 WTG layout.

Table 7-1: 53 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Non-Relevant Sites at 8ms^{-1} wind speed with the cumulative impact from Capital and Woodlawn wind farms

Receiver	Criteria, dB(A)	CONCAWE Worst Case Meteorological Conditions 8m/s, dB(A)
G01 (Panhandle)	45	43
G02 (Luckdale)	45	42.5
G04 (Lakoona)	45	42.5
E04 (Ellenden)	45	44.5

Table 7-2: 53 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Relevant Sites at 8ms^{-1} Wind Speeds with the influence of CWFI and Woodlawn Wind Farms

Relevant Receiver	Wind speed ms^{-1}						
	4	5	6	7	8	9	10
Criterion : Luckdale (G2)							
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*
Kullingrah (G03)**	**40.0**	**40.5**	**41.0**	**42.0**	**42.0**	**42.0**	42.0
Gundry	15.5	15.5	15.5	16.5	16.5	15.5	15.5
Roth	27	27	27	28.5	28.5	27	27
Criterion : Euroka (G7)							
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*
Bernallah (G5)	32.5	33.0	33.0	34.0	34.0	33.5	33.5
Widgemore (G6)	34.0	34.0	35.0	35.5	36.0	35.5	35.5
Euroka (G7)**	**40.0**	**40.5**	**42.0**	**42.0**	**42.5**	**43.0**	**43.0**
Criterion : Sunnybrook 1 (G8)							
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*
Sunnybrook 1 (G8)**	**36.0**	**36.5**	**38.0**	**38.0**	**38.5**	39.0	39.0
Sunnybrook 2 (G9)**	**37.0**	**37.5**	**39.0**	**39.0**	**39.5**	**40.0**	40.0
LaGranja (G10)	34.0	34.5	**36.0**	**36.5**	36.5	37.0	37.0
G11	32.5	33.0	34.5	34.5	35.0	35.5	35.5
Narine Green (G12)	32.5	33.0	34.0	34.5	35.0	35.0	35.0
G13	29.5	30.0	31.5	31.5	32.0	32.5	32.5
G14	30.0	30.5	32.0	32.0	32.5	33.0	33.0

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
G15	30.0	30.5	32.0	32.0	32.5	32.5	33.0
G17	29.5	30.5	32.0	32.0	32.5	32.5	32.5
Criterion: Torokina (G18)							
Criterion	*35*	*35*	*36*	*37*	*38*	*39*	*40*
Torokina (G18)	30.0	31.5	32.5	32.5	33.0	33.5	33.5
Criterion: L'Orizon (E2)							
Criterion	*35*	*35*	*35*	*38*	*40*	*43*	*45*
L'Orizon (E2)**	**56.0**	**56.5**	**57.0**	**57.5**	**58.0**	**58.0**	**58.0**
Criterion: Currandooley (H2)							
	35	*35*	*35*	*37*	*38*	*39*	*40*
Currandooley (H1)**	**35.5**	**36.5**	**37.0**	**37.5**	38.0	37.5	37.5
Currandooley (H2)**	**36.5**	**37.0**	**38.0**	**38.5**	**38.5**	39.0	39.0
E03**	**51.0**	**51.5**	**52.5**	**53.0**	**53.0**	**53.5**	**53.5**
E05**	**40.5**	**41.0**	**42.5**	**42.5**	**43.0**	**42.5**	**43.0**
E06**	**37.5**	**38.5**	**39.0**	**39.5**	**40.0**	**40.0**	40.0
E07**	**37.5**	**37.5**	**38.5**	**39.0**	**39.0**	39.0	39.0
Criterion: Wyoming (E1)							
	35	*35*	*35*	*36*	*37*	*39*	*40*
Wyoming (E1)**	**35.5**	**35.5**	**35.5**	**36.5**	36.5	36.0	36.0

** Denotes non relevant noise receivers for Capital I Wind Farm.

Noise associated with the CWFI and Woodlawn Wind Farm projects are to be assessed separately from the CWFII assessment, and is covered in the respective individual wind farm noise impact assessments ([5],[6]). We note that several receivers associated with the CWFI project (i.e. non-relevant receivers for CWFI) are non relevant receivers for the CWFII Project, and similarly for the Woodlawn wind farm project. The noise impact on these receivers (indicated by ** in Table 7-2) by CWFII is negligible as the noise levels at these receivers and G10 are dominated by CWFI (with the exception of E07). Any noise at these receivers due to the CWFI is to be treated as outlined in [5] and [6]. Therefore, all noise at most relevant receiver locations for both CWFI and CWFII meet the stipulated requirements. Sites where a noise agreement has been made (within the lease for CWFI), the allowable noise levels are not to exceed the WHO noise guidelines for sleep disturbance noise levels of 45dB(A) unless otherwise agreed within the lease (*"Guidelines for Community Noise"*, World Health Organization (WHO) Geneva, Switzerland, 1999). In light of this, we understand that the cumulative noise impact of both wind farms is within the stipulated criteria.

Combined noise predictions (from CWFI, CWFII and Woodlawn Wind Farm) at receiver G10 show that there is a marginal exceedance at wind speeds of 6 and $7ms^{-1}$. We note that the impact of CWFII on this receiver is much lower than CWFI (levels from CWFII are approximately 20 – 24dB(A), as opposed to 34-37dB(A) from CWFI), and the overall impact at this receiver from CWFII is negligible (approx 0.1 – 0.2dB). Any exceedance/marginal exceedance at this relevant receiver is to be treated as outlined in [5] and [6].

We note that the impact of the Woodlawn wind farm is negligible at most receivers, as this development is a large distance away from residences associated with CWFII. The residence with any noticeable impact from Woodlawn wind farm is G18, where the noise levels from Woodlawn wind farm range from 29dB(A) to 31dB(A). We note however that with these noise levels are combined with the predicted noise levels for CWFI and CWFII, are still under the relevant criteria for this site.

In addition, due to the locations and distances of the residences relative to the turbines, there is not likely to be any detectable or perceptible impact due to vibration, infrasound or low frequency noise during operation of the wind farm. Transmission line noise (due to corona or Aeolian noise) is not significant or annoying at moderate distances (distances greater than 100m) from the lines and is therefore not likely to be an issue at residences. The nearest residential receiver from overhead transmission wires is approximately 200m away, and therefore noise from the transmission wires will not be an issue.

7.1.2. 57 Turbine Layout

Table 7-3 and Table 7-4 provide a cumulative impact of both CWFI and CWFII turbines on the residences closest to CWFII with the 57 WTG layout.

Table 7-3: 57 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Non-Relevant Sites at 8ms^{-1} wind speed with the cumulative impact from Capital and Woodlawn wind farms

Receiver	Criteria, dB(A)	CONCAWE Worst Case Meteorological Conditions 8m/s, dB(A)
G01 (Panhandle)	45	44
G02 (Luckdale)	45	44.5
G04 (Lakoona)	45	42.5
E04 (Ellenden)	45	44.5

Table 7-4: 57 WTG Layout Predicted Noise Levels (L_{Aeq} dB(A)) for Relevant Sites at 8ms^{-1} Wind Speeds with the influence of CWFI and Woodlawn Wind Farms

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Criterion : Luckdale (G2)							
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*
Kullingrah (G03)**	**41.5**	**42.0**	**42.5**	**43.0**	**43.0**	**42.5**	42.5
Gundry	15.5	15.5	15.5	16.5	16.5	15.5	15.5
Roth	27	27	27	28.5	28.5	27	27
Criterion : Euroka (G7)							
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*
Bernallah (G5)	32.5	33.0	33.0	34.0	34.0	33.5	33.5
Widgemore (G6)	34.0	34.0	35.0	35.5	36.0	35.5	35.5
Euroka (G7)**	**40.0**	**40.5**	**42.0**	**42.0**	**42.5**	**43.0**	**43.0**
Criterion : Sunnybrook 1 (G8)							
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*
Sunnybrook 1 (G8)**	**36.0**	**36.5**	**38.0**	**38.0**	**38.5**	39.0	39.0
Sunnybrook 2 (G9)**	**37.0**	**37.5**	**39.0**	**39.0**	**39.5**	**40.0**	40.0
LaGranja (G10)	34.5	35.0	**36.0**	**36.5**	36.5	37.0	37.0
G11	33.0	33.5	35.0	35.0	35.5	35.5	35.5
Narine Green (G12)	32.5	33.5	34.5	35.0	35.5	35.5	35.5
G13	30.0	30.5	32.0	32.0	32.5	33.0	33.0
G14	30.5	31.0	32.5	32.5	33.0	33.5	33.5
G15	30.5	31.0	32.5	32.5	33.0	33.0	33.5
G16	30	30.5	32.0	32.0	32.5	32.5	32.5
G17	30.0	31.0	32.5	32.5	33.0	33.0	33.0
Criterion: Torokina (G18)							
Criterion	*35*	*35*	*36*	*37*	*38*	*39*	*40*
Torokina (G18)	30.5	31.5	32.5	33	33.5	33.5	33.5
Criterion: L'Orizon (E2)							
Criterion	*35*	*35*	*35*	*38*	*40*	*43*	*45*
L'Orizon (E2)**	**56.0**	**56.5**	**57.0**	**57.5**	**58.0**	**58.0**	**58.0**
Criterion: Currandooley (H2)							
	35	*35*	*35*	*37*	*38*	*39*	*40*
Currandooley (H1)**	**35.5**	**36.5**	**37.0**	**37.5**	38.0	37.5	37.5

Relevant Receiver	Wind speed ms^{-1}						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Currandooley (H2)**	**36.5**	**37.0**	**38.0**	**38.5**	**38.5**	39.0	39.0
E03**	**51.0**	**51.5**	**52.5**	**53.0**	**53.0**	**53.5**	**53.5**
E05**	**40.5**	**41.0**	**42.5**	**42.5**	**43.0**	**42.5**	**43.0**
E06**	**37.5**	**38.5**	**39.0**	**39.5**	**40.0**	**40.0**	40.0
E07**	**37.5**	**37.5**	**38.5**	**39.0**	**39.0**	39.0	39.0
Criterion: Wyoming (E1)							
	35	*35*	*35*	*36*	*37*	*39*	*40*
Wyoming (E1)**	**36.0**	**36.0**	**36.5**	**37.5**	37.0	36.0	36.5

** Denotes non relevant noise receivers for CWFI.

Noise associated with the CWFI and Woodlawn Wind Farm projects are to be assessed separately from the CWFII assessment, and is covered in the respective individual wind farm noise impact assessments ([5],[6]). We note that several receivers associated with the CWFI project (i.e. non-relevant receivers for CWFI) are non relevant receivers for the CWFII Project, and similarly for the Woodlawn wind farm project. The noise impact on these receivers (indicated by ** in Table 7-2) by CWFII is negligible as the noise levels at these receivers and G10 are dominated by CWFI (with the exception of E07). Any noise at these receivers due to the CWFI is to be treated as outlined in [5] and [6]. Therefore, all noise at most relevant receiver locations for both CWFI and CWFII meet the stipulated requirements. Sites where a noise agreement has been made (within the lease for CWFI), the allowable noise levels are not to exceed the WHO noise guidelines for sleep disturbance noise levels of 45dB(A) unless otherwise agreed within the lease (*"Guidelines for Community Noise"*, World Health Organization (WHO), Geneva, Switzerland, 1999). In light of this, we understand that the cumulative noise impact of both wind farms is within the stipulated criteria.
Combined noise predictions (from CWFI, CWFII and Woodlawn Wind Farm) at receiver G10 show that there is a marginal exceedance at wind speeds of 6 and $7ms^{-1}$. We note that the impact of CWFII on this receiver is much lower than CWFI (levels from CWFII are approximately 20 – 24dB(A), as opposed to 34-37dB(A) from CWFI), and the overall impact at this receiver from CWFII is negligible (approx 0.1 – 0.2dB). Any exceedance/marginal exceedance at this relevant receiver is to be treated as outlined in [5] and [6].
We note that the impact of the Woodlawn wind farm is negligible at most receivers, as this development is a large distance away from residences associated with CWFII. The residence with any noticeable impact from Woodlawn wind farm is G18 (and small 0.5dB impact at G16), where the noise levels from Woodlawn wind farm range from 29dB(A) to 31dB(A). We note however that with these noise levels are combined with the predicted noise levels for CWFI and CWFII, are still under the relevant criteria for this site.

Mitigation measures are therefore not required for the criteria to be met. As a contingency measure, if levels higher than those predicted eventuate, then mitigation could be easily applied in the form of modifying sound power levels by de-rating the turbines or applying wind sector management to a subset of the turbines.

In addition, due to the locations and distances of the residences relative to the turbines, there is not likely to be any detectable or perceptible impact due to vibration, infrasound or low frequency noise during operation of the wind farm. Transmission line noise (due to corona or Aeolian noise) is not significant or annoying at moderate distances (distances greater than 100m) from the lines and is therefore not likely to be an issue at residences. The nearest residential receiver from overhead transmission wires is approximately 200m away, and therefore noise from the transmission wires will not be an issue.

7.2. Substation Noise

The proposed modifications to the project avoid the installation of the substation and the associated 66kV overhead line for grid connection. Therefore no new transformers will be implemented for the CWFII project and instead it is proposed that grid connection is via the existing 33kV/330kV CWFI substation and Woodlawn substation that would be augmented for this purpose. Note that these substations and transformers have been previously assessed and accepted by the DoP for the other projects.

The existing 33kV/330kV Capital Wind Farm I substation has two 33kV/330kV transformers rated at 80MVA, with the addition of one extra 33kV/330kV transformer rated at 180MVA for the nearby Woodlawn Wind Farm (which would accommodate the load from CWFII). By installing an additional 33kV/330kV transformer at this location together with various 33kV items and a 33kV overhead line between the CWFII and the CWFI substation it is possible to export the CWFII power via the existing 330kV TransGrid switchyard within the CWFI substation. This assessment reviews the cumulative noise impact of the existing CWFI substation augmented with an additional transformer at Woodlawn WF.

The two existing 33kV/330kV (80MVA) transformers at CWFI are indicated to have sound power levels of 92.6 dB(A), and the additional potential 33kV/330kV (180MVA) transformer at Woodlawn WF is to have a conservative sound power level of 100dB(A). Based on these figures a combined conservative sound power level of 101dB(A) is expected for the two augmented substations. However, note that no additional substation noise will be generated as part of the CWFII project.

The Capital Wind Farm substation is about 1,200 metres from the nearest residential receivers (relevant receivers H26& H27, located south east of the project). To date no complaints have been received from these closest neighbours in respect of noise from the operating substation. Review of potential noise levels at the closest receivers following augmentation of the substation (based on the conservative 101dB(A) sound power level) indicates that the predicted noise level from the substation at the receivers is likely to be about 32dB(A) (similar to worst case wind turbine levels) and up to 33 to 34 dB(A) in certain meteorological conditions. The combined noise level of the substation and wind turbines at the receiver locations is estimated to be less than 35dB(A). Also, the maximum loading and noise generation from the substation will occur during periods of strong winds and associated high background noise.

Due to the distance between the substation and the receivers the 100Hz frequency component of transformer noise is not expected to be significant at the receiver locations.

7.3. Construction Noise

We note that the assessment of noise from construction of the wind turbines and roads etc for associated infrastructure is not governed by the Environmental Noise Guidelines : Wind Farms; rather, the guidelines laid out in the NSW DECC's Interim Construction Noise Guideline are applicable to construction noise.

The NSW DECC Construction Noise Guideline provides the following noise criteria :

Construction period	Criterion dB(A)
Within Acceptable Construction Hours	$L_{A10,15min}$ <= background L_{A90} + 10
Outside Acceptable Construction Hours	$L_{A10,15min}$ <= background L_{A90} + 5

Table 7-5: Construction noise criteria

Acceptable construction hours are defined below:

Day	Acceptable construction times
Monday to Friday	7:00 am to 6:00pm
Saturday	8:00 am to 1:00pm

Table 7-6: **Construction time restrictions**

The construction programme is likely to occur over an 8 month period. Due to the distributed nature of the development, noise impacts at turbine sites will progress across the wind farm site. Therefore, the extent of construction in any one area is likely to be less than 6 months (and the erection time for individual turbines being only a matter of days).

With all construction activities occurring on weekdays and only during normal working hours, the potential for sleep disturbance to occur is reduced, and the evening and night time amenity of residents in the vicinity of the construction activities being unaffected by those activities.

Regarding the impact of traffic noise, we anticipate that existing roads will be utilised as far as possible, minimising the time and cost of constructing additional infrastructure and reducing the impact of temporary road construction on residential locations. The short-term increase in heavy vehicle movement may be noticeable to residences along the existing roads utilised during construction. The number of Concrete Mixer Truck movements on local roads will be lower with the use of an on-site Batching Plant.

Construction activities will include: site preparation/establishment, earthworks/excavation, foundation works and structural/construction works. The following table provides indicative short-term noise levels which may be experienced at varying distances from typical items of equipment used for construction activities:

Predicted Typical Construction Noise Levels dB(A)				
Equipment	**Distance from equipment**			
	500m	**1000m**	**1500m**	**2000m**
Compactor	45-52	38-45	33-40	29-36
Concrete mixer truck	35-44	28-37	23-32	<30
Concrete pump	<30	<30	<30	<30
Crane	46-50	39-41	34-36	30-32
Batching Plant	42-46	35-39	30-34	26-30
Crushing Plant	45-52	38-45	33-40	29-36
Front End Loader/Dozer	46-50	39-41	34-36	30-32
Excavator	42-46	35-39	30-34	26-30
Grader	42-46	35-39	30-34	26-30
Piling	44-49	37-42	32-37	28-33
Roller	<30	<30	<30	<30

Table 7-7: Predicted Typical Construction Noise Levels dB(A)

The following average day time background (L_{A90}) noise levels were measured during the noise monitoring period of the CWFI project, with the corresponding criteria:

Construction Noise Criteria				
Location		**Average Background Noise Level L_{A90} dB(A)**	**Construction Noise Criterion Level L_{A10} dB(A)**	**Average Daytime Ambient Noise Level L_{Aeq} dB(A)**
G2	Luckdale	36	46	48
G7	Euroka	32	42	50
G8	Sunnybrook1	31	41	43
E2	L'Orizon	31	41	43
H2	Currandooley	31	41	41
E1	Wyoming	32	42	42

Table 7-8: Construction Noise Criterion Levels dB(A)

As distances from the nearest turbine to each residence are mostly above 1000m (2 non-relevant residences are 970m away from the nearest construction activities, and the nearest relevant receiver is 1.2km from the nearest construction activities), the noise criteria for construction noise is likely to be achieved at most residences, with those at distances less than approximately 1000m of the construction activities being exposed to short term noise levels which may exceed this criterion.

Where multiple plant is likely to be used, we have assumed the following scenarios with their total conservative expected noise levels given in Table 7-9.

Construction Type	Units Used / Activities	Maximum Expected Noise Levels (dB(A))	
		Non-Relevant (1km)	Relevant (1.2km)
WTG Erection	Crane, Concrete Truck, Front End Loader	45dB(A)	41dB(A)
Road Preparation	Grader, Roller, Compactor	46dB(A)	43dB(A)
WTG foundation preparation	Excavator, Piling	43dB(A)	41dB(A)

Table 7-9: Expected Worst Case Noise Levels From Construction Activities

With Table 7-9 in mind, the non-relevant receivers will have noise from construction activities meet or slightly exceed the noise criteria by up to approximately 1dB, and the likely number of non-relevant residences affected by construction noise (non-relevant residences less than 1.5km) would be approximately 4. Non-relevant receivers G01 and G02 will experience construction noise of up to approximately 46dB(A) (1km away from construction activities), which meets the construction noise criteria of 46dB(A) outlined in Table 7-8 for this residence. Construction noise levels for non-relevant receiver G04 will meet the selected criteria of 46dB(A), and the construction noise levels fro non-relevant receiver E04 will be met (below 40dB(A)).

Additionally, there is to be some resource extraction activities at the gravel pit sites at the north west of the site. This site is approximately 1.6km away from the nearest residential receiver (relevant receiver G03). Measurements from previous projects have indicated that the approximate sound power levels from a gravel pit (mobile crusher and screen) of 114db(A). Therefore the predicted sound pressure levels at the nearest non-relevant receiver (1600m away) from the gravel pit operations are predicted to be approximately 39dB(A), and within the construction noise criteria.

However, as the construction of either the appropriate infrastructure or the turbines themselves are not confined to a single location for any significant length of time, the actual exposure of any given residence to any construction noise is only for a limited time period (possibly as short as a few weeks depending on construction activity).

We note also that construction noise levels at residences in the vicinity of the proposed Capital Wind Farm are likely to be within the general rise-and-fall of ambient noise levels experienced at the residences.

Vibration levels generated from construction machinery (including vibration from construction traffic movements) are likely to be below the threshold of detection, and therefore minimal, at residences. Given the locations and distances of the residences there are not likely to be any vibration sensitive receivers. Blasting activities are not likely to occur during construction at this site and any piling activities may cause some noticeable short-term or distant low frequency noise events.

Therefore, construction noise and vibration is not anticipated to cause significant detrimental effect to the amenity of the residences in the vicinity of the wind farm during construction.

We note that it is not uncommon for exemption from environmental noise policies to be sought, and granted, for construction noise, however this should not be viewed as an evasion of responsibility to minimise the acoustic impact of construction activities.

7.4. Discussion of results

Predicted noise levels have been assessed against the criteria described in section 3, viz. the SA EPA *Environmental Noise Guidelines – Wind Farms* [1].

Due to the absence of any published noise characteristics (such as tonality, impulsiveness, modulation or low frequency components) in the potential selection of WTGs (e.g. Suzlon or Sinovel), no penalty adjustments are required to be applied to the predicted levels.

The predicted L_{Aeq} noise levels, for worst case wind conditions range up to 36 dB(A), at the relevant receivers and at two locations up to 42dB(A) (sites E02 and E03, which are non-relevant receivers for CWI). These predicted levels at maximum WTG power setting achieve the appropriate criteria for all relevant receivers, where noise from the CWFII turbines are dominant (i.e. significantly louder than CWFI turbines).

The cumulative impact of Stages I and II of the wind farm meet the selected criteria where CWFII turbines are dominant (or meet the WHO noise guidelines for sleep disturbance at the sites with noise agreements).

Mitigation measures are therefore not required for the criteria to be met. As a contingency measure, if levels higher than those predicted eventuate, then mitigation could be easily applied in the form of modifying sound power levels by de-rating the turbines or applying wind sector management to a subset of the turbines.

APPENDIX A GLOSSARY OF ACOUSTIC TERMINOLOGY

dB(A) A unit of measurement, decibels(A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.

L_{10} The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and is used in Australia as the descriptor for intrusive noise [usually in dB(A)]. Nominal measurement period is usually 15 minutes.

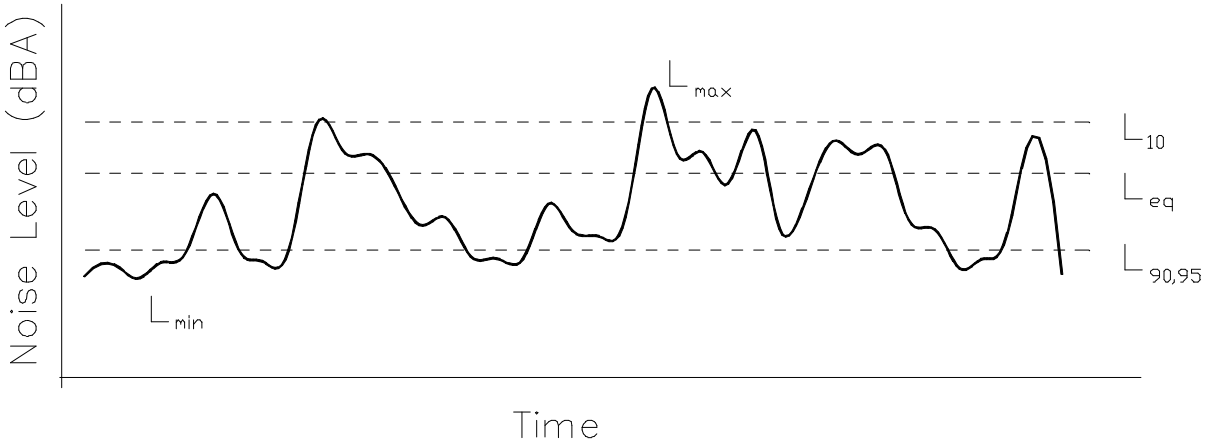
L_{90} The noise level which is equalled or exceeded for 90% of the measurement period. L_{90} or L_{95} is an indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise [usually in dB(A)].

L_{eq} The equivalent continuous noise level for the measurement period, weighted for duration and intensity. L_{eq} is an indicator of the average noise level [in dB(A)].

L_{max} The maximum noise level for the measurement period [usually in dB(A)].

L_{peak} The maximum numerical noise level, usually unweighted, attained during the measurement period [usually in dB(Z), or formerly as dB(lin)].

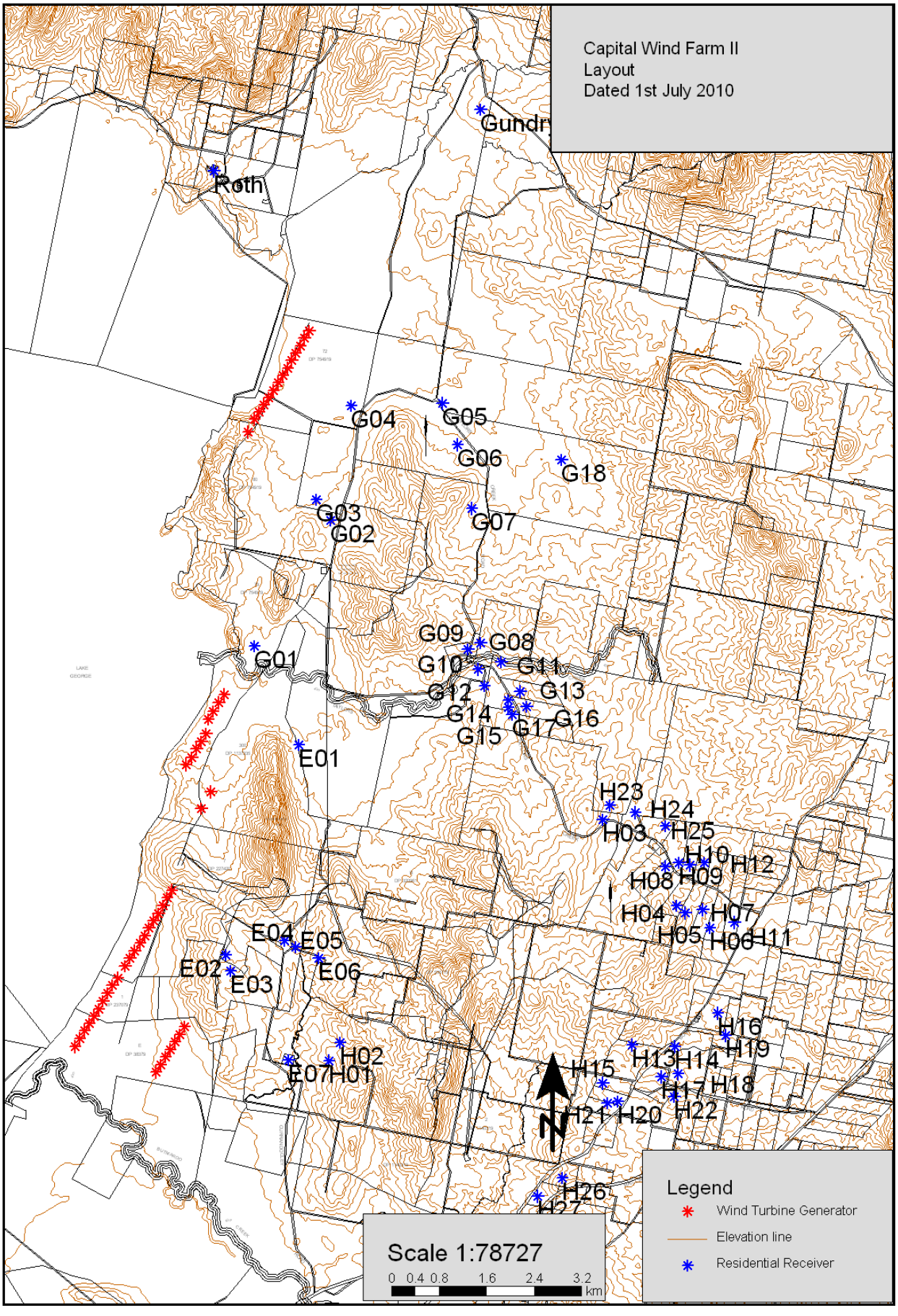
SEL The single event Sound Exposure Level is the equivalent A-weighted sound level which, if it lasted for one second, would produce the same sound energy as the actual event [in dB(A)].

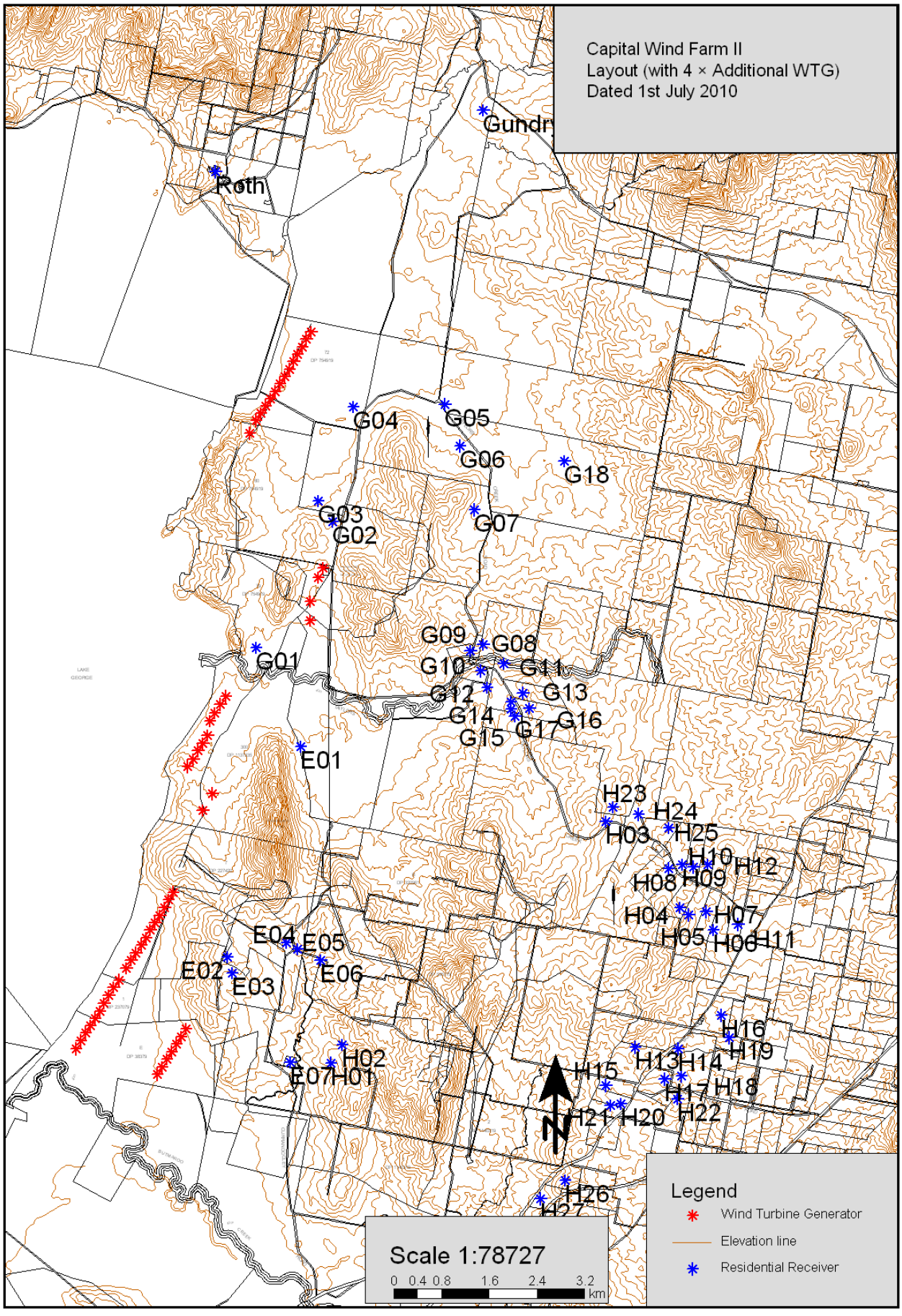


Note: *The subjective response or reaction to changes in noise levels can be described as follows:*

A 3 dB(A) change in sound pressure level is just perceptible to the average human ear; a 5 dB(A) increase is quite noticeable and a 10 dB(A) increase is typically perceived as a doubling in loudness.

APPENDIX B LAYOUT MAP OF CAPITAL II WIND FARM


Capital Wind Farm II
Layout
Dated 1st July 2010
Gundr
Roth
G04
G05
G06
G18
G03
G02
G07
G09
G08
G01
G10
G11
G12
G13
G14
G16
G15
G17
E01
H23
H24
H03
H25
H10
H12
H08
H09
H04
H07
H05
H06
H11
E04
E05
E02
E03
E06
H16
H19
H02
H13
H14
E07
H01
H15
H18
H17
H21
H20
H22
N
H26
Legend
Wind Turbine Generator
Elevation line
Residential Receiver
Scale 1:78727
0 0.4 0.8 1.6 2.4 3.2
km


Capital Wind Farm II
Layout (with 4 × Additional WTG)
Dated 1st July 2010
Roth
G04
G05
G06
G18
G03
G02
G07
G09
G08
G01
G10
G11
G12
G13
G14
G17
G16
G15
E01
H23
H24
H03
H25
H10
H12
H08
H09
H04
H07
H05
H06
H11
E04
E05
E02
E03
E06
H16
H19
H02
H13
H14
H15
E07
H01
H17
H18
H21
H20
H22
N
H26
H27
Legend
Wind Turbine Generator
Elevation line
Residential Receiver
Scale 1:78727
0 0.4 0.8 1.6 2.4 3.2
km

APPENDIX C LIST AND DETAILS OF RESIDENTIAL PREMISES NEAR WIND FARM.

Name	Easting	Northing	Dist. to nearest (CWFII) WTG (m)	Wind Farmer	
				CWFI	CWFII
E01 - M Osborne	726923	6110147	1516	Yes	No
E02 - L'Orizon A	725687	6106628	1329	Yes	No
E03 - L'Orizon B	725775	6106368	1219	Yes	No
E04 - Ellenden A	726684	6106871	2077	No	Yes
E05 - Ellenden B	726866	6106771	2285	Yes	No
E06 - vacant	727251	6106575	2528	Yes	No
E07	726745	6104869	1835	Yes	No
G01 - Panhandle	726179	6111808	961	No	Yes
G02 - Luckdale	727456	6113915	966	No	Yes
G03 - Kalingrah	727214	6114255	1274	Yes	No
G04 - Lakoona	727801	6115830	1243	No	Yes
G05	729334	6115863	2549	No	No
G06 - Widgemore	729586	6115177	3114	No	No
G07 - Euroka	729830	6114114	2855	Yes	No
G08 - Sunnybrook 1	729977	6111854	2917	Yes	No
G09 - Sunnybrook 2	729758	6111751	2718	Yes	No
G10 - LaGranja	729938	6111422	2969	No	No
G11	730320	6111533	3312	No	No
G12 - Narine Green	730039	6111135	3156	No	No
G13	730635	6111045	3747	No	No
G14	730435	6110892	3613	No	No
G15	730442	6110783	3662	No	No
G17	730502	6110650	3771	No	No
G18 - Torokina	731337	6114923	4562	No	No
Gundry	729968	6120792	4693	No	No
H01 - Currandooley	727431	6104865	2497	Yes	No
H02 - Currandooley	727611	6105163	2627	Yes	No
Roth	725495	6119759	3118	No	No

APPENDIX D LIST AND DETAILS OF PROPOSED WIND TURBINE GENERATORS

Proposed Wind Turbine Generators (WTGs)		
WTG No.	**Easting**	**Northing**
E01	727094	6117082
E02	727019	6116956
E03	726947	6116831
E04	726873	6116706
E05	726800	6116583
E06	726729	6116460
E07	726650	6116338
E08	726576	6116213
E09	726494	6116088
E10	726415	6115969
E11	726339	6115848
E12	726258	6115724
E13	726177	6115603
E14	726072	6115386
E15	725666	6110996
E16	725573	6110854
E17	725486	6110716
E18	725404	6110577
E19	725366	6110339
E20	725279	6110210
E21	725203	6110080
E22	725115	6109943
E23	725029	6109815
E24	725445	6109360
E25	724998	6105429
E26	725284	6109081
E27	724783	6107709
E28	724708	6107585
E29	724636	6107458
E30	724558	6107329
E31	724481	6107205
E32	724405	6107080
E33	724332	6106952
E34	724251	6106827
E35	724167	6106701
E36	724086	6106580
E37	724003	6106448
E38	723878	6106246
E39	723794	6106118
E40	723706	6105986
E41	723626	6105856
E42	723558	6105722
E43	723479	6105603
E44	723395	6105482
E45	723319	6105358
E46	723243	6105232
E47	723164	6105104
E48	724920	6105301

Proposed Wind Turbine Generators (WTGs)		
WTG No.	**Easting**	**Northing**
E49	724838	6105174
E50	724763	6105048
E51	724683	6104923
E52	724606	6104794
E53	724525	6104667
Additional WTGs		
ADD1	727205	6112982
ADD2	727209	6112982
ADD3	727087	6112252
ADD4	727085	6112581

APPENDIX E SOUND POWER SPECTRUM OF THE SUZLON S88 2.1MW WTG IN L_{AEQ} THIRD OCTAVE BANDS, MEASURED AT REFERENCE WIND SPEED OF 8MS^{-1} AT 10MAGL

Sound Power Levels - WTG and Estimated Standard Conditions

WTG:	S88/2100	Rated Power:	2100kW	Generator:	Single Generator
Hub Height (m):	80	Power Control:	Pitch	Blade:	AE43
Rotor Diameter (m):	88	Number of Rotor Blades:	3 (upwind)		
Air Density (kg/m³):	1.225	Tower Type:	Tubular steel		
Est. Wind Shear:	0.16	Rated RPM:	15.6		

Hub Height Wind Speed (m/s)	4.2	5.6	7.0	8.4	9.8	11.2	12.6	13.9	15.3	16.7
10m AGL Wind Speed (m/s)	3	4	5	6	7	8	9	10	11	12
A-Weighted Sound Power Level (dBA)	103.4	104.1	104.7	105.2	105.6	105.9	106.1	106.2	106.2	106.1

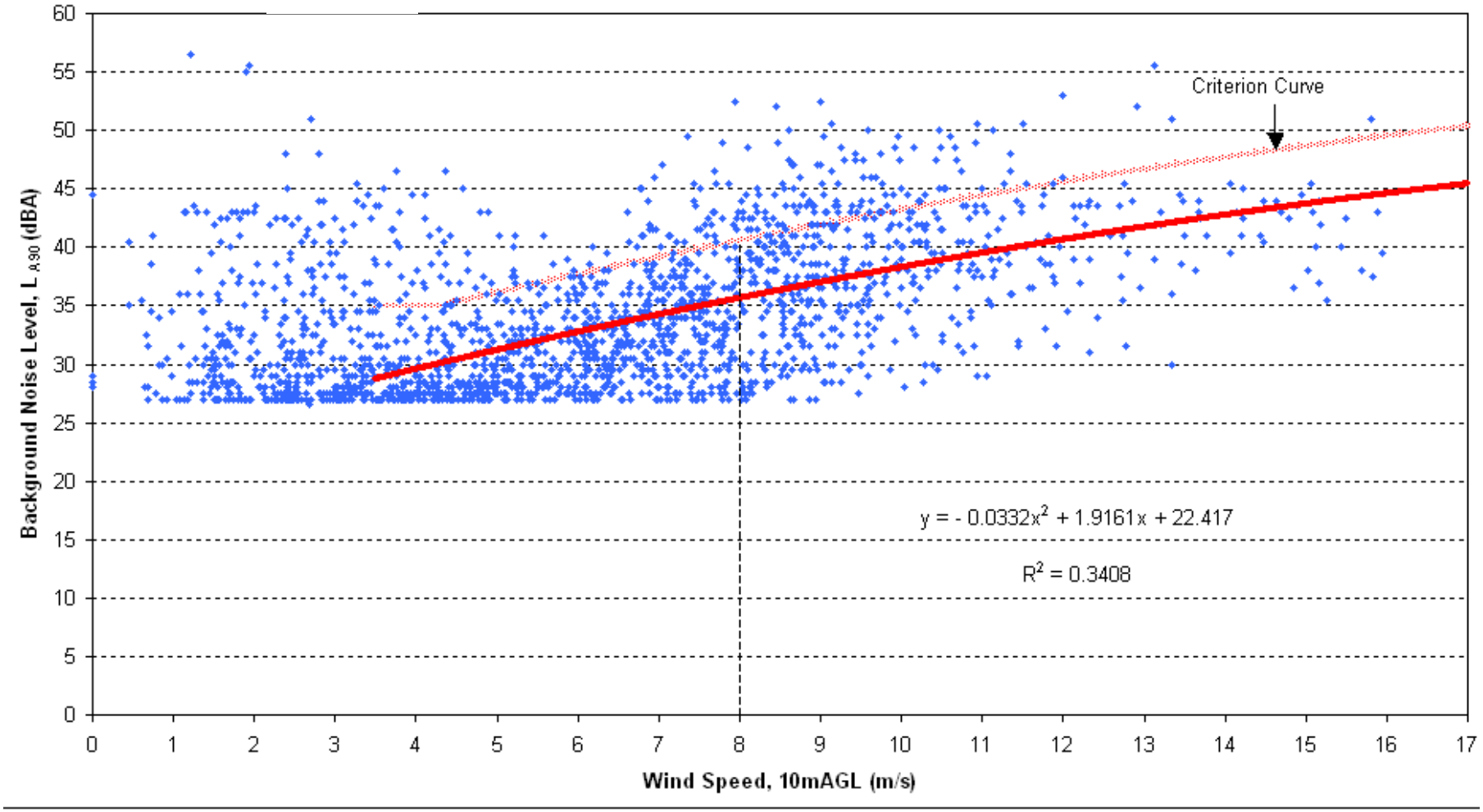
1/3 Octave Band Data - A-Weighted Sound Power Level (dBA)										
	10m agl Wind Speed (m/s)									
Freq (Hz) Bin	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
16	59.3	60.1	61.4	61.3	62.0	61.3	61.5	61.6	61.6	61.5
20	59.4	60.1	61.4	61.3	62.0	61.2	61.4	61.5	61.5	61.4
25	62.8	63.5	65.0	64.8	65.2	64.8	65.0	65.1	65.1	65.0
31.5	66.2	66.9	68.6	68.3	68.4	68.5	68.7	68.8	68.8	68.7
40	72.1	72.8	73.9	74.5	73.6	74.0	74.2	74.3	74.3	74.2
50	74.2	74.9	72.2	76.6	74.1	75.3	75.5	75.6	75.6	75.5
63	75.3	76.0	76.3	77.7	75.9	75.5	75.7	75.8	75.8	75.7
80	77.6	78.3	80.3	81.5	81.0	81.3	81.5	81.6	81.6	81.5
100	81.7	82.4	83.9	86.2	84.8	85.4	85.6	85.7	85.7	85.6
125	83.6	84.3	85.8	87.5	87.5	88.1	88.3	88.4	88.4	88.3
160	85.5	86.2	87.8	88.9	90.3	90.9	91.1	91.2	91.2	91.1
200	87.9	88.6	90.5	92.3	93.7	94.3	94.5	94.6	94.6	94.5
250	90.2	90.9	92.5	94.0	94.9	95.6	95.8	95.9	95.9	95.8
315	92.1	92.8	93.8	95.6	96.3	97.0	97.2	97.3	97.3	97.2
400	93.0	93.7	94.6	96.2	96.5	97.1	97.3	97.4	97.4	97.3
500	93.5	94.2	94.8	96.4	96.4	96.8	96.8	96.9	96.9	96.8
630	94.4	95.1	95.5	96.4	96.0	95.9	96.1	96.2	96.2	96.1
800	94.4	95.1	95.0	95.3	94.4	94.2	94.4	94.5	94.5	94.4
1000	94.8	95.3	95.2	95.7	94.4	94.3	94.5	94.6	94.6	94.5
1250	93.6	94.3	94.2	92.7	93.1	93.8	93.8	93.9	93.9	93.8
1600	91.7	92.4	93.0	87.3	93.1	93.7	93.9	94.0	94.0	93.9
2000	88.6	89.3	90.7	84.9	90.6	90.6	90.8	90.9	90.9	90.8
2500	84.5	85.2	86.7	83.9	87.4	87.6	87.8	87.9	87.9	87.8
3150	80.2	80.9	82.9	79.4	83.7	84.4	84.6	84.7	84.7	84.6
4000	74.7	75.4	81.8	77.7	78.0	79.8	80.0	80.1	80.1	80.0
5000	71.8	72.5	78.4	75.1	75.5	75.9	76.1	76.2	76.2	76.1
6300	66.7	67.4	74.2	70.5	72.2	72.1	72.3	72.4	72.4	72.3
8000	63.0	63.7	68.8	66.3	68.7	68.5	68.7	68.8	68.8	68.7
10000	57.0	57.7	63.8	61.8	66.5	65.6	65.8	65.9	65.9	65.8
12500	52.9	53.6	56.0	57.1	62.9	62.1	62.3	62.4	62.4	62.3
16000	49.9	50.6	51.8	52.6	55.0	54.2	54.4	54.5	54.5	54.4
20000	47.4	48.1	48.5	48.9	48.7	48.7	48.9	49.0	49.0	48.9

1 Octave Band Data - A-Weighted Sound Power Level (dBA)										
	10m agl Wind Speed (m/s)									
Freq (Hz) Bin	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
62.5	81.5	82.2	83.1	84.6	83.6	83.8	84.0	84.1	84.1	84.0
125	88.6	89.3	90.9	92.4	92.9	93.5	93.7	93.8	93.8	93.7
250	95.2	95.9	97.2	98.9	99.9	100.5	100.7	100.8	100.8	100.7
500	98.4	99.1	99.8	101.1	101.1	101.3	101.5	101.6	101.6	101.5
1000	99.0	99.7	99.6	99.5	98.8	98.8	99.0	99.1	99.1	99.0
2000	94.0	94.7	95.6	90.4	95.7	98.1	98.3	98.4	98.4	98.3
4000	81.7	82.4	86.7	82.5	85.2	86.1	86.3	86.4	86.4	86.3
8000	66.8	69.5	75.7	72.5	74.9	74.8	74.8	74.9	74.9	74.8

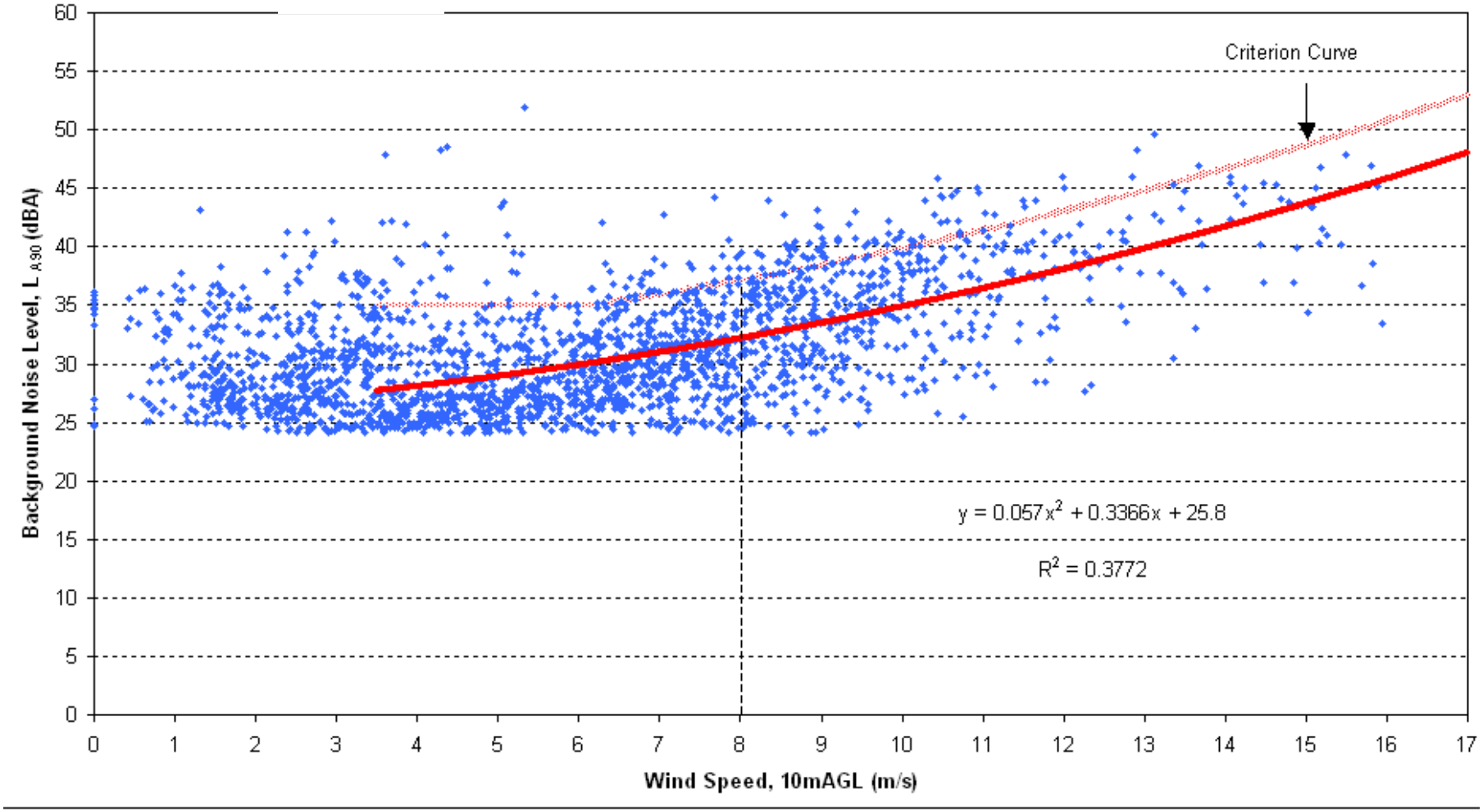
Sound Power Data: Commercial Warranty Value at 12/7/2005. Calculated from initial S88 noise measurements.
Test conditions -wind shear coeff. estimate of 0.16, standard air density, 10% site turbulence, Clean Blades, No Ice/Snow on blades,
No Damage to Leading Edge, Terrain to IEC 61400-12, Inflow Angle: 0+/-2 Deg. Should site conditions vary substantially
from these values the actual sound power level output may also vary.

APPENDIX F CWFI BACKGROUND NOISE MONITORING MEASUREMENTS

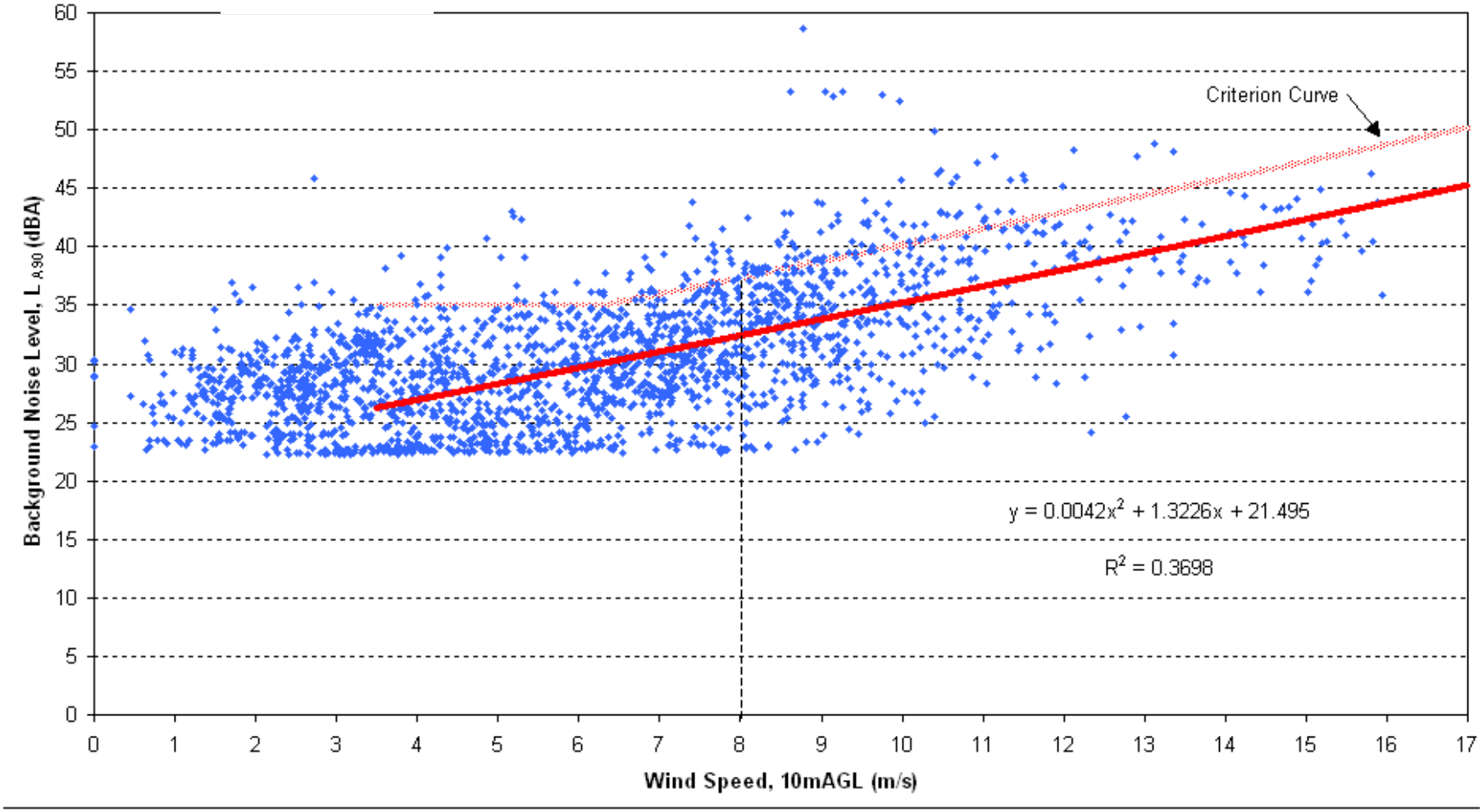
G2 : Background Noise at Receiver vs Wind Speed at Windfarm



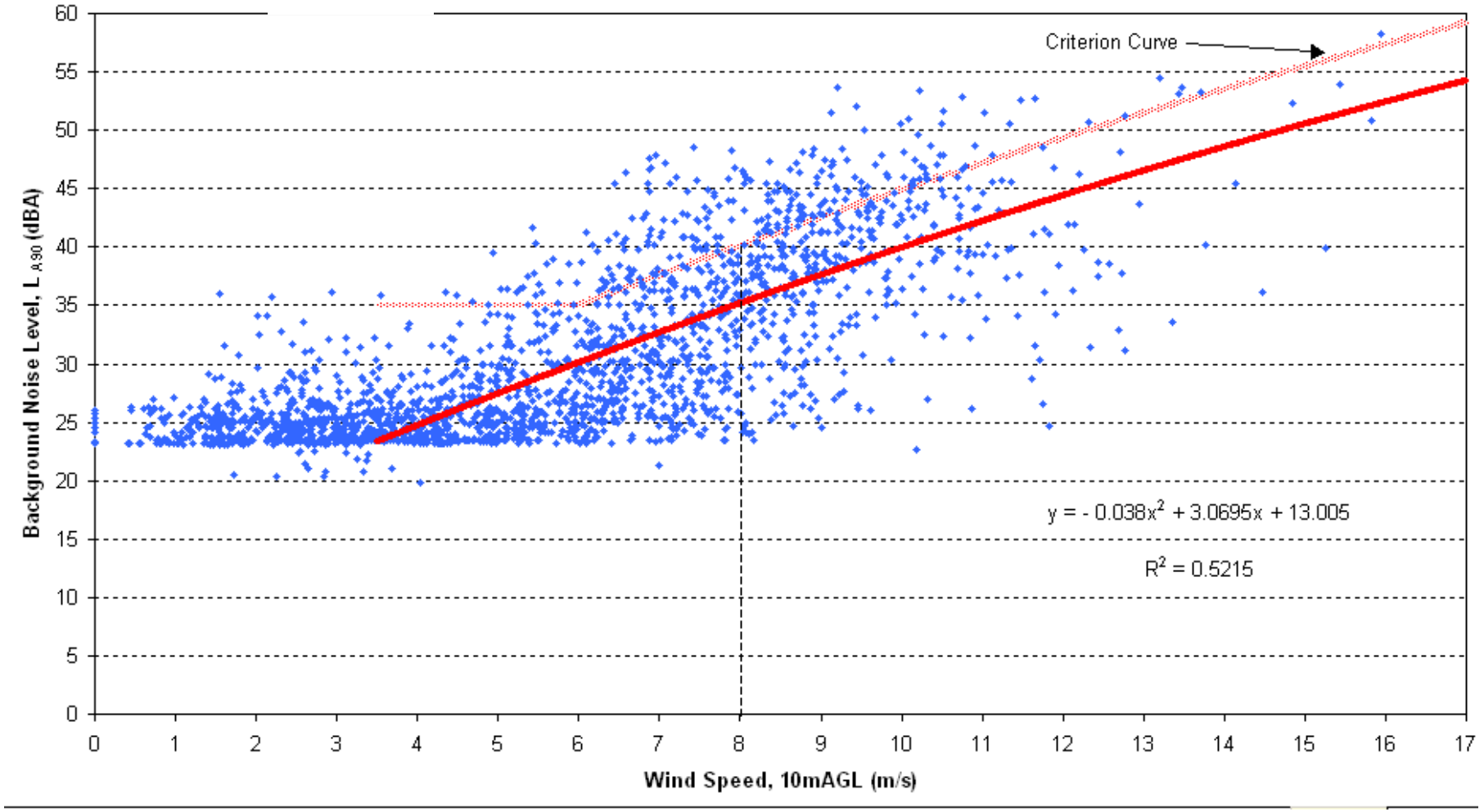
G7 Background Noise at Receiver vs Wind Speed at Windfarm



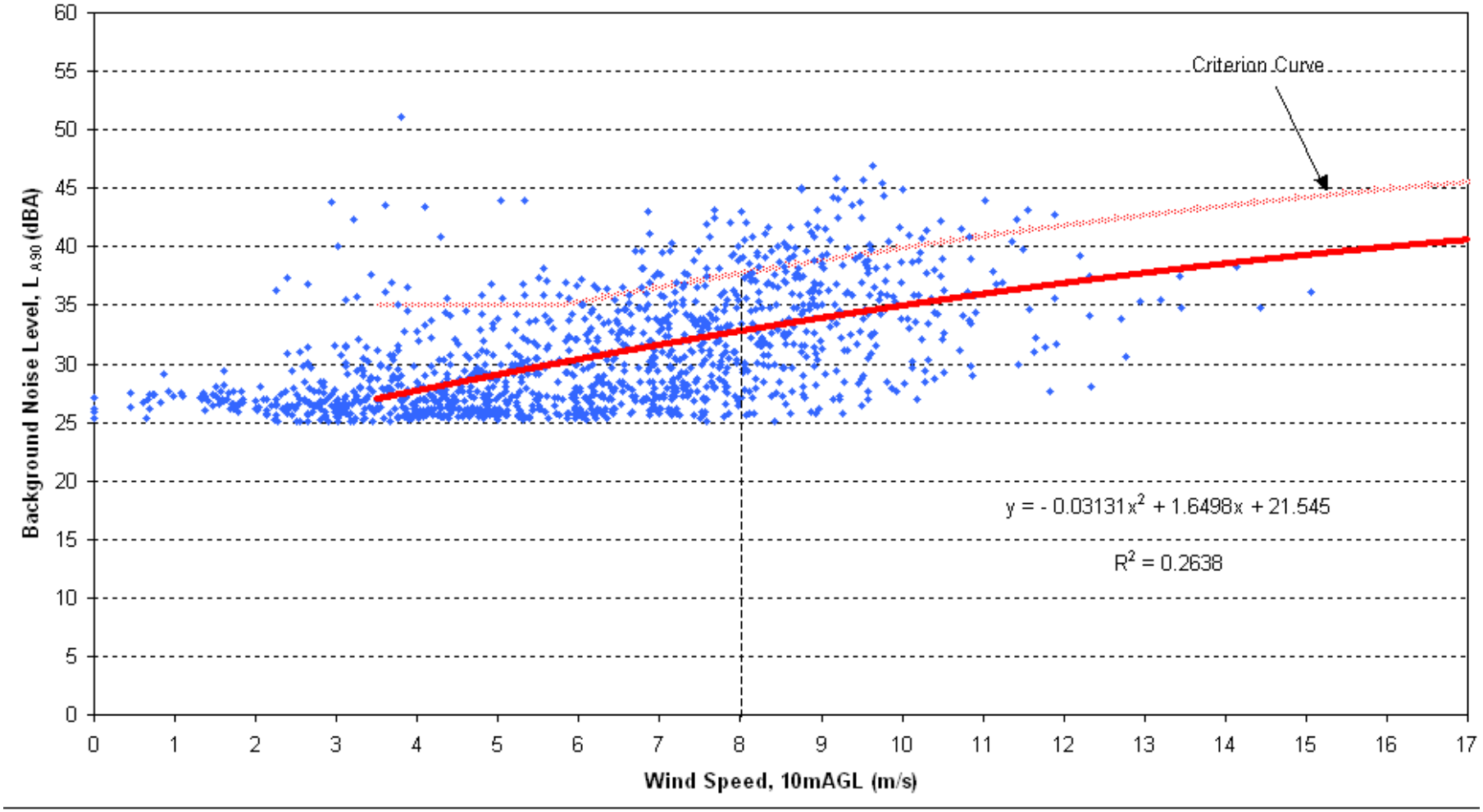
G8 Background Noise at Receiver vs Wind Speed at Windfarm



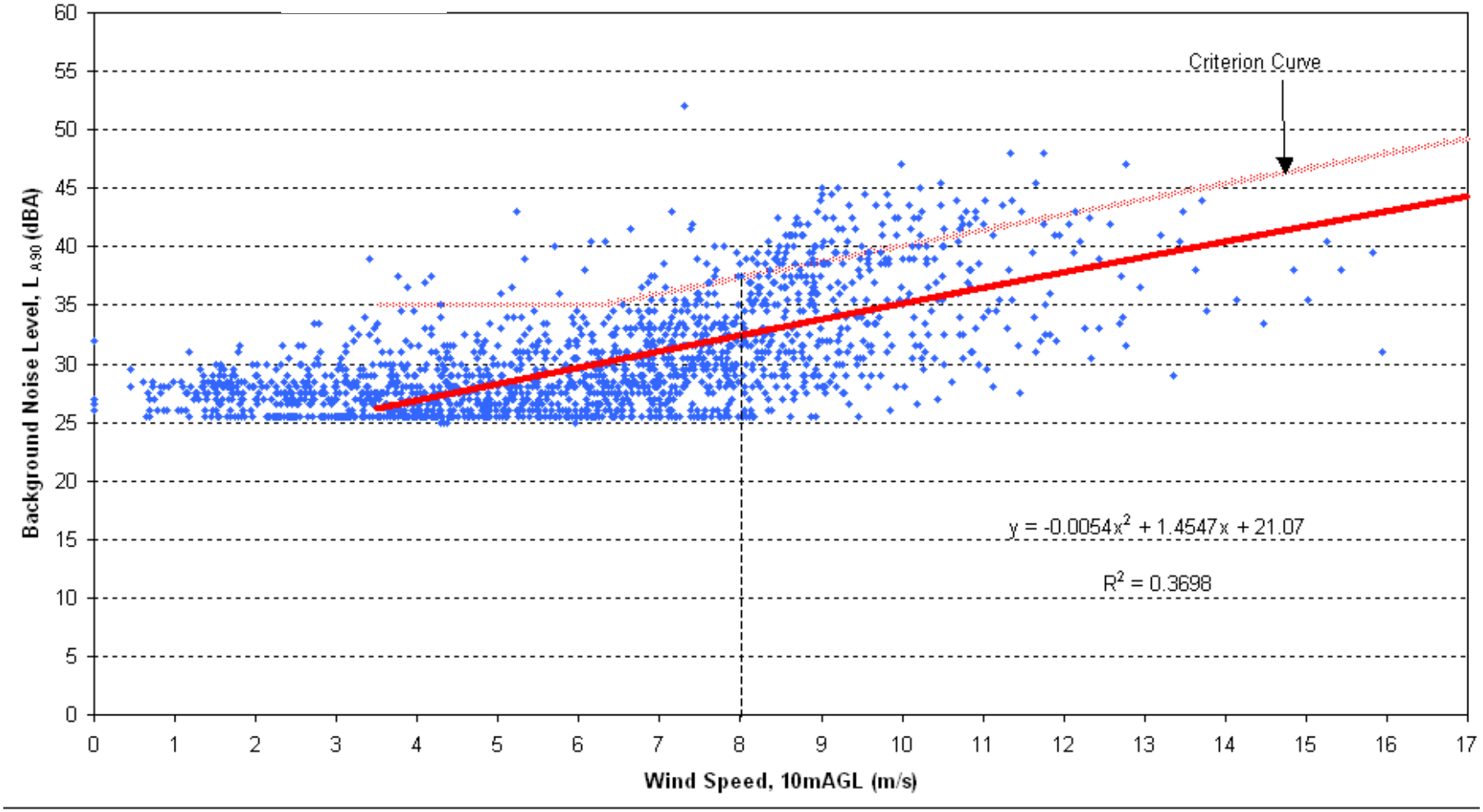
E2 Background Noise at Receiver vs Wind Speed at Windfarm



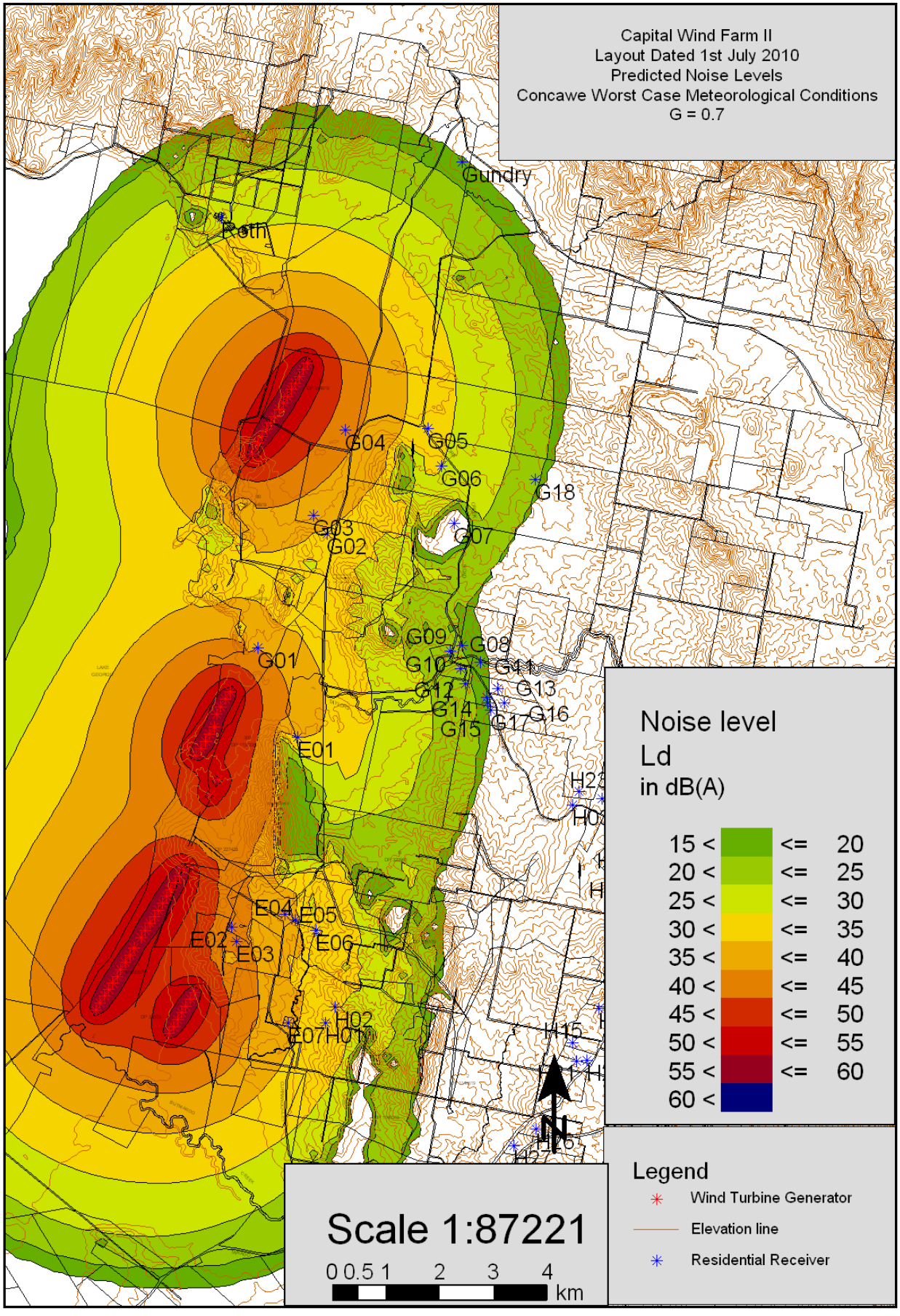
H2 : Background Noise at Receiver vs Wind Speed at Windfarm

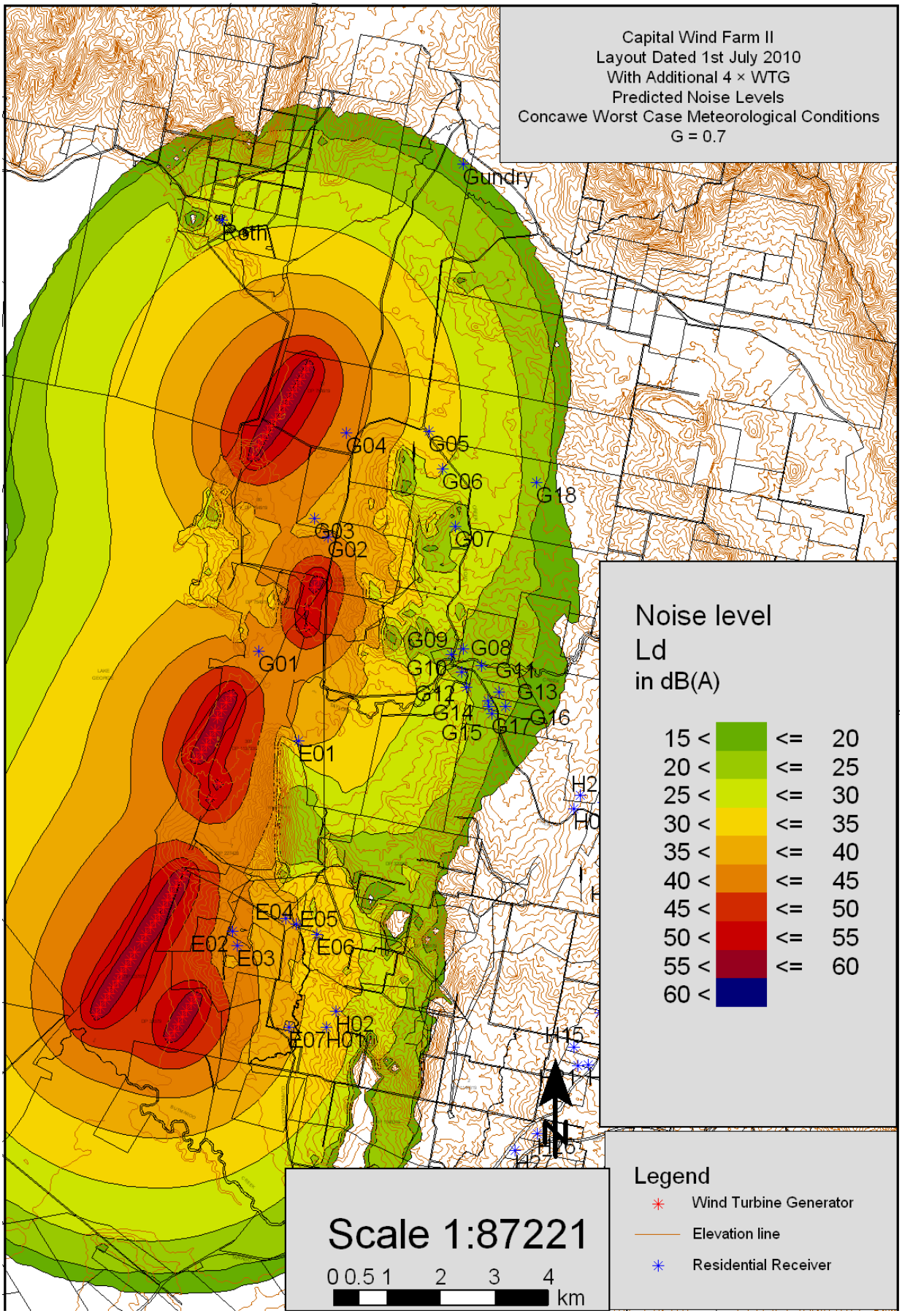


E1 Background Noise at Receiver vs Wind Speed at Windfarm



APPENDIX G COLOUR NOISE CONTOUR PLOTS FOR THE MAXIMUM POWER SETTING FOR THE CONCAWE 8MS^{-1} WORST CASE WIND PROPAGATION SCENARIOS FOR BOTH 53 WTG AND 57WTG LAYOUT


Capital Wind Farm II
Layout Dated 1st July 2010
Predicted Noise Levels
Concawe Worst Case Meteorological Conditions
G = 0.7
Gundry
Roth
G04
G05
G06
G18
G03
G02
G07
G09
G08
G01
G10
G11
G12
G13
G14
G16
G15
G17
E01
H23
H03
E04
E05
E02
E03
E06
H02
E07
H01
H15
H16
N
Noise level
Ld
in dB(A)
15 < <= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 <
Scale 1:87221
0 0.5 1 2 3 4
km
Legend
Wind Turbine Generator
Elevation line
Residential Receiver


Capital Wind Farm II
Layout Dated 1st July 2010
With Additional 4 × WTG
Predicted Noise Levels
Concawe Worst Case Meteorological Conditions
G = 0.7
Gundry
Roth
G04
G05
G06
G18
G03
G02
G07
G09
G08
G01
G10
G11
G12
G13
G14
G16
G15
G17
E01
H2
E04
E05
E02
E03
E06
H02
E07
H01
H15
N
Noise level
Ld
in dB(A)
15 < <= 20
20 < <= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 <
Scale 1:87221
0 0.5 1 2 3 4
km
Legend
Wind Turbine Generator
Elevation line
Residential Receiver