3.2 Noise assessment

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PROJECT:	GULLEN RANGE WIND FARM NOISE IMPACT ASSESSMENT
CLIENT:	EPURON Pty Ltd Level 11, 75 Miller Street NORTH SYDNEY, NSW 2060
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DATE:	5 June 2008

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DOCUMENT STATUS

Revision	Purpose	Date delivered
-	Incomplete draft issued to client	29 February 2008
-	Revised incomplete draft issued to client	5 March 2008
	Report issued to client	12 March 2008
01	Deleted Figure 19 and updated Appendix I noise contours	14 March 2008
01-002	Revised contour background	17 March 2008
02	Incorporates sensitivity analysis	2 June 2008
02-002	Incorporates changes to Section 8.5 and Addenda 1.0 to 3.0	4 June 2008

1.0 EXECUTIVE SUMMARY

Marshall Day Acoustics Pty Ltd has been requested by EPURON Pty Ltd to conduct a noise impact assessment of the proposed Gullen Range Wind Farm.

This noise impact assessment will form part of an environmental impact statement that will assess the impact of up to 84 wind turbine generators proposed for the site.

Three alternative layouts (Layouts A, B & C) have been assessed in accordance with the South Australia EPA's *Environmental Noise Guidelines: Wind Farms (2003)*.

At the time of finalising this report, a decision with respect to turbine type has not yet been made. Accordingly, the REpower MM82 and MM92 turbines have been used for the noise assessment as being representative of the range of turbines that are being considered.

In total, 17 dwellings have been identified as *relevant receivers*. Background noise monitoring was conducted at these locations over a ten-week period between the12 July to 16 November 2007. The majority of monitoring was conducted in the winter months of July and August 2007 in order to establish worst case (lowest) background noise curves.

Noise levels have been predicted for each of the six alternative scenarios using SoundPLAN modelling software implementing the ISO9613-2:1996 noise propagation standard.

Layout	No. of WTG's	Turbine Model	Compliance at all receiver locations	Marginal Excess (<2dBA) at:
Layout A	77	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a
Layout B	81	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27
Layout C	84	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27 & K01

The results confirm compliance on all three layouts using the MM82 turbine and marginal compliance, within the error limits of the model, using the larger MM92 turbine.

It is appreciated that the final turbine selection has not been made and accordingly further assessment is required to ensure compliance. However, this assessment concludes and demonstrates that the proposed layout has the flexibility to be compliant with the SA Noise Guidelines (across a range of turbines) in the following ways:

- by slightly relocating turbines (within 250m)
- removal of turbines
- using active noise control functions of turbines.

Additional background noise monitoring is proposed for B9, B18a, B121a & B122a during the winter months of 2008 in order to better determine the existing ambient noise environment at these locations.

It should be noted that the levels of marginal excess for the MM92 layout range between 0.6dBA to 1.6dBA, which is within the stated accuracy limit of the model (+/-3dBA) and is below the threshold of perceptible noise increase at 3dBA.

Noise agreements with the owners of nearby residences B18a, B27, B121a & B122a are considered a potential mechanism to ensure compliance with the guidelines, should it be required.

B9 is an operational chicken farm and therefore the 40dBA intensive rural noise limit should apply (as stated in Section 2.2 of interim 2007 SA Guideline).

Additional analysis of the sensitivity of the physical dimensions and rated power output of the turbines under consideration was undertaken to demonstrate that these parameters did not significantly increase noise propagation to receivers. This analysis also presents the potential worst case noise impacts based on the turbine with the highest sound power curve (the V90) on the current layout and identifies that mitigation would be required to achieve compliance if this turbine was ultimately used.

Construction noise has been assessed in accordance with the NSW EPA's *Environmental Noise Control Manual*. Construction noise has been predicted to each receiver location with the results indicating that noise levels will be within prescribed limits.

Transformer noise has been predicted to the closest noise sensitive receiver location (PW07). Predicted levels are shown to be below the measured background levels at this dwelling.

2.0 INTRODUCTION

Marshall Day Acoustics Pty Ltd has been engaged by EPURON Pty Ltd to provide acoustical consultancy services in relation to the proposed Gullen Range Wind Farm to be located approximately 6km to the south of Crookwell, NSW. This report has been prepared for inclusion in the Environmental Impact Statement (EIS) submission to the NSW Department of Planning.

This report details the methodology and findings of our noise assessment on the impact to the amenity of 89 dwellings located within 2.5km of up to 84 wind turbine generators (WTG's).

The assessment has been performed in accordance with the South Australia EPA's *Environmental Noise Guidelines: Wind Farms (2003)* (referred to herein as the Guideline), which is currently the applicable guideline in the state of New South Wales for the assessment of the wind farm noise on non-involved landowners. Dwellings that have been assessed in accordance with the Guideline are termed *relevant receivers* within this report.

The European Working Group on Noise from Wind Turbines – *ETSU-R-97* as well as the World Health Organisation's *Guidelines for Community Noise* have been reviewed for guidance where landowners have entered into an agreement with EPURON. Landowners that have been assessed within this report are termed *involved landowners.*

In addition to assessing the impact of the operational wind farm, an assessment of construction noise has also been undertaken in accordance with the *Environmental Noise Control Manual.*

Table 1 summarises test reports, documents and files received from EPURON that have been used as the basis for this assessment.

Table 1

Document Name	Document Number	Date Received
MM82 Technical Data	NA	15/6/2007
MM82PP – Wind Test Report 3539	D-21.2-VM.SM.10-A-A-WT3539	15/6/2007
MM82PP – Wind Test Report 3236	D-21.2-VM.SM.07-C-A-GB-2-WT3236	15/6/2007
MM92 Technical Data	NA	5/11/2007
MM92E – Wind Test Report SE06010B2A1	D-2.9-VM.SM.03-D A-GB MM92E LM45.3	5/11/2007
MM92E - Sound Power Level	SD-2.9-WT.SL-1-B	5/11/2007
Turbine Layout A	Turbines GUL Layout A 180208	18/02/2008
Turbine Layout B	Turbines GUL Layout B 180208	18/02/2008
Turbine Layout C	Turbines GUL Layout C 180208	18/02/2008

Acoustic terminology used throughout this report is defined in Appendix A.

3.0 SITE DESCRIPTION

The Gullen Range Wind Farm is located along a contiguous north to south ridgeline that forms a part of the Great Dividing Range of Australia. The area surrounding the range is known as the Southern Tablelands, whose topography is characterised by flat land that is elevated above sea level. Over the years the landscape has been progressively cleared and converted into pastureland for cattle grazing.

Property to the west and east of the aforementioned ridgeline has been selected by EPURON Pty Ltd as proposed locations for up to 84 WTG's. The wind farm is split into four individual sections, namely Kialla, Bannister, Gurrundah and Pomeroy West. It should be noted that the Kialla and Bannister sections are adjacent each other.

The Kialla section is located closest to Crookwell and lies approximately 6km to the south of the township. The section is approximately 2.5km long and forms the northern-most site of the wind farm. In total, 10-14 WTG's are proposed for this section, with four involved landowners.

The Bannister section is the southern continuation of the ridgeline and is located 2km south of the Kialla section. In total, 22-30 WTG's are proposed for the 6.5km long section with eight involved landowners.

To the east of Gurrundah Creek, approximately 4km south of the Bannister section, is the Pomeroy West section. A total of 23 WTG's are proposed for the 4.5km long site with one involved landowner. This site is immediately south of the existing 330kV power line, which will form the connection point to the national grid.

Finally, the Gurrundah section is located approximately 2km to the south-east of Pomeroy West and forms the southern-most part of the wind farm. In total, 18 WTG's are proposed for the 4km long section, with two involved landowners.

A site overview map for the proposed maximum 84 turbines can be found in Appendix B.

4.0 PROPOSED WIND FARM LAYOUT SCENARIOS

The Gullen Range Wind Farm proposal includes up to 84 WTG's. Three alternative layouts have been assessed for noise compliance, namely Layout's A, B & C (a summary of all turbine and receiver locations used within this assessment can be found in Appendices C & D).

At the time of finalising this report, a decision with respect to turbine type has not yet been made. Accordingly, the REpower MM82 and MM92 turbines have been used for the noise assessment as being representative of the range of turbines that are being considered. In total there are six unique scenarios considered within this assessment.

Both turbine types run three upwind rotor blades and use active blade pitch and rotor speed to control power generation. The rotor diameters measure 82m & 92m respectively and each has a rated turbine electrical power output of 2MW.

The one-third octave band sound power level data for each unit is shown in Appendix E. These figures have been determined by independent tests conducted in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and are sourced from documents received from EPURON Pty Ltd.

Table 2 summarises the relevant specifications of the two alternative turbines proposed for the development.

Table 2
WTG manufacturer specifications

Description	Turbine 1	Turbine 2
Make and Model	REpower MM82 2MW	REpower MM92 2MW
Rotor Blade	PP82-20-A	Evolution
Rotor Diameter (m)	82	92.5
Hub Height (m)	80	80
Rotor RPM	8.5 – 17.1	7.8 – 15.0
Cut-in Wind Speed (ms^{-1})	3.5	3.0
Rated Wind Speed (ms^{-1})	13.0	11.2
Cut-out Wind Speed (ms^{-1})	25.0	24.0
Sound Power $L_{WA\ 9ms-1}$ (dBA)	104.4	105.0

If at any stage after the finalisation of this report, a modification is made to any aspect of the three layouts, EPURON understands that a re-evaluation of the affected model will be required. Additionally, where a change is made to the specification of a turbine, data measured in accordance with IEC-61400-11 will be required in order to re-access noise levels as well as tonality.

5.0 NOISE LIMIT CRITERIA

Currently the NSW Department of Environment and Climate Change (DECC) has no specific guidelines relating to wind farm development within New South Wales. The DECC has itself, acknowledged that the NSW Industrial Noise Policy (INP) is not appropriate for new wind farm developments.

The DECC has (in a consultation meeting conducted in September 2007) recommended that the South Australia EPA *Environmental Noise Guidelines: Wind Farms (2003)* be adopted as the sole basis for the noise assessment of the Gullen Range Wind Farm. Furthermore, the Director General's Requirements (DGR's) also require the use of the Guideline.

With respect to the applicability of the criteria to landowners, Section 2.3 of the Guideline states:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with wind farm developers.*

These are termed *non-involved* landowners within this report.

A non-involved landowner is defined as a landowner who has not entered into an agreement with a wind farm developer in exchange for financial compensation.

Where on the other hand, a landowner is involved with the project; we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97 - The Assessment and Rating of Noise from Wind Farms,* in addition to the World Health Organisation document *Guidelines for Community Noise* for guidance on setting limits.

Additionally, noise associated with the construction of the wind farm has been assessed in accordance with the NSW EPA *Environmental Noise Control Manual* (as requested by the DECC). It should be noted that blasting has been assessed in accordance with ANZECC guidelines.

It should be noted that in 2003 the NSW EPA was incorporated into the Department of Environment Conservation NSW (DEC). In April 2007 the DEC became the Department of Environment and Climate Change (DECC) which is the current body governing noise emissions from developments such as these.

5.1 SA EPA Noise Guideline 2003

In determining the operational noise criteria for each non-involved relevant receiver for the Gullen Range Wind Farm, the Guideline states that:

> *The predicted equivalent noise level ($L_{Aeq,10min}$), adjusted for tonality in accordance with these guidelines, should not exceed 35dBA, or the background noise ($L_{A90, 10 min}$) by more than 5dBA, whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*

The Guideline also proposes a 5dBA penalty for characteristics of turbine operation that would be deemed annoying, such as tonality. Additionally, it should be noted that the Guideline accepts that modern-day "upwind" turbine designs do not exhibit significant levels of infrasound.

SA EPA Noise Guideline 2007 (Interim)

The interim (2007) version of the Guideline has been reviewed in relation to potential impacts to this assessment. The interim guideline recognises that some rural zones are intended for rural industry or intensive primary production, where the amenity of the area may include noise from industrial noise sources. The interim guideline recommends that:

> *The predicted equivalent noise level ($L_{Aeq,10min}$), adjusted for tonality in accordance with these guidelines, should not exceed 40dBA, or the background noise ($L_{A90, 10 min}$) by more than 5dBA, whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*

It also notes:

> *In order for the higher, 40dBA base criterion to be applicable, the zone objectives and principals should indicate that the zone…is intended for intensive uses (e.g. intensive animal keeping…).*

It is understood that the interim 2007 guideline has not been officially recognised by the DECC for assessment of wind farm noise in NSW. However, the Director General's requirements in relation to the proposal state that consideration must be given to any relevant guidelines.

5.2 ETSU-R-97 and World Health Organisation Guidelines

With respect to landowners, the Guideline criteria have been developed to minimise the impact on the amenity of those uninvolved with the project. It is recognised however that where financial agreements exist, developers cannot absolve themselves of the responsibility of ensuring that an adverse effect on an area's amenity does not occur as a result of the operation of the wind farm.

In light of the aforementioned requirement, we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97* in determining noise criteria for involved landowners. It states:

> *The Noise Working Group recommends that both day- and night-time lower fixed limits can be increased to 45dBA and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.*

It should be noted that the Noise Working Group limit of 45dBA is in agreement to the World Health Organisation (WHO) criteria (for protection of amenity and avoidance of sleep disturbance) as published in the document *Guidelines for Community Noise*.

The criterion for involved landowners within this assessment recognises the changed attitudinal response to noise from the wind farm for those financially involved with the project. Furthermore, we understand that EPURON have discussed the implications of wind turbine noise with each of the involved landowners in relation to their property. Each of the involved landowners have been or will be provided with noise agreements that outline the noise criteria applied to them as outlined within this report.

We have therefore adopted a night-time limit of L_{Aeq} 45dBA in conjunction with limits stipulated by the Guideline. This effectively makes the limit L_{Aeq} 45dBA *or* background L_{A90} + 5dBA; whichever is the greater; at all involved relevant receivers for each integer wind speed from cut-in to rated power of the WTG.

5.3 Construction Noise Guidelines

In NSW, there is no current guidance in relation to appropriate construction noise criteria. In the absence of a current standard, the DECC advises that the now out-of-date *Environmental Noise Control Manual* is used to determine the allowable level of construction noise at residential receivers. The noise level restrictions are as follows:

- *Construction period 4 weeks and under.*

  The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 20 dBA

- *Construction period greater than 4 weeks and not exceeding 26 weeks.*

  The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 10 dBA.

The construction duration associated with the proposed development is estimated to take 12-24 months in total. However, due to the large coverage area of the wind farm and up to 84 individual turbine sites, intensive works will be located in any one location for only a short period of time.

We therefore consider it appropriate to allow construction (L_{10}) noise levels to exceed background (L_{90}) noise levels for short and intermittent periods by up to 20dBA (as per Environmental Noise Control Manual recommendations).

The DECC sets time restrictions for noise generated during construction work as follows:

- Monday to Friday, 7am to 6pm
- Saturday, 7am to 1pm if audible on residential premises, otherwise 8am to 1pm
- No construction work is to take place on Sundays or Public Holidays.

5.4 Blasting Noise Guidelines

Noise control in relation to blasting is guided by ANZEC guidelines. Times of day, air-blast overpressure level and ground vibration peak particle velocity limits are all considered. Table 3 summarises the criteria limits in order to minimise annoyance due to blasting overpressure and ground vibration at nearby residences.

Table 3

Time of Blasting	Blast Over-pressure Level (dB Lin Peak)	Ground Vibration Peak Particle Velocity (mm/sec)
Monday – Saturday: 9am – 5pm	115	5
Sunday & public holidays:	-	-
No blasting to take place		

The NSW DECC accepts that on infrequent occasions the overpressure limit of 115 dB (Lin Peak) may be exceeded. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 120dB (Lin Peak) at any time whatsoever.

Additionally, ground vibration peak particle velocity may also exceed the 5mm/sec limit on infrequent occasions. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 10mm/sec at any time whatsoever.

Blasting should generally take place no more than once per day. Additionally, the restrictions referred to above do not apply at premises where the effects of the blasting are not perceived at noise sensitive sites.

6.0 ASSESSMENT METHODOLOGY

Predictions and Receiver Assessment

A preliminary noise impact assessment was performed with the proprietary environmental noise prediction software SoundPLAN, using sound power data determined in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques.*

The prediction was performed for all dwellings located within a maximum radius of approximately 5km of a WTG and for a wind velocity of $9ms^{-1}$. From this, levels were calculated for the entire wind speed range of interest ($3\text{-}10ms^{-1}$) using the difference in measured sound power level between $9ms^{-1}$ and all other wind speeds of interest.

It should be noted that the wind velocity of $9ms^{-1}$ was chosen because this is the point at which the turbines considered within this assessment generate maximum noise level at the receiver and would therefore indicate any potential sensitivity to noise criteria in the initial assessment phase.

The algorithm used in the initial prediction model as well as all successive models, is that found within *ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.* This standard predicts noise levels through directivity and spherical spreading effects and includes variables for atmospheric absorption, ground attenuation and screening.

A detailed evaluation was made for all receiver locations where the initial prediction model indicated a potential sensitivity to the acceptable noise criteria. Dwellings with an initial predicted noise level of 32dB L_{Aeq} or greater were included for further assessment. This can be justified due to the +/- 3dB stated level of accuracy of the ISO9613-2:1996 model (Table 5 from ISO9613-2).

Dwellings below 32dBA were automatically assumed to comply with the noise criteria. It should be noted that all 250+ receiver locations were re-assessed on this basis for subsequent model iterations.

As a result of this evaluation, a shortlist of seventeen receiver locations (from this point onwards referred to as *relevant receivers*) was compiled for short term noise monitoring. Where a cluster of receiver locations occurred, one receiver was selected as being a *worst-case* representation of the cluster as a whole. A more detailed explanation of the methodology behind this selection process, in addition to the background noise monitoring process can be found in Sections 7.0 & 8.0 respectively.

Background Noise Monitoring

Background noise monitoring ($L_{A90, 10min}$) was conducted at each relevant receiver for a 2-week period equivalent to approximately 2000 data points. Simultaneous monitoring of local weather conditions was undertaken in order to determine periods of rainfall. Where it was determined that rainfall had occurred, the representative background noise data were excluded from the dataset.

Establishment of Noise Limits

Each dataset was then plotted on an x-y scatter graph as a function of wind velocity in the range of 3-10ms^{-1}. A regression analysis was performed, with a third order polynomial giving a best-fit line representing the site-specific background noise level across the wind speed range of interest.

The noise criteria for new wind farm developments, as stipulated by the South Australian EPA was then applied to the derived background noise levels from 3-10ms^{-1} in order to determine noise limits.

Assessment of Acceptability of Wind Farm Noise

Finally, a comparison was made between the predicted equivalent L_{Aeq} levels and the L_{A90} noise limits set in accordance with the Guideline for each relevant receiver in order to ensure that each of the layout scenarios resulted in a compliant wind farm.

7.0 RELEVANT RECEIVER ASSESSMENT

7.1 Selection of Relevant Receivers

In total, there are approximately 250 residential dwellings located within a 5km radius of the Gullen Range Wind Farm. The majority of dwellings lie to the east of Grabben Gullen Road and span approximately 30km north-to-south. Many of the dwellings are concentrated in the Grabben Gullen, Kialla and Bannister areas.

The Guideline states that background noise monitoring should be carried out at locations that are relevant for assessing the impact of WTG noise on nearby premises. These locations are termed *relevant receivers* and are defined within the Guideline as premises:

- on which someone resides or has development approval to build a residential dwelling and
- at which the predicted noise level exceeds the relevant base noise level for wind velocities (V_{10m}) of 10ms^{-1} or less and
- which are representative of the worst-case situation for a cluster of similarly located dwellings.

As previously discussed, receiver locations considered within this assessment include all dwellings within a radius of 5km of a WTG. It should be noted that all relevant receivers are within a 2.5km radius of a WTG.

Dwellings located further than 5km distance from a WTG have not been considered within this assessment. This can be justified because at greater distances, existing ambient noise levels will dominate.

A detailed evaluation was made for all receiver locations where the initial prediction model indicated a potential sensitivity to the acceptable noise criteria. Dwellings with a predicted noise level of 32dB L_{Aeq} or greater were included for further assessment. From this shortlist, relevant receiver locations were selected.

Where a cluster of receiver locations occurred, a worst-case determination was made that involved selecting a single dwelling as being representative of the cluster. Factors that were used in this determination included: elevation, foliage coverage, topography of surrounding land, proximity to the nearest WTG and of course, overall predicted L_{Aeq} level.

Table 4 lists all relevant receiver locations where background noise monitoring was undertaken.

Table 4
Relevant receiver locations

Location	Easting (m)	Northing (m)	Elevation above sea level (m)	Distance to closest WTG (km)	Distance to mast (km)	Indicative of cluster
B08	725764	6171873	894	1.1	1.3	B19, B02*, B03*
B11	725246.68	6169677.78	888	1.8	2.5	B09,10, B20-24, B35, B54
B12a	724846.72	6174932.53	917	1.0	2.9	
B13	725472.35	6175319.6	920	1.7	3.5	B05, B14-16, B34
B18	722690.17	6172849.83	928	1.3	1.9	B07, B17, B18a, B01, B30*-32*, B121a&122a
B26*	725030.17	6176599.08	937	1.7	4.6	B04, B12, B25*
B27[W]	722878.96	6175614.31	973	0.5	3.9	
B29	721643.62	6175202.88	933	1.3	4.2	B28, B55-59, B68 & B117
B33[W]	724946.23	6172601.65	921	0.5	0.8	B06
B53*	722272.46	6174050.43	964	0.8	3.0	B77
K01	724163.80	6178435.30	982	0.9	0.5	K03, K05-08, K12&13
K02*	721491.99	6178959.59	949	0.8	2.3	K04, K14, K18-20
G31	727534.28	6155923.68	792	1.5	2.7	G35
G37*	728218.93	6161914.50	714	0.8	3.3	G32&33, G36, G38, G47
G39	729557.27	6160137.49	682	1.7	2.5	G26-28, G30, G40, G43&44
PW07	725225	6166206	922	0.8	5.9	PW03-05, PW29, PW34-36
PW09[W]	723273.32	6165570.23	895	1.3	6.6	PW08

* Denotes involved landowner. [W] denotes weather station logging collectively conducted at these locations for the entire monitoring program.

7.2 Background Noise Monitoring

Background noise monitoring was undertaken over a 10-week period from the 12 July to 16 November 2007. The majority of monitoring was conducted in the winter months of July and August 2007 in order to establish worst case (lowest) background noise curves.

Monitoring equipment (the logger) was generally placed within 20m of a house and no closer than 5m to any reflective surface (other than the ground). The microphone was positioned at a consistent height of 1.2m AGL (above ground level) for all locations and fitted with a manufacturer-supplied (9cm) windshield in order to protect against wind-induced noise across the microphone diaphragm.

The microphone windshields used for monitoring on the Gullen Range provide approximately 26dBA of wind noise attenuation up to $20ms^{-1}$.

Loggers were placed on each property near the dwelling façade that was on-axis to the closest proposed WTG location.

Logging was conducted using Acoustic Research Laboratories (ARL) model numbers EL015, EL215 and EL316 noise loggers. These are Type 1 & 2 measurement devices, certified in accordance with AS1259-1990 or IEC-61672 (*International Electrotechnical Commission 2002*).

Calibration and time drift was checked for each monitoring installation, in addition to site photographs and detailed notations of the immediate surroundings. Factors that could affect the measurements including potential noise sources and unusual topography were carefully noted. Pre and post-measurement calibrations were conducted using a Rion NC-74 Class 1 calibrator complying with IEC942.

7.3 Weather Station Monitoring

In accordance with the Guideline, any data affected by rainfall or extraneous noise events must be excluded from the assessment. In order to determine rainfall events, a WeatherPro-Plus weather station was placed at dwellings B33, PW09 & B27 for the duration of the monitoring programme.

Weather data recorded at these three sites could be relied upon for capturing weather events local to the area, more so than using weather data from the closest Bureau of Meteorology weather station (with sufficient climate records) located in Goulburn, in excess of 30km distance from Gullen Range. The WeatherPro weather station recorded local atmospheric pressure, wind velocity and direction, rainfall, temperature and humidity.

Additionally, weather observations for Goulburn were downloaded from the NSW Bureau of Meteorology website and used to corroborate weather station indications that local weather conditions had exceeded threshold limits for data exclusion.

The weather station data confirmed that for the entire monitoring period, very little rainfall occurred. The general meteorological conditions for the assessment period were dry and cool, with a daily average of 1.3mm rainfall, temperature of 10 degrees Celsius and a prevailing westerly wind of $4ms^{-1}$ at 1.8m AGL.

7.4 Reference Mast Data

The $L_{A90,\ 10min}$ background noise level data for each relevant receiver was synchronised and correlated to the reference mast wind data (10m AGL) and provided by EPURON.

Mast data was available for the Kialla, Bannister and Gurrundah sites (see Appendix B for mast locations in relation to the overall site). It should be noted that in the absence of Pomeroy West mast data, Bannister mast data was used to determine relevant receiver noise limits for the Pomeroy West site. The Bannister mast data gave the highest correlation and was also the closest mast to PW07 & PW09.

7.5 Data Analysis

Approximately 2000 intervals of measured background noise level $L_{A90,\ 10min}$ data were collected for each relevant receiver. A review of the data was then undertaken in order to determine the occurrence of extraneous noise events (e.g. bird noise, noise due to rainfall, lawn mowing etc). After excluding all data affected by extraneous noise events, all remaining data were plotted as an XY scatter as a function of the wind velocity at 10m AGL.

A regression analysis was performed for each relevant receiver data set in order to determine the background noise line of best fit. The third order polynomial gave the highest R^2 value. The R^2 value, also called the coefficient of determination, describes the degree of variability of a set a data. The R value on the other hand, describes the strength of relationship between variables. Table 5 summarises the data statistics for each relevant receiver location.

Table 5
Relevant receiver logger statistics

Location	Measurement Period	Logger Serial No.	Total Data points	Valid Data points	Correlation R	R^2
B08	26/07/07 to 09/08/07	194545	2017	1949	0.86	0.74
B11	23/08/07 to 07/09/07	16-207-028	2181	2171	0.84	0.75
B12A	02/11/07 to 17/11/07	16-207-029	2066	1779	0.78	0.62
B13	10/08/07 to 24/08/07	194419	2019	1980	0.83	0.74
B18	26/07/07 to 09/08/07	16-207-029	2013	1927	0.79	0.64
B26*	09/08/07 to 23/08/07	16-207-027	2005	1946	0.84	0.79
B27^W	02/11/07 to 17/11/07	16-207-028	2110	2037	0.81	0.67
B29	09/08/07 to 23/08/07	16-207-029	2011	1973	0.75	0.58
B33^W	12/07/07 to 09/08/07	192433	3943	3844	0.93	0.90
B53*	12/07/07 to 26/07/07	194419	2034	1985	0.80	0.69
K01	26/07/07 to 09/08/07	16-207-027	2008	1940	0.93	0.83
K02*	26/07/07 to 09/08/07	194419	1920	1863	0.82	0.70
G31	09/08/07 to 23/08/07	192408	2022	0	-	-
	02/11/07 to 17/11/07	192433	1935	1821	0.56	0.33
G37*	26/07/07 to 09/08/07	16-207-028	2018	1947	0.76	0.58
G39	09/08/07 to 23/08/07	16-207-028	2021	1975	0.84	0.76
PW07	12/07/07 to 26/07/07	194545	1930	1897	0.87	0.80
PW09^W	10/08/07 to 24/08/07	192433	2008	1970	0.81	0.70
	24/08/07 to 07/09/07	16-207-029	2241	2220		

* Denotes involved landowner. ^{W} denotes weather station location

It should be noted that, in accordance with the Guideline, data was excluded from each dataset in the following ways:

- where extraneous noise was indicated (i.e. low wind speed but elevated background $L_{A90,\ 15min}$ levels)
- where rainfall was recorded by the weather station.

7.6 Relevant Receiver Noise Assessments

Section 7.6 describes each monitoring location and the results obtained in terms of the noise criteria assessment conducted in accordance with the Guideline. Photographs of each logger relative to the dwelling can be found in Appendix F. Please refer to Appendix G for measured background noise vs wind speed graphs for each location.

The ambient noise environment for all relevant receiver locations was characterised by bird and insect noise, live stock activity and wind-induced vegetation noise.

Relevant Receiver B8 – Bannister

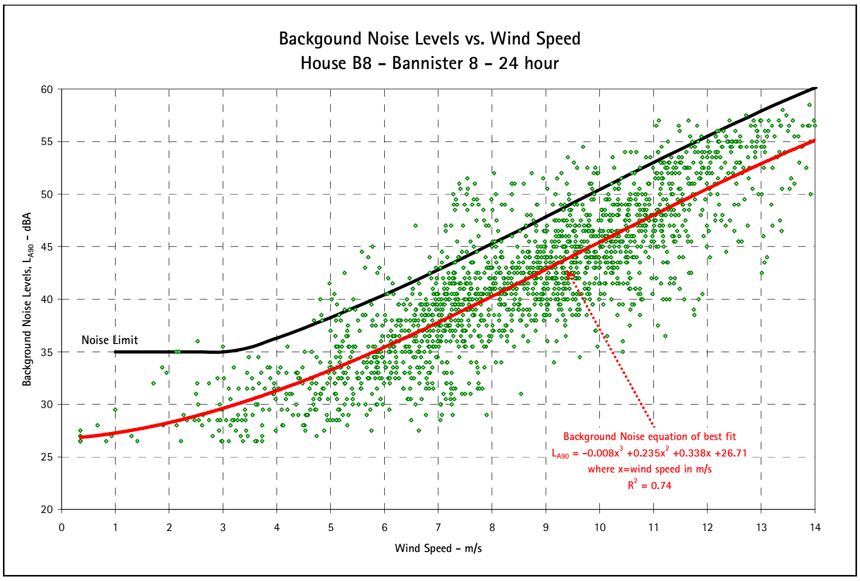
Background noise monitoring was carried out at "Windsong" 3226 Range Rd, Bannister, from the 26 July to 9 August 2007 using logger EL215 serial no. 194545.

B8 was selected as a monitoring location based on its proximity to a group of turbines headed by BAN_25 (1.1km distance). Additionally, it was determined that this location was indicative of being worst-case amongst other houses in the cluster (B02, B03 & B19) due to its relatively exposed nature.

The environment surrounding the measurement location consisted of some sparse but tall trees and smaller plants, a gravel driveway and a three-car aluminium garage located approximately 11m to the west. The logger was placed on the southern façade of the dwelling with Gullen Ridge visible towards the west.

A total of 68 data points were excluded from the analysis due to extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 1 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 1
B8 derived noise limits



Relevant Receiver B11 – Bannister

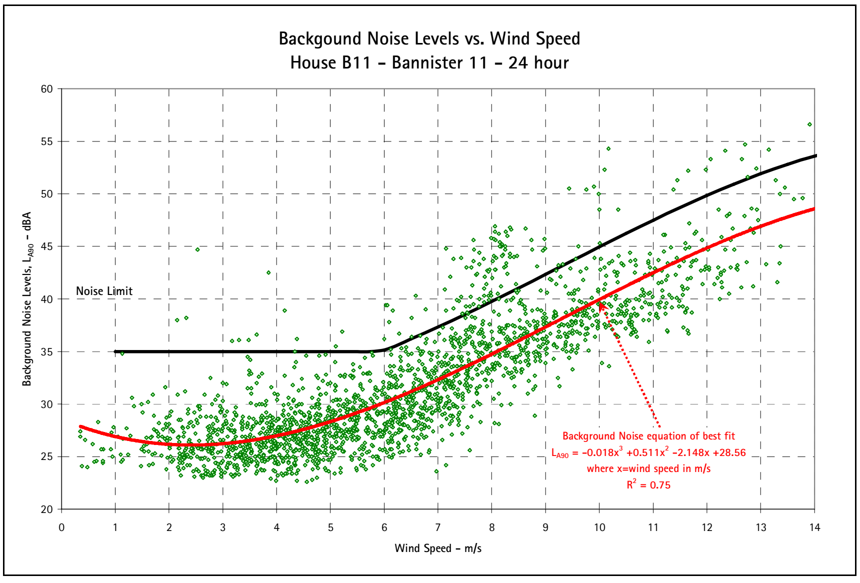
Background noise monitoring was carried out at "Bannister Hall" 198 Bannister Lane, Bannister, from the 23 August to 7 September 2007 using logger EL316 serial no. 16-207-028.

B11 was selected as a representative monitoring location after being unable to gain access permission to locations B10 and B20. The location can be considered representative of the cluster (B09-10, 20-24, 35 & B54) due having a similar average distance to all Bannister turbines in addition to similar topography.

The logger was placed in the rear garden of the property, approximately 26m distance from the northern façade of the dwelling. The monitoring location was bounded to the east by a line of tall trees approximately 5m away, in addition to smaller trees to the north and west.

A total of 10 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 2 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 2
B11 derived noise limits



Relevant Receiver B12A – Bannister

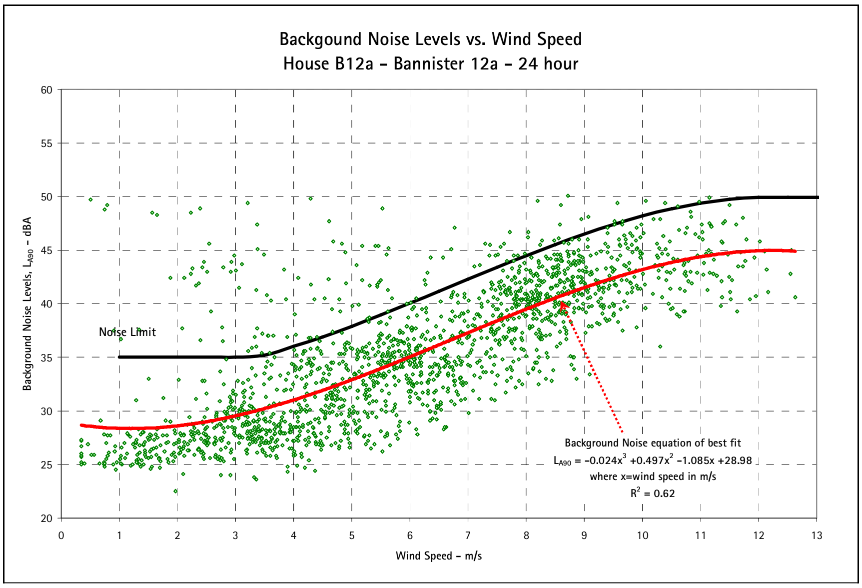
Background noise monitoring was carried out on the property of B11, at 141 Kialla Rd, Kialla, in the vicinity of the boundary line with property B12 from the 2 to 16 November 2007 using logger EL316 16-207-029.

This location was selected on the grounds of a development approval being granted for the construction of a dwelling in the adjacent property to the north, approximately 100m from the monitoring location.

The environment surrounding the logger can be described as open pastureland with tall trees approximately 30m to the east. The owner of the property has confirmed that no livestock used the paddock during the period of monitoring.

A total of 286 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 3 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 3
B12A derived noise limits



Relevant Receiver B13 – Bannister

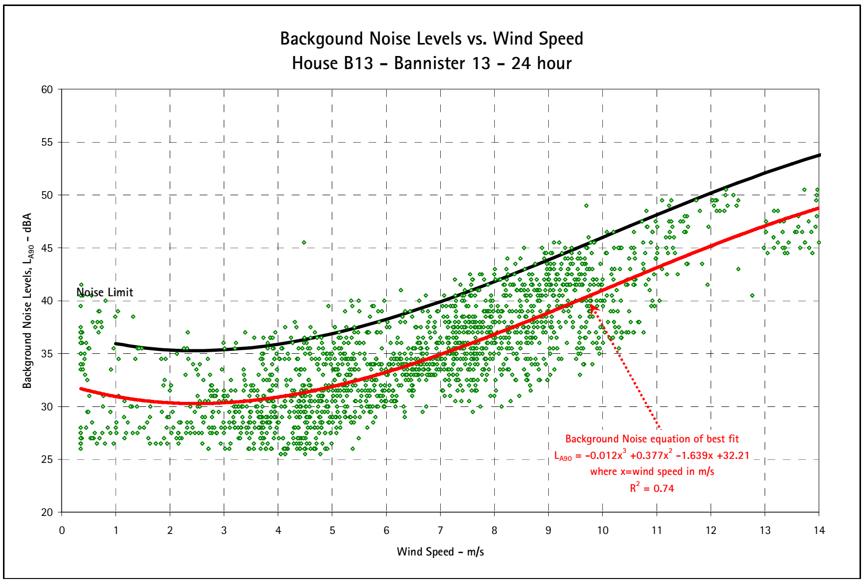
Background noise monitoring was carried out at 329 Kialla Rd, Kialla, from the 10 to 24 August 2007 using logger EL215 serial no. 194419.

B13 was selected as a monitoring location based on being the closest dwelling out of the cluster (B05, B13-16, B34) to turbine BAN_15 (1.7km west). Initial predictions indicated a potential sensitivity to noise limit criteria and the dwelling was therefore chosen as being worst-case out of the cluster.

The dwelling is surrounded on all sides by tall trees and foliage, with the logger located on the least vegetated side - 10m from the southern façade. The siting of the logger afforded clear line-of-sight to Gullen Ridge towards the west.

A total of 39 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 4 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 4
B13 derived noise limits



Relevant Receiver B18 – Bannister

Background noise monitoring was carried out at 3598 Range Rd, Grabben Gullen, from the 26 July to 9 August 2007 using logger EL316 serial no. 16-207-029.

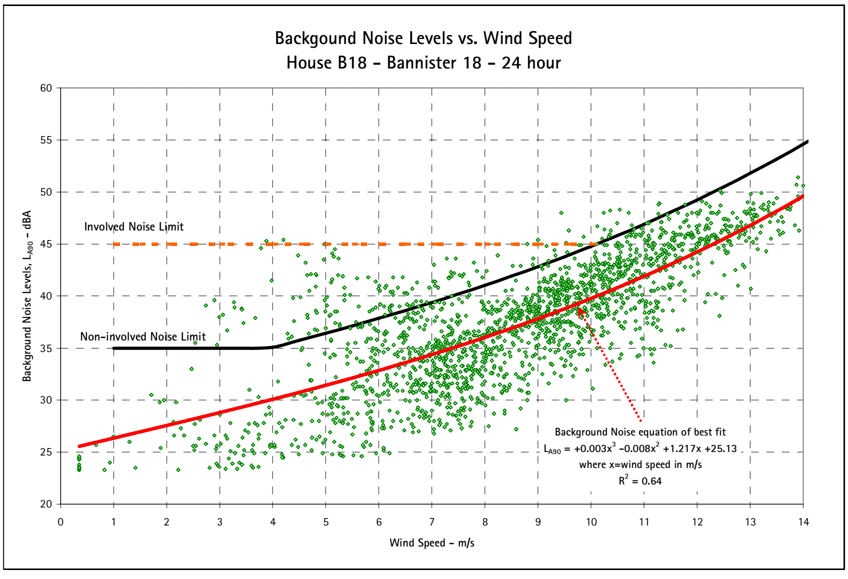
B18 was selected as a monitoring location based on being the closest dwelling out of the cluster (B07, B17 and B30-32) to turbine BAN_18 (1.3km east). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster of houses due to its exposed easterly outlook, with direct line-of-sight to Gullen Ridge.

It should be noted that additional dwellings were added to this assessment cluster after commencement of background noise monitoring when it became apparent that planning approval was being sought for residential dwellings on these properties. The dwellings were given the designations B18a, B121a & B121a and can be considered as potentially involved landowners (noise agreements have been discussed).

The logger was located on pastureland on the eastern façade of the dwelling, with unobstructed line of sight to Gullen Ridge toward the east. The distance to the dwelling façade was approximately 24m, with the intermediate ground devoid of any obstructions like foliage or wooden fences. The western façade of the dwelling was flanked by an outcrop of tall trees. The monitoring location was approximately 20m distance from Range Road.

A total of 86 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 5 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 5
B18 derived noise limits



Relevant Receiver B26 – Bannister

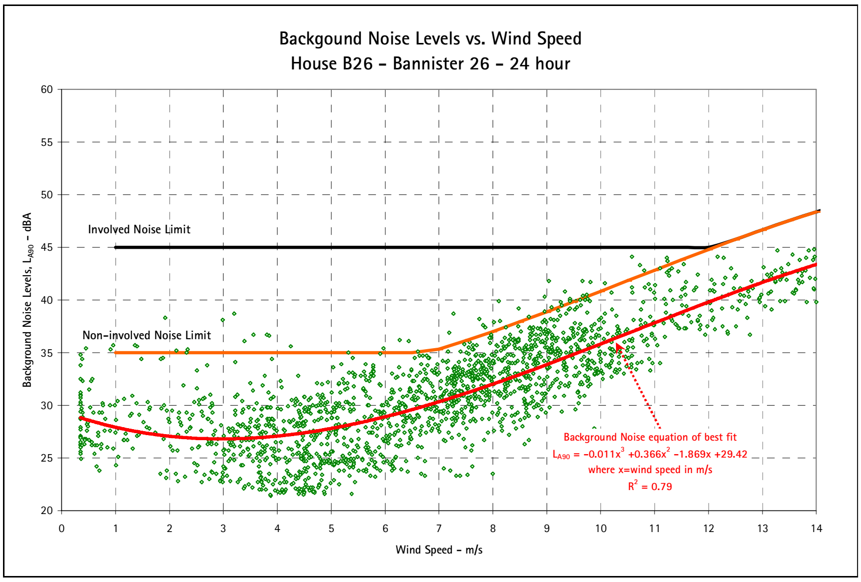
Background noise monitoring was carried out at "Valley View" 471 Kialla Rd, Kialla, from the 9 to 23 August 2007 using logger EL316 serial no. 16-207-027.

B26 was selected as a representative monitoring location after being unable to gain access to locations B04 and B12. With no trees surrounding the property whatsoever, the location could be considered worst-case when compared to B04, B12 & B25.

The logger was placed 17m from the western façade of the dwelling, with no vegetation in the immediate vicinity. The property was bounded on four sides by pastureland where livestock was grazing.

A total of 59 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 6 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 6
B26 derived noise limits



Relevant Receiver B27 – Bannister

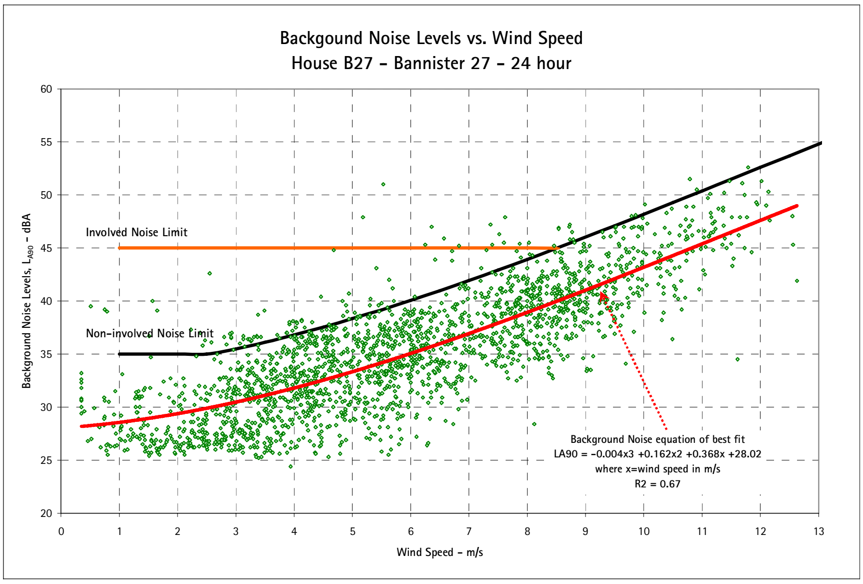
Background noise monitoring was carried out at 3842 Range Rd, Grabben Gullen, from the 2 to 16 November 2007 using logger EL316 serial no. 16-207-028.

B27 was chosen as a monitoring location due to its relative proximity to the BAN_07 (for Layouts B & C) turbine location, located approximately 550m away.

The logger was located approximately 25m distance from the southern façade, but in-line with the eastern façade of the dwelling. Tall trees were located to the east of the logger, approximately 30m distance with additional trees to the west, approximately 80m distance.

A total of 73 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 7 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 7
B27 derived noise limits



Relevant Receiver B29 – Bannister

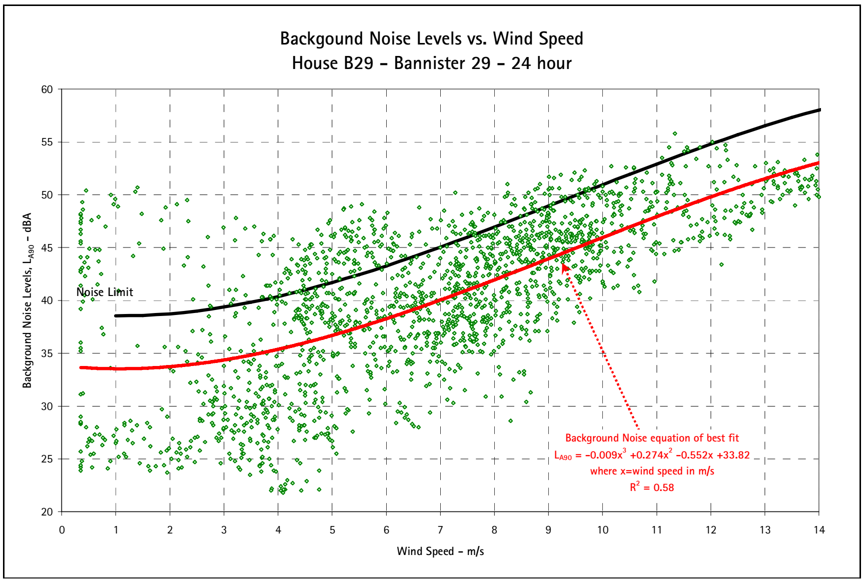
Background noise monitoring was carried out at "Keieda" 3840 Range Rd, Bannister, from the 9 to 23 August 2007 using logger EL316 serial no. 16-207-029.

B29 was selected as a monitoring location based on being the closest dwelling out of the cluster (B28, B55-59, B68 & B117) to turbines BAN_09 & BAN_10 (1.3-1.4km east). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster of houses due to its exposed easterly outlook, with direct line-of-sight to Gullen Ridge.

The logger was positioned approximately 8m from the eastern façade of the dwelling, with unobstructed line-of-sight eastward toward the closest proposed turbine. The dwelling was fenced off from the rest of the property by trees and other vegetation lining its perimeter.

A total of 38 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 8 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 8
B29 derived noise limits



Relevant Receiver B33 – Bannister

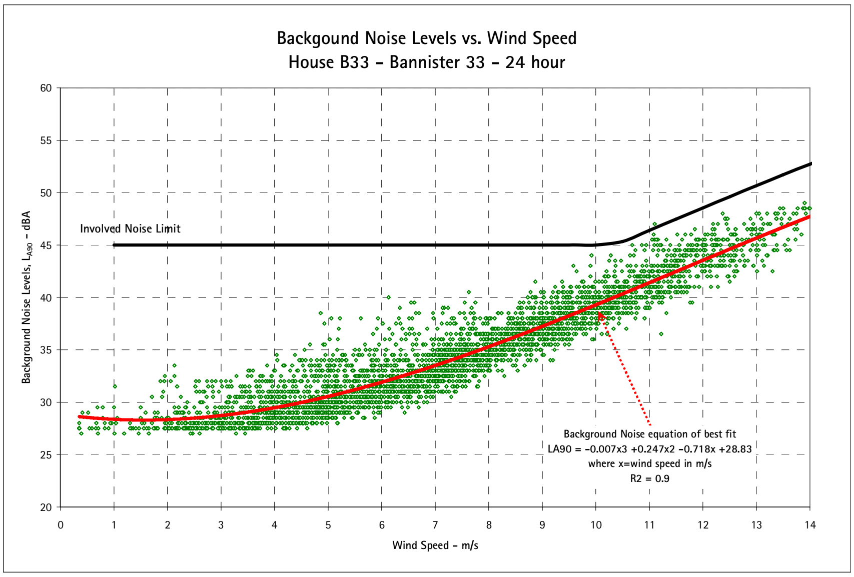
Background noise monitoring was carried out at 3336 Range Rd, Bannister, for a total of 4 weeks from the 12 July to 10 August 2007 using logger EL015 serial no. 192433. In conjunction with the baseline noise monitoring, a weather station was also set up to simultaneously monitor the local weather conditions over the same period.

B33 is an involved landowner that was selected as a monitoring location based on its proximity to the BAN_21 turbine (approximately 520m). Additionally, the location was considered worst-case due to its proximity to the ridge line, which could afford shielding from the prevailing wind.

The dwelling is located on the eastern side of Gullen Ridge with a substantial growth of trees and bush immediately to the west of the property. To the south-west, the ridge itself is partially visible through an outcrop of tall trees that line Range Rd. Livestock were found to be grazing in pastureland directly adjacent the measurement location to the east and south. The logger was placed on the lawn on the southern façade of the dwelling facing toward the closest proposed WTG location.

A total of 99 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 9 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 9
B33 derived noise limits



Relevant Receiver B53 – Bannister

Background noise monitoring was carried out at "Leonardville" 3680 Range Rd, Bannister, from the 12 - 26 July 2007 using logger EL215 serial no. 194419.

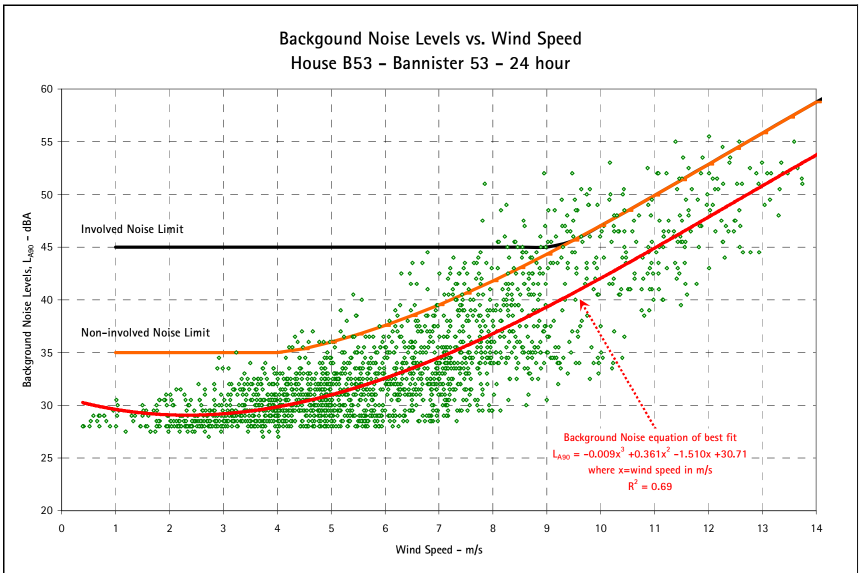
B53 is an involved landowner that was selected as a monitoring location based on its proximity to three turbines, namely BAN_09, BAN_10 & BAN_12 (0.8-1.1km distance). Additionally, the location of the dwelling would afford unobstructed line-of-sight to the proposed turbines.

The dwelling is located on top of a hill with trees affording shelter from the prevailing wind. The dwelling is fenced off from the rest of the farm with livestock free to roam in close proximity to the north and east facades. The logger was located 6m distance from the northern façade of the dwelling.

A total of 49 data points were excluded from the analysis on the basis of extraneous noise events.

The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 10 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 10
B53 derived noise limits



Relevant Receiver K1 – Kialla

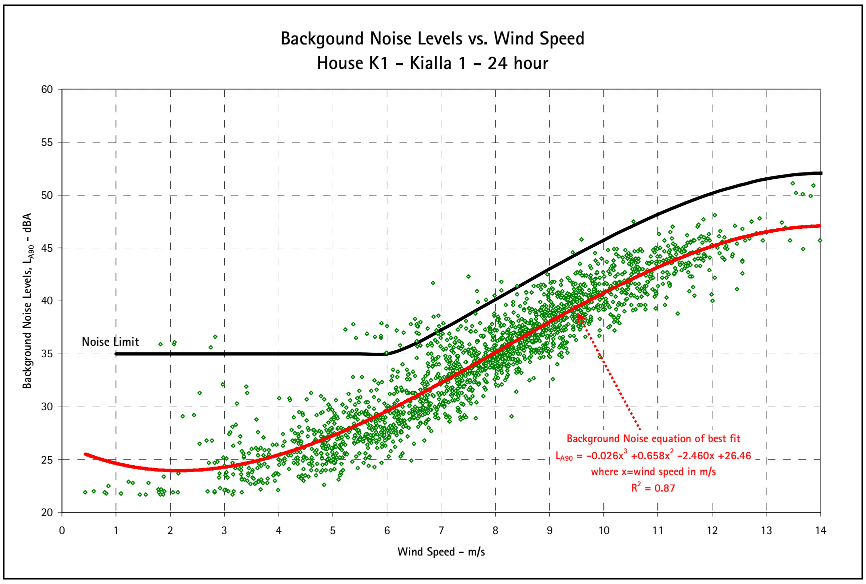
Background noise monitoring was carried out at 609 Kialla Rd, Kialla, from the 26 July to 9 August 2007 using logger EL316 serial no. 16-207-027.

K1 was selected as a monitoring location based on its proximity to three turbines, namely KIA_06, KIA_07 & KIA_10 (between 1.2-1.3km distance). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster (K03, K05-08, & K12-13) of houses due to having direct line-of-sight to the closest turbine, namely KIA_10.

The logger was located on the lawn adjacent to but 11m from the western façade of the dwelling. The dwelling was located on a hilltop, surrounded by trees to the north and west, with the ground to the east falling away rapidly. Located in close proximity to the measurement location was a two-vehicle garage, with a loose gravel driveway.

A total of 68 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 11 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 11
K1 derived noise limits



Relevant Receiver K2 – Kialla

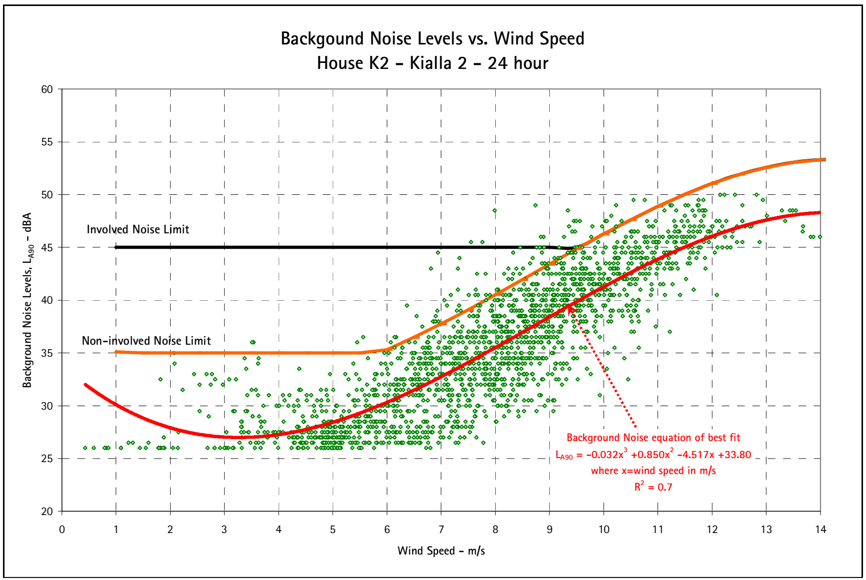
Background noise monitoring was carried out at "Fern Hill" 3416 Grabben Gullen Rd, Crookwell, from the 27 July to 10 August 2007 using logger EL215 serial no. 194419.

K2 was selected as a monitoring location based on its proximity to three turbines, namely KIA_02, KIA_03 & KIA_04 (between 0.9-1.0km distances). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster (K04, K14, & K18-20) of houses due to having direct line-of-sight to KIA_04 (to the east).

The logger was located on an open expanse of lawn approximately 17m from the eastern façade of the dwelling. The dwelling concerned was surrounded to the north, west and south by tall trees, with farm animals free-ranging close to the measurement location.

A total of 57 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 12 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 12
K2 derived noise limits



Relevant Receiver G31 – Gurrundah

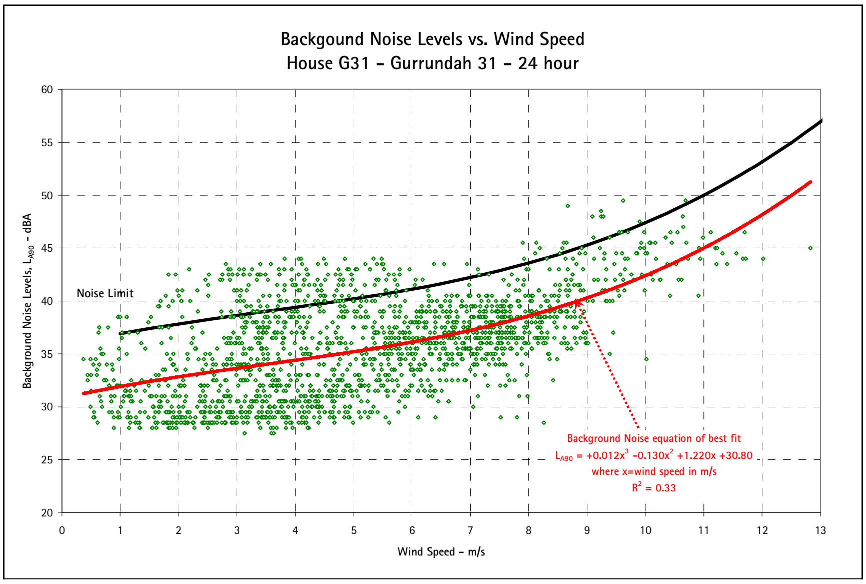
Background noise monitoring was carried out at "The Range" 2091 Gurrundah Rd, Gurrundah. Initial logging at this location was conducted from the 9 to 23 August 2007. However, due to a logger malfunction insufficient data intervals were captured. Logging was therefore re-conducted for the period 2 to16 November 2007 using logger EL015 serial no. 192433.

Background noise logging was undertaken at G31 in order to determine the existing noise environment at the southern end of the wind farm site. Additionally, predictions indicated a potential sensitivity to the acceptable noise criteria. The closest turbine is GUR_15, located 1.5km to the north.

The logger was located 15m from the eastern façade of the dwelling. The area surrounding the monitoring location was populated by low-lying vegetation with a dog kennel located approximately 25m to the south-west. Additionally, a large outcrop of trees was located 80m to the west.

A total of 114 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 13 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 13
G31 derived noise limits



Relevant Receiver G37 – Gurrundah

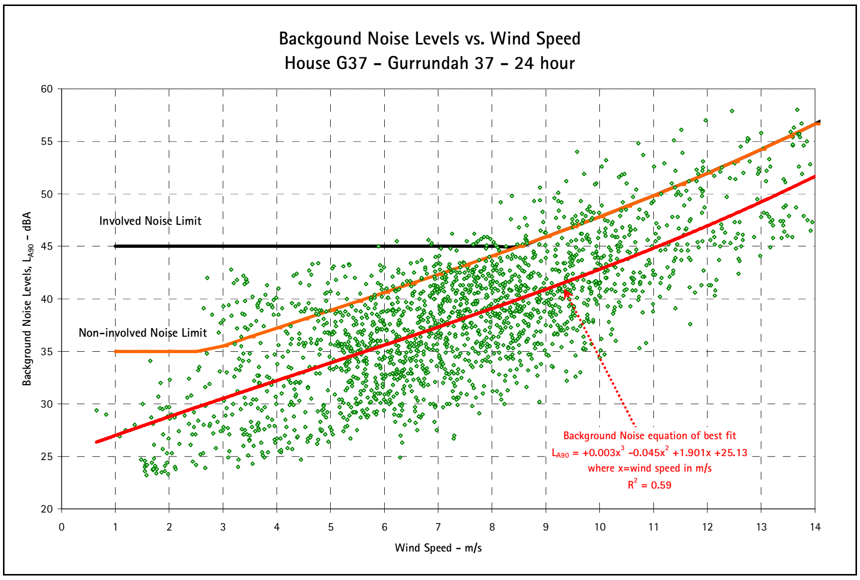
Background noise monitoring was carried out at "Cooyar" 1455 Pomeroy Rd, Goulburn, from the 26 July to 9 August 2007 using logger EL316 serial no. 16-207-028.

G37 is an involved landowner that was selected as a monitoring location based on its proximity to GUR_01 turbine (approximately 800m). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster (G32-33, G36, G38 & G47) due to an exposed south-westerly outlook.

The logger was located in the pool enclosure, 18m from the eastern façade of the dwelling (the pool was not in use during winter months). The position afforded line of sight to the south-western ridge behind the property where the closest proposed WTG is to be located.

A total of 71 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 14 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 14
G37 derived noise limits



Relevant Receiver G39 – Gurrundah

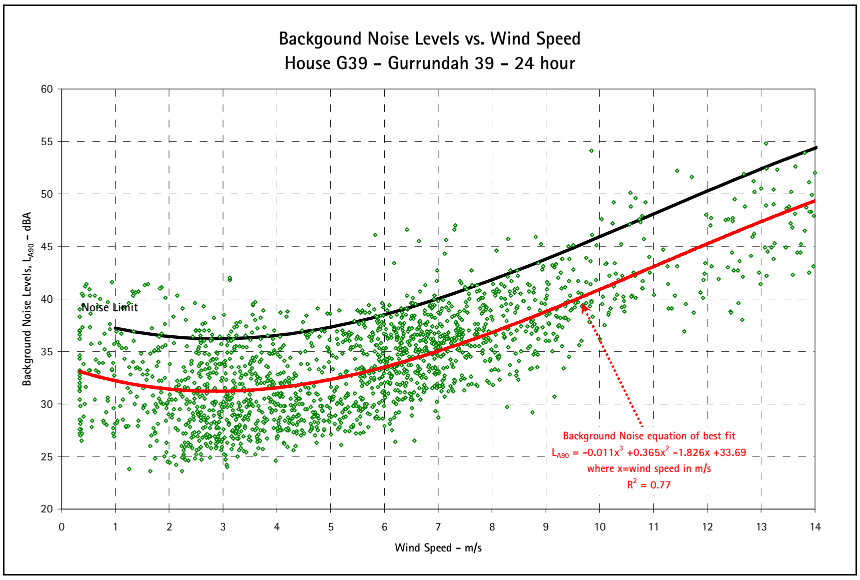
Background noise monitoring was carried out at 1213 Pomeroy Rd, Pomeroy, from the 9 to 23 August 2007 using logger EL316 serial no. 16-207-028.

G39 was selected as a monitoring location based on its proximity to GUR_16 turbine (approximately 1.7km). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster (G26-28, G30, G40, & G43-44) due to an exposed westerly outlook toward Gullen Ridge.

The logger was located 12m from the western façade of the dwelling. The property and surrounding environment was devoid of vegetation, with the exception of a large tree to the south-west of the logger that afforded unobstructed line-of-sight to the ridgeline towards the west.

A total of 46 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 15 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 15
G39 derived noise limits



Relevant Receiver PW07 – Pomeroy West

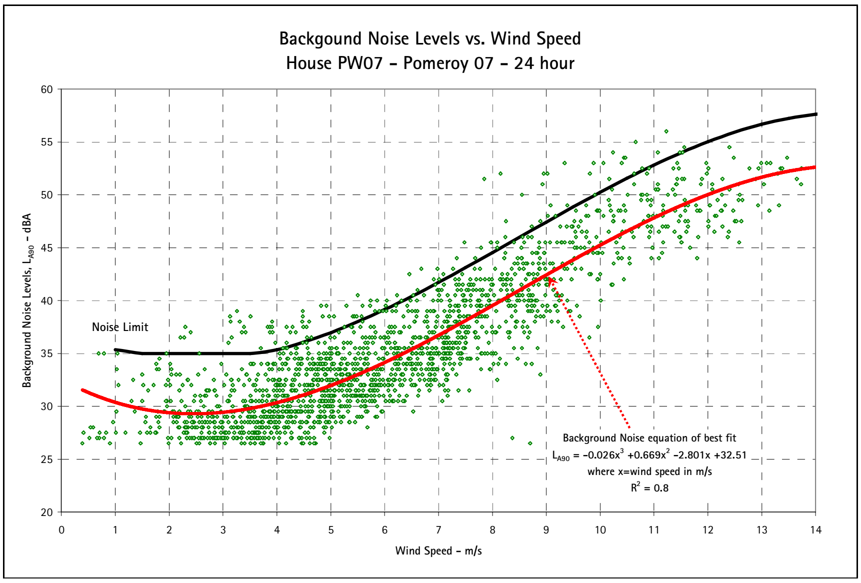
Background noise monitoring was carried out at 130 Storriers Lane, Pomeroy, from the 12 to 26 July 2007 using logger EL215 serial no. 194545.

PW07 was selected as a monitoring location based on its proximity to POM_01 turbine (approximately 800m). Additionally, it was determined that this location was indicative of being worst-case amongst the cluster (PW03-05 & PW29) due to being located between two groups of turbines (headed by POM_01 to the east and POM_08 900m to the south).

The logger was located in empty pastureland approximately 15m from the southern façade of the dwelling. Surrounding the property to the north, east and west were tall trees with farm animals (including sheep dogs) free-ranging around the property. The intermediate lawn area was devoid of any obstructions like foliage or wooden fences.

A total of 33 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 16 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 16
PW07 derived noise limits



Relevant Receiver PW09 – Pomeroy West

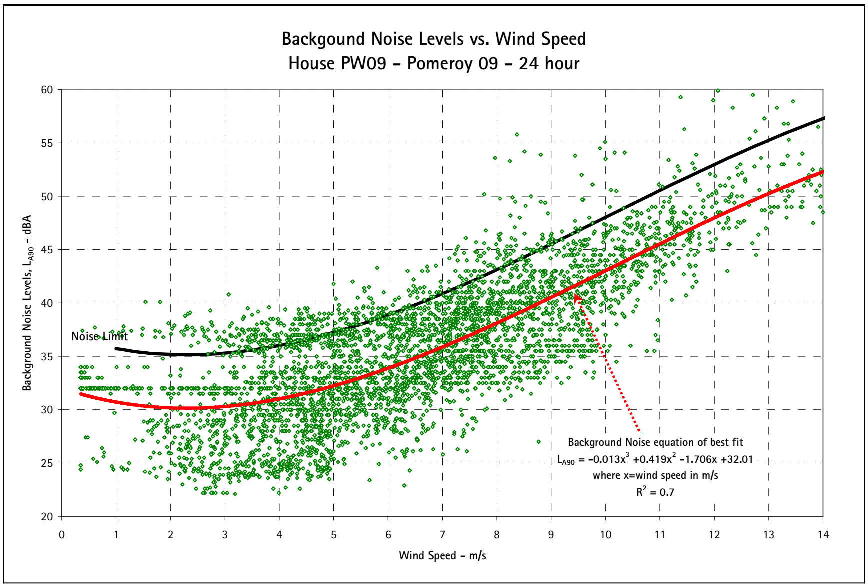
Background noise monitoring was carried out at "Hillview" 312 Prices Lane, Bannister, for a total of 4 weeks from the 10 August to 8 September 2007 using loggers EL015 serial no. 192433 and EL316 serial no. 16-207-029 respectively. In conjunction with the baseline noise monitoring, a weather station was also set up to simultaneously monitor the local weather conditions over the same period.

PW09 was selected as a monitoring location based on its proximity to POM_12 turbine (approximately 1.3km). The dwelling is representative of worst-case because it is situated on an elevated outlook with direct line-of-sight to the closest proposed WTG to the south-east.

The logger was set up 14m from the southern façade of the dwelling, but in line with the eastern façade. The surrounding environment consisted of a shelter belt of tall trees to the west of the dwelling; to the east the car garage and driveway, in addition to a outcrop of tall trees approximately 30m away; and exposed to the north and south.

A total of 58 data points were excluded from the analysis on the basis of extraneous noise events. The results of the baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 17 below, including the data scatter, SA guideline noise criteria and regression line of best fit.

Figure 17
PW09 derived noise limits



8.0 NOISE LEVEL PREDICTIONS

8.1 Selection of Prediction Model

The DECC has requested (in consultation meetings held in September 2007 and May 2008) that sufficient justification be given to demonstrate that the chosen model can accurately predict wind farm noise (based on published/recognised studies). The following outlines our justification for the use of ISO9613-2:1996 (the Standard).

It has been empirically shown that where the distance between source and receiver is significant, and the intermediate ground displays significant topographic features, ISO9613 predictions are more accurate than CONCAWE and NZS6808[1]. This does however require the use of high quality terrain information, such as can be provided by a digital terrain file. It should be noted that a digital terrain model has been used as one of the input parameters in this assessment.

A study by Bass, Bullmore and Sloth[2] compared three prediction models (IEA: Part 4, ISO9613-2 and ENM (implementing CONCAWE) and found that for flat, rolling and complex terrain sites ISO9613 predicted noise levels to within 1.5dBA accuracy of levels measured under conditions of an $8ms^{-1}$ positive wind vector. Furthermore, they noted that the output of ISO9613 was not unduly sensitive to meteorological input parameters when compared to ENM (CONCAWE).

The study by Bass et al recommended modifications to the ISO96913 model to improve its accuracy under conditions of partial acoustic screening due to the barrier effect. Another modification was recommended where the mean propagation height between source and receiver was equal to or greater than 1.5 times the mean propagation height over flat ground.

These modifications have been considered within the context of the Gullen Range model. It should be noted that no barrier effect attenuation due to partial acoustic screening has been applied to the predicted results and therefore no modification is applicable. Secondly, source-to-receiver mean propagation heights have been assessed, with only one instance where the mean propagation height was equal to or greater than 1.5 times the height over flat ground (PW09). We have therefore arithmetically added 3dBA to the predicted level for this receiver, as recommended by the study.

Furthermore, a study conducted by Hoare Lea Consulting Engineers[3] compared predicted levels using ISO9613 to measured levels at four receiver locations between 100 – 800m distance from an operational UK wind farm.

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[1] Stakeholder Review & Technical Comments – NZS6808:1998 Acoustics- Assessment and measurement of sound from wind turbine generators; 22.0001.06.04(CC,) May 2007.

[2] Bass, Bullmore and Sloth - Development of a wind farm noise propagation prediction model; Contract JOR3-CT95-0051, Final Report, January 1996 to May 1998.

[3] Bullmore, Adcock, Jiggins & Cand – Wind Farm Noise Predictions: The Risks of Conservatism; Presented at the Second International Meeting on Wind Turbine Noise in Lyon, September 2007.

The downwind measurements used in the comparison were between +/- 15 to 45 degrees, with hub height wind speeds of 8-14 ms^{-1}. Two ground assumptions were modelled, a hard ground assumption (G=0) and a mixed ground assumption (G=0.5).

Results from the study indicated that when considering worst case downwind directions of +/- 45 degrees from the direct line between source and receiver, ISO9613 predicted levels approximately 1-2 dBA higher than measured levels at the farthest measurement location.

Where the wind direction angle was limited to downwind +/- 15 degrees, ISO9613 predicted levels up to 3dBA higher than measured levels, up to 13ms^{-1}. However, it was noted that as distance from source to receiver increased, the comparative difference decreased, until at the farthest measurement position, predicted and measured levels were equal. This trend could be attributed to the increasing contribution of background noise to overall noise level as a function of distance.

On the basis of these findings, the report concluded that using ISO9613 with a single wind speed reference offered a robust representation of wind farm noise levels.

8.2 ISO9613-2:1996 Model

Operational wind farm noise levels were predicted to all residential dwellings considered within this assessment using a three-dimensional computer noise model generated in SoundPLAN.

The model was implemented in SoundPLAN version 6.4, which is an industry leading software package produced by Braunstein & Berndt GmbH. The software has the ISO9613-2:1996 standard built-in to the calculation core. The SoundPLAN implementation of the Standard has been tested in-house by developers to ensure compliance with the standard.

Noise levels were calculated for all integer wind velocities in the range of 3-12ms^{-1} at all receiver locations within a 5km radius of a WTG.

The ISO9613-2: 1996 propagation model predicts sound pressure level at a field point using equation [1]:

$$L_p = L_{Wpoint} + D - A_{div} - A_{atm} - A_{ground} - A_{screen} - A_{misc} \quad [1]$$

where:

L_p is the sound pressure level at a field point, L_{wpoint} is the sound power level of a point source, D is the directivity index of the source in dB, A_n are the attenuation allowances for geometrical divergence, atmospheric absorption, ground hardness, screening and miscellaneous effects.

8.3 Attenuation Factors

L_w – Point Source Sound Power Level

The sound power level data for each turbine type used in our assessment can be found in Appendix E. The sound power data provided by EPURON has been calculated in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and is expressed in terms of A-weighted decibels (dBA), for each integer multiple of the wind speed range of interest.

It should be noted that for the wind speed bins where manufacturer-supplied data was not provided, we have extrapolated sound power levels based on data provided for the standard blade type for each turbine (see Appendix E).

D – Directivity Factor

The directivity factor (D) allows for an adjustment to be made to the radiated sound power level where the source is understood to radiate higher levels of sound in the direction of interest. It is a convention of the IEC-61400-11 standard that sound power levels are derived from downwind sound pressure level measurements and as such, implies worst-case sound propagation conditions in all directions. As such, no directivity correction has been used in our model.

A_{div} – Unidirectional Spherical Divergence

At a hub height of 80m, the turbine is considered to be a point sound source radiating sound energy in a free-field. As such, sound energy propagating distance (r) will be attenuated according to the following equation:

$$A_{div} = 20\log(r) + 11dB \qquad [2]$$

A_{atm} – Atmospheric Absorption

Sound propagation through the atmosphere is considered to be a diabatic process in that as the wave front propagates outwards from the source, energy is converted to heat. The attenuation provided by this process is largely dependant on the relative humidity and temperature of the air through which the sound propagates.

Atmospheric attenuation is also frequency dependent, with attenuation increasing as a function of frequency. Table 6 summarises the octave band attenuation values used in our predictions.

Table 6
Octave band atmospheric attenuation coefficients

Description	Octave band mid frequency (Hz) 63	125	250	500	1k	2k	4k	8k
Atmospheric attenuation (dB/km)	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0

Source: Table 2 ISO9613-2:1996

The attenuation coefficients summarised in Table 6 have been calculated using 70% humidity, 10-degrees Celsius temperature and an atmospheric pressure of 101.325kPa. The humidity and temperature readings used are based on averages calculated from the WeatherPro weather station for the duration of the monitoring period.

A_{ground} – Ground Effect

The ISO9613-2:1996 standard describes three distinct ground surface types, namely hard, porous and mixed ground. The ground effect parameter input into the model uses a mixed ground assumption, that is, 50% acoustically hard and 50% acoustically soft ground at the source and receiver positions. Ground effect attenuation based on this assumption thus accounts for an average of 3dBA reduction in noise level calculated at each receiver.

A source height of 80m AGL (hub-height) and a receiver height of 1.5m AGL have also been used.

A_{screen} – Acoustic Screening

No barrier attenuation assumptions have been used within this model. It should be noted that attenuation due to topographic screening is inherently calculated by SoundPLAN from the digital terrain file.

A_{misc} – Miscellaneous Effects

No miscellaneous attenuation affects have been used within this model.

8.4 Predicted Results

Results of the predicted levels calculated in accordance with ISO9613-2:1996 are presented in Table 7 for $9ms^{-1}$ wind speed for Layouts A, B & C for the MM82 and MM92.

Table 7
Relevant receiver predicted levels (L_{Aeq}) in dBA re $2x10^{-5}$ Pa

Location	MM82			MM92		
	Layout A	Layout B	Layout C	Layout A	Layout B	Layout C
B08	37.5	37.5	37.5	36.4	36.5	36.5
B11	33.6	33.7	33.6	32.3	32.3	32.3
B12a	38.5	38.7	38.9	37.5	37.7	37.8
B13	35.3	35.8	36.1	33.9	34.3	34.7
B18	37.3	37.5	37.6	36.1	36.3	36.3
B26*	35.9	36	37.1	34.6	34.7	35.9
B27[W]	40.1	43.7	43.7	39.2	42.8	42.9
B29	35.7	37.4	37.6	34.4	36.2	36.4
B33*[W]	43.4	43.4	43.4	42.6	42.6	42.6
B53*	38.9	39.3	39.3	37.8	38.2	38.3
K01	37.6	36.3	38.1	36.6	35.1	37.1
K02*	39	39.2	39.2	38.1	38.3	38.3
G31	31.7	31.7	31.7	30.3	30.3	30.3
G37*	37.3	37.3	37.3	36.2	36.2	36.2
G39	34.8	34.8	34.8	33.5	33.5	33.5
PW07	40.5	40.5	40.5	39.6	39.6	39.6
PW09[W]	37.9	38	37.9	36.7	36.7	36.7

Please see Appendix H for predicted noise level versus noise limit plots for all assessed receiver locations. Appendix I shows predicted levels at each receiver relative to the associated compliance limits.

The predicted noise contour plots for the Kialla, Bannister, Pomeroy West and Gurrundah sites are presented in Appendix J.

Table 8 summarises the compliance status for each of the six scenarios.

Table 8

Layout	No. of WTG's	Turbine Model	Compliance at all receiver locations	Marginal Exceedance (<2dBA) at:
Layout A	77	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a
Layout B	81	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27
Layout C	84	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27 & K01

The results confirm compliance on all three layouts using the MM82 turbine and marginal compliance, within the error limits of the model, using the larger MM92 turbine.

It is appreciated that the final turbine selection has not been made and accordingly, further assessment is required to ensure compliance. However, this assessment concludes that the layout has the flexibility to be compliant with the SA Noise Guidelines across a range of turbines by slightly relocating turbines (within 250m), removing turbines or using active noise control functions of the turbines.

Additional background noise monitoring is proposed for B18a, B121a & B122a during the winter months of 2008 in order to more accurately determine the worst case existing ambient noise environment at these locations.

With respect to B9 which is an operational chicken farm, the 40dBA intensive rural noise limit (from the interim 2007 SA Guideline) has been applied.

It should be noted that the level excesses for the MM92 layout (Table 8) range from 0.6dBA to 1.6dBA, which is within the stated accuracy limits of +/- 3dBA of the prediction model and is below the threshold of perceptible noise increase (3dBA).

8.5 Sensitivity Analysis

A sensitivity analysis has been performed in order to objectively demonstrate that the physical dimensions and power output of wind turbines, as sought in the development proposal, are not determining factors in the modelling of noise impacts.

This sensitivity analysis tests the impact of height adjustments (hub height and maximum tip height) by modelling the MM92 turbine on a 90m hub (higher than is proposed) with a maximum tip height of 136m (again higher than proposed).

The analysis also models a 3MW turbine, the Vestas V90, which is representative of the upper range of power output and is the noisiest turbine in the group of turbines under consideration (see Addendum 3.0 for a comparison list of turbines). The turbines used in this analysis are as follows:

Table 9

Description	Turbine 1	Turbine 2
Make and Model	Vestas V90 3MW	REpower MM92
Comment	Mode 0	Evolution blade
Rotor Diameter (m)	90	92.5
Hub Height (m)	80	90
Blade Tip Height (m)	125	136.25
Rotor RPM	8.6 – 18.4	7.8 – 15.0
Cut-in Wind Speed (ms^{-1})	4	3.0
Rated Wind Speed (ms^{-1})	15.5	11.2
Cut-out Wind Speed (ms^{-1})	25.0	24.0
Sound Power L_{WA} ($9ms^{-1}$)	109.4	105.0

The results of the sensitivity analysis for each receiver location considered within this assessment are summarised in report Addenda 1.0 and 2.0.

The results show that noise propagation from the MM92 modelled at the upper limits of the physical dimensions (i.e. 90m hub height and 136m maximum tip height) of turbines under consideration is not significantly different from the MM92 modelling as presented in this report (i.e. 80m hub height and 126m maximum tip height).

The modelling of the V90, representative of the upper limits of power output and the single noisiest turbine under consideration, show that on the current layout (Layout C) mitigation would be required to be compliant with the SA guidelines.

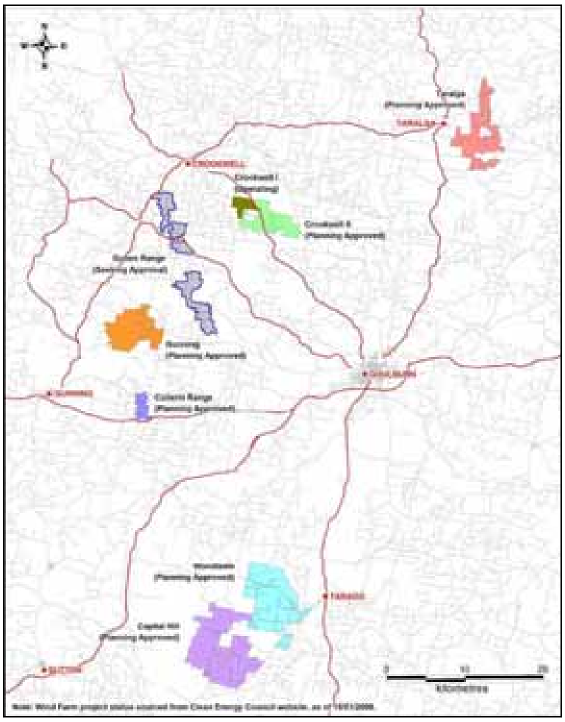
Where predicted levels in Addendum 1.0 indicate noise levels above limits determined in accordance with SA 2003 guidelines, the areas where mitigation is required will be achieved in the following ways:

- relocation of turbines
- removal of turbines
- using active noise control functions of turbines, for example "low operational noise" mode, which enables the sound power of selected turbines to be reduced at specific times of the day, wind directions and/or wind speeds.

8.6 Cumulative Effect of Other Wind Farm Developments

There is currently one active wind farm in addition to five sites with planning approval that are located within a 30km radius of Goulburn. Figure 18 summarises all sites.

Figure 18
Southern Tablelands wind farm sites



The cumulative impact of all adjacent wind farms has been assessed. An important parameter in this determination is the separation distance of one site from another. With respect to the proposed Gullen Range Wind Farm, the closest proposed and operational wind farms are as follows:

- Gunning – 7km
- Crookwell I – 9km
- Crookwell II – 8.5km
- Cullerin – 14km

In light of the above, the distances involved are sufficiently large (and the attenuation of sound pressure level sufficiently great) that predicted levels likely to occur as a result of adjacent wind farm operation will be negligible.

8.7 Transformer Noise Levels

Transformer noise has been assessed with the transformers located to the south of the existing 330kV transmission line, approximately 100m west of turbine POM_01. Figure 18 indicates the proposed location.

Figure 18
Proposed location of 330kV substation

Image courtesy of EPURON PTY LTD

The substation configuration consists of dual 33-330kV transformers with an estimated sound power level of 98dBA each (estimated according to Figure AA1 from Australian Standard AS2374.6-1994 -*Power transformers – Determination of transformer and reactor sound levels.* It should be noted that transformers of this nature display strong tonality at 100Hz.

Noise levels have been predicted for the dual transformer installation to the nearest dwelling located 875m to the south-west (PW07). Predicted noise levels, adjusted for tonality in accordance with Table 4.1 of the NSW Industrial Noise Policy, are expected to be approximately 24dBA. This level is below the existing ambient level in addition to the predicted cumulative level from the wind farm.

8.8 WTG Tonality Assessment

Where tonality is a characteristic of a WTG's frequency spectrum, the Guideline states that a 5dBA penalty should be added to the cumulative predicted results at each receiver location. Tests for tonality have been independently conducted in accordance with *IEC-61400-11* and the results of which have been supplied to Marshall Day Acoustics by EPURON.

For the wind speed range considered within this assessment, it is evident that tonality is not an audible component of either the MM82 or MM92's sound power spectra and therefore no penalty has been applied to the predicted results.

8.9 WTG Annoying Characteristics

The SA Guideline has been developed with the inherent noise characteristic from WTG's already taken into account. This includes aerodynamic noise from the blades passing through the air (commonly referred to as "swish").

With respect to infrasound, it is generally accepted that modern WTG design, with rotor blades located upwind of the main tower, do not exhibit significant levels of infrasound in their frequency spectra. In fact the levels have been shown to be significantly below the threshold limits of human hearing[4].

In light of these previous findings, no additional penalty has been applied to predicted results with respect to annoying characteristics.

8.10 Meteorological Assessment

Meteorological factors such as air stability, wind direction, temperature and humidity can have a marked effect on the propagation of sound from a noise source. Our noise predictions have been modelled based on the average site-specific winter temperature and humidity values. Additionally, the ISO9613-2:1996 propagation model predicts noise levels to all receivers based on down wind conditions in all directions. In light of this, our meteorological assessment has focussed on the effect of atmospheric stability and temperature effects on noise propagation.

Atmospheric Stability and Wind Profile

The vertical wind velocity profile (or shear exponent) describes a change in wind velocity as a function of height. Wind velocity is generally at a minimum at ground level and follows an isotropic increase with altitude up to the jet stream. The primary factors that determine the wind velocity profile are ground surface roughness (*z)*, (0.05 has been used within this assessment), topography and atmospheric stability.

Atmospheric stability is a measure of the degree to which the atmosphere resists turbulence and vertical motion. It is determined by the net heat flux to the ground, which is the sum of incoming solar and outgoing thermal radiation in addition to thermal exchange with the air and subsoil.

The concept of atmospheric stability can be further explained by considering the daily thermal exchange that occurs due to solar activity. During clear days the net flux is dominated by incoming solar radiation, heating the ground. Air is heated from below and rises, causing thermal turbulence and vertical air movement. As a result if this turbulence, the atmosphere is unstable, preventing significant changes in the vertical wind velocity profile over short distances.

[4] A McKenzie – Infra-sound, Low Frequency Noise & Vibration from Wind Turbines; AUSWIND 2004

At night the net flux is dominated by outgoing thermal radiation, resulting in cooling of the ground; the air is cooled from below. Vertical thermal turbulence reduces or stops, leading to a decoupling of horizontal layers of the air mass and thus creating greater changes in vertical wind profile over short distances.

van den Berg Effect

In 2003, Dr van den Berg undertook a study of the effect of stable air on wind farm noise emissions at the Rhede Wind Park located in the northwest of Germany near the Dutch border. He found that during periods where the air was highly stable (mostly at night) noise emissions from the wind farm increased significantly[5].

Dr van den Berg undertook a study of this kind at only one particular site with very specific topographical characteristics. The potential increase of noise levels due to stable air has become known as the eponymous "van den Berg effect" and has been raised on many other wind farm projects where the site has very different characteristics from the wind farm studied by Dr van den Berg.

The increase in noise emissions reported by Dr van den Berg is mostly due to an increase in air stability which leads to a change in wind profile (wind speed vs. height). As an example, for a constant wind speed at hub height, where the noise is generated, the wind speed at 10m can vary significantly. However, it is very difficult to quantify the change in wind speed at 10m in relation to the change in air stability.

As noise emissions from the wind farm are dependant on the wind speed at hub height, we have undertaken an additional noise impact assessment with wind speeds referenced at this height (using a surface roughness coefficient of 0.05m) in order to eliminate the potential effect of air stability on predicted noise levels. This assessment has been conducted on dwellings closest to the noise limit criteria and therefore provides a worst case scenario with respect to potential impact.

Results of this assessment are presented in Figure K1 to K4 of Appendix K. These results are not dependant on air stability and therefore not dependant on the "van den Berg effect".

The results indicate that noise emission levels from the wind farm will remain within noise limit criteria at receiver locations closest to the limit.

The issue of the van den Berg Effect was explored during the Taralga wind farm appeal heard by the Land and Environment Court of NSW[6] (LEC 2006). The judgement handed down by the court noted that the SA Guidelines adopted a very cautious approach to accommodate the impacts of any and all noise effects caused by wind farms by using a lower 35dBA limit instead of 40dBA, as adopted by New Zealand (NZS6808:1998).

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[5] G P van den Berg – Effects of the wind profile at night on wind turbine sound, Journal of Sound and Vibration, 2003.09.050

[6] Taralga Landscape Guardians Inc vs Minister for Planning and RES Southern Cross Pty Ltd(2007) NSWLEC59

A further observation was that if the van den Berg Effect did occur, it would be on a cold winters night when people were unlikely to be outside their dwellings and the façade effect (estimated at 10dBA) would reduce the transmission loss for exterior noise to the interior of the house.

The commissioner concluded:

> *I am satisfied that the combination of the low probability of occurrence of the van den Berg Effect, the small number of houses which would be impacted and the infrequent occasions when it did occur (if it did occur), does not warrant the extensive monitoring proposed.*

It was noted in the judgement that a precautionary approach to the possible (albeit low probability) occurrence of the van den Berg Effect would be to consider ameliorative action to those dwellings proven to be impacted by the phenomenon.

Temperature Inversions

As previously discussed, the SA EPA Guideline has been adopted as the sole basis for this noise impact assessment. The Guideline does not mention or advocate the inclusion of temperature inversion effects in the assessment. However, in light of the potential for inversions to increase noise levels generally, the phenomenon has been carefully considered in the context of wind farm noise.

In a temperature inversion, the vertical motion in the atmosphere is suppressed due to mild atmospheric conditions (calm and cool conditions that are generally experienced in winter time). Temperature inversions reverse the normal atmospheric temperature gradient i.e. temperature increases with height, rather than decreases. The resulting colder layer of air (in contact with the ground) is trapped beneath a warmer layer of air and can cause sound waves propagating from a sound source to be refracted downwards. This can lead to higher noise levels than would otherwise be the case.

We have looked to the NSW INP for guidance with respect to including temperature inversions within the assessment. The INP states:

> *If the frequency of temperature inversions during winter months is less than 30% of the total night-time (hours)…these effects are not considered significant and no additional assessment is needed.*

There is currently insufficient data to accurately determine the frequency of temperature inversions in the region. Feedback from the local community suggests that the phenomenon does occur, but the frequency of occurrence still remains unknown.

Irrespective of the above the ISO9613-2:1996 model allows for down wind propagation of sound in all directions, which is analogous to moderate temperature inversion conditions.

Additionally, our background noise monitoring campaign in the winter months of July and August has been timed to capture data during conditions likely to lead to temperature inversions (i.e. calm and cool conditions) and therefore can be considered worst case (quietest) conditions.

It should be noted that moderate inversions generally occur on cool and calm winter nights, with wind speed of <3ms^{-1}. This is below the proposed turbine cut-in wind velocity of 3-5 ms^{-1}.

Notwithstanding the above, if it is identified that elevated wind farm noise levels are occurring as a result of temperature effects then an adaptive management approach could be implemented.

9.0 SITE CONSTRUCTION NOISE IMPACT ASSESSMENT

9.1 Construction Site Noise Sources

Construction tasks associated with the project include the following:

- Access road construction
- Turbine tower foundation construction (It should be noted that some rock blasting may be required during the early part of the construction phase. This is covered in Section 6.4)
- Trench digging to accommodate underground cabling
- Assembly of turbine tower, nacelle and rotor blades.

Equipment required to complete the tasks outlined above include:

- Bulldozer, grader, excavator, dump trucks, roller, concrete trucks, front end loader, crane, blasting dynamite, pneumatic jack hammer etc
- Concrete batching plant (located on Pomeroy and Gurrundah sites)
- 4WD vehicles and flat-bed delivery trucks.

In order to predict noise levels associated with the construction phase, we have used measurement data from previous projects of a similar nature in addition to data obtained from our noise source database. Table 10 summarises the sound power levels used within this assessment.

Table 10
Construction equipment (L_{10}) sound power levels in dB, re 10^{-12} W

	Octave band mid frequency							
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**dBA**
Excavator	121	126	111	107	106	101	96	113
Grader	118	124	115	114	115	114	113	120
Dump truck	111	105	108	106	107	104	99	111
Rock breaking	113	115	117	122	121	120	118	126
Concrete truck	104	101	96	95	94	93	91	100
Front end loader	120	117	101	101	92	88	88	104
Crane	108	105	109	107	111	105	97	113
Bulldozer	113	119	110	109	110	109	108	115
Concrete batching	100	97	92	91	90	89	87	96
Delivery trucks	118	110	99	104	99	95	91	105
4WD vehicles	96	92	88	84	84	80	75	88

9.2 Construction Site Noise Limits

As detailed in Section 5.3, it is considered appropriate to allow the construction noise level when measured over a 15-minute period ($L_{A10,\ 15min}$) to exceed the background level (L_{A90}) by up to 20dBA.

Background noise levels for the day period have been determined in accordance with the procedure detailed in Table 3.1 *Methods for determining background noise* from the *NSW Industrial Noise Policy (INP)*. (Section 9.3 Table 11 summarises the background noise level for each site).

It will be a requirement that all construction companies and construction sub-contractors will comply with the noise limits outlined in Section 9.3 Table 11.

9.3 Construction Noise Assessment

Noise levels associated with the construction of each turbine installation have been predicted based on the sound power levels summarised in Section 9.1 Table 10.

We have predicted noise levels at each relevant receiver location based on a 15-minute assessment period, which is in line with the monitoring period outlined within the *NSW Industrial Noise Policy.*

Table 11 summarises the predicted noise levels at each relevant receiver location.

Table 11
Predicted noise levels at each relevant receiver location

	Predicted Noise Level (L_{10}) in dBA						
Location	Background Noise Level	Limit L_{90}+ 20 dBA	Access Road Construction	Turbine Foundation Construction	Cable Trench Digging	WTG Assembly	Concrete Batching
B08	36	56	35	39	24	34	2
B11	27	50	31	35	20	30	7
B12a	34	54	36	40	25	35	-
B13	30	50	31	36	20	30	-
B18	29	50	33	37	22	32	-
B26*	27	50	31	35	20	30	-
B27^W	35	55	38	43	27	37	-
B29	32	52	33	38	22	32	-
B33*^W	30	50	42	46	30	40	1
B53*	32	52	38	42	26	36	-
K01	32	52	36	41	25	35	-
K02*	31	51	37	42	26	36	-
G31	36	56	32	36	21	31	7
G37*	32	52	37	42	26	36	7
G39	27	50	31	36	20	30	14
PW07	29	53	37	42	26	36	22
PW09^W	40	60	34	38	22	32	15

From the results summarised in Table 11, it can be seen that noise levels associated with the construction of the wind farm are expected to comply with noise limits set in accordance with the DECC *Environmental Noise Control Manual.*

9.4 Construction Noise Control Measures

With regard to construction activities, reference should be made to *AS2436 – 1981: Guide to noise control on construction, maintenance and demolition sites*, which offers detailed guidance on the control of noise and vibration from demolition and construction activities. In particular, it is proposed that various practices be adopted during construction, including:

- Limiting the hours during which site activities are likely to create high levels of noise or vibration
- Establishing channels of communication between the contractor/developer, Local Authority and residents
- Appointing a site representative responsible for matters relating to noise and vibration
- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations
- All site access roads will be kept even so as to mitigate the potential for vibration from trucks.

Furthermore, it is envisaged that a variety of practicable noise control measures will be employed. These may include:

- Selection of machinery with low inherent potential for generation of noise and/or vibration
- Erection of barriers as necessary around items such as generators or high duty compressors
- Siting of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary.

9.5 Blasting Assessment

Should bedrock be encountered during foundation excavation, it is possible that blasting may be required during the construction phase. No site specific blasting data is available at this stage however we understand that the minimum distance between blasting and residences is likely to be 550m. At this distance a blast with a maximum instantaneous charge (MIC) of 15-18kg is unlikely to exceed the limits detailed in Section 5.4.

10.0 CONCLUSION

- Marshall Day Acoustics Pty Ltd has performed a noise impact assessment against noise limit criteria determined in accordance with the South Australia EPA's *Environmental Noise Guidelines: Wind Farms (2003)*
- Noise levels from the wind farm have been predicted for 89 noise sensitive receivers for six alternative layouts:

Layout	No. of WTG's	Turbine Model	Compliance at all receiver locations	Marginal Excess (<2dBA) at:
Layout A	77	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a
Layout B	81	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27
Layout C	84	MM82	Yes	
		MM92	Marginal compliance	B09, B18a, B121a, B122a, B27 & K01

- All layouts for the MM82 comply with SA Guideline criteria
- Marginal excesses have occurred at B09, B18a, B121a & B122a for all MM92 layouts in addition to B27 for Layout B & C and K01 for Layout C
- We recommend that background noise monitoring should be carried out at B18a, B121a & B122a in order to determine the existing ambient noise environment at these locations and to fully confirm the noise limit criteria
- B18a, B27, B121a & B122a have the option to become involved with the project if necessary
- With respect to B9, which is an operational chicken farm, the 40dBA intensive rural noise limit (from the interim 2007 SA Guideline) has been applied
- It should be noted that the levels of marginal excess for the MM92 layout range between 0.6dBA to 1.6dBA, which is within the stated accuracy limit of the model (+/- 3dBA) and is below the threshold of perceptible noise increase at 3dBA
- No penalty has been applied to predicted results due to wind turbine generator annoying characteristics, namely infrasound and tonality
- A hub-height assessment has indicated that predicted levels will remain within noise limit criteria

- Additional analysis of the sensitivity of the physical dimensions and rated power output of the turbines under consideration was undertaken to demonstrate that these parameters did not significantly increase noise propagation to receivers
- A potential worst case noise impact based on the turbine with the highest sound power levels (the V90) identified that mitigation would be required to achieve compliance if this turbine was ultimately used
- Predictions using the ISO9613-2:1996 noise propagation standard allow for down wind propagation in all directions, which is analogous to moderate temperature inversion conditions
- Construction noise has been predicted to each receiver location with the results indicating that noise levels will be within predetermined limits
- Transformer noise has been predicted to the closest noise sensitive receiver location (PW07) and has been found to be of an acceptable level.

Figure F5 – B18 measurement location relative to dwelling

Figure F6 – B26 measurement location relative to dwelling

Figure F7 – B27 measurement location relative to dwelling

Figure F8 – B29 measurement location relative to dwelling

Figure F9 – B33 measurement location relative to dwelling

Figure F10 – B53 measurement location relative to dwelling

Figure F11 – K1 measurement location relative to dwelling

Figure F12 – K2 measurement location relative to dwelling

Figure F5 – B18 measurement location relative to dwelling

Figure F6 – B26 measurement location relative to dwelling

Figure F7 – B27 measurement location relative to dwelling

Figure F8 – B29 measurement location relative to dwelling

Figure F9 – B33 measurement location relative to dwelling

Figure F10 – B53 measurement location relative to dwelling

Figure F11 - K1 measurement location relative to dwelling

Figure F12 - K2 measurement location relative to dwelling

Figure F13 – G31 measurement location relative to dwelling

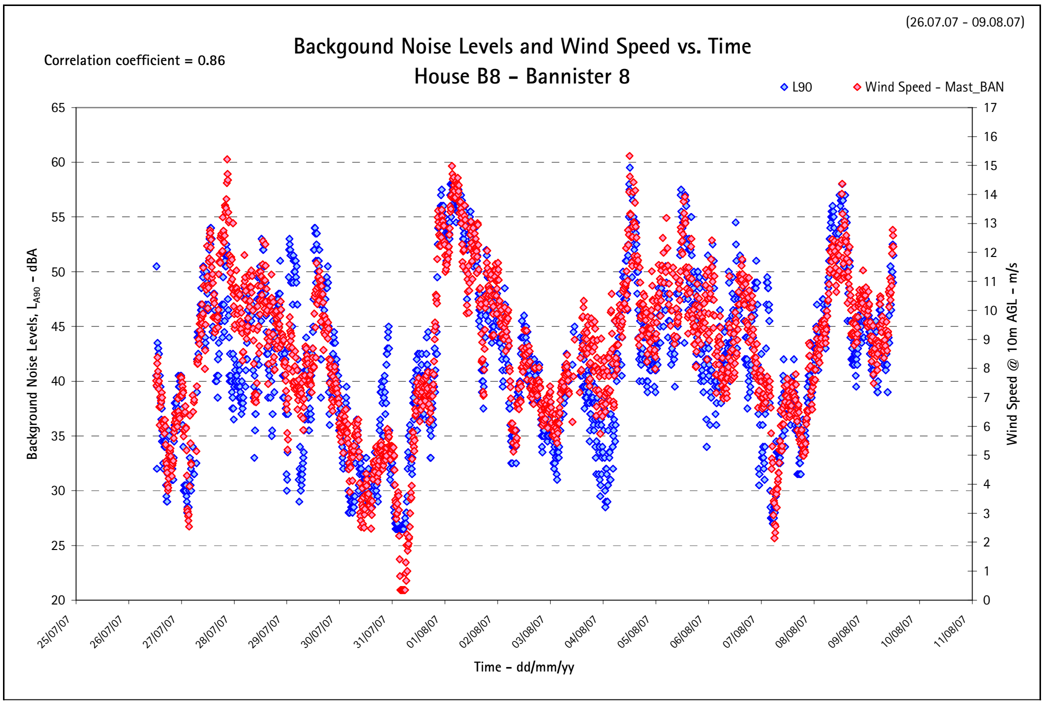
Figure F14 – G37 measurement location relative to dwelling

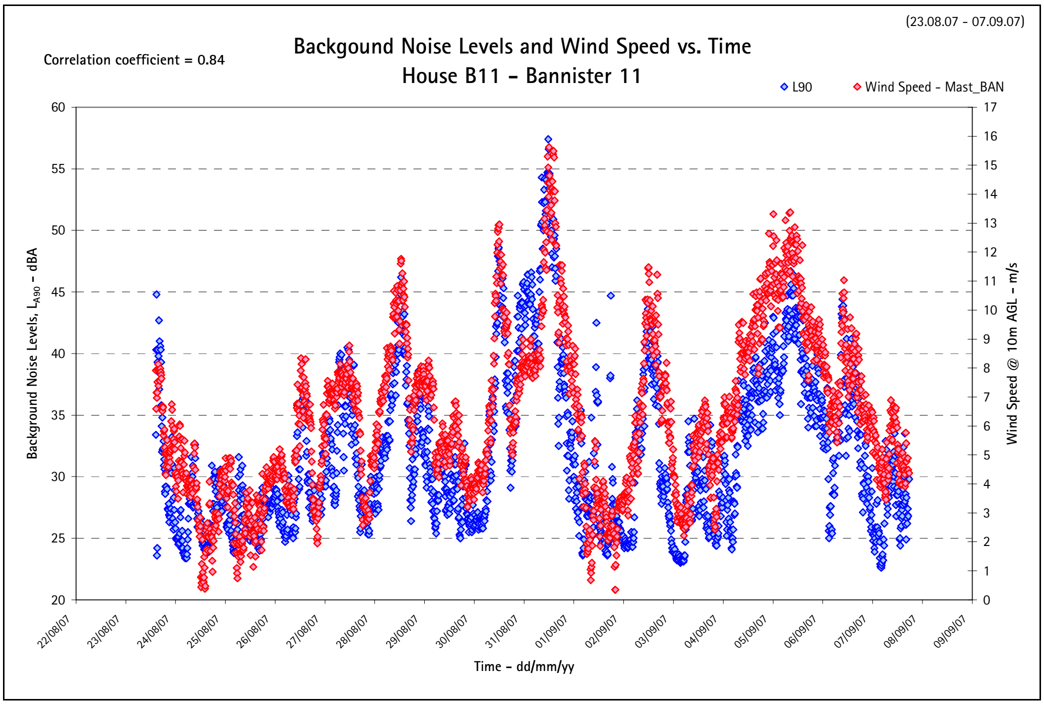
Figure F15 – G39 measurement location relative to dwelling

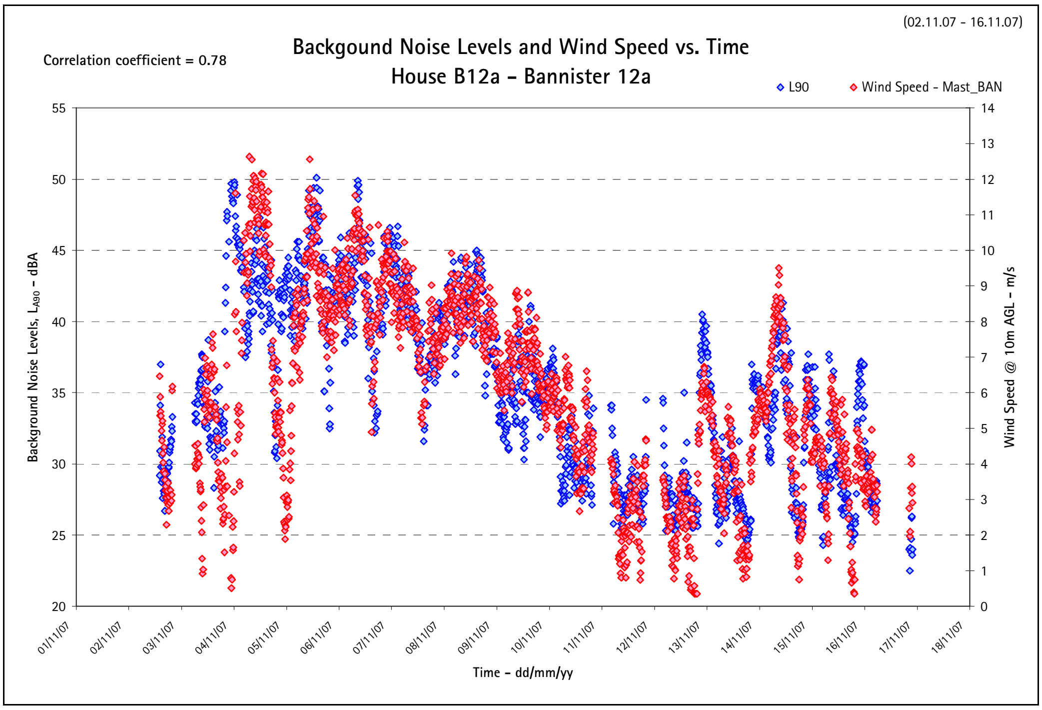
Figure F16 – P07 measurement location relative to dwelling

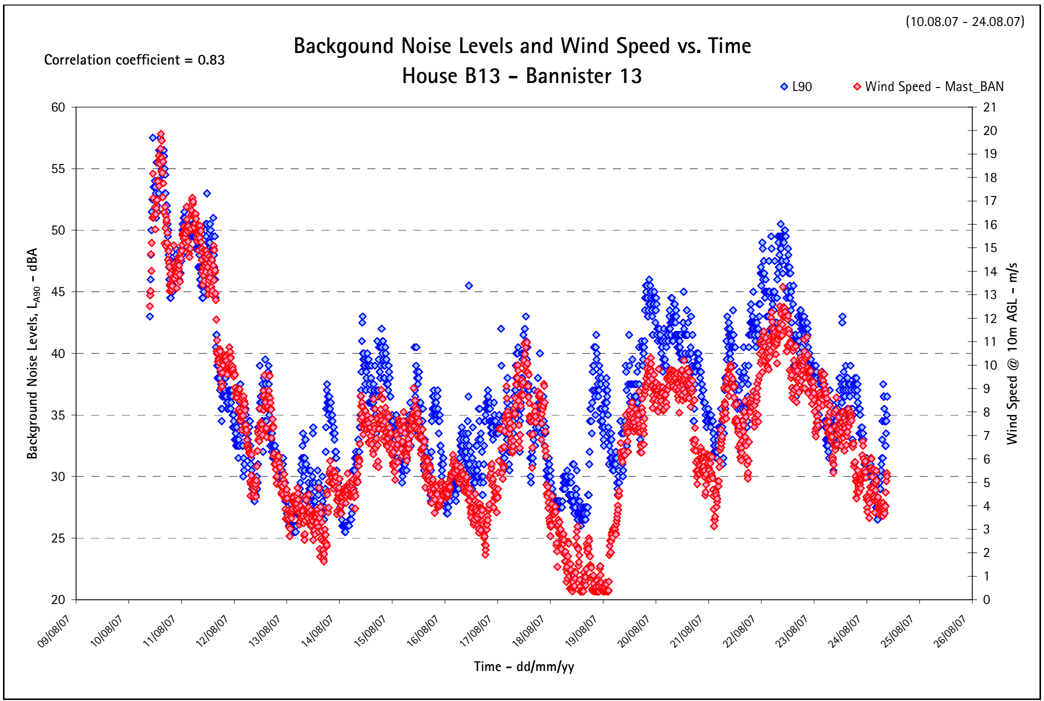
Figure F17 – PW09 measurement location relative to dwelling

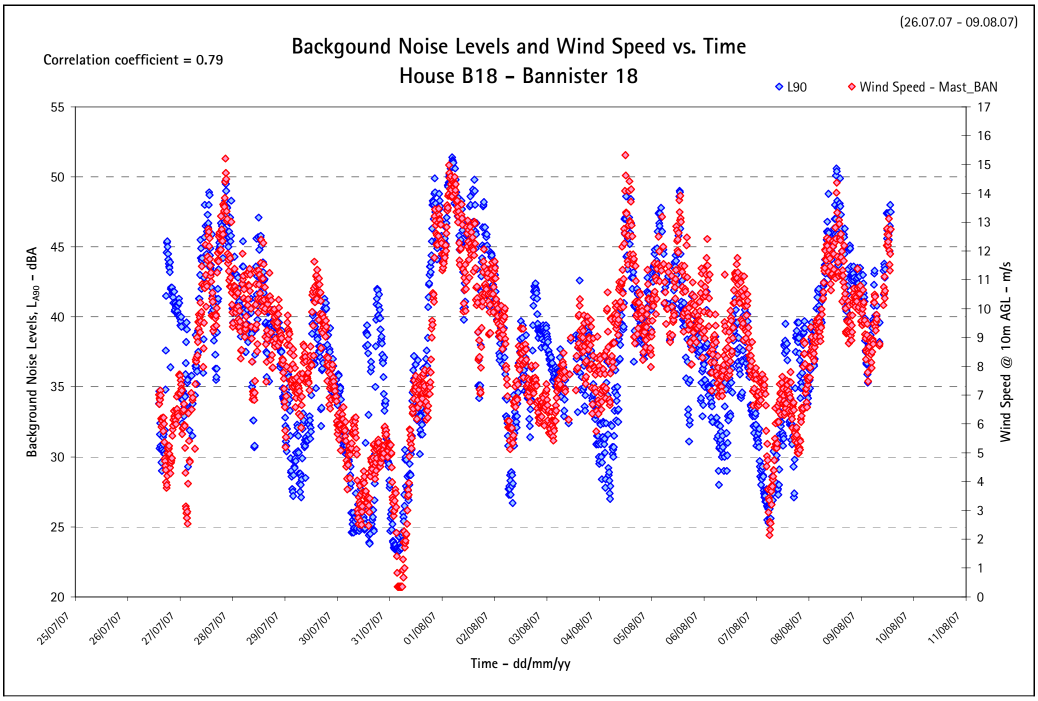
APPENDIX G
MEASURED BACKGROUND NOISE LEVEL VS WIND SPEED

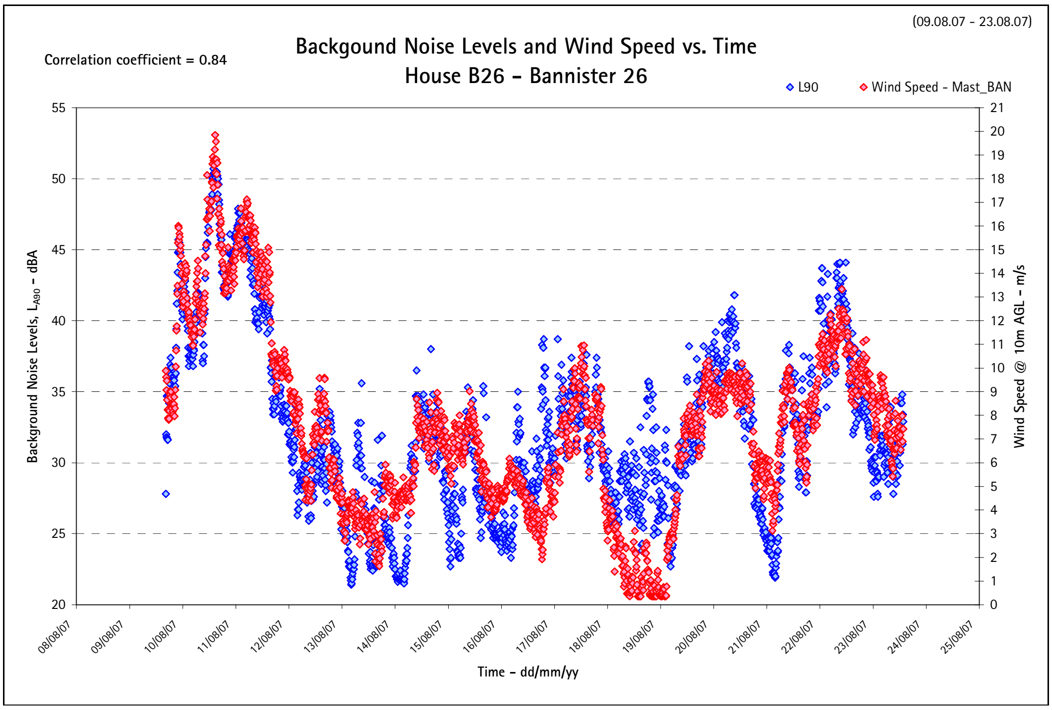


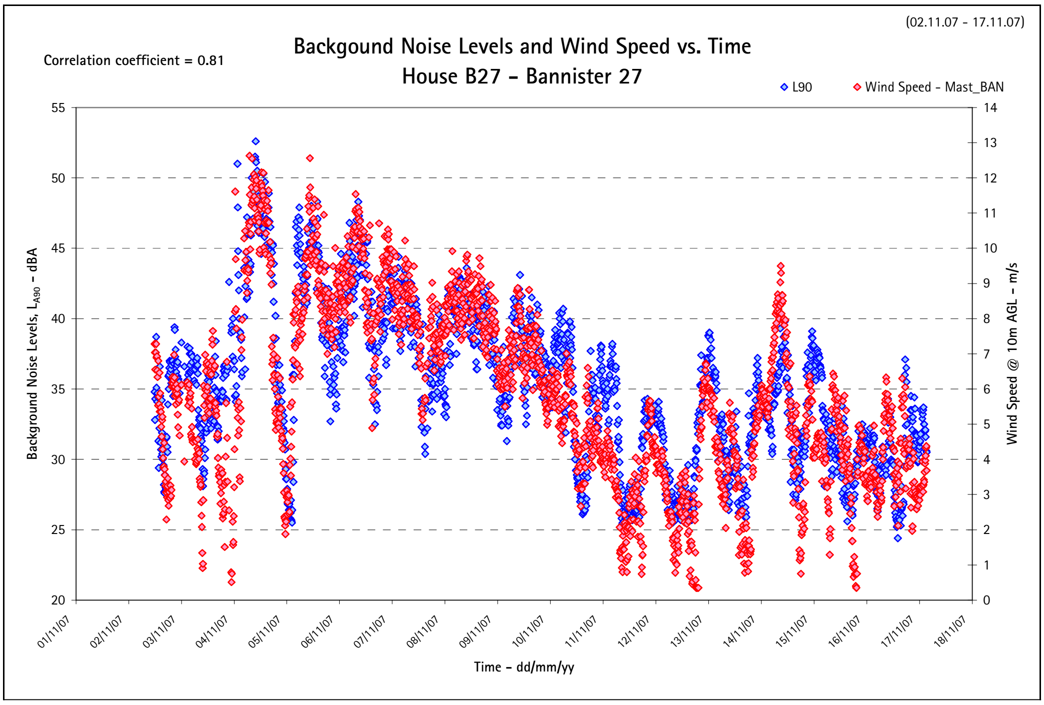


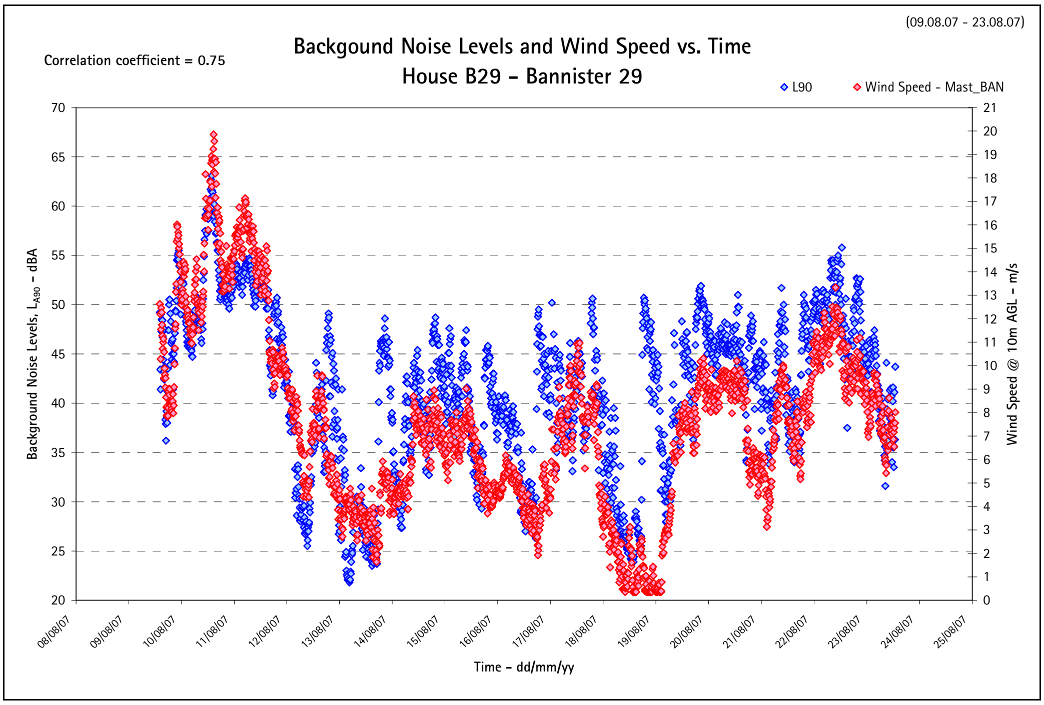

(02.11.07 - 16.11.07)
Correlation coefficient = 0.78
Backgound Noise Levels and Wind Speed vs. Time
House B12a - Bannister 12a
L90
Wind Speed - Mast_BAN
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(10.08.07 - 24.08.07)
Correlation coefficient = 0.83
Backgound Noise Levels and Wind Speed vs. Time
House B13 - Bannister 13
L90
Wind Speed - Mast_BAN
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy

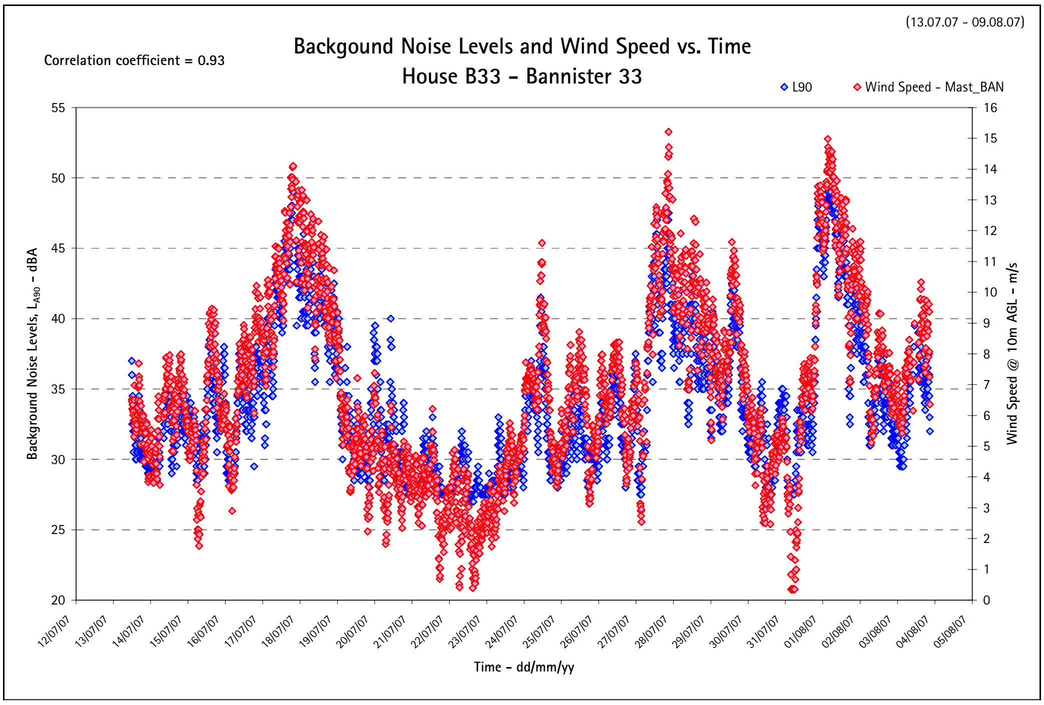

(26.07.07 - 09.08.07)
Correlation coefficient = 0.79
Backgound Noise Levels and Wind Speed vs. Time
House B18 - Bannister 18
L90
Wind Speed - Mast_BAN
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
55
50
45
40
35
30
25
20
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
25/07/07
26/07/07
27/07/07
28/07/07
29/07/07
30/07/07
31/07/07
01/08/07
02/08/07
03/08/07
04/08/07
05/08/07
06/08/07
07/08/07
08/08/07
09/08/07
10/08/07
11/08/07
Time - dd/mm/yy

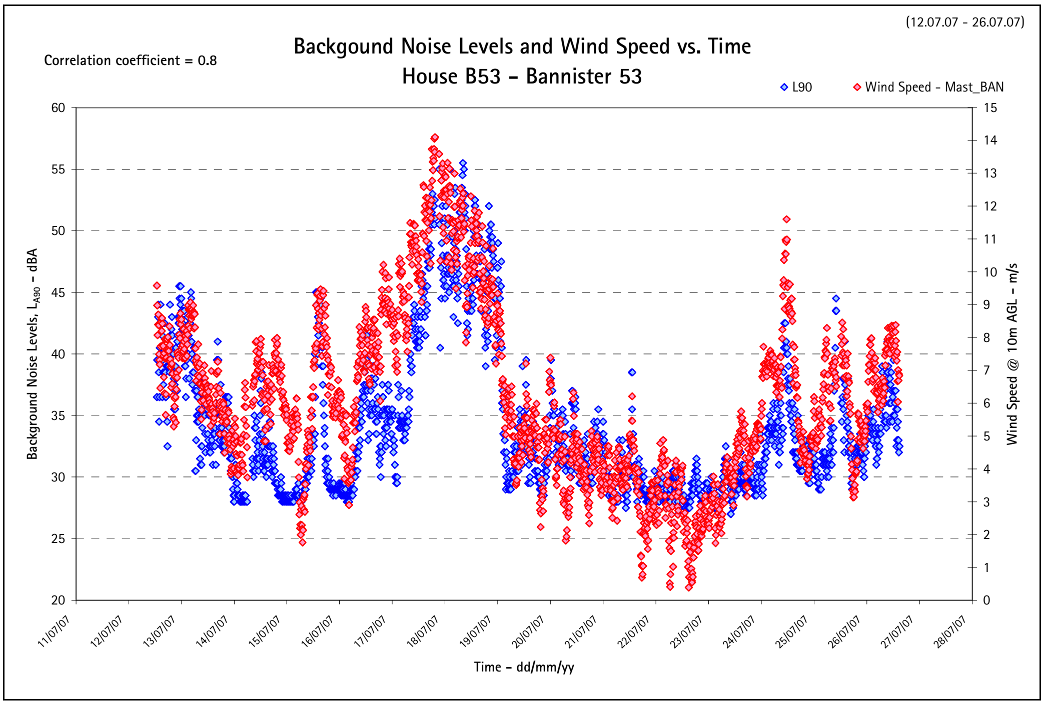

(09.08.07 - 23.08.07)
Correlation coefficient = 0.84
Backgound Noise Levels and Wind Speed vs. Time
House B26 - Bannister 26
L90
Wind Speed - Mast_BAN
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
55
50
45
40
35
30
25
20
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
08/08/07
09/08/07
10/08/07
11/08/07
12/08/07
13/08/07
14/08/07
15/08/07
16/08/07
17/08/07
18/08/07
19/08/07
20/08/07
21/08/07
22/08/07
23/08/07
24/08/07
25/08/07
Time - dd/mm/yy

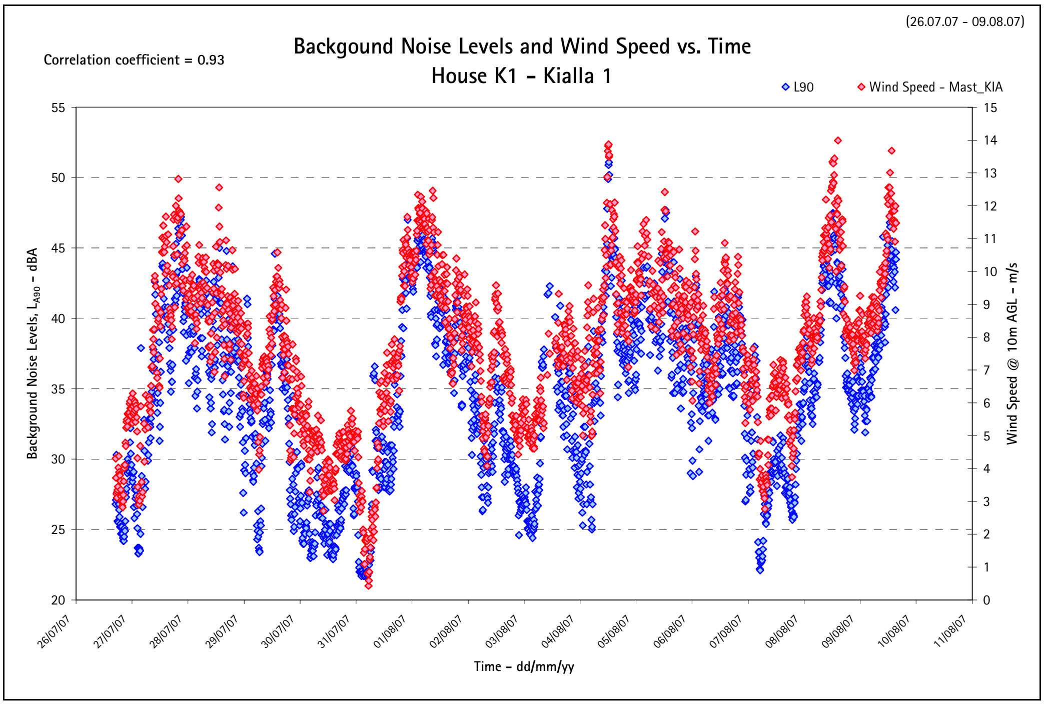

(02.11.07 - 17.11.07)
Backgound Noise Levels and Wind Speed vs. Time
House B27 - Bannister 27
Correlation coefficient = 0.81
L90
Wind Speed - Mast_BAN
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy

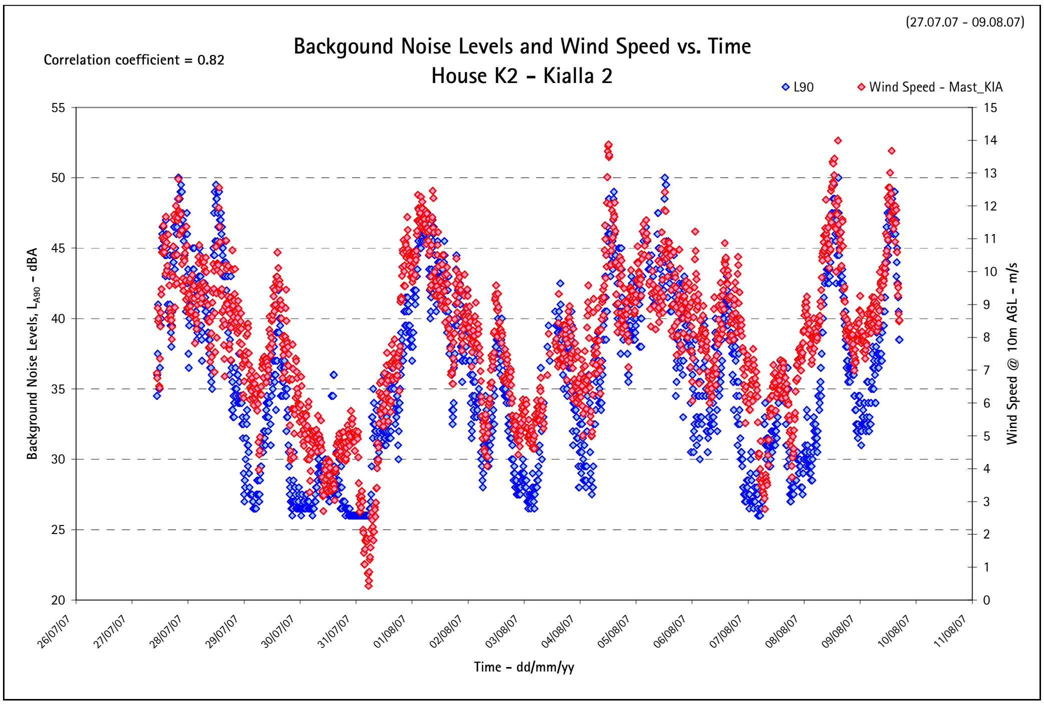

(09.08.07 - 23.08.07)
Backgound Noise Levels and Wind Speed vs. Time
House B29 - Bannister 29
Correlation coefficient = 0.75
L90
Wind Speed - Mast_BAN
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy

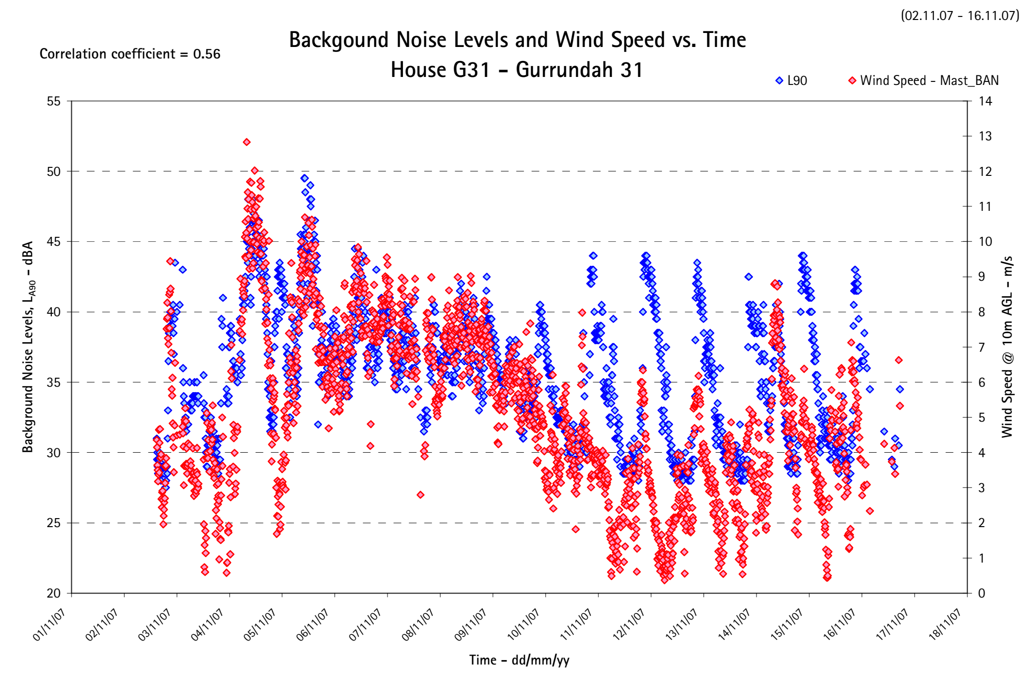
MARSHALL DAY Acoustics






(26.07.07 - 09.08.07)
Correlation coefficient = 0.93
Backgound Noise Levels and Wind Speed vs. Time
House K1 - Kialla 1
L90
Wind Speed - Mast_KIA
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(27.07.07 - 09.08.07)
Correlation coefficient = 0.82
Backgound Noise Levels and Wind Speed vs. Time
House K2 - Kialla 2
L90
Wind Speed - Mast_KIA
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(02.11.07 - 16.11.07)
Correlation coefficient = 0.56
Backgound Noise Levels and Wind Speed vs. Time
House G31 - Gurrundah 31
L90
Wind Speed - Mast_BAN
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
55
50
45
40
35
30
25
20
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
01/11/07
02/11/07
03/11/07
04/11/07
05/11/07
06/11/07
07/11/07
08/11/07
09/11/07
10/11/07
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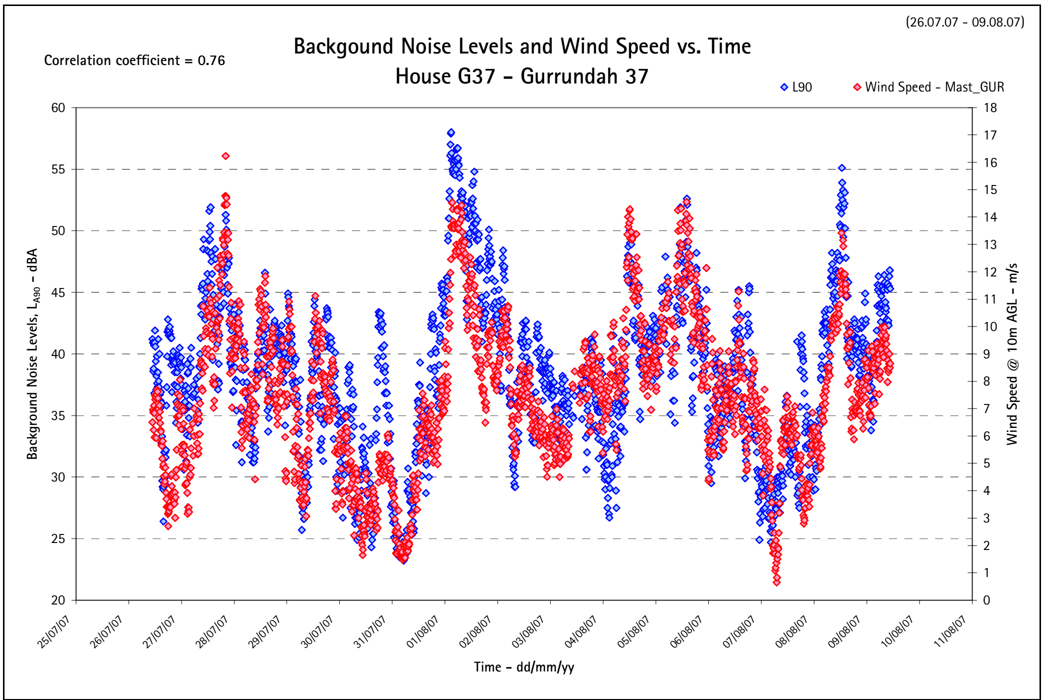
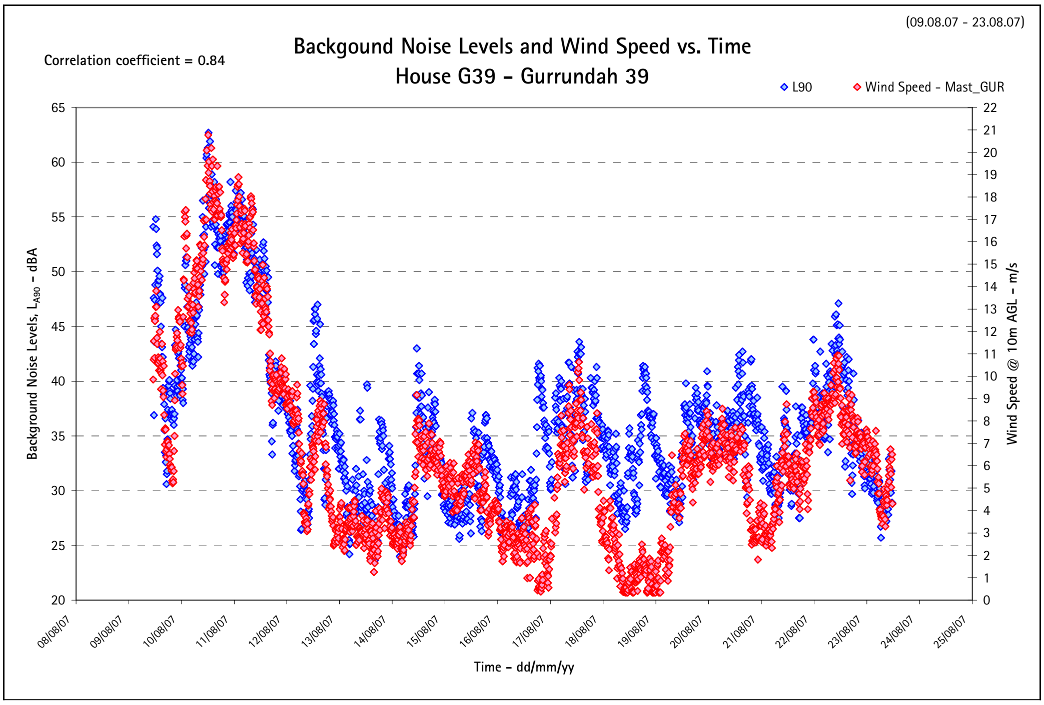
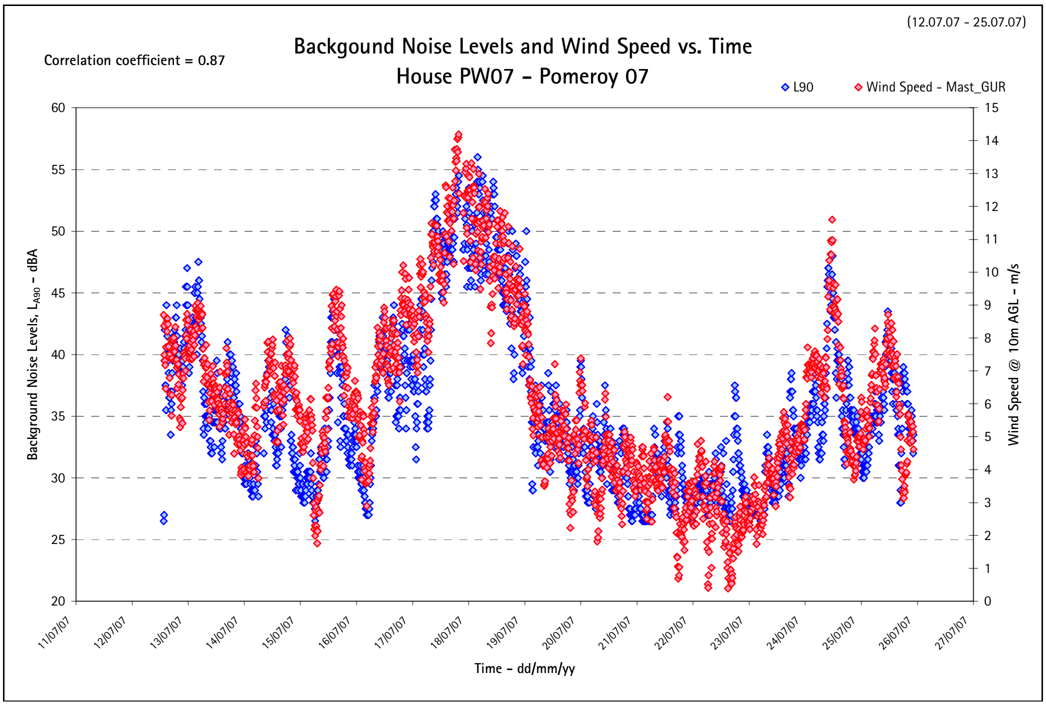
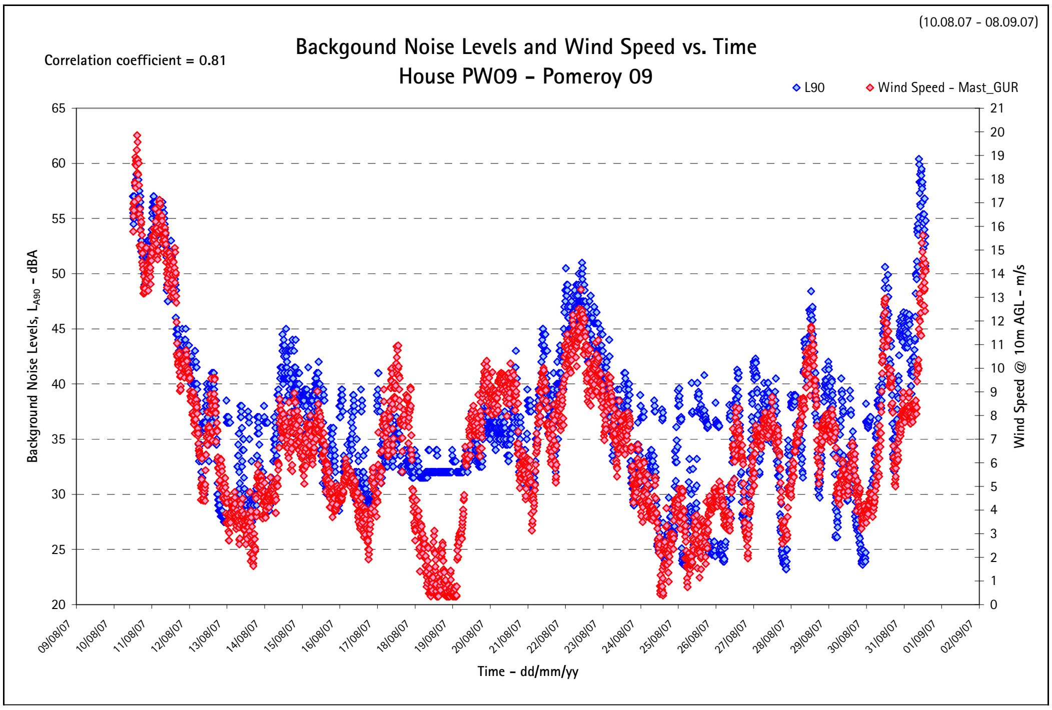
16/11/07
17/11/07
18/11/07


(26.07.07 - 09.08.07)
Correlation coefficient = 0.76
Backgound Noise Levels and Wind Speed vs. Time
House G37 - Gurrundah 37
L90
Wind Speed - Mast_GUR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
60
55
50
45
40
35
30
25
20
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
25/07/07
26/07/07
27/07/07
28/07/07
29/07/07
30/07/07
31/07/07
01/08/07
02/08/07
03/08/07
04/08/07
05/08/07
06/08/07
07/08/07
08/08/07
09/08/07
10/08/07
11/08/07

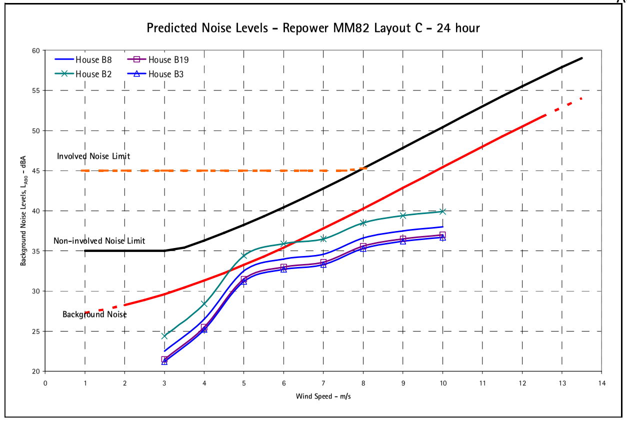
MARSHALL DAY Acoustics

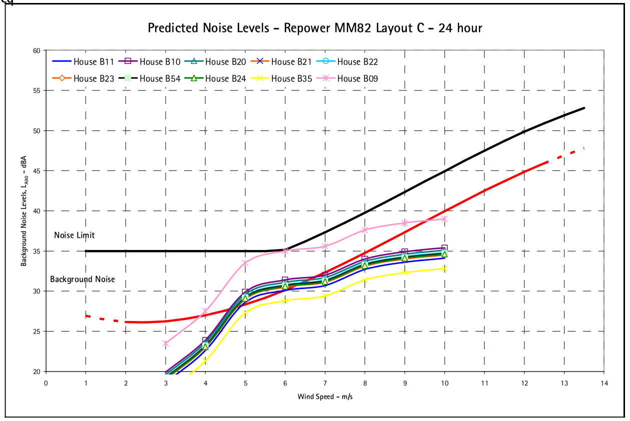


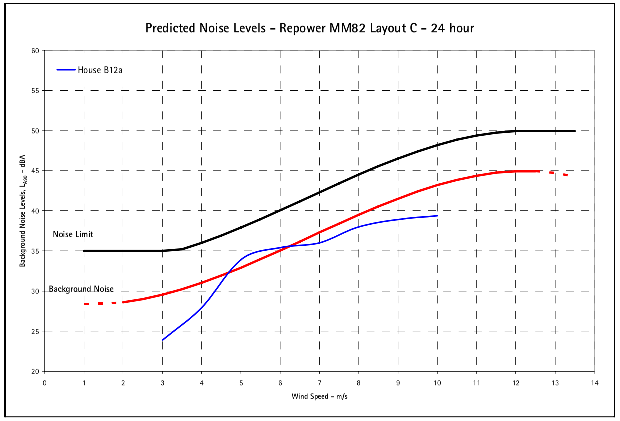


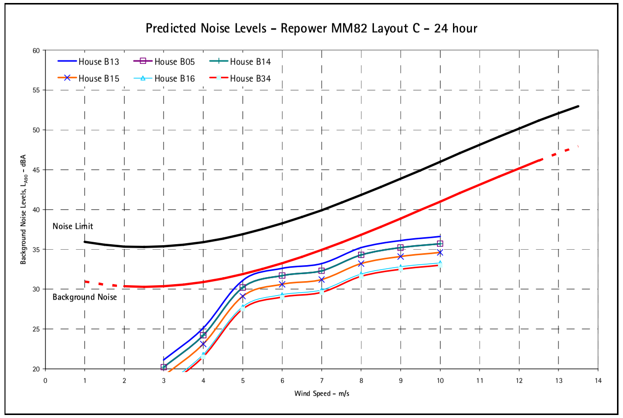

(10.08.07 - 08.09.07)
Correlation coefficient = 0.81
Backgound Noise Levels and Wind Speed vs. Time
House PW09 - Pomeroy 09
L90
Wind Speed - Mast_GUR
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
65
60
55
50
45
40
35
30
25
20
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
09/08/07
10/08/07
11/08/07
12/08/07
13/08/07
14/08/07
15/08/07
16/08/07
17/08/07
18/08/07
19/08/07
20/08/07
21/08/07
22/08/07
23/08/07
24/08/07
25/08/07
26/08/07
27/08/07
28/08/07
29/08/07
30/08/07
31/08/07
01/09/07
02/09/07
Time - dd/mm/yy

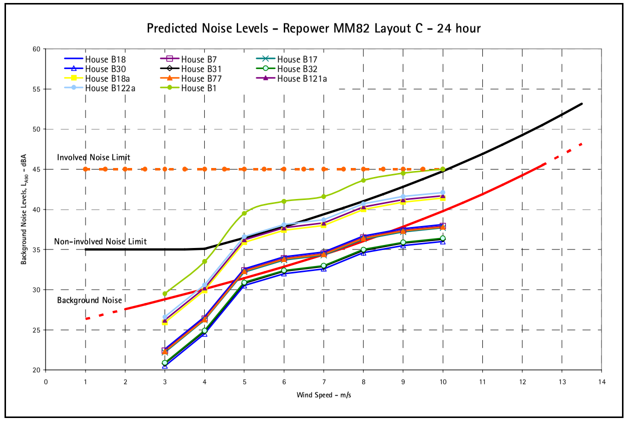
APPENDIX H
RELEVANT RECEIVER PREDICTED NOISE LEVELS (L_{Aeq})

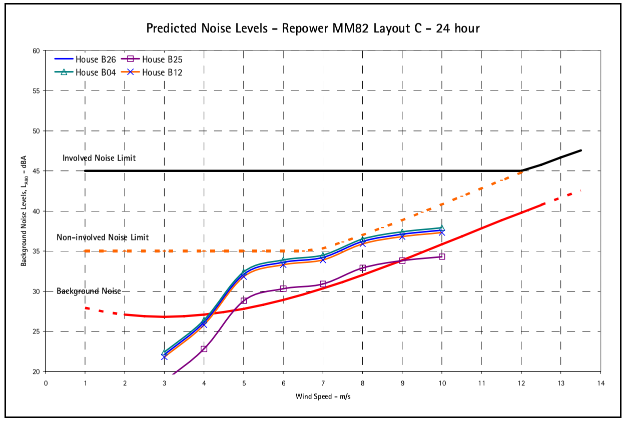




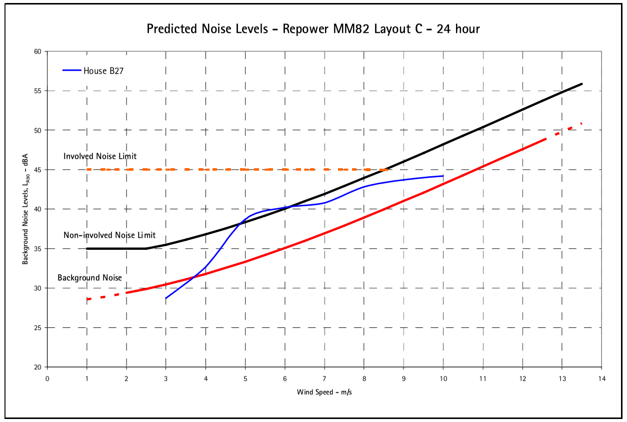


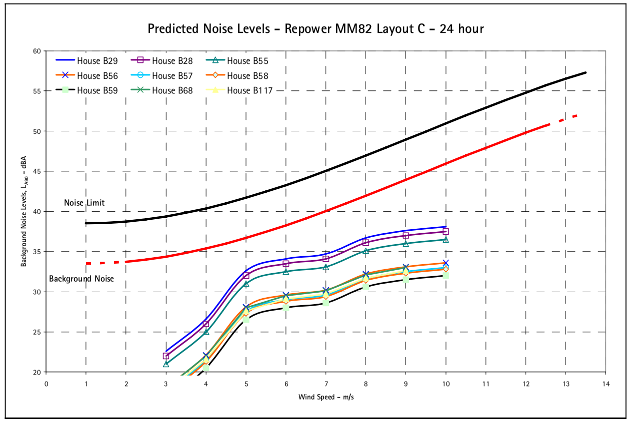


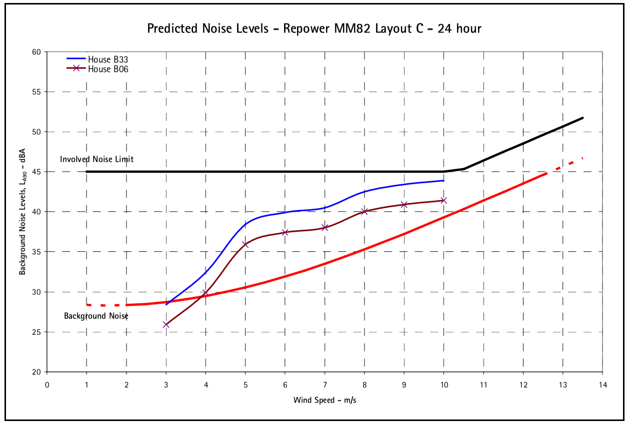


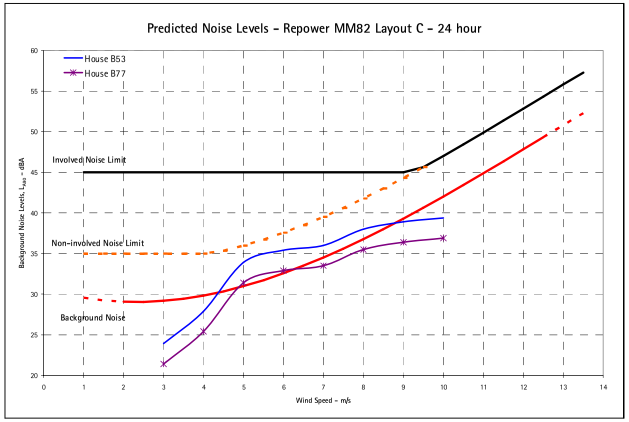


MARSHALL DAY Acoustics

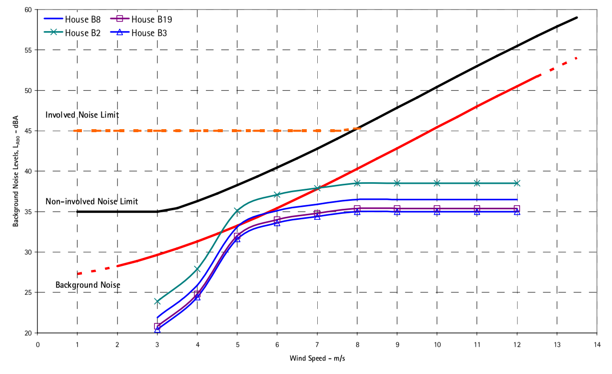




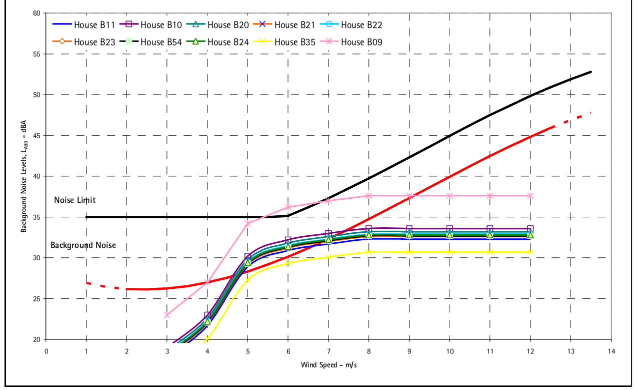




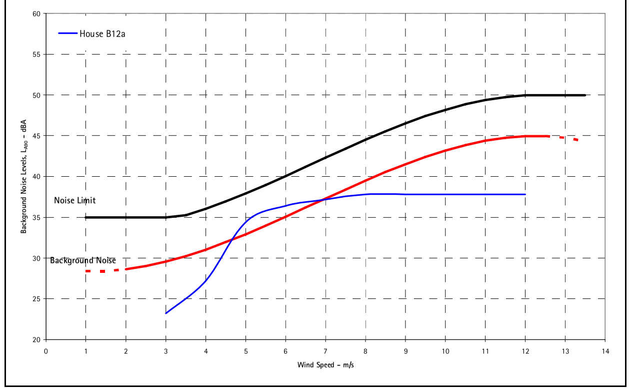
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour



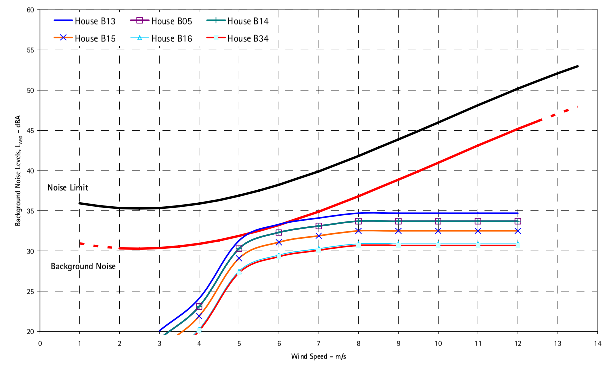
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour



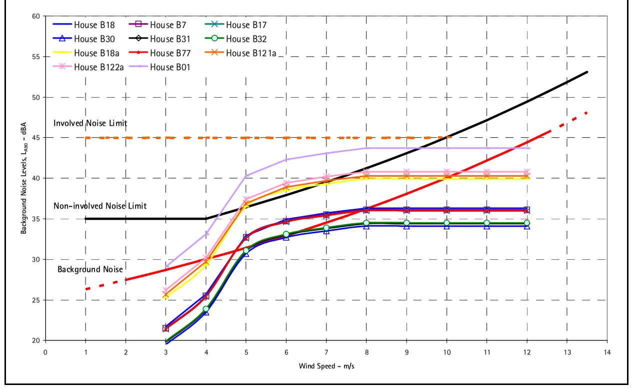
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour



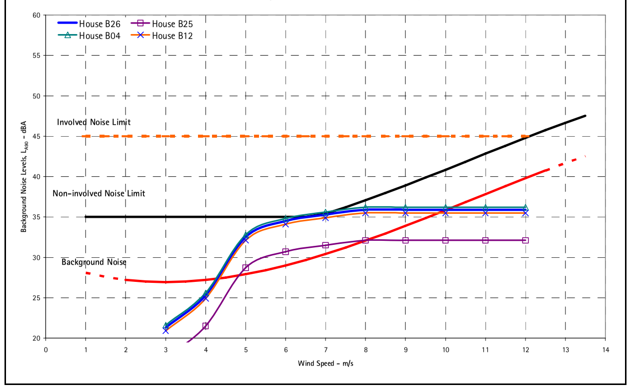
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour

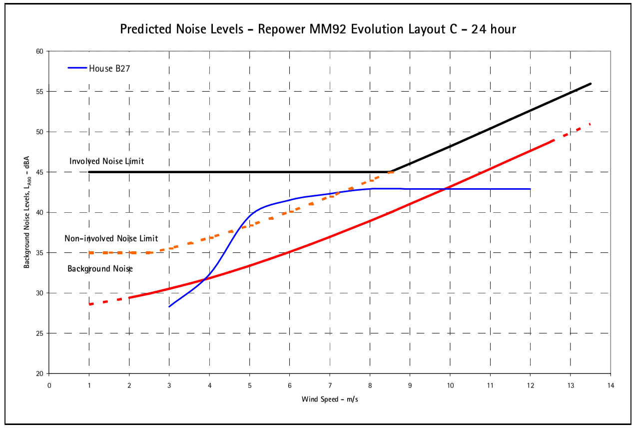


Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour

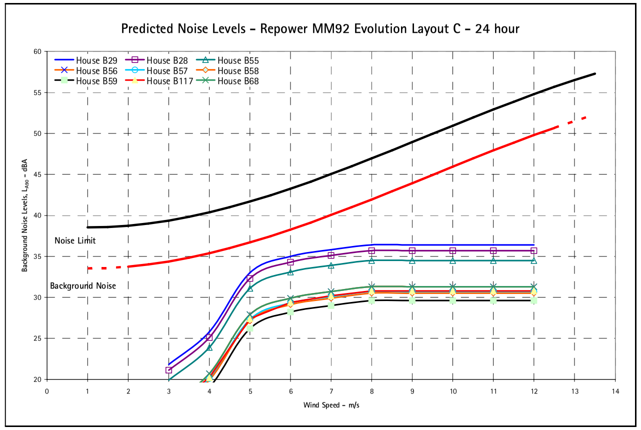


Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour

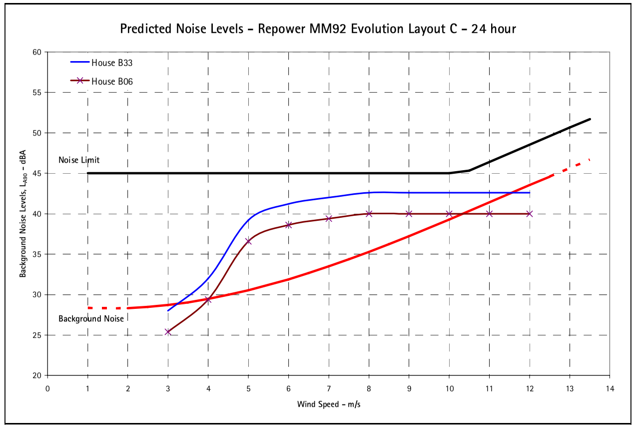




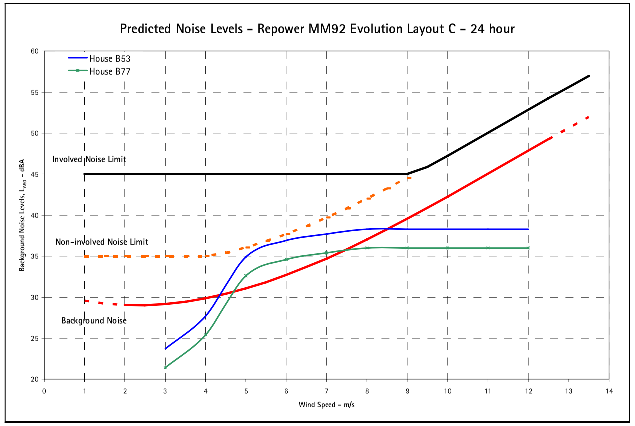
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House B27
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s



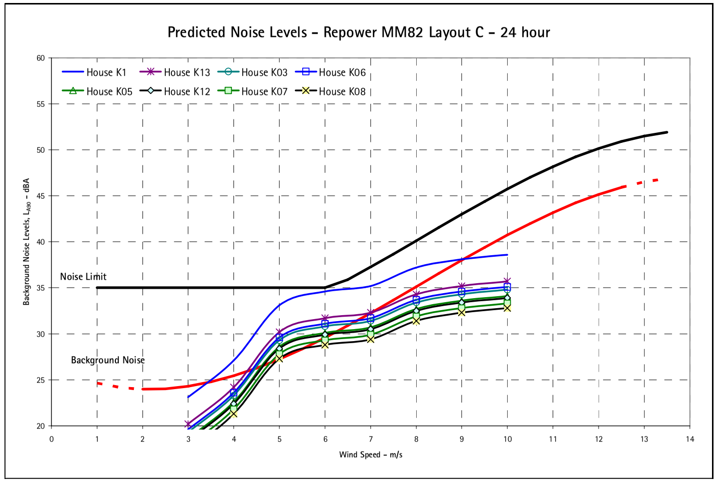
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House B29
House B28
House B55
House B56
House B57
House B58
House B59
House B117
House B68
Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s



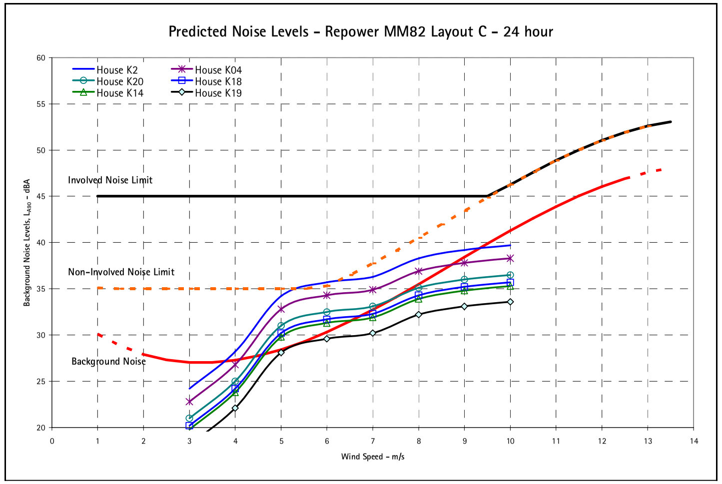
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House B33
House B06
Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s



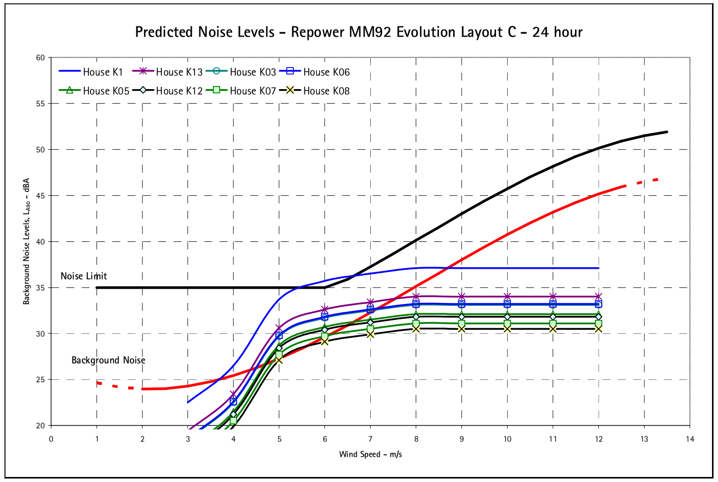
Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House B53
House B77
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s



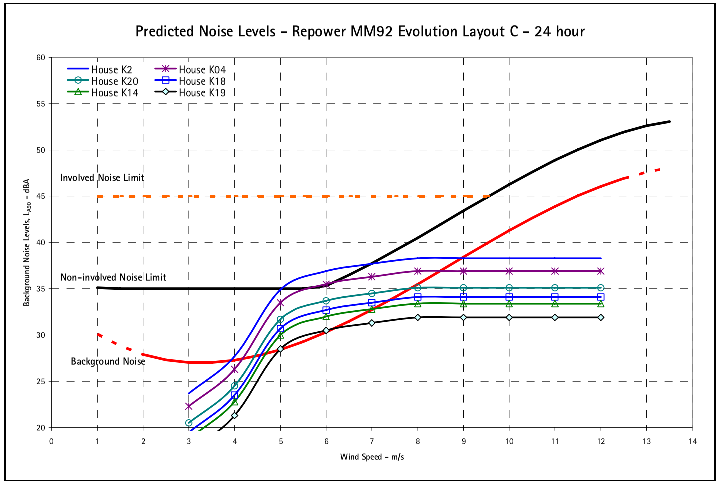
Predicted Noise Levels - Repower MM82 Layout C - 24 hour
House K1
House K13
House K03
House K06
House K05
House K12
House K07
House K08
Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s



Predicted Noise Levels - Repower MM82 Layout C - 24 hour
House K2
House K20
House K14
House K04
House K18
House K19
Involved Noise Limit
Non-Involved Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s

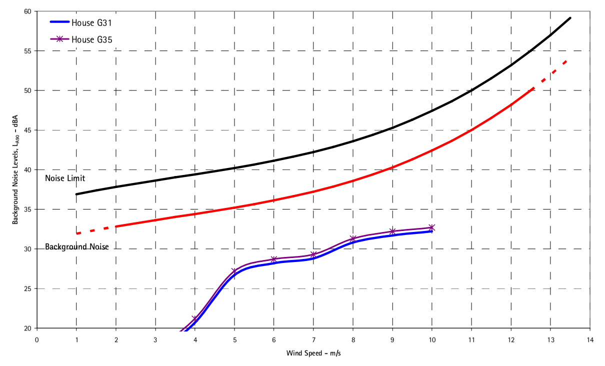


Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House K1
House K13
House K03
House K06
House K05
House K12
House K07
House K08
Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s

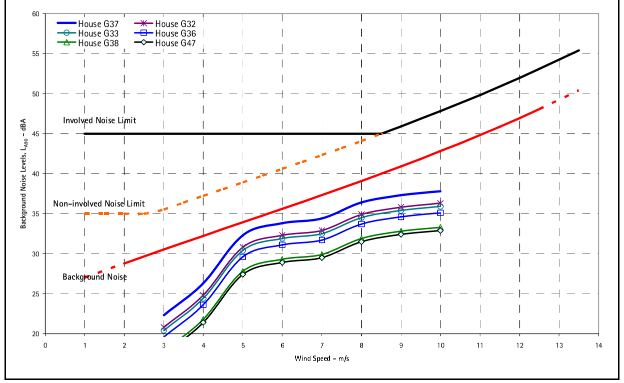


Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House K2
House K20
House K14
House K04
House K18
House K19
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s

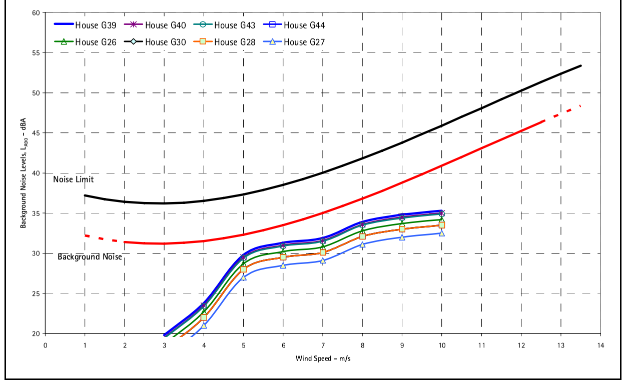
Predicted Noise Levels – Repower MM82 Layout C – 24 hour



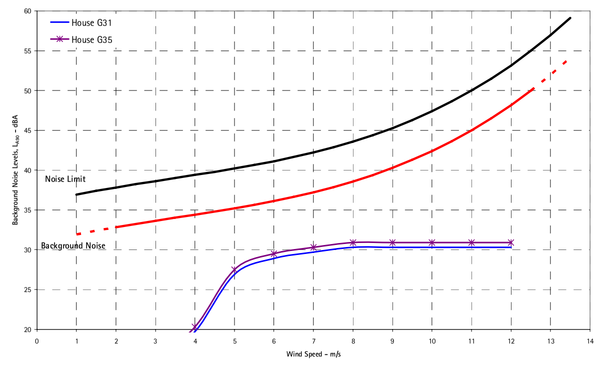
Predicted Noise Levels – Repower MM82 – 24 hour



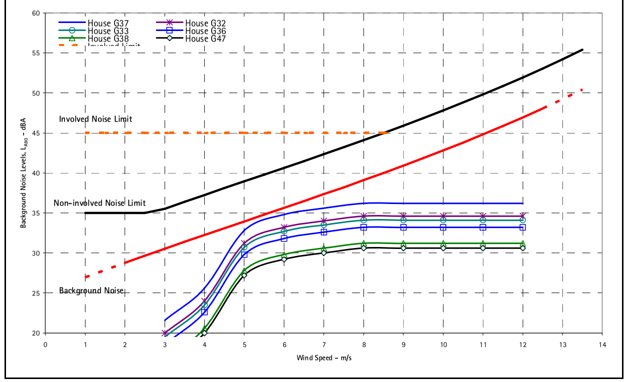
Predicted Noise Levels – Repower MM82 Layout C – 24 hour



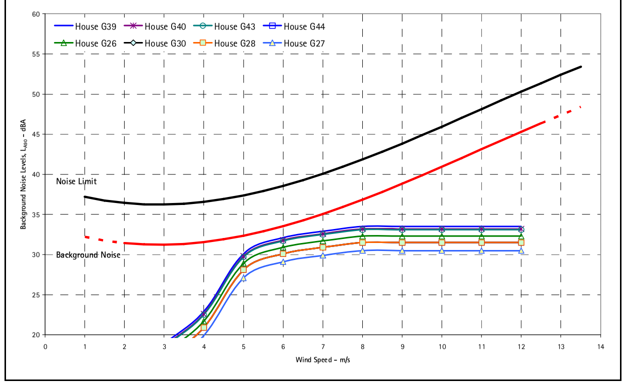
Predicted Noise Levels – Repower MM92 Evolution Layout C – 24 hour

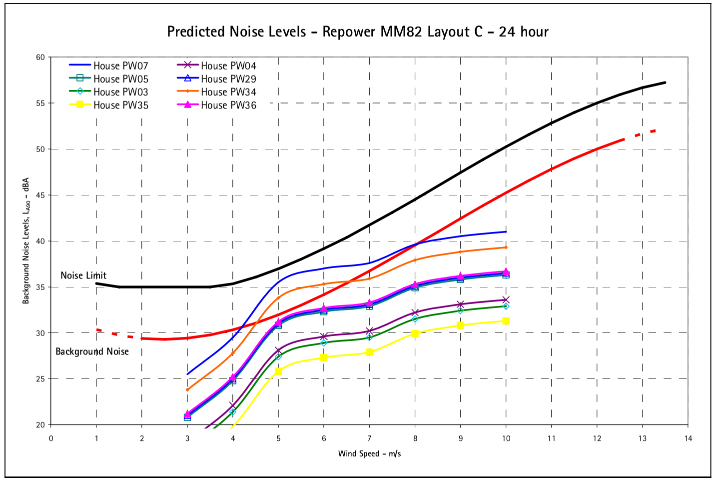


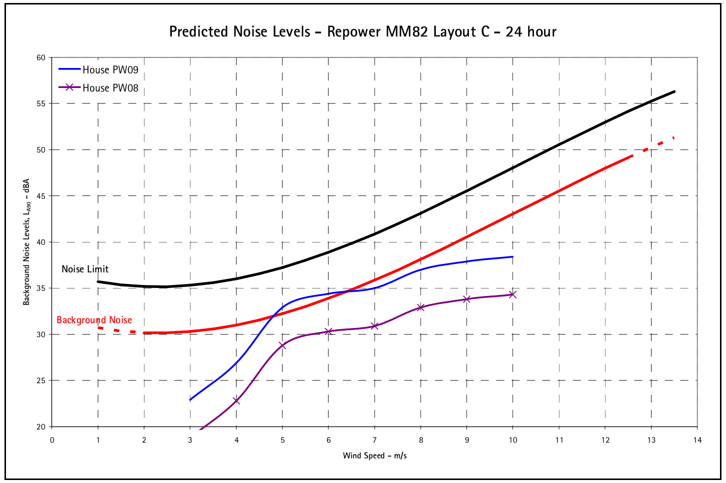
Predicted Noise Levels – Repower MM92 Evolution Layout C – 24 hour

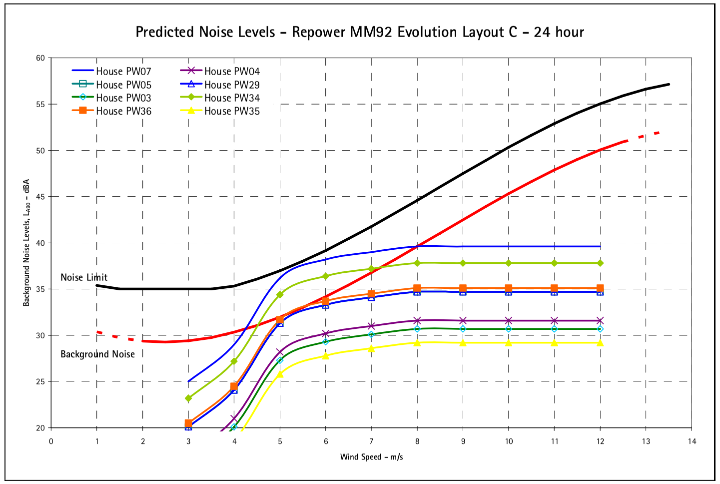


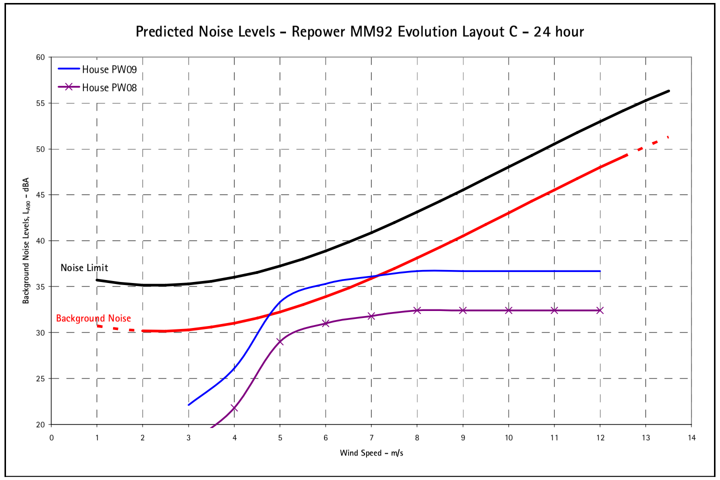
Predicted Noise Levels – Repower MM92 Evolution Layout C – 24 hour




Predicted Noise Levels - Repower MM82 Layout C - 24 hour
House PW07
House PW05
House PW03
House PW35
House PW04
House PW29
House PW34
House PW36
Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Repower MM82 Layout C - 24 hour
House PW09
House PW08
Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House PW07
House PW05
House PW03
House PW36
House PW04
House PW29
House PW34
House PW35
Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

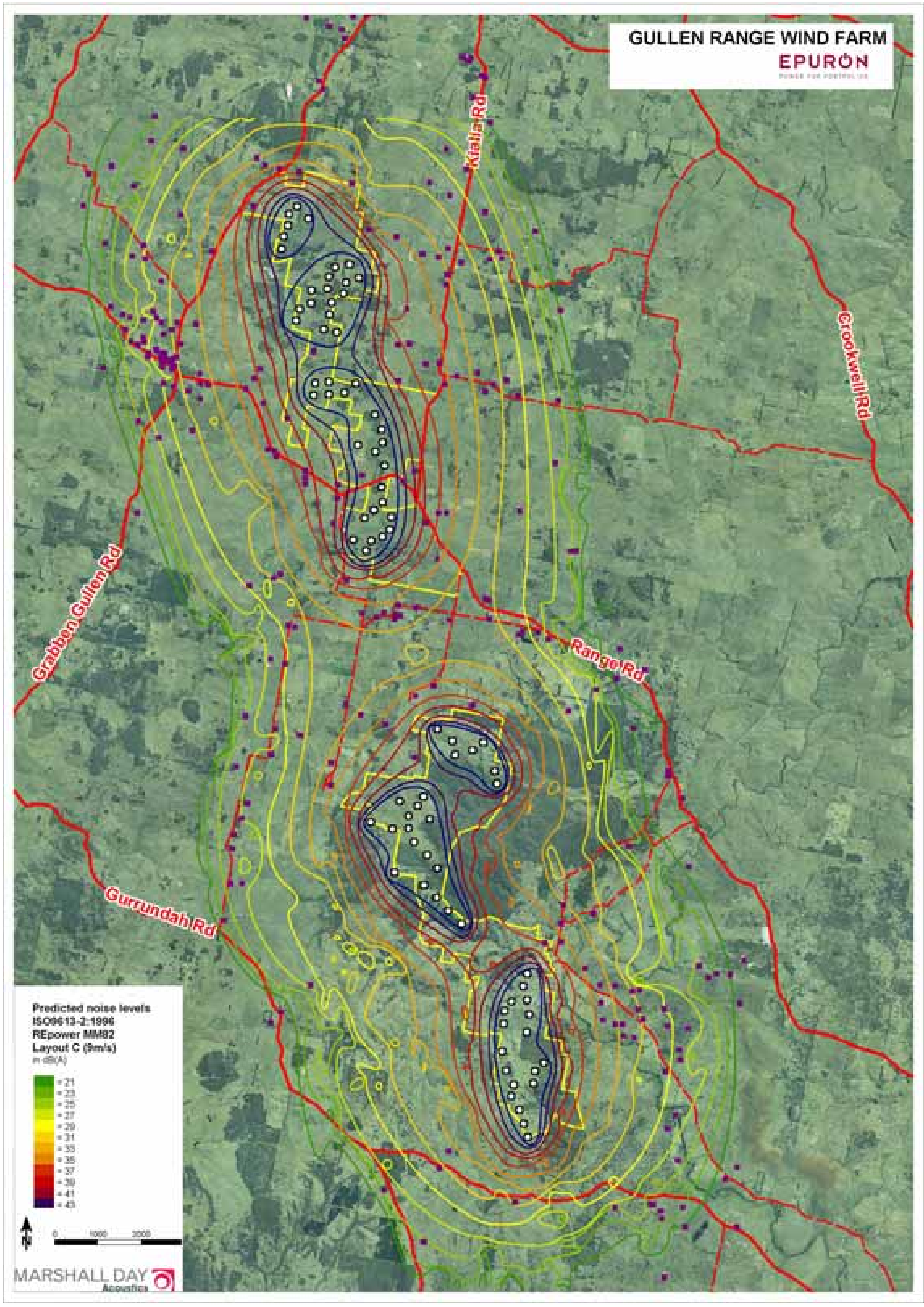

Predicted Noise Levels - Repower MM92 Evolution Layout C - 24 hour
House PW09
House PW08
Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

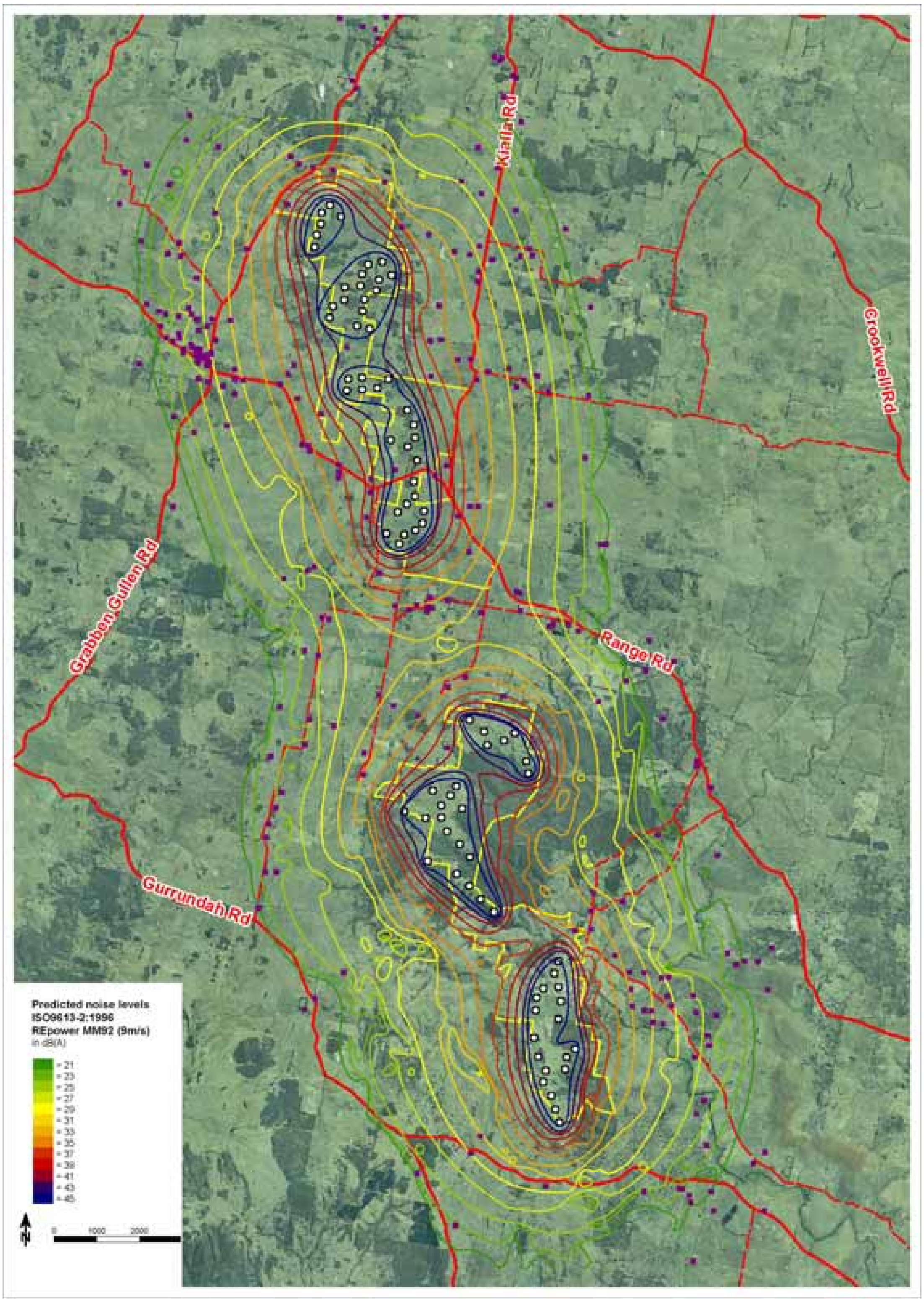
APPENDIX I
RECEIVER PREDICTED NOISE LEVELS (L_{Aeq}) RELATIVE TO COMPLIANCE LIMITS

			Difference Between Compliance Limits and Predicted Noise Levels - MM92 Layout C									
Receiver	Associated Compliance	Prediction @ 9m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
B10	B11	33.6	-16.0	-12.0	-4.8	-3.0	-4.4	-6.3	-8.9	-11.6	-14.2	-16.7
B11	B11	32.3	-17.3	-13.3	-6.1	-4.3	-5.7	-7.6	-10.2	-12.9	-15.5	-18.0
B20	B11	33.2	-16.4	-12.4	-5.2	-3.4	-4.8	-6.7	-9.3	-12.0	-14.6	-17.1
B21	B11	32.8	-16.8	-12.8	-5.6	-3.8	-5.2	-7.1	-9.7	-12.4	-15.0	-17.5
B22	B11	32.9	-16.7	-12.7	-5.5	-3.7	-5.1	-7.0	-9.6	-12.3	-14.9	-17.4
B23	B11	32.6	-17.0	-13.0	-5.8	-4.0	-5.4	-7.3	-9.9	-12.6	-15.2	-17.7
B24	B11	32.8	-16.8	-12.8	-5.6	-3.8	-5.2	-7.1	-9.7	-12.4	-15.0	-17.5
B35	B11	30.7	-18.9	-14.9	-7.7	-5.9	-7.3	-9.2	-11.8	-14.5	-17.1	-19.6
B54	B11	32.7	-16.9	-12.9	-5.7	-3.9	-5.3	-7.2	-9.8	-12.5	-15.1	-17.6
B9	B11	37.6	-12.0	-8.0	-0.8	1.0	-0.4	-2.3	-4.9	-7.6	-10.2	-12.7
B12a	B12A	37.8	-11.8	-8.9	-3.6	-3.8	-5.3	-7.0	-9.2	-11.0	-12.4	-13.3
B13	B13	34.7	-15.3	-11.8	-5.6	-5.1	-6.0	-7.4	-9.5	-11.8	-14.1	-16.4
B14	B13	33.7	-16.3	-12.8	-6.6	-6.1	-7.0	-8.4	-10.5	-12.8	-15.1	-17.4
B15	B13	32.5	-17.5	-14.0	-7.8	-7.3	-8.2	-9.6	-11.7	-14.0	-16.3	-18.6
B16	B13	30.9	-19.1	-15.6	-9.4	-8.9	-9.8	-11.2	-13.3	-15.6	-17.9	-20.2
B34	B13	30.7	-19.3	-15.8	-9.6	-9.1	-10.0	-11.4	-13.5	-15.8	-18.1	-20.4
B5	B13	33.7	-16.3	-12.8	-6.6	-6.1	-7.0	-8.4	-10.5	-12.8	-15.1	-17.4
B1	B18	43.7	-15.9	-11.9	-4.7	-2.7	-1.9	-1.3	-1.3	-1.3	-2.8	-5.1
B121a	B18	40.3	-9.3	-5.4	0.5	1.1	0.4	-0.6	-2.3	-4.2	-6.2	-8.5
B122a	B18	40.8	-8.8	-4.9	1.0	1.6	0.9	-0.1	-1.8	-3.7	-5.7	-8.0
B17	B18	36	-13.6	-9.7	-3.8	-3.2	-3.9	-4.9	-6.6	-8.5	-10.5	-12.8
B18	B18	36.3	-13.3	-9.4	-3.5	-2.9	-3.6	-4.6	-6.3	-8.2	-10.2	-12.5
B18a	B18	39.9	-9.7	-5.8	0.1	0.7	0.0	-1.0	-2.7	-4.6	-6.6	-8.9
B30	B18	34.1	-25.5	-21.5	-14.3	-12.3	-11.5	-10.9	-10.9	-10.9	-12.4	-14.7
B31	B18	34.4	-25.2	-21.2	-14.0	-12.0	-11.2	-10.6	-10.6	-10.6	-12.1	-14.4
B32	B18	34.5	-25.1	-21.1	-13.9	-11.9	-11.1	-10.5	-10.5	-10.5	-12.0	-14.3
B7	B18	36.1	-13.5	-9.6	-3.7	-3.1	-3.8	-4.8	-6.5	-8.4	-10.4	-12.7
B12	B26	35.5	-14.1	-10.1	-2.9	-0.9	-0.7	-1.8	-3.8	-5.8	-8.0	-10.1
B25	B26	32.1	-27.5	-23.5	-16.3	-14.3	-13.5	-12.9	-12.9	-12.9	-12.9	-13.5
B26	B26	35.9	-23.7	-19.7	-12.5	-10.5	-9.7	-9.1	-9.1	-9.1	-9.1	-9.7
B4	B26	36.2	-13.4	-9.4	-2.2	-0.2	0.0	-1.1	-3.1	-5.1	-7.3	-9.4
B27	B27	42.9	-7.2	-4.5	1.1	1.4	0.3	-1.2	-3.3	-5.6	-7.9	-10.2
B117	B29	30.8	-23.2	-20.2	-14.4	-14.0	-15.1	-16.5	-18.7	-20.9	-23.1	-25.3
B28	B29	35.7	-18.3	-15.3	-9.5	-9.1	-10.2	-11.6	-13.8	-16.0	-18.2	-20.4
B29	B29	36.4	-17.6	-14.6	-8.8	-8.4	-9.5	-10.9	-13.1	-15.3	-17.5	-19.7
B55	B29	34.5	-19.5	-16.5	-10.7	-10.3	-11.4	-12.8	-15.0	-17.2	-19.4	-21.6
B56	B29	31.3	-22.7	-19.7	-13.9	-13.5	-14.6	-16.0	-18.2	-20.4	-22.6	-24.8
B57	B29	30.7	-23.3	-20.3	-14.5	-14.1	-15.2	-16.6	-18.8	-21.0	-23.2	-25.4
B58	B29	30.5	-23.5	-20.5	-14.7	-14.3	-15.4	-16.8	-19.0	-21.2	-23.4	-25.6
B59	B29	29.6	-24.4	-21.4	-15.6	-15.2	-16.3	-17.7	-19.9	-22.1	-24.3	-26.5
B68	B29	31.3	-22.7	-19.7	-13.9	-13.5	-14.6	-16.0	-18.2	-20.4	-22.6	-24.8
B33	B33	42.6	-17.0	-13.0	-5.8	-3.8	-3.0	-2.4	-2.4	-2.4	-3.9	-6.1
B6	B33	40	-19.6	-15.6	-8.4	-6.4	-5.6	-5.0	-5.0	-5.0	-6.5	-8.7
B53	B53	38.3	-21.3	-17.3	-10.1	-8.1	-7.3	-6.7	-6.7	-9.4	-12.4	-15.4
B77	B53	36	-13.6	-9.6	-3.5	-3.2	-4.5	-6.2	-8.9	-11.7	-14.7	-17.7
B19	B8	35.4	-14.2	-11.5	-6.3	-6.5	-8.0	-10.0	-12.6	-15.2	-17.8	-20.4
B2	B8	38.5	-21.1	-17.1	-9.9	-7.9	-7.1	-6.9	-9.5	-12.1	-14.7	-17.3
B3	B8	35	-24.6	-20.6	-13.4	-11.4	-10.6	-10.4	-13.0	-15.6	-18.2	-20.8
B8	B8	36.5	-13.1	-10.4	-5.2	-5.4	-6.9	-8.9	-11.5	-14.1	-16.7	-19.3
G31	G31	30.3	-22.9	-19.7	-13.3	-12.1	-12.4	-13.1	-14.7	-16.7	-19.2	-22.2
G35	G31	30.9	-22.3	-19.1	-12.7	-11.5	-11.8	-12.5	-14.1	-16.1	-18.6	-21.6
G32	G37	34.6	-15.5	-13.2	-7.7	-7.3	-8.2	-9.2	-10.9	-12.7	-14.5	-16.4
G33	G37	34.1	-16.0	-13.7	-8.2	-7.8	-8.7	-9.7	-11.4	-13.2	-15.0	-16.9
G36	G37	33.2	-16.9	-14.6	-9.1	-8.7	-9.6	-10.6	-12.3	-14.1	-15.9	-17.8
G37	G37	36.2	-23.4	-19.4	-12.2	-10.2	-9.4	-8.8	-9.3	-11.1	-12.9	-14.8
G38	G37	31.2	-18.9	-16.6	-11.1	-10.7	-11.6	-12.6	-14.3	-16.1	-17.9	-19.8
G47	G37	30.6	-19.5	-17.2	-11.7	-11.3	-12.2	-13.2	-14.9	-16.7	-18.5	-20.4
G26	G39	32.3	-18.5	-14.9	-8.4	-7.6	-8.3	-9.5	-11.5	-13.6	-15.8	-18.0
G27	G39	30.5	-20.3	-16.7	-10.2	-9.4	-10.1	-11.3	-13.3	-15.4	-17.6	-19.8
G28	G39	31.5	-19.3	-15.7	-9.2	-8.4	-9.1	-10.3	-12.3	-14.4	-16.6	-18.8
G30	G39	31.5	-19.3	-15.7	-9.2	-8.4	-9.1	-10.3	-12.3	-14.4	-16.6	-18.8
G39	G39	33.5	-17.3	-13.7	-7.2	-6.4	-7.1	-8.3	-10.3	-12.4	-14.6	-16.8
G40	G39	33.2	-17.6	-14.0	-7.5	-6.7	-7.4	-8.6	-10.6	-12.7	-14.9	-17.1
G43	G39	33.1	-17.7	-14.1	-7.6	-6.8	-7.5	-8.7	-10.7	-12.8	-15.0	-17.2
G44	G39	31.5	-19.3	-15.7	-9.2	-8.4	-9.1	-10.3	-12.3	-14.4	-16.6	-18.8
K1	K1	37.1	-12.5	-8.5	-1.3	0.7	-1.1	-3.5	-6.6	-9.6	-12.3	-14.7
K12	K1	31.8	-17.8	-13.8	-6.6	-4.6	-6.4	-8.8	-11.9	-14.9	-17.6	-20.0
K13	K1	34	-15.6	-11.6	-4.4	-2.4	-4.2	-6.6	-9.7	-12.7	-15.4	-17.8
K3	K1	33.1	-16.5	-12.5	-5.3	-3.3	-5.1	-7.5	-10.6	-13.6	-16.3	-18.7
K5	K1	32.1	-17.5	-13.5	-6.3	-4.3	-6.1	-8.5	-11.6	-14.6	-17.3	-19.7
K6	K1	33.2	-16.4	-12.4	-5.2	-3.2	-5.0	-7.4	-10.5	-13.5	-16.2	-18.6
K7	K1	31.1	-18.5	-14.5	-7.3	-5.3	-7.1	-9.5	-12.6	-15.6	-18.3	-20.7
K8	K1	30.5	-19.1	-15.1	-7.9	-5.9	-7.7	-10.1	-13.2	-16.2	-18.9	-21.3
K14	K2	33.4	-16.2	-12.2	-5.0	-3.4	-5.1	-7.3	-10.3	-13.2	-16.0	-18.3
K18	K2	34.1	-15.5	-11.5	-4.3	-2.7	-4.4	-6.6	-9.6	-12.5	-15.3	-17.6
K19	K2	31.9	-17.7	-13.7	-6.5	-4.9	-6.6	-8.8	-11.8	-14.7	-17.5	-19.8
K2	K2	38.3	-21.3	-17.3	-10.1	-8.1	-7.3	-6.7	-6.7	-8.3	-11.1	-13.4
K20	K2	35.1	-14.5	-10.5	-3.3	-1.7	-3.4	-5.6	-8.6	-11.5	-14.3	-16.6
K4	K2	36.9	-12.7	-8.7	-1.5	0.0	-1.6	-3.8	-6.8	-9.7	-12.5	-14.8
PW29	PW7	34.7	-14.9	-11.3	-5.8	-6.0	-7.8	-10.1	-13.2	-16.2	-19.0	-21.5
PW3	PW7	30.7	-18.9	-15.3	-9.8	-10.0	-11.8	-14.1	-17.2	-20.2	-23.0	-25.5
PW34	PW7	37.8	-11.8	-8.2	-2.7	-2.9	-4.7	-7.0	-10.1	-13.1	-15.9	-18.4
PW36	PW7	35.1	-14.5	-10.9	-5.4	-5.6	-7.4	-9.7	-12.8	-15.8	-18.6	-21.1
PW4	PW7	31.6	-18.0	-14.4	-8.9	-9.1	-10.9	-13.2	-16.3	-19.3	-22.1	-24.6
PW5	PW7	34.7	-14.9	-11.3	-5.8	-6.0	-7.8	-10.1	-13.2	-16.2	-19.0	-21.5
PW7	PW7	39.6	-10.0	-6.4	-0.9	-1.1	-2.9	-5.2	-8.3	-11.3	-14.1	-16.6
PW8	PW9	32.4	-17.5	-14.3	-8.3	-8.1	-9.3	-11.1	-13.7	-16.5	-19.2	-22.0
PW9	PW9	36.7	-13.2	-10.0	-4.0	-3.8	-5.0	-6.8	-9.4	-12.2	-14.9	-17.7

	Difference Between Compliance Limits and Predicted Noise Levels - MM82 Layout C									
Receiver	Associated Compliance	Prediction @ 9m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
B10	B11	34.9	-15.1	-11.1	-5.1	-3.8	-5.4	-5.9	-7.6	-9.8
B11	B11	33.6	-16.4	-12.4	-6.4	-5.1	-6.7	-7.2	-8.9	-11.1
B20	B11	34.6	-15.4	-11.4	-5.4	-4.1	-5.7	-6.2	-7.9	-10.1
B21	B11	34.2	-15.8	-11.8	-5.8	-4.5	-6.1	-6.6	-8.3	-10.5
B22	B11	34.3	-15.7	-11.7	-5.7	-4.4	-6.0	-6.5	-8.2	-10.4
B23	B11	34	-16.0	-12.0	-6.0	-4.7	-6.3	-6.8	-8.5	-10.7
B24	B11	34.1	-15.9	-11.9	-5.9	-4.6	-6.2	-6.7	-8.4	-10.6
B35	B11	32.3	-17.7	-13.7	-7.7	-6.4	-8.0	-8.5	-10.2	-12.4
B54	B11	34.2	-15.8	-11.8	-5.8	-4.5	-6.1	-6.6	-8.3	-10.5
B9	B11	38.5	-11.5	-7.5	-1.5	-0.2	-1.8	-2.3	-4.0	-6.2
B12a	B12A	38.9	-11.1	-8.2	-4.1	-4.8	-6.5	-6.8	-8.1	-9.4
B13	B13	36.1	-14.3	-10.8	-5.8	-5.8	-6.9	-6.9	-8.1	-9.9
B14	B13	35.2	-15.2	-11.7	-6.7	-6.7	-7.8	-7.8	-9.0	-10.8
B15	B13	34.1	-16.3	-12.8	-7.8	-7.8	-8.9	-8.9	-10.1	-11.9
B16	B13	32.8	-17.6	-14.1	-9.1	-9.1	-10.2	-10.2	-11.4	-13.2
B34	B13	32.5	-17.9	-14.4	-9.4	-9.4	-10.5	-10.5	-11.7	-13.5
B5	B13	35.2	-15.2	-11.7	-6.7	-6.7	-7.8	-7.8	-9.0	-10.8
B1	B18	44.5	-15.5	-11.5	-5.5	-4.0	-3.4	-1.4	-0.5	0.0
B121a	B18	41.2	-8.8	-4.9	-0.2	-0.1	-1.0	-0.6	-1.4	-2.8
B122a	B18	41.7	-8.3	-4.4	0.0	0.0	-0.5	-0.1	-0.9	-2.3
B17	B18	37.2	-12.8	-8.9	-4.2	-4.1	-5.0	-4.6	-5.4	-6.8
B18	B18	37.6	-12.4	-8.5	-3.8	-3.7	-4.6	-4.2	-5.0	-6.4
B18a	B18	40.9	-9.1	-5.2	-0.5	-0.4	-1.3	-0.9	-1.7	-3.1
B30	B18	35.5	-24.5	-20.5	-14.5	-13.0	-12.4	-10.4	-9.5	-9.0
B31	B18	35.8	-24.2	-20.2	-14.2	-12.7	-12.1	-10.1	-9.2	-8.7
B32	B18	35.9	-24.1	-20.1	-14.1	-12.6	-12.0	-10.0	-9.1	-8.6
B7	B18	37.4	-12.6	-8.7	-4.0	-3.9	-4.8	-4.4	-5.2	-6.6
B12	B26	36.8	-13.2	-9.2	-3.2	-1.7	-1.7	-1.4	-2.5	-4.0
B25	B26	33.8	-26.2	-22.2	-16.2	-14.7	-14.1	-12.1	-11.2	-10.7
B26	B26	37.1	-22.9	-18.9	-12.9	-11.4	-10.8	-8.8	-7.9	-7.4
B4	B26	37.4	-12.6	-8.6	-2.6	-1.1	-1.1	-0.8	-1.9	-3.4
B27	B27	43.7	-6.8	-4.1	0.0	0.0	-1.2	-1.3	-2.5	-4.2
B117	B29	32.6	-21.8	-18.8	-14.2	-14.3	-15.6	-15.6	-16.9	-18.6
B28	B29	37	-17.4	-14.4	-9.8	-9.9	-11.2	-11.2	-12.5	-14.2
B29	B29	37.6	-16.8	-13.8	-9.2	-9.3	-10.6	-10.6	-11.9	-13.6
B55	B29	36	-18.4	-15.4	-10.8	-10.9	-12.2	-12.2	-13.5	-15.2
B56	B29	33.1	-21.3	-18.3	-13.7	-13.8	-15.1	-15.1	-16.4	-18.1
B57	B29	32.5	-21.9	-18.9	-14.3	-14.4	-15.7	-15.7	-17.0	-18.7
B58	B29	32.3	-22.1	-19.1	-14.5	-14.6	-15.9	-15.9	-17.2	-18.9
B59	B29	31.5	-22.9	-19.9	-15.3	-15.4	-16.7	-16.7	-18.0	-19.7
B68	B29	33	-21.4	-18.4	-13.8	-13.9	-15.2	-15.2	-16.5	-18.2
B33	B33	43.4	-16.6	-12.6	-6.6	-5.1	-4.5	-2.5	-1.6	-1.1
B6	B33	40.9	-19.1	-15.1	-9.1	-7.6	-7.0	-5.0	-4.1	-3.6
B53	B53	39.3	-20.7	-16.7	-10.7	-9.2	-8.6	-6.6	-5.7	-7.9
B77	B53	37.3	-12.7	-8.7	-3.8	-4.0	-5.5	-5.8	-7.6	-9.9
B19	B8	36.5	-13.5	-10.8	-6.8	-7.5	-9.2	-9.8	-11.5	-13.6
B2	B8	39.4	-20.6	-16.6	-10.6	-9.1	-8.5	-6.9	-8.6	-10.7
B3	B8	36.1	-23.9	-19.9	-13.9	-12.4	-11.8	-10.2	-11.9	-14.0
B8	B8	37.5	-12.5	-9.8	-5.8	-6.5	-8.2	-8.8	-10.5	-12.6
G31	G31	31.7	-21.9	-18.7	-13.5	-12.8	-13.3	-12.6	-13.3	-14.8
G35	G31	32.2	-21.4	-18.2	-13.0	-12.3	-12.8	-12.1	-12.8	-14.3
G32	G37	35.8	-14.7	-12.4	-8.1	-8.2	-9.3	-8.9	-9.7	-11.0
G33	G37	35.4	-15.1	-12.8	-8.5	-8.6	-9.7	-9.3	-10.1	-11.4
G36	G37	34.6	-15.9	-13.6	-9.3	-9.4	-10.5	-10.1	-10.9	-12.2
G37	G37	37.3	-22.7	-18.7	-12.7	-11.2	-10.6	-8.6	-8.2	-9.5
G38	G37	32.8	-17.7	-15.4	-11.1	-11.2	-12.3	-11.9	-12.7	-14.0
G47	G37	32.4	-18.1	-15.8	-11.5	-11.6	-12.7	-12.3	-13.1	-14.4
G26	G39	33.7	-17.5	-13.9	-8.6	-8.3	-9.2	-9.0	-10.1	-11.7
G27	G39	32	-19.2	-15.6	-10.3	-10.0	-10.9	-10.7	-11.8	-13.4
G28	G39	33	-18.2	-14.6	-9.3	-9.0	-9.9	-9.7	-10.8	-12.4
G30	G39	33	-18.2	-14.6	-9.3	-9.0	-9.9	-9.7	-10.8	-12.4
G39	G39	34.8	-16.4	-12.8	-7.5	-7.2	-8.1	-7.9	-9.0	-10.6
G40	G39	34.5	-16.7	-13.1	-7.8	-7.5	-8.4	-8.2	-9.3	-10.9
G43	G39	34.4	-16.8	-13.2	-7.9	-7.6	-8.5	-8.3	-9.4	-11.0
G44	G39	33	-18.2	-14.6	-9.3	-9.0	-9.9	-9.7	-10.8	-12.4
K1	K1	38.1	-11.9	-7.9	-1.9	-0.4	-2.4	-3.4	-5.6	-8.1
K12	K1	33.4	-16.6	-12.6	-6.6	-5.1	-7.1	-8.1	-10.3	-12.8
K13	K1	35.2	-14.8	-10.8	-4.8	-3.3	-5.3	-6.3	-8.5	-11.0
K3	K1	34.3	-15.7	-11.7	-5.7	-4.2	-6.2	-7.2	-9.4	-11.9
K5	K1	33.6	-16.4	-12.4	-6.4	-4.9	-6.9	-7.9	-10.1	-12.6
K6	K1	34.6	-15.4	-11.4	-5.4	-3.9	-5.9	-6.9	-9.1	-11.6
K7	K1	32.8	-17.2	-13.2	-7.2	-5.7	-7.7	-8.7	-10.9	-13.4
K8	K1	32.3	-17.7	-13.7	-7.7	-6.2	-8.2	-9.2	-11.4	-13.9
K14	K2	34.8	-15.2	-11.2	-5.2	-4.1	-6.0	-6.8	-8.9	-11.3
K18	K2	35.2	-14.8	-10.8	-4.8	-3.7	-5.6	-6.4	-8.5	-10.9
K19	K2	33.1	-16.9	-12.9	-6.9	-5.8	-7.7	-8.5	-10.6	-13.0
K2	K2	39.2	-20.8	-16.8	-10.8	-9.3	-8.7	-6.7	-5.8	-6.9
K20	K2	36	-14.0	-10.0	-4.0	-2.9	-4.8	-5.6	-7.7	-10.1
K4	K2	37.8	-12.2	-8.2	-2.2	-1.1	-3.0	-3.8	-5.9	-8.3
PW29	PW7	36	-14.0	-10.4	-6.1	-6.8	-8.8	-9.7	-11.9	-14.4
PW3	PW7	32.4	-17.6	-14.0	-9.7	-10.4	-12.4	-13.3	-15.5	-18.0
PW34	PW7	38.8	-11.2	-7.6	-3.3	-4.0	-6.0	-6.9	-9.1	-11.6
PW36	PW7	36.2	-13.8	-10.2	-5.9	-6.6	-8.6	-9.5	-11.7	-14.2
PW4	PW7	33.1	-16.9	-13.3	-9.0	-9.7	-11.7	-12.6	-14.8	-17.3
PW5	PW7	35.8	-14.2	-10.6	-6.3	-7.0	-9.0	-9.9	-12.1	-14.6
PW7	PW7	40.5	-9.5	-5.9	-1.6	-2.3	-4.3	-5.2	-7.4	-9.8
PW8	PW9	33.8	-16.5	-13.3	-8.5	-8.8	-10.2	-10.6	-12.3	-14.6
PW9	PW9	37.9	-12.4	-9.2	-4.4	-4.7	-6.1	-6.5	-8.2	-10.5

APPENDIX J
SOUNDPLAN NOISE CONTOUR PLOTS




Kialla Rd
Crookwell Rd
Grabben Gullen Rd
Range Rd
Gurrundah Rd
Predicted noise levels
ISO9613-2:1996
REpower MM92 (9m/s)
in dB(A)
= 21
= 23
= 25
= 27
= 29
= 31
= 33
= 35
= 37
= 39
= 41
= 43
= 45
N
0
1000
2000

APPENDIX K

HUB-HEIGHT ASSESSMENT PREDICTIONS

Figure K1 – B09

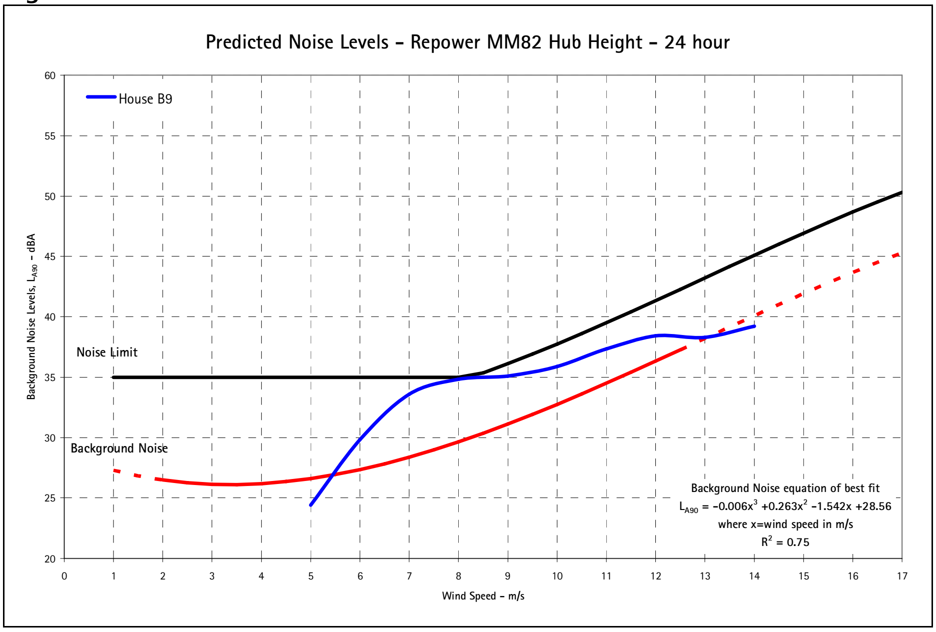


Figure K2 – B04

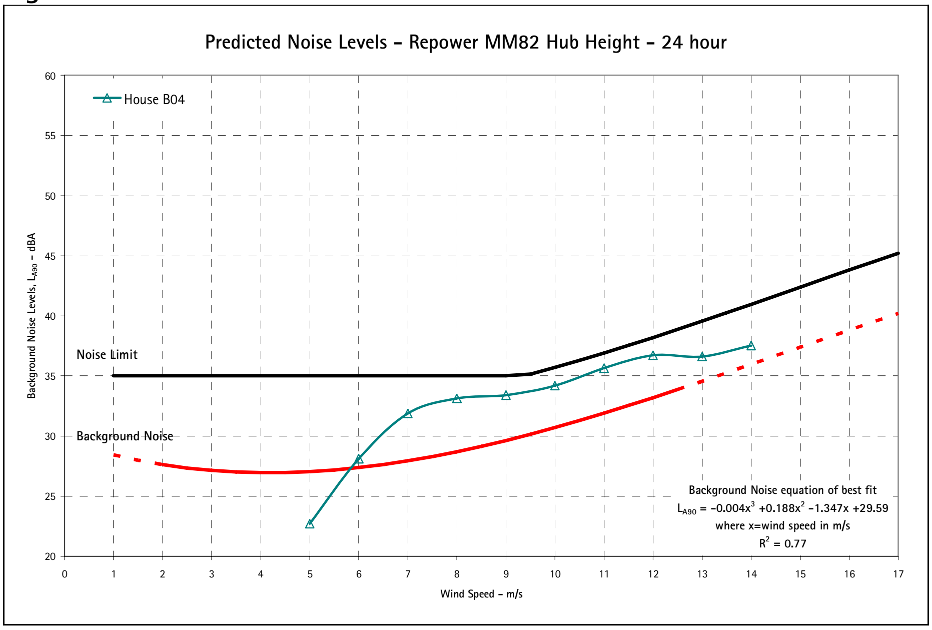


Figure K3 – B27

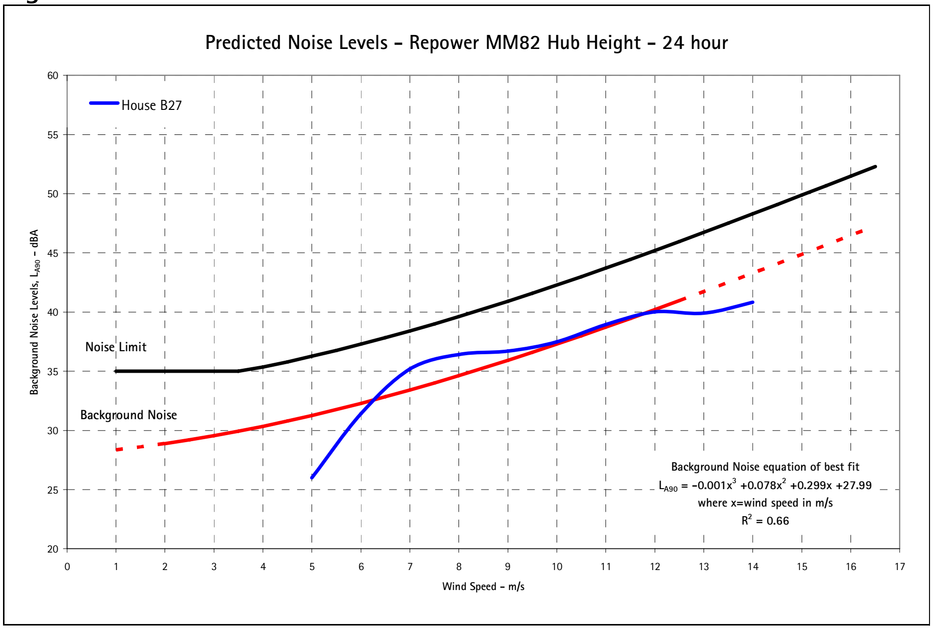
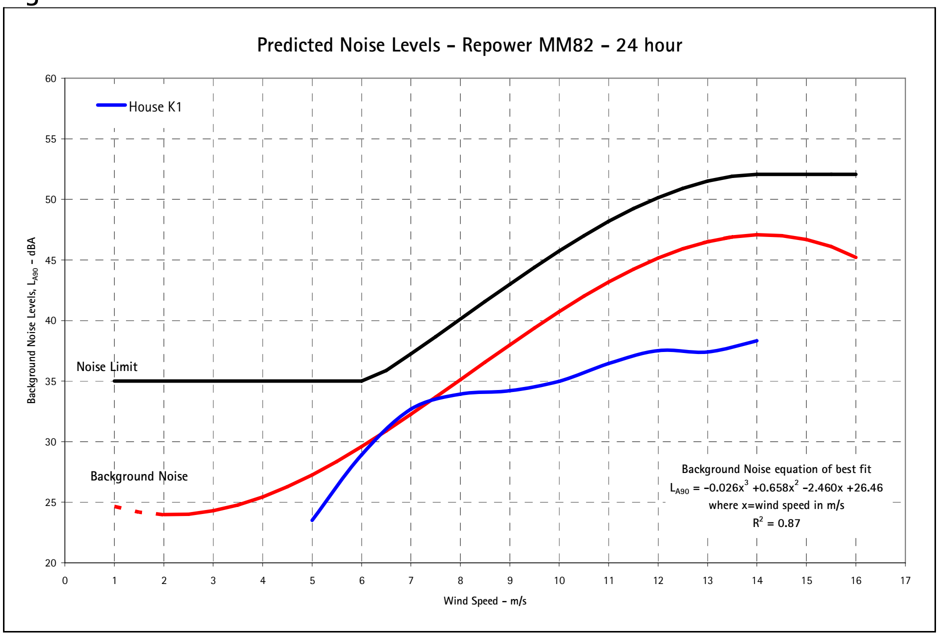
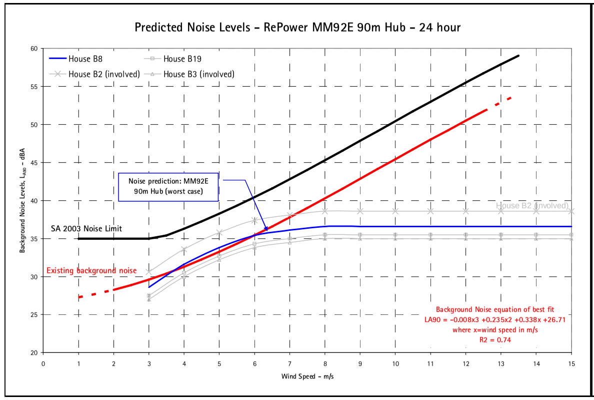
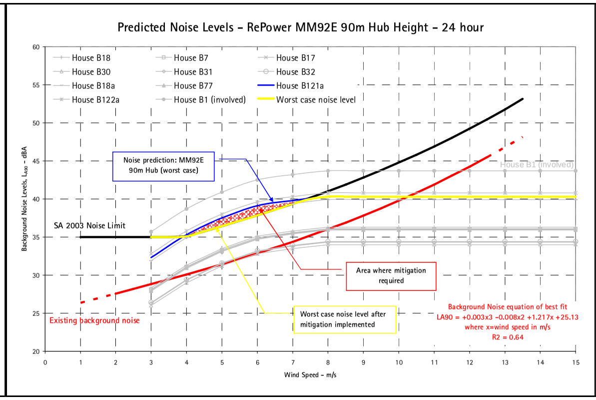


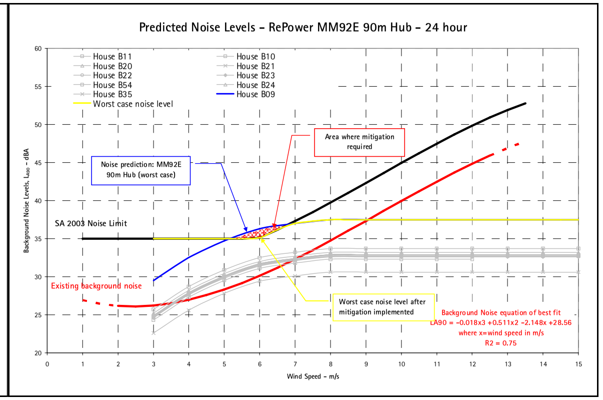
Figure K4 – K1

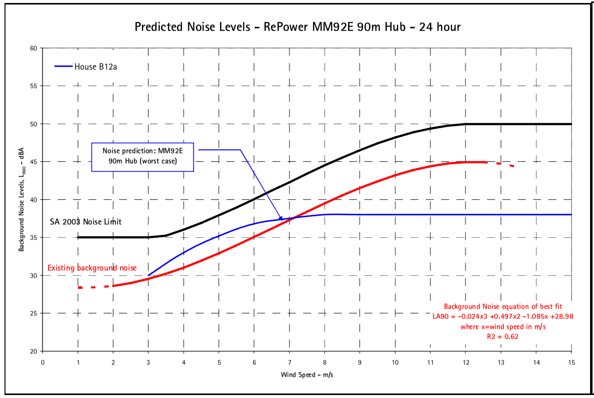


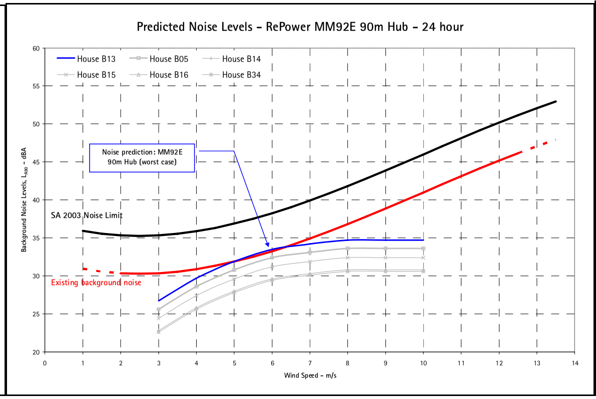
ADDENDUM 1.0
SENSITIVITY ANALYSIS

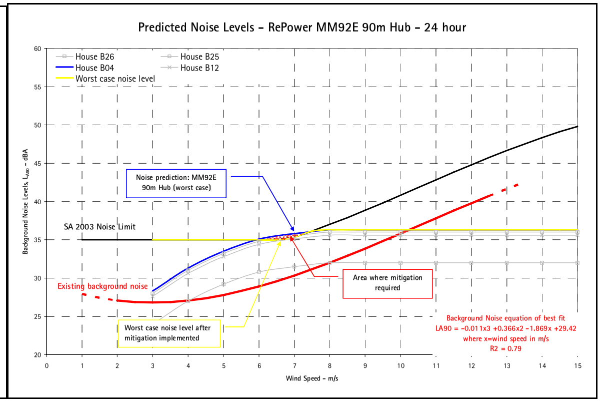


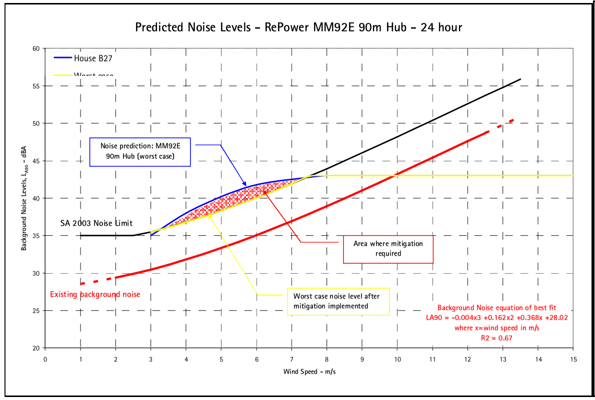


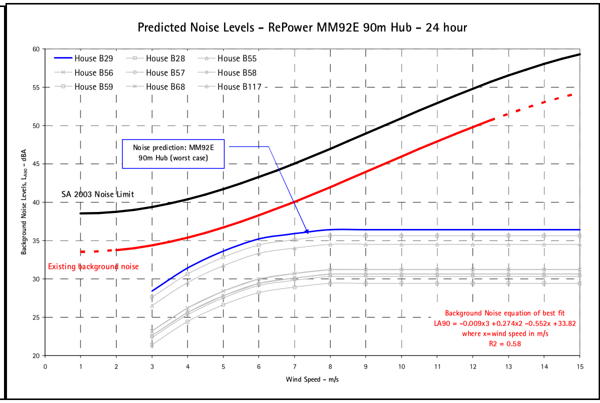


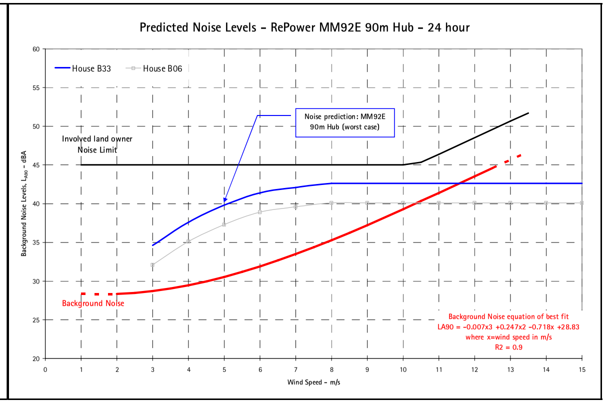


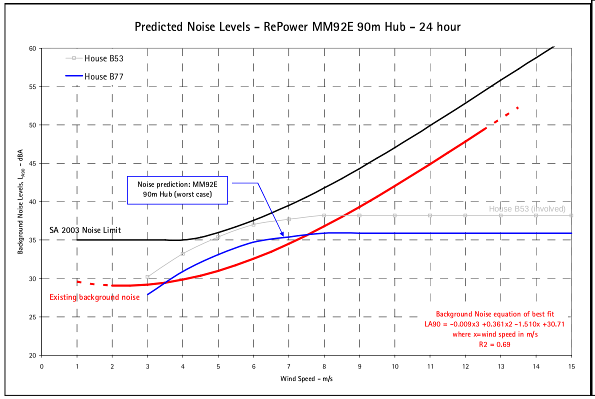


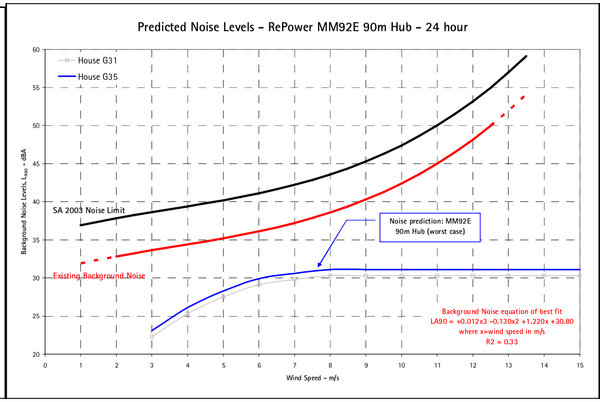


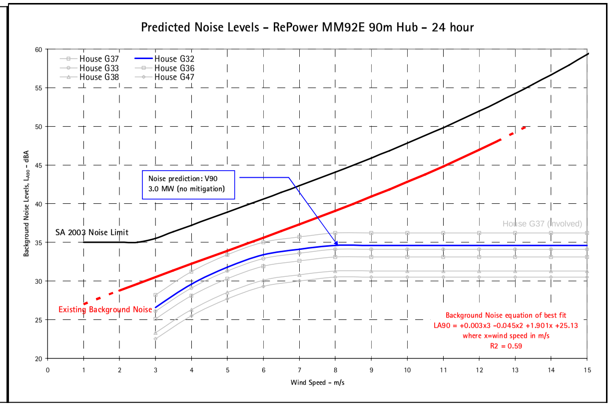

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House B27
Noise prediction: MM92E
90m Hub (worst case)
SA 2003 Noise Limit
Area where mitigation required
Existing background noise
Worst case noise level after mitigation implemented
Background Noise equation of best fit
LA90 = -0.004x3 +0.162x2 +0.368x +28.02
where x=wind speed in m/s
R2 = 0.67
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

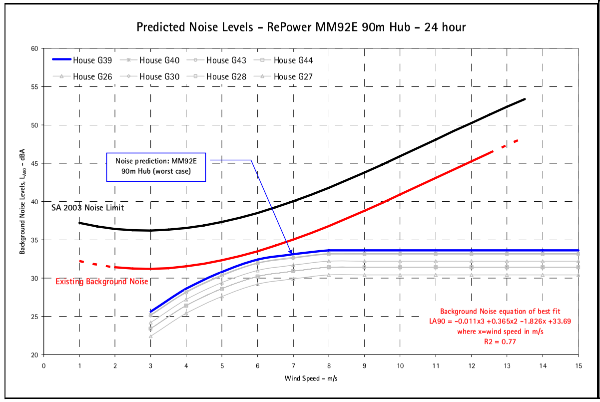

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House B29
House B28
House B55
House B56
House B57
House B58
House B59
House B68
House B117
Noise prediction: MM92E
90m Hub (worst case)
SA 2003 Noise Limit
Existing background noise
Background Noise equation of best fit
LA90 = -0.009x3 +0.274x2 -0.552x +33.82
where x=wind speed in m/s
R2 = 0.58
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

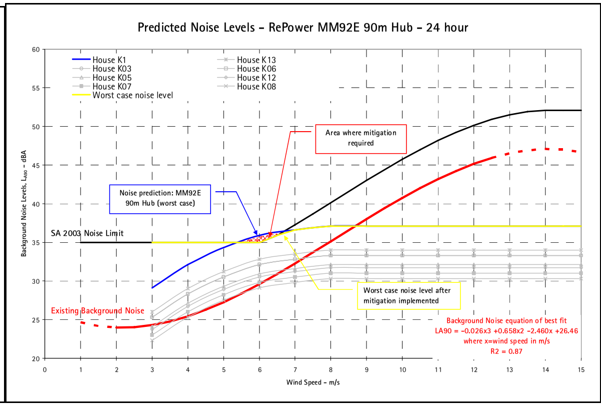

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House B33
House B06
Noise prediction: MM92E
90m Hub (worst case)
Involved land owner
Noise Limit
Background Noise
Background Noise equation of best fit
LA90 = -0.007x3 +0.247x2 -0.718x +28.83
where x=wind speed in m/s
R2 = 0.9
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

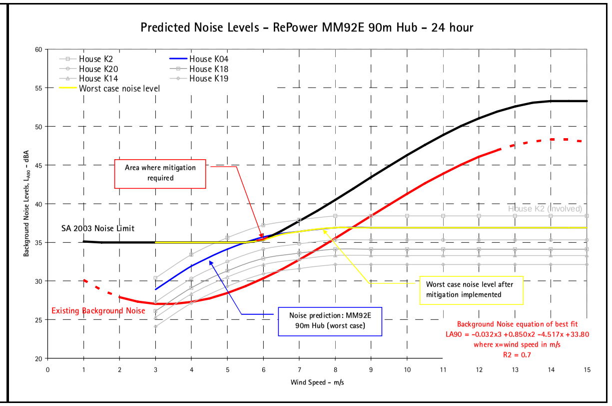

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House B53
House B77
Noise prediction: MM92E
90m Hub (worst case)
House B53 (involved)
SA 2003 Noise Limit
Existing background noise
Background Noise equation of best fit
LA90 = -0.009x3 +0.361x2 +1.510x +30.71
where x=wind speed in m/s
R2 = 0.69
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

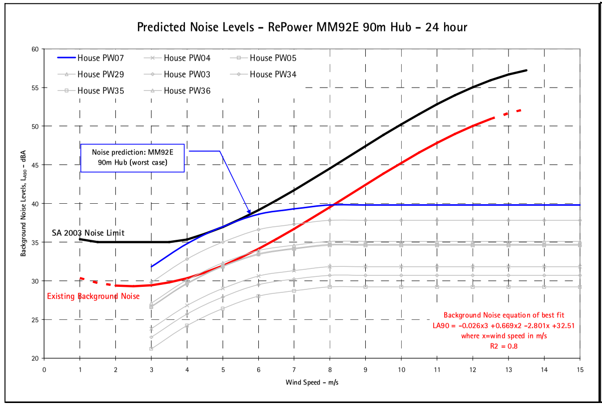

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House G31
House G35
SA 2003 Noise Limit
Existing Background Noise
Noise prediction: MM92E
90m Hub (worst case)
Background Noise equation of best fit
LA90 = +0.012x3 -0.130x2 +1.220x +30.80
where x=wind speed in m/s
R2 = 0.33
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

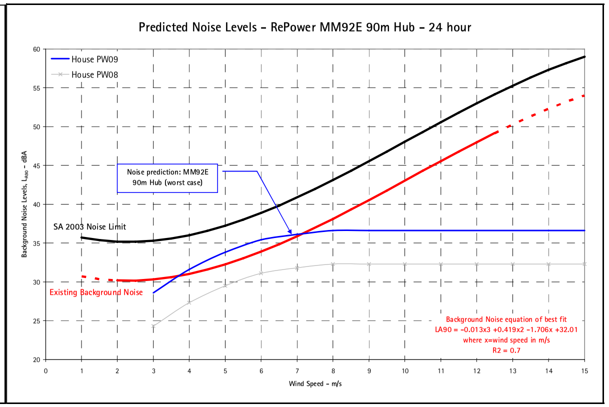

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House G37
House G33
House G38
House G32
House G36
House G47
Noise prediction: V90
3.0 MW (no mitigation)
House G37 (involved)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit
LA90 = +0.003x3 -0.045x2 +1.901x +25.13
where x=wind speed in m/s
R2 = 0.59
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

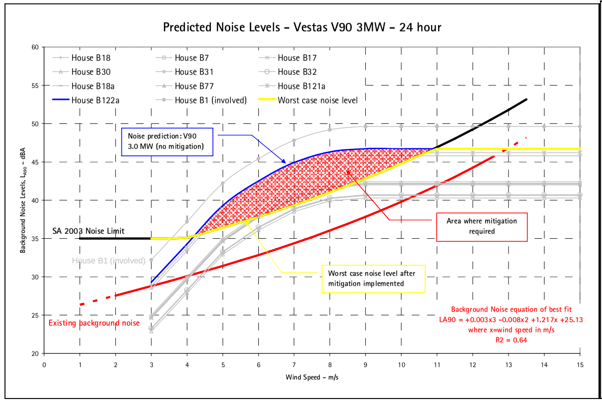

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House G39
House G40
House G43
House G44
House G26
House G30
House G28
House G27
Noise prediction: MM92E 90m Hub (worst case)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit LA90 = -0.011x3 +0.365x2 -1.826x +33.69 where x=wind speed in m/s R2 = 0.77
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

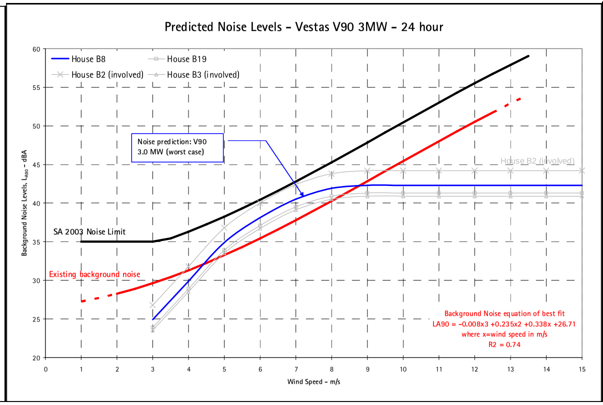

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House K1
House K03
House K05
House K07
Worst case noise level
House K13
House K06
House K12
House K08
Area where mitigation required
Noise prediction: MM92E 90m Hub (worst case)
SA 2003 Noise Limit
Existing Background Noise
Worst case noise level after mitigation implemented
Background Noise equation of best fit LA90 = -0.026x3 +0.658x2 -2.460x +26.46 where x=wind speed in m/s R2 = 0.87
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

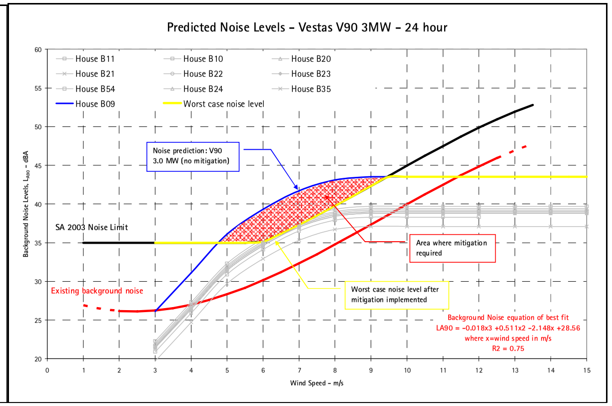

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House K2
House K20
House K14
Worst case noise level
House K04
House K18
House K19
Area where mitigation required
SA 2003 Noise Limit
Existing Background Noise
Noise prediction: MM92E 90m Hub (worst case)
Worst case noise level after mitigation implemented
Background Noise equation of best fit LA90 = -0.032x3 +0.850x2 -4.517x +33.80 where x=wind speed in m/s R2 = 0.7
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

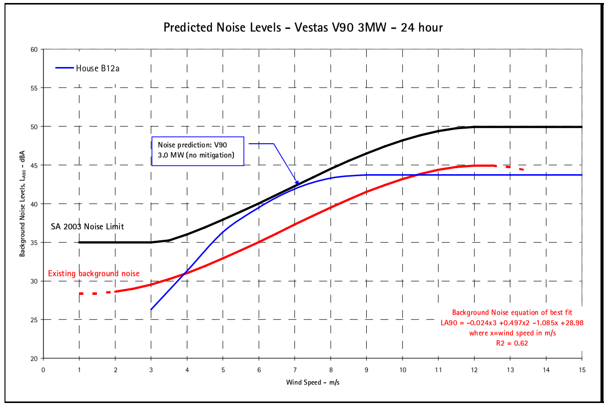

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House PW07
House PW04
House PW05
House PW29
House PW03
House PW34
House PW35
House PW36
Noise prediction: MM92E 90m Hub (worst case)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit LA90 = -0.026x3 +0.669x2 -2.801x +32.51 where x=wind speed in m/s R2 = 0.8
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

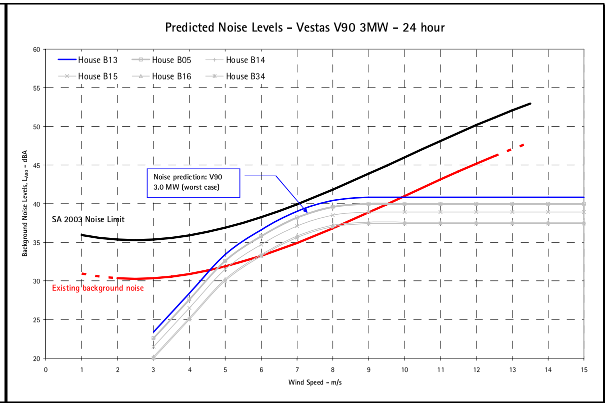

Predicted Noise Levels - RePower MM92E 90m Hub - 24 hour
House PW09
House PW08
Noise prediction: MM92E 90m Hub (worst case)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit LA90 = -0.013x3 +0.419x2 -1.706x +32.01 where x=wind speed in m/s R2 = 0.7
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

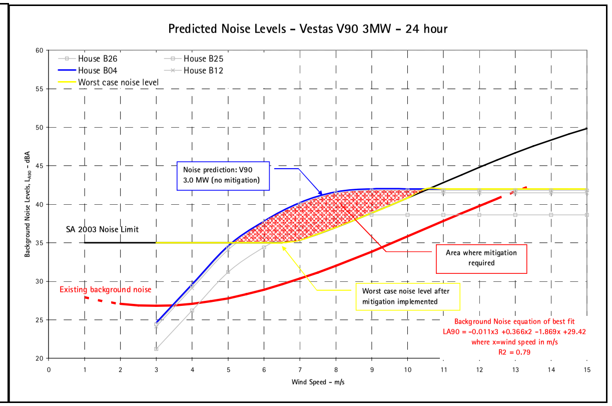

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B18
House B30
House B18a
House B122a
House B7
House B31
House B77
House B1 (involved)
House B17
House B32
House B121a
Worst case noise level
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
Existing background noise
Area where mitigation required
Worst case noise level after mitigation implemented
Background Noise equation of best fit
LA90 = +0.003x3 -0.008x2 +1.217x +25.13
where x=wind speed in m/s
R2 = 0.64
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

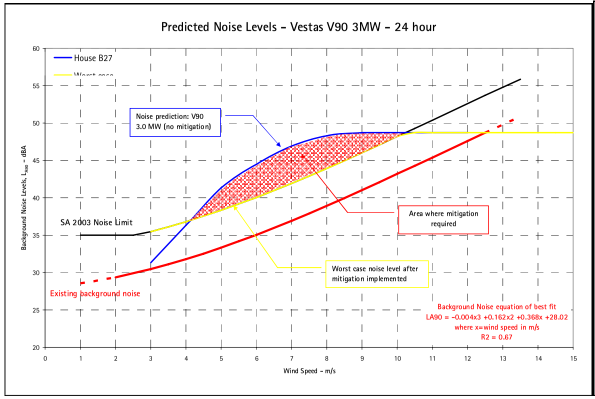

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B8
House B2 (involved)
House B19
House B3 (involved)
Noise prediction: V90 3.0 MW (worst case)
SA 2003 Noise Limit
Existing background noise
Background Noise equation of best fit
LA90 = -0.008x3 +0.235x2 +0.338x +26.71
where x=wind speed in m/s
R2 = 0.74
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

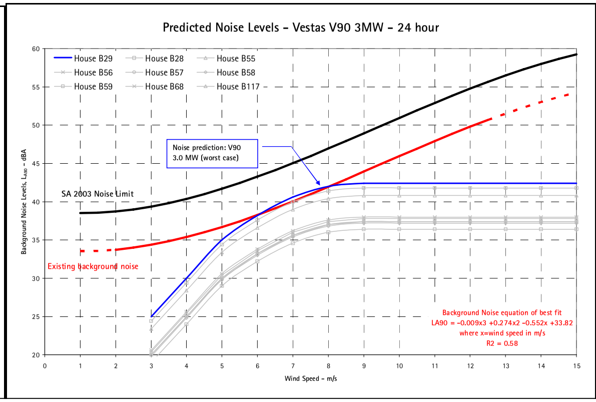

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B11
House B21
House B54
House B09
House B10
House B22
House B24
Worst case noise level
House B20
House B23
House B35
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
Existing background noise
Area where mitigation required
Worst case noise level after mitigation implemented
Background Noise equation of best fit
LA90 = -0.018x3 +0.511x2 -2.148x +28.56
where x=wind speed in m/s
R2 = 0.75
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

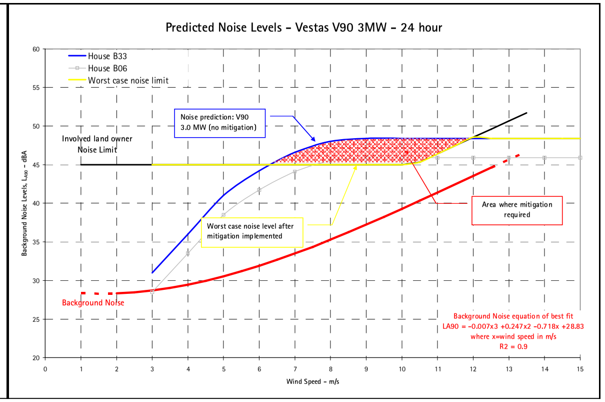

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B12a
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
Existing background noise
Background Noise equation of best fit
LA90 = -0.024x3 +0.497x2 -1.085x +28.98
where x=wind speed in m/s
R2 = 0.62
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

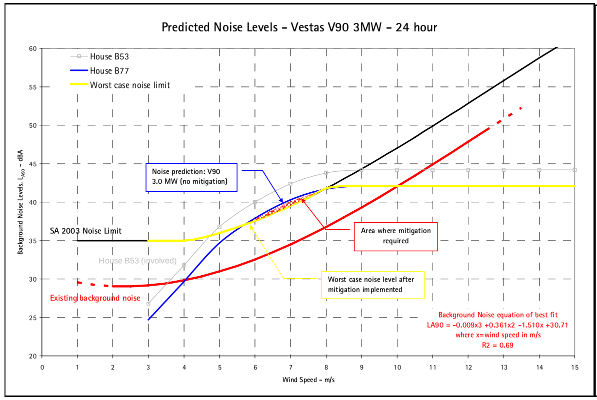

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B13
House B15
House B05
House B16
House B14
House B34
Noise prediction: V90 3.0 MW (worst case)
SA 2003 Noise Limit
Existing background noise
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

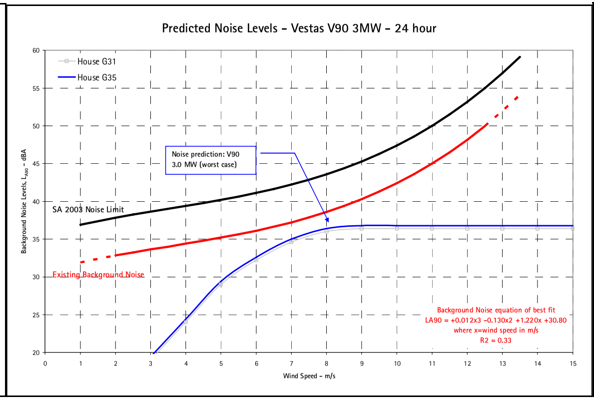

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B26
House B04
Worst case noise level
House B25
House B12
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
Existing background noise
Area where mitigation required
Worst case noise level after mitigation implemented
Background Noise equation of best fit
LA90 = -0.011x3 +0.366x2 -1.869x +29.42
where x=wind speed in m/s
R2 = 0.79
Wind Speed – m/s
Background Noise Levels, LA90 – dBA

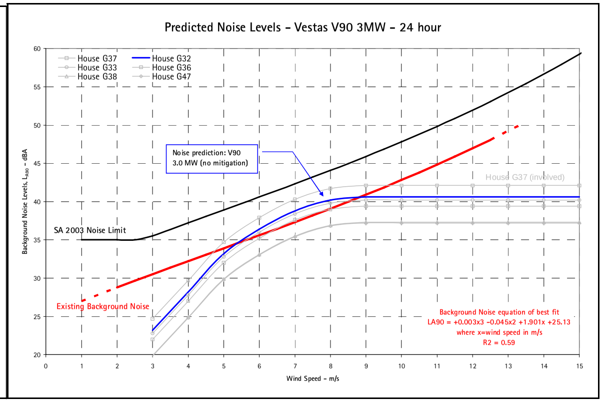

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B27
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
Area where mitigation required
Worst case noise level after mitigation implemented
Existing background noise
Background Noise equation of best fit
LA90 = -0.004x3 +0.162x2 +0.368x +28.02
where x=wind speed in m/s
R2 = 0.67
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B29
House B28
House B55
House B56
House B57
House B58
House B59
House B68
House B117
Noise prediction: V90 3.0 MW (worst case)
SA 2003 Noise Limit
Existing background noise
Background Noise equation of best fit
LA90 = -0.009x3 +0.274x2 -0.552x +33.82
where x=wind speed in m/s
R2 = 0.58
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

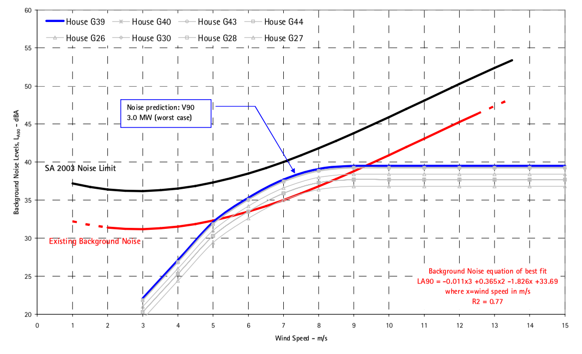

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B33
House B06
Worst case noise limit
Noise prediction: V90 3.0 MW (no mitigation)
Involved land owner Noise Limit
Worst case noise level after mitigation implemented
Area where mitigation required
Background Noise
Background Noise equation of best fit
LA90 = -0.007x3 +0.247x2 -0.718x +28.83
where x=wind speed in m/s
R2 = 0.9
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels – Vestas V90 3MW – 24 hour
House B53
House B77
Worst case noise limit
Noise prediction: V90 3.0 MW (no mitigation)
SA 2003 Noise Limit
House B53 (involved)
Area where mitigation required
Worst case noise level after mitigation implemented
Existing background noise
Background Noise equation of best fit
LA90 = -0.009x3 +0.361x2 -1.510x +30.71
where x=wind speed in m/s
R2 = 0.69
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

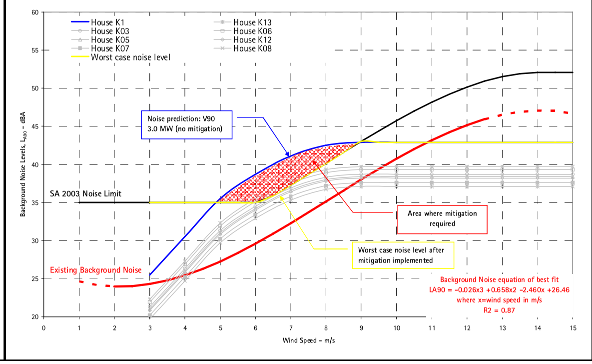

Predicted Noise Levels – Vestas V90 3MW – 24 hour
House G31
House G35
Noise prediction: V90 3.0 MW (worst case)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit
LA90 = +0.012x3 -0.130x2 +1.220x +30.80
where x=wind speed in m/s
R2 = 0.33
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels – Vestas V90 3MW – 24 hour
House G37
House G32
House G33
House G36
House G38
House G47
Noise prediction: V90 3.0 MW (no mitigation)
House G37 (involved)
SA 2003 Noise Limit
Existing Background Noise
Background Noise equation of best fit
LA90 = +0.003x3 -0.045x2 +1.901x +25.13
where x=wind speed in m/s
R2 = 0.59
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

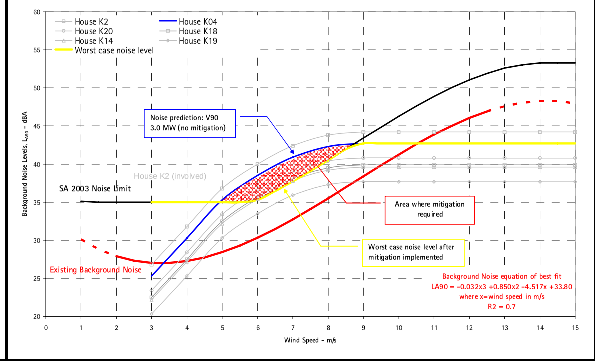
Predicted Noise Levels - Vestas V90 3MW - 24 hour



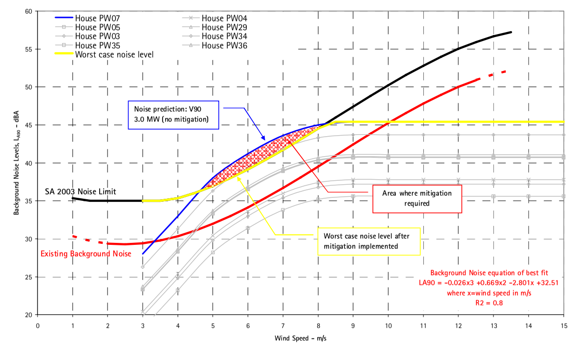
Predicted Noise Levels - Vestas V90 3MW - 24 hour



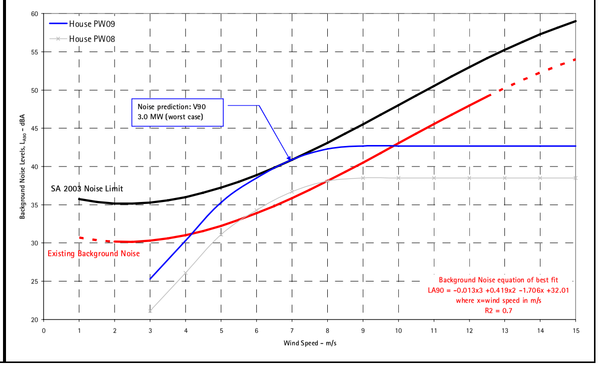
Predicted Noise Levels - Vestas V90 3MW - 24 hour



Predicted Noise Levels - Vestas V90 3MW - 24 hour



Predicted Noise Levels - Vestas V90 3MW - 24 hour



ADDENDUM 2.0

RECEIVER PREDICTED NOISE LEVELS (L_{Aeq}) RELATIVE TO COMPLIANCE LIMITS

			Sensitivity Analysis									
			Difference Between Compliance Limits and Predicted Noise Levels - MM92 90m Hub Layout C									
Receiver	Associated Compliance	Prediction @ 9m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
B10	B11	33.7	-15.9	-11.9	-4.7	-2.9	-4.3	-6.2	-8.8	-11.5	-14.1	-16.6
B11	B11	32.3	-17.3	-13.3	-6.1	-4.3	-5.7	-7.6	-10.2	-12.9	-15.5	-18.0
B20	B11	33.2	-16.4	-12.4	-5.2	-3.4	-4.8	-6.7	-9.3	-12.0	-14.6	-17.1
B21	B11	32.8	-16.8	-12.8	-5.6	-3.8	-5.2	-7.1	-9.7	-12.4	-15.0	-17.5
B22	B11	32.9	-16.7	-12.7	-5.5	-3.7	-5.1	-7.0	-9.6	-12.3	-14.9	-17.4
B23	B11	32.6	-17.0	-13.0	-5.8	-4.0	-5.4	-7.3	-9.9	-12.6	-15.2	-17.7
B24	B11	32.9	-16.7	-12.7	-5.5	-3.7	-5.1	-7.0	-9.6	-12.3	-14.9	-17.4
B35	B11	30.6	-19.0	-15.0	-7.8	-6.0	-7.4	-9.3	-11.9	-14.6	-17.2	-19.7
B54	B11	32.7	-16.9	-12.9	-5.7	-3.9	-5.3	-7.2	-9.8	-12.5	-15.1	-17.6
B9	B11	37.5	-12.1	-8.1	-0.9	0.9	-0.5	-2.4	-5.0	-7.7	-10.3	-12.8
B12a	B12A	38	-11.6	-8.7	-3.4	-3.6	-5.1	-6.8	-9.0	-10.8	-12.2	-13.1
B13	B13	34.7	-15.3	-11.8	-5.6	-5.1	-6.0	-7.4	-9.5	-11.8	-14.1	-16.4
B14	B13	33.6	-16.4	-12.9	-6.7	-6.2	-7.1	-8.5	-10.6	-12.9	-15.2	-17.5
B15	B13	32.4	-17.6	-14.1	-7.9	-7.4	-8.3	-9.7	-11.8	-14.1	-16.4	-18.7
B16	B13	30.8	-19.2	-15.7	-9.5	-9.0	-9.9	-11.3	-13.4	-15.7	-18.0	-20.3
B34	B13	30.6	-19.4	-15.9	-9.7	-9.2	-10.1	-11.5	-13.6	-15.9	-18.2	-20.5
B5	B13	33.6	-16.4	-12.9	-6.7	-6.2	-7.1	-8.5	-10.6	-12.9	-15.2	-17.5
B1	B18	43.7	-15.9	-11.9	-4.7	-2.7	-1.9	-1.3	-1.3	-1.3	-2.8	-5.1
B121a	B18	40.3	-9.3	-5.4	0.5	1.1	0.4	-0.6	-2.3	-4.2	-6.2	-8.5
B122a	B18	40.8	-8.8	-4.9	1.0	1.6	0.9	-0.1	-1.8	-3.7	-5.7	-8.0
B17	B18	36	-13.6	-9.7	-3.8	-3.2	-3.9	-4.9	-6.6	-8.5	-10.5	-12.8
B18	B18	36.3	-13.3	-9.4	-3.5	-2.9	-3.6	-4.6	-6.3	-8.2	-10.2	-12.5
B18a	B18	39.9	-9.7	-5.8	0.1	0.7	0.0	-1.0	-2.7	-4.6	-6.6	-8.9
B30	B18	34	-25.6	-21.6	-14.4	-12.4	-11.6	-11.0	-11.0	-11.0	-12.5	-14.8
B31	B18	34.3	-25.3	-21.3	-14.1	-12.1	-11.3	-10.7	-10.7	-10.7	-12.2	-14.5
B32	B18	34.4	-25.2	-21.2	-14.0	-12.0	-11.2	-10.6	-10.6	-10.6	-12.1	-14.4
B7	B18	36.1	-13.5	-9.6	-3.7	-3.1	-3.8	-4.8	-6.5	-8.4	-10.4	-12.7
B12	B26	35.6	-14.0	-10.0	-2.8	-0.8	-0.6	-1.7	-3.7	-5.7	-7.9	-10.0
B25	B26	32	-27.6	-23.6	-16.4	-14.4	-13.6	-13.0	-13.0	-13.0	-13.0	-13.6
B26	B26	36	-23.6	-19.6	-12.4	-10.4	-9.6	-9.0	-9.0	-9.0	-9.0	-9.6
B4	B26	36.3	-13.3	-9.3	-2.1	-0.1	0.0	-1.0	-3.0	-5.0	-7.2	-9.3
B27	B27	43	-7.1	-4.4	1.2	1.5	0.4	-1.1	-3.2	-5.5	-7.8	-10.1
B117	B29	30.6	-23.4	-20.4	-14.6	-14.2	-15.3	-16.7	-18.9	-21.1	-23.3	-25.5
B28	B29	35.6	-18.4	-15.4	-9.6	-9.2	-10.3	-11.7	-13.9	-16.1	-18.3	-20.5
B29	B29	36.4	-17.6	-14.6	-8.8	-8.4	-9.5	-10.9	-13.1	-15.3	-17.5	-19.7
B55	B29	34.5	-19.5	-16.5	-10.7	-10.3	-11.4	-12.8	-15.0	-17.2	-19.4	-21.6
B56	B29	31.2	-22.8	-19.8	-14.0	-13.6	-14.7	-16.1	-18.3	-20.5	-22.7	-24.9
B57	B29	30.6	-23.4	-20.4	-14.6	-14.2	-15.3	-16.7	-18.9	-21.1	-23.3	-25.5
B58	B29	30.3	-23.7	-20.7	-14.9	-14.5	-15.6	-17.0	-19.2	-21.4	-23.6	-25.8
B59	B29	29.4	-24.6	-21.6	-15.8	-15.4	-16.5	-17.9	-20.1	-22.3	-24.5	-26.7
B68	B29	31.2	-22.8	-19.8	-14.0	-13.6	-14.7	-16.1	-18.3	-20.5	-22.7	-24.9
B33	B33	42.6	-17.0	-13.0	-5.8	-3.8	-3.0	-2.4	-2.4	-2.4	-3.9	-6.1
B6	B33	40.1	-19.5	-15.5	-8.3	-6.3	-5.5	-4.9	-4.9	-4.9	-6.4	-8.6
B53	B53	38.2	-21.4	-17.4	-10.2	-8.2	-7.4	-6.8	-6.8	-9.5	-12.5	-15.5
B77	B53	35.9	-13.7	-9.7	-3.6	-3.3	-4.6	-6.3	-9.0	-11.8	-14.8	-17.8
B19	B8	35.5	-14.1	-11.4	-6.2	-6.4	-7.9	-9.9	-12.5	-15.1	-17.7	-20.3
B2	B8	38.6	-21.0	-17.0	-9.8	-7.8	-7.0	-6.8	-9.4	-12.0	-14.6	-17.2
B3	B8	35	-24.6	-20.6	-13.4	-11.4	-10.6	-10.4	-13.0	-15.6	-18.2	-20.8
B8	B8	36.6	-13.0	-10.3	-5.1	-5.3	-6.8	-8.8	-11.4	-14.0	-16.6	-19.2
G31	G31	30.3	-22.9	-19.7	-13.3	-12.1	-12.4	-13.1	-14.7	-16.7	-19.2	-22.2
G35	G31	31.1	-22.1	-18.9	-12.5	-11.3	-11.6	-12.3	-13.9	-15.9	-18.4	-21.4
G32	G37	34.6	-15.5	-13.2	-7.7	-7.3	-8.2	-9.2	-10.9	-12.7	-14.5	-16.4
G33	G37	34.1	-16.0	-13.7	-8.2	-7.8	-8.7	-9.7	-11.4	-13.2	-15.0	-16.9
G36	G37	33.1	-17.0	-14.7	-9.2	-8.8	-9.7	-10.7	-12.4	-14.2	-16.0	-17.9
G37	G37	36.2	-23.4	-19.4	-12.2	-10.2	-9.4	-8.8	-9.3	-11.1	-12.9	-14.8
G38	G37	31.3	-18.8	-16.5	-11.0	-10.6	-11.5	-12.5	-14.2	-16.0	-17.8	-19.7
G47	G37	30.5	-19.6	-17.3	-11.8	-11.4	-12.3	-13.3	-15.0	-16.8	-18.6	-20.5
G26	G39	32.2	-18.6	-15.0	-8.5	-7.7	-8.4	-9.6	-11.6	-13.7	-15.9	-18.1
G27	G39	30.4	-20.4	-16.8	-10.3	-9.5	-10.2	-11.4	-13.4	-15.5	-17.7	-19.9
G28	G39	31.4	-19.4	-15.8	-9.3	-8.5	-9.2	-10.4	-12.4	-14.5	-16.7	-18.9
G30	G39	31.4	-19.4	-15.8	-9.3	-8.5	-9.2	-10.4	-12.4	-14.5	-16.7	-18.9
G39	G39	33.6	-17.2	-13.6	-7.1	-6.3	-7.0	-8.2	-10.2	-12.3	-14.5	-16.7
G40	G39	33.2	-17.6	-14.0	-7.5	-6.7	-7.4	-8.6	-10.6	-12.7	-14.9	-17.1
G43	G39	33.1	-17.7	-14.1	-7.6	-6.8	-7.5	-8.7	-10.7	-12.8	-15.0	-17.2
G44	G39	31.4	-19.4	-15.8	-9.3	-8.5	-9.2	-10.4	-12.4	-14.5	-16.7	-18.9
K1	K1	37.1	-12.5	-8.5	-1.3	0.7	-1.1	-3.5	-6.6	-9.6	-12.3	-14.7
K12	K1	31.7	-17.9	-13.9	-6.7	-4.7	-6.5	-8.9	-12.0	-15.0	-17.7	-20.1
K13	K1	34	-15.6	-11.6	-4.4	-2.4	-4.2	-6.6	-9.7	-12.7	-15.4	-17.8
K3	K1	33.3	-16.3	-12.3	-5.1	-3.1	-4.9	-7.3	-10.4	-13.4	-16.1	-18.5
K5	K1	32.1	-17.5	-13.5	-6.3	-4.3	-6.1	-8.5	-11.6	-14.6	-17.3	-19.7
K6	K1	33.3	-16.3	-12.3	-5.1	-3.1	-4.9	-7.3	-10.4	-13.4	-16.1	-18.5
K7	K1	31	-18.6	-14.6	-7.4	-5.4	-7.2	-9.6	-12.7	-15.7	-18.4	-20.8
K8	K1	30.3	-19.3	-15.3	-8.1	-6.1	-7.9	-10.3	-13.4	-16.4	-19.1	-21.5
K14	K2	33.3	-16.3	-12.3	-5.1	-3.5	-5.2	-7.4	-10.4	-13.3	-16.1	-18.4
K18	K2	34.1	-15.5	-11.5	-4.3	-2.7	-4.4	-6.6	-9.6	-12.5	-15.3	-17.6
K19	K2	32.1	-17.5	-13.5	-6.3	-4.7	-6.4	-8.6	-11.6	-14.5	-17.3	-19.6
K2	K2	38.4	-21.2	-17.2	-10.0	-8.0	-7.2	-6.6	-6.6	-8.2	-11.0	-13.3
K20	K2	35.3	-14.3	-10.3	-3.1	-1.5	-3.2	-5.4	-8.4	-11.3	-14.1	-16.4
K4	K2	36.9	-12.7	-8.7	-1.5	0.0	-1.6	-3.8	-6.8	-9.7	-12.5	-14.8
PW29	PW7	34.7	-14.9	-11.3	-5.8	-6.0	-7.8	-10.1	-13.2	-16.2	-19.0	-21.5
PW3	PW7	30.7	-18.9	-15.3	-9.8	-10.0	-11.8	-14.1	-17.2	-20.2	-23.0	-25.5
PW34	PW7	37.8	-11.8	-8.2	-2.7	-2.9	-4.7	-7.0	-10.1	-13.1	-15.9	-18.4
PW36	PW7	35.1	-14.5	-10.9	-5.4	-5.6	-7.4	-9.7	-12.8	-15.8	-18.6	-21.1
PW4	PW7	31.8	-17.8	-14.2	-8.7	-8.9	-10.7	-13.0	-16.1	-19.1	-21.9	-24.4
PW5	PW7	34.6	-15.0	-11.4	-5.9	-6.1	-7.9	-10.2	-13.3	-16.3	-19.1	-21.6
PW7	PW7	39.8	-9.8	-6.2	-0.7	-0.9	-2.7	-5.0	-8.1	-11.1	-13.9	-16.4
PW8	PW9	32.3	-17.6	-14.4	-8.4	-8.2	-9.4	-11.2	-13.8	-16.6	-19.3	-22.1
PW9	PW9	33.6	-16.3	-13.1	-7.1	-6.9	-8.1	-9.9	-12.5	-15.3	-18.0	-20.8

ADDENDUM 3.0
GULLEN RANGE PROJECT WIND TURBINE GENERATORS