THE ACOUSTIC GROUP PTY LTD
CONSULTING ACOUSTICAL & VIBRATION ENGINEERS

PEER REVIEW OF ACOUSTIC ASSESSMENT

FLYERS CREEK WIND FARM

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EXECUTIVE SUMMARY

The Acoustic Group has performed a desk-top review of the acoustic documents comprising the acoustic assessment for the Flyers Creek Wind Farm. Further, The Acoustic Group has conducted preliminary sound monitoring at an existing operational wind farm (the Capital Wind Farm) which was approved in New South Wales on the basis of similar analyses, guidelines and reports to that provided for the Flyers Creek Wind Farm. The conclusions of the Acoustic Group are set out below.

The Background Noise Monitoring Survey Report has been found to be flawed:

- Noise data that has been supplied does not truly reflect ambient background level;
- Logger positions with respect to residences and trees have not been adequately identified to enable assessment;
- One "residence" had two different logger positions;
- There are unexplained discrepancies in wind speed data;
- There is no evidence re essential wind speed correlations;
- There is no evidence that wind direction has been analysed for correlation to background levels nominated for residential receivers

The Noise Impact Assessment (Chapter 12, Environmental Assessment and Appendix G2 Noise Impact Assessment) has been found to be inadequate and likely to be inaccurate. They fail to properly examine:

- The lack of data for the type of turbine assumed;
- An appropriate sound power level for modelling purposes that reflects actual operating turbines;
- Modulation, interference patterns, low frequency noise and infrasound;
- The impact of meteorological conditions on sound propagation;
- Identify the actual noise impact of the wind farm;
- Substation noise, construction noise and transmission line noise.

There has been found to be a fundamental inadequacy in the acoustic assessments in that they do not attempt to discuss or examine the actual noise impact for the community. Such an analysis is required by the Director-General's Requirements and by the principles contained in the South Australian legislative framework.

The adequacy of the South Australian Guidelines in protecting the amenity of the community surrounding the wind farm has been examined. Fundamental inconsistencies and omissions in the South Australian legislative framework relating to wind farm noise have been identified. There are fundamental inconsistencies and omissions in relation to Indicative Noise Levels and in relation to low frequency noise and infrasound. It has been found that the Guidelines establish criteria which conflict with their own objectives.

It has been found that application of the South Australian Guidelines cannot be reconciled with the New South Wales Protection of the Environment Operation Act (POEA) nor with the New South Wales Industrial Noise Policy. The proposed wind farm will result in the generation of offensive noise breaching the New South Wales legislative framework.

Initial results from preliminary testing at the Capital Wind Farm have been found to confirm concerns that the Flyers Creek Wind Farm will result in the generation of intrusive and offensive noise. Testing has demonstrated that the Capital Wind Farm is generating audible noise significantly above predicted levels and above levels prescribed by its consent at the residential site tested. These noise levels validate complaints of significant adverse impacts.

Preliminary testing at the Capital Wind Farm demonstrates low frequency noise and infrasound at levels and fluctuations likely to impact on residents.

On the basis of the above, The Acoustic Group has found that approval of the Flyers Creek Wind Farm proposal would expose the surrounding community to intrusive and offensive noise and would leave the approval authority, land owners and the proponent open to litigation and complaint accordingly.

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1.0 INTRODUCTION

I Steven Edwin Cooper the Principal of The Acoustic Group Pty Ltd, Consulting Acoustical and Vibration Engineers, provide this desk top review of the acoustic assessment prepared for the Flyers Creek Wind Farm.

I have been in practice as an Acoustical Consulting Engineer for 34 years. I hold a Bachelor of Science (Engineering) degree from the University of New South Wales and a Master of Science (Architecture) degree from the University of Sydney and am a Chartered Professional Engineer. I am a Fellow of the Institution of Engineers Australia, a Member of the Australian Acoustical Society and a Member of the Institute of Noise Control Engineering (USA). In the course of my Acoustical Consulting practice I have been involved in numerous projects for private, commercial and government organisations requiring expertise in acoustics, noise and vibration issues. Furthermore as a practising Acoustical Consulting Engineer I am or have been a member of the Standards Association of Australia Committees AV4, AV/10, AV/10/4 and EV/11 dealing with Architectural Acoustics, Whole-Body Vibration, Rail Traffic Noise, and Aircraft Noise respectively. I was a member of the Australian Acoustical Society NSW Membership Grading Committee from 1979 to 1997 and was a member of the Australian Acoustical Society Federal Grading Committee in 1998. My curriculum vita is set out in Annexure A.

The primary acoustic documents for the Flyers Creek Wind Farm are:

- Flyers Creek Wind Farm Environmental Assessment Chapter 12
- Flyers Creek Wind Farm – Background Noise Monitoring Survey Report by Vipac (ref 50B-08-0098 – TRP-771535-1 dated 7 June 2010
- Flyers Creek Wind Farm –Noise Impact Assessment by Vipac (ref 50B-08-0098 – TRP-773906-2 dated 21 December 2010

2.0 THE BASIS OF ASSESSMENT

At the time of the preparation of the assessment there were no noise guidelines issued by the Department of Environment, Climate Change and Water ("DECCW") with respect to wind farms and at this point in time there are still no NSW guidelines.

The Director-General's Requirements in relation to the "Noise Impacts" of the Flyers Creek Wind Farm specify that the Environmental Assessment must "include a comprehensive noise assessment of all phases and components of the project including turbine operation, construction and traffic noise. The assessment must identify noise sensitive locations...., the levels and character of noise (e.g. tonality, impulsiveness etc) generated by noise sources, noise criteria, modelling assumptions and worst case and representative noise impacts. In relation to wind turbine operation, the EA must determine noise impacts under operating meteorological conditions (i.e. wind speeds from cut in to rated power), which may include impacts under meteorological conditions that exacerbate impacts. The probability of such occurrences must be quantified."

The Director General's requirements for the Wind Farm state further that the assessment "must be undertaken consistent with" the Environmental Noise Guidelines: Wind Farms issued by the South Australian EPA in February 2003 ("the Guidelines").

The Vipac report identifies the 2003 SA EPA guidelines were replaced by a revised document issued in July 2009.

The EPA guidelines rely upon noise level limits from the SA *Environment Protection (Industrial Noise) Policy 1994* that nominate a base level of 40 dB(A) or the lowest typical background noise level + 5 dB(A) (whichever is the greater) in rural areas from 10 PM until 7 AM the following day.

This limit applies to existing noise sources whereas for a new wind farm development the criteria are reduced such that when the noise emission level is expressed as an equivalent noise level ($L_{Aeq,10}$), adjusted for tonality in accordance with the guidelines, should not exceed:

- 35dB(A), or
- the background noise (LA90,10) by more than 5 dB(A)

whichever is the greater, and all relevant receivers for each integer wind speed from cut-in the rated power of the wind turbine generator.

The basis of the noise criteria to exceed 35 dB(A) is on the assumption that when the wind increases so does the background noise level.

Therefore the assessment procedure requires the conduct of ambient measurements under different weather conditions to derive the background level for various wind speeds upon which a regression line is derived to then determine the noise limits that would apply for the integer wind speeds from cut-in to the rated power of the wind turbine generators.

The noise criteria provided in the Vipac report indicates the cut-in speed is 3 m/s when assessed at a height of 10 m above ground level with the highest wind speed used for the purpose of establishing noise criteria being 9 m/s.

The method of predicting the noise emission from the wind farm is by use of a computer program in which the Vipac report identifies a tolerance of up to ± 4 to 5dB(A) for 95% confidence level that is reduced to ±2 dB(A) in Chapter 12 of the Environmental Assessment. Section 12.11.1 of the Environmental Assessment identifies that in the design phase if the predicted level are more than 2dB(A) below the derived criteria then an uncertainty level of 2 dB(A) will be added to the predicted level. However this correction is not identified in the Vipac report.

Under the compliance checking section of the EPA Guidelines there is a requirement that if under the Environment Protection Act the wind farm exhibits tonality as a characteristic then a 5 dB(A) penalty is added to the measured background level from the wind farm. The same section identifies that annoying characteristics such as infrasound or adverse mechanical noise are not fundamental to a typical wind farm and if present should be rectified.

3.0 BACKGROUND NOISE MONITORING REPORT

Examination of the Vipac background survey report has identified a number of anomalies which have not been identified in the report and are outlined below.

3.1 No True Ambient Background Levels

Section 4 nominates equipment and locations used for the purpose of monitoring and identifies that the equipment satisfies the requirements of IEC 61672 *Electroacoustics – Sound Level Meters Part1: Specifications*.

The Standard permits a tolerance limit on the measurements depending upon whether the meter is a Type I or Type II instrument. Whereas the prediction assessment has indicated a tolerance in relation to the noise emitted from the proposed wind farm the background noise monitoring report has not identified a tolerance of the measurements.

As the ambient noise levels in rural areas are significantly lower than those obtained in suburban built-up areas then there is a question as to the accuracy/capability of the meters used for assessment purposes to obtain true background levels.

The Vipac report did not identify the lower limit of the sound level meters and examination of the ambient background level charts demonstrates that the meters used for assessment purposes are not capable of measuring the true ambient background level by reason of the graphs exhibiting a flat line for the lowest measurements obtained during the monitoring.

For the instruments used one obtains an electronic noise floor below which the meter simply cannot measure below a certain level. This noise floor may be presented as a combination of the preamplifier noise + system electronics, or in some cases is identified as the microphone noise + preamplifier noise + system electronics. These two noise floors are not the same and can be confusing for persons seeking to find the noise limits of the measuring system as a means of determining the true background level. The ARL logger used for the last set of measurements at location 78 and 89 has a specified noise limit significantly above the base limit suggested in the regression analysis charts for those two locations, with different documentation for the ARL 316 logger specifying the lowest microphone limit of 22 and 28 dB(A).

Testing of sound level meters in our anechoic chamber has revealed that for a number of instruments the manufacturer's specifications as to the lower limit of the meter relate to the electrical capabilities of the meter and ignore the noise floor of the microphone, which will govern the lower limit of sound that the sound level meter can detect.

If the noise data that has been obtained at the various monitoring locations does not truly reflect the ambient background level and in fact measures higher than what actually occurs then the regression analysis that has been applied is incorrect, i.e. with the provision of more data points below the observed lower noise threshold the regression line must move down.

Furthermore, the background level results do not continue below 3 m/s and therefore the report has not defined the ambient background level that is obtained when there is no wind present, or the background level that would be used for assessment purposes under procedures used by the NSW DECCW (now OEH) for the assessment of industrial noise sources.

Examination of the logger graphs would suggest that the true background level used by the NSW DECCW for the assessment of industrial noise sources is likely to be at or below 20 dB(A).

3.2 Logger positions with respect to Residences and Trees not identified

The 2003 EPA Guideline that has been identified by Vipac as being the basis of assessment nominates that all measurements are to be conducted 1200 to 1500 mm above the ground at least 5 m from any reflecting surface other than the ground. An explanatory comment to the noise measurement location identifies that a position within 20 m of the house and in the direction of the wind farm would be a valid measuring point but that the presence of trees nearby can significantly affect the background levels.

Under NSW industrial noise guidelines for rural properties the assessment point is to be taken within a 30 m envelope of a residence. It would therefore appear that if the assessment was to be consistent with standard practice for noise monitoring the monitoring locations would be between 5 and 30 m of a residence and free of nearby trees.

One would expect that where there were variations to the appropriate noise monitoring locations the report would indicate that position.

However, Section 4 of the background noise monitoring report does not identify the relationship of each logger position with respect to the residence to which the ambient background level is to apply.

We are instructed that with respect to location 12 the logger was initially located at a position approximately 165 metres from the dwelling and was then relocated to a position 34 metres from the dwelling in proximity to a small tree.

The report does not indicate the change in the monitoring location or whether there was any difference in relation to the background levels for the two different locations identified as logger location 12.

We are instructed that location 25 was 8 m from a brick shed and not in proximity to trees whilst location 27 was within 12 m of the dwelling.

3.3 Essential Wind Speed Correlations Not Identified

The background noise monitoring report indicates that whilst there were five environmental noise loggers there were three weather stations used to determine local wind conditions at the microphone level. Page 7 indicates the weather stations were located at positions 27, 78 and 89 and agree with the photos shown on pages 16, 17 and 18.

However in Appendix C of the noise monitoring report the graphs of the measured levels include the wind speed at the met tower and also wind speed at the microphone. The results for location 12 show by the light blue graph that there was a weather station at location 12 for at least the period of 13 November to 17 December which is not identified in the report.

Comparison of the microphone wind speed and the met tower wind speed for locations 12, 25 and 27 reveals a similar pattern in relation to the wind but the same pattern or correlation in terms of the met tower wind is not that apparent for location 89. There is no explanation of the differences and how the met tower wind speed relates to the background level at location 89.

Comparison of the microphone wind speed versus the met tower wind speed indicates that there are periods of wind at the met tower greater than 3 m/s, yet at the monitoring locations there is no wind present.

The correlation between the met tower results at a height of 80 m above ground level versus the wind at 10 m (to accord with the EPA guidelines) versus the actual wind and background levels that occurred at the residential receivers has not been identified. Without such meteorological data one is simply left with the position of trusting Vipac to have undertaken the assessment (which they purportedly claim has been conducted) without any evidence/proof of that correlation having been carried out.

3.4 Wind Direction Analysis

Appendix C of the background noise monitoring report provides wind speed but not direction. The relevance of the wind at the receiver location with respect to the met tower must be dependent upon the direction of the wind.

The Assessment does not demonstrate that the analysis has considered the wind direction for each location for correlation to the background levels. On the assumption that it did not do so, the regression data is invalid.

4.0 VIPAC NOISE IMPACT ASSESSMENT

The assessment report relies upon the background measurement report to determine the acoustic criteria that will apply at residential receivers. Table 5-2 nominates the noise targets to apply from a cut in speed of 3 m/s where that speed is determined at the met tower with Table 5-3 determining the criteria that would apply at a reference height of 10 m above ground level. These wind speeds are at the wind farm site and not the noise monitoring locations at residential receivers.

4.1 Lack of data re turbine characteristics

Section 6 refers to the prediction of noise by way of a computer model with an assumption of the type of turbine to be used. There is discussion that the turbine nominated for assessment purposes has a tone and that there is a lack of data in relation to significant characteristics such as impulsiveness, modulation or low frequency components in the sound power spectrum.

It is of interest to note that the report has not actually provided any details as to the spectral characteristics of the turbine that has been used in the assessment yet provides a suggestion that whilst a tone may be obtained in the near field to the turbines it is likely to be not audible at residential receivers. This is an unjustified and unsubstantiated assertion.

The recent closures of turbines at night at the Hallett 2 wind farm in South Australia, apparently as a result of tonality, highlight the significance of identifying tonality in noise assessments at the outset. It appears that there was a failure to identify tonality in the Vipac reports for Hallett 2.

4.2 Failure to properly examine modulation, interference patterns, low frequency noise and infrasound.

Whilst the manufacturers might not have provided published data in relation to modulation or low frequency components of the turbine that has been nominated by Vipac for assessment purposes, there is significant and published material in relation to noise issues concerning wind farms that highlights these very facts.

Of significance that is not identified in the predictions provided in the report is the **beating effect that may occur between the interference patterns by multiple noise sources (i.e. wind turbines). The computer model simply locates noise sources at various positions and does not consider any interference patterns that may be generated by various turbines or the modulation effects in the audible range of hearing associated with the blade path frequency of turbines and turbulence effects.**

Similarly the noise prediction whilst working in A-weighted levels fails to address the matter of infrasound, which is sound below the range of frequencies detected or perceived by the human ear.

The last paragraph on page 9 of the Vipac report states:

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

It would seem that the above paragraph is an unqualified statement in relation to low frequency noise, infrasound and health effects, which is disputed by persons living near wind farms both here in Australia and overseas.

The Director-General's Requirements specifically require the assessment to examine the levels and character of the predicted noise, including "tonality, impulsiveness etc." Neither the Environmental Assessment nor the Vipac Noise Impact Assessment make any proper attempt to deal with these issues.

4.3 Failure to Identify the Impact of Meteorological Conditions

The noise predictions provided by Vipac do not identify the meteorological conditions (temperature and humidity) that are being used for assessment of the noise, nor any allowance for temperature inversions that can dramatically alter the propagation of noise. Observations at existing wind farms indicate that the turbines can be operating when there is a fog present in the area and no wind at residential receivers.

It has been suggested that the position of a turbine in the elevated hills allows thermal flows to permit the turbines to be operating whilst the surrounding area does not experience such wind. Furthermore the provision of turbines on elevated hills versus residences in valleys below can have the turbines operating whilst a temperature inversion is occurring over the valley. Such situations dramatically alter the propagation of noise to residential receivers removed from the wind farm, which has not been included in the Vipac assessment. The Director-General's Requirements specifically require that the impacts of such occurrences must be determined and their probability quantified.

In the NSW EPA's *Industrial Noise Policy* Appendix D "Estimating noise increase due to inversions" provides a table " as a rough guide for predicting inversion effects as a site at the **initial screening test stage**".

On the basis of a simple flat ground and no barrier model the following table (Table D1 from the INP) gives an estimate of the difference in predicted noise levels with and without inversion conditions.

Table D1. Increase in noise level due to inversions

Distance (m)	Increase in noise level, dB			
	3°C/100m	3°C/100m and 2 m/s	8°C/100m	8°C/100m and 1 m/s
100	1.0	2.0	2.3	3.0
200	1.0	3.0	3.0	4.0
300	1.0	3.0	3.0	4.0
400	1.5	3.5	3.5	5.0
500	1.5	4.0	4.0	5.5
600	1.5	4.5	4.5	6.5
700	1.5	5.0	5.0	6.5
800	1.5	5.0	5.0	6.5
900	1.5	5.0	5.0	6.5
1000	1.5	5.0	5.0	6.5
1500	1.5	4.5	4.5	6.5
2000	1.5	4.5	4.5	6.5
3000	1.5	4.5	4.5	6.0
4000	1.5	4.0	4.0	6.0
5000	1.0	4.0	4.0	5.5

Notes:
The above data represent the results of single-point source calculations performed using ENM ver. 3.06 assuming a broadband noise source rounded-off to the nearest 0.5 dB. The following parameters were adopted in the calculations:
- temperature 12°C (winter), humidity 85%
- wind direction from source to receiver (270°)
- source height 3 m, receiver height 2 m
- rural, ground type: grass, rough pasture.

The above guide indicates the significant difference temperature inversions can have on the propagation of noise for locations removed from the noise source.

4.4 Failure to Identify Impact of Individual Noise Sources

Under a heading of "Noise Impact Assessment" one would expect the author of the report to actually identify what the impact would be for the various noise sources associated with the proposed development. However, that is not the case for this assessment. Again, this omission has occurred despite the express direction of the Director-General's Requirements to examine all noise components of the project.

4.4.1 Sub-Station

With respect to noise from the substation (Section 7) there is the identification of the cumulative sound power level for two transformers operating simultaneously under certain 'worst case' meteorological conditions. Those meteorological conditions are not defined.

A conclusion for the substation noise identifies that the 100 Hz frequency component "is not expected to be significant at the receiver locations". One can assume that this is an appropriate assessment of the noise impact as assessed by Vipac but the matter of **what is significant at receiver locations is not identified**.

The operation of the substation is a separate entity to wind farm noise and if the predicted noise level from the substation at receivers is likely to be 30 dB(A) then such noise in an ambient background level of less than 25 dB(A) is likely to be annoying. If that noise includes a low frequency tone then an adjustment for that tone of + 5 dB(A) is required. Therefore where such noise is clearly audible one needs to ascertain the basis of what is in Vipac's assessment a "significant" noise.

Furthermore, monitoring at two substations have revealed differences in the propagation of noise and noticeable directional characteristics in the 100Hz component that also change with load conditions. The Vipac assessment would **appear to assume uniform hemispherical radiation of the noise.**

A resident in proximity to the Capital wind farm substation has advised the author he regularly experiences noise from that substation that interferes with his rest and repose at levels less than 40 dB(A) – see below. The Vipac assessment of Capital Wind Farm failed to predict that the resident will experience any disturbance.

4.4.2 Construction Noise

Section 7.2 "Construction Noise" claims on page 18 that "construction noise and vibration is not anticipated to cause significant detrimental effect to the amenity of the residences in the vicinity of the wind farm during construction". From an acoustic perspective **"significant detrimental effect" is not defined in the document and a reasonable person viewing the assessment would not be able to comprehend the noise impact that would occur**.

On page 17 of the assessment report Table 7-4 nominates average background noise levels to then provide a criterion of 10 dB(A) above that average background level. However, the construction noise guideline referred to by Vipac is the NSW DECC's Interim Construction Noise Guideline which sets out on page 12 of that document the noise criteria when used as a quantitative assessment is rating background level + 10 dB(A).

The rating background level ("RBL") is not the average background level nominated by Vipac. The RBL is determined as the median of the individual daily background levels when assessed in accordance with the procedures identified in the NSW *Industrial Noise Policy*. At no point in either the background noise report or the assessment report are the RBL's identified at the receiver location.

The RBL will by definition be lower than the average of background noise level nominated by Vipac as the RBL method requires consideration of L90 background levels for wind speeds less than 5 m/s. As identified above,Vipac have not provided that material.

Table 7-3 indicates predicted noise levels for individual items of plant for a distance of 1500 m to be up to 40 dB(A) with Table 7-5 indicating maximum expected noise levels at the nearest residential receiver to be up to 45 dB(A) on the basis of multiple plant operating simultaneously. There is no information as to weather conditions that are being considered in relation to the prediction of noise under construction activities and whether the noise levels provided on page 17 of the assessment report are under neutral weather conditions.

Utilising the regression line charts of the background noise at receiver locations contained in the background noise monitoring report indicates **the RBL is likely to be below 30 dB(A) thereby revealing the proposed construction activities would exceed the DECC noise limits and as such would create an acoustic impact**.

Discussions with residents in proximity to the Capital wind farm (see below) have revealed that the construction phase of that development gave rise to significant noise impacts and that construction operations occurred outside the approved times contained in the conditions of consent.

4.4.3 Transmission Line Noise

Section 7.3 **"Transmission Line Noise" does not provide any noise levels but a general statement that it will not be an issue at any residences** and that corona discharge noise will only be present in high humidity conditions (such as periods of rainfall or fog) and will only be significant or distracting near the power line.

4.4.4 Failure to examine the Noise Impact of the Wind Farm as a Whole

There is no separate subsection in Section 7 that deals with the noise impact of the wind farm. What one obtains in the first three paragraphs of the section is an indication the wind farm will comply with the noise limits contained in the EPA Guideline. However the **"Noise Impact Assessment" section of the report does not actually discuss the noise impact of the wind farm. This would appear to be a fundamental inadequacy in the acoustic assessment.**

Apparently Vipac have experience in monitoring noise of wind farms. Compliance reports from Vipac are in the public domain for, inter alia, Hallett 2. It can be assumed that Vipac is aware of complaints from residents concerning the noise from the wind farm. Yet despite having that experience there is no discussion in terms of the actual noise impact that wind farms generate.

Reliance as to unreasonable interference or sleep disturbance is placed upon a World Health Organisation (WHO) Report issued in the last century and based on noise data obtained more than 15 years ago. The subject WHO document does not identify at any point in that document that the criteria relates to or involves any assessment of wind farms.

The absence of consideration of wind farms in the WHO Report therefore does not account for the spectral characteristics of wind farm noise, the lower external and internal ambient noise levels in rural areas and the attenuation performance of typical light weight structures being significantly less at low frequencies than that assumed for general traffic noise.

The WHO material in relation to sleep disturbance is not that of rural areas but relates to suburban areas where acousticians expect an ambient noise level to be significantly higher than that experienced in rural areas. To suggest that the generation of noise some 15 dB(A) above the background level would not interfere with the sleep disturbance defies logic for any acoustician that is involved in real-world measurements.

A reasonable person being aware of the relevant criteria that apply to the assessment of noise impacting upon residents could only find that the concluding section of the Noise Assessment Report has not actually provided a noise impact that confirms there will be a minimal disturbance as a result of the proposal. In fact Section 7 when examined in light of the relevant criteria and the subjective comments provided in the report reveals that the proposed development will create a significant acoustic impact.

The fact that the noise impact of the wind farm has not been addressed in the specialist acoustic report becomes a relevant matter in terms of an independent assessment bearing in mind that Chapter 12 of the Environmental Assessment goes beyond the Noise Assessment Report by stating on page 12-2:

> "The proposed layout has been designed to achieve acceptable impact to neighbouring residences primarily through ensuring sufficient setback of turbines from the closest residents. The noise assessment has derived the predicted noise levels for each of the residences within three kilometres from the nearest wind turbine to ensure that the selected layout enables compliance with the noise level criteria."

The first sentence in the above extract in acoustic terms contradicts the second sentence. At no point in the Vipac acoustic assessment is there any identification of what is an acceptable impact. The authors of the Environmental Assessment may be considering the design in terms of the Applicant's view of an acceptable impact.

5.0 GENUINE NOISE IMPACT ASSESSMENT – THE RELEVANCE AND ADEQUACY OF PRESENT GUIDELINES

5.1 SA EPA Guidelines for Wind Farms

Whilst there are different Regulations or Acts pertaining to noise in New South Wales and South Australia, in the first instance there is a direction for the assessment of the Flyers Creek wind farm to utilise the SA EPA guidelines. These Guidelines are part of a legislative framework in South Australia which, as indicated above, comprises The Environment Protection Act 1993, the Guidelines and the SA Environment Protection (Noise) Policy. In general, the 2003 version of the Guidelines is similar to the 2009 version but there are subtle differences that become relevant in terms of an acoustic assessment of the subject wind farm. This Section examines inconsistencies and inadequacies in the applicable South Australian framework.

The 2003 Guidelines are not an Act of Parliament but Guidelines that purport to have been established in accordance with the objects *Environment Protection Act1993 (SA).* That Act constrains the Guidelines as they are established pursuant to its objects. The shaded box on page 1 of the Guidelines identifies that the Act requires a duty of care for the environment and that under Section 25 of the Act:

> *A person must not undertake an activity that pollutes, or might pollute, the environment unless a person takes all reasonable and practical measures to prevent or minimise any resulting environmental harm.*

In addition to the constraining duty of the Act, the introduction to the guideline identifies that the core objective of the guideline "*is to* ***balance the advantage of developing wind energy projects in this State with protecting the amenity of the surrounding community from adverse noise impacts***". Therefore a fundamental issue of concern with respect to the guideline is what constitutes the amenity of the rural environment, and what constitutes a level that protects the surrounding community from adverse noise impacts.

When examining the Guidelines, it is essential to take into account these overriding objectives and obligations. When this is done, inconsistencies and omissions in the South Australian position, taken as whole, preclude their providing an effective legislative noise impact framework. The Guidelines establish criteria that in fact contravene the overriding obligation to protect the amenity of the surrounding community.

Indicative Noise Levels

There is a contradiction between indicative noise levels for rural areas when the Policy is compared with the Guidelines.

Subsection 5 in Part 1 of the Policy provides indicative noise levels. For rural level the "Indicative noise factor" is 47 dB(A) in the day and 40 dB(A) at night.

The same subsection indicates that if a measurement place within a habitable room cannot be located near the open window the indicative noise level for the noise source is the satisfactory level set out in Australian Standard AS 2107:200 – Acoustic Recommended Design Sound Levels and Reverberation Times for Building Interiors, or 20 dB(A) less than the indicative noise level, whichever is the greater.

AS 2107 nominates a satisfactory level of 25 dB(A) for sleeping areas in houses in areas with negligible transportation.

If one considers a difference of 10 dB(A) from outside inside for an open windows then one obtains an external noise target of 35 dB(A).

Alternatively if one takes the indicative noise factor of 40 dB(A) at night then the internal indicative noise level would become 40 – 20 = 20 dB(A), that for an open window would therefore give an external criteria of 30 dB(A).

The greater of the two levels becomes 35 dB(A).

Under Part 4 of the Policy, the noise goal to satisfy the general environmental duty under section 25 of the Act is that the source noise level (continuous) is not to exceed the background noise level plus 5 dB(A), or the source level (continuous) is not to exceed the indicative noise level for the noise source.

Therefore if one was considering the obligations of the SA EPA under the general environmental duty set out in the Act the operation of a wind farm that generates a noise level more than background plus 5 dB(A) should be reduced to that level, whereas the base criterion of 35 dB(A) applied for wind farms clearly breaches the general environmental duty set out in the Act. The criteria established by the Guidelines contravene the obligations created under the legislative framework.

In addition to the above contradiction, the basis of what is deemed to be an acceptable level in a rural environment is not dealt with. The basis of how the indicative levels have been determined for a rural environment have not been identified in either the EPA information document to the Policy or the EPA wind farm guideline.

A valid question therefore arises and remains as to the appropriateness of the indicative noise factor for rural dwellings that are not located in townships or near major roads or industry. The ambient noise data contained in the Flyers Creek Environmental Assessment certainly does not support the indicative noise factor that has been nominated in the policy.

The issue of the actual noise impact on residential receivers is not identified in the EPA guidelines. It is noted that in Section 2 of the guidelines (fourth paragraph) the EPA guidelines state:

> *If the noise generated does not exceed the background noise by more than 5 dB(A) the impact will be marginal and acceptable.*

This statement tends to agree with the concept provided in Appendix A of the previous (1984) version of Australian Standard AS 1055.2 *Acoustics – Description and measurement of environmental noise*, i.e where a noise exceeds the background it is likely to be annoying and differences of 5 dB or less may be of marginal significance with respect to annoyance.

Dependent upon the surrounding topography, bush and wildlife there can be different levels of ambient noise in the rural environment. The character or quality of the sound generated by a wind farm can be out of context with the rural environment.

Residents subject to noise from wind farms have described the noise as having a constant sound like a distant aircraft or aircraft overflying a site at high altitude which remains there all the time. Generally the character of the wind farm noise described by residents is of a low frequency type of noise (see below) that is punctuated by a swishing sound which is normally attributed to the blade pass frequency of the turbine blades.

Modulation

There is inconsistency between the Policy and the Guidelines in relation to modulation, an increasingly important aspect of wind turbine acoustic assessments and the real impact of wind turbine noise. The Policy requires adjustment to the noise if there are characteristics. The Policy identifies modulation of the noise as one characteristic requiring correction whereas the Guidelines do not identify modulation of the noise as a characteristic.

Infrasound and Low Frequency Noise

Schedule 1 of the Policy identifies noise that is excluded from the Policy and whilst not citing wind farms identifies as item 10 that "Noise outside of the human audible range" is a noise excluded from the Policy. As to what constitutes the lower threshold of hearing, the SA EPA Guidelines and Policy document appear to place a limit of 20Hz as the lower threshold of hearing whereas Australian Standard AS 1633-1985 *Glossary of acoustic terms* sets the lower limit of audibility for hearing at 16Hz. In any event the information document issued by the EPA with respect to the Policy refers to infrasound being assessed by a separate procedure. But there is no procedure and this form of noise is not contained in the Policy. Therefore the matter of infrasound is not covered by the Policy.

The 2003 EPA Guideline does not define an assessment procedure for infrasound and by way of the guideline one would need to go back to the SA *Environment Protection (Industrial Noise) Policy 1994.* This policy was revoked when the SA *Environment Protection (Noise) Policy 2007* was issued. The Noise Policy Guideline (2007) whilst identifying what is meant by impulsive characteristic, low frequency characteristic, modulating characteristic and tonal characteristic in Section 3 of the Policy does not include infrasound. This may very well be the case because the Policy specifically identifies that it is only dealing with noise when measured using dB(A).

Contained in the Noise Policy Guideline (2007) is a reference to the *Guidelines for the use of the Environment Protection (Noise) Policy 2007* (issued by the SA EPA) where on page 13 of that document under heading of "Noise outside of the human audible range" one finds the following:

> *In extremely isolated situations, some noise sources may produce noise that is outside of the human audible range, that can still unreasonably interfere with a person's amenity. Exclusion of this situation is to ensure that such an isolated event is assessed using a specific procedure, rather than the Noise Policy.*

But there does not appear to be any specific procedure nominated for addressing infrasound.

Moller H, Pedersen CS. Hearing at low and infrasonic frequencies (Noise Health 2004;6:37-57) identify that the lower limit of the audible range of human hearing is typically given as 16 or 20Hz.despite the fact that humans can perceive sound down to a few Hertz. Whilst there are technical issues with describing noise below 20 Hz as infrasound, if one utilises the general concept of infrasound then the sensitivity to changes in pressure levels for infrasound and low frequency sound (less than 200Hz) occurs at a faster rate than sound at higher frequencies.

This pattern of growth in sensitivity appears in the equal-loudness contours. Moller and Pederson report that the implication of the growth in loudness "is that if a low-frequency sound is just audible then a relatively small increase in level will result in a much louder sound. They report on research on testing for the threshold of hearing for infrasound.

International Standard ISO 7196:1995 "Acoustics – Frequency weighting characteristics for infrasound measurements" provides the G-weighting characteristics for the measurement of sound pressure levels within the frequency band from 1 Hz to 20 Hz. The Standard does not provide threshold level or maximum exposure levels of infrasound but only a means of determining the dB(G) value.

If one goes to the 2009 Wind Farm Guideline there is a note in Section 4.7 that consultation with the (wind farm) working group and an extensive literature search did not apparently find any information as to "infrasound being present at any modern wind farm site". Contrary to the suggestion in the 2009 EPA Guidelines that "an extensive literature search" could not find any evidence of infrasound there are a significant number of papers reporting low frequency noise impacting upon residents in proximity to wind farms where the modulation of the noise and/or physical energy produced by the wind farm give rise to frequencies below that of the human ear.

Papers presented by M.A. Swinbanks ("The Audibility of Low Frequency Wind Turbine Noise") and D. Siponen ("The Assessment of Low Frequency Noise and Amplitude Modulation of Wind Turbine Noise') to the 4th International Meeting on wind turbine noise in Rome in April 2011 are but two examples. This issue was considered by the Federal Senate Inquiry in 2011 at Chapter 2 of its Report - Noise and Any Adverse Health Effects. The Senate referred to evidence and submissions from William Husan, acoustics consultant, as well as evidence from the United Kingdom and Italy in coming to its conclusion and specific recommendation (at 2.44) that noise standards adopted for States and Territories for the planning and operation of wind farms **should include appropriate measures to calculate the impact of low frequency noise and vibrations indoors at impacted dwellings.**

Given the extensive and growing number of papers dealing with infrasound and low frequency noise impacts of wind turbines, the Guideline objective of preventing surrounding community from adverse noise impact cannot, on any reasonable basis, be said to be met when these frequencies are ignored.

2003/2009 Wind Speed Measurement Heights/Wind at Location

The two versions of the SA EPA Guidelines refer to different assessment locations with respect to the wind speed upon which the background levels at residential locations are to be correlated. One guideline refers to the height of the turbine hub and another one refers to the standard meteorological reference of 10 m above the ground at the wind farm site. However, as the location of wind farms tends to be at an elevated position when compared to residential receivers. Clarification is required to

identify that when wind farms are operating (assuming a cut-in speed of 3 m/s) there may be no wind at the receiver location.

The reliance upon wind at the turbine provides confusion in identifying the background level at residential receivers when there is no corresponding information to identify or correlate the differences between the wind at the wind farm site versus the receiver location.

Where there are limited ambient monitoring stations, that also incorporate monitoring of the wind at the microphone, then the assessment requires assumptions with respect to the criteria that may be applied at locations other than the location that has been monitored.

5.2 NSW Protection of the Environment Operations Act & the Industrial Noise Policy

Whilst the Director General can specify the assessment of the wind farm is to be in accordance with the South Australian 2003 EPA guideline for wind farms this does not release the operator of the wind farm or the landowner upon which the wind farm is located from fulfilling the obligations not to create offensive noise as defined in the Protection of the Environment Operations Act ("the POEA").

There is a requirement under the POEA to ensure that wind farms do not create offensive noise, which by definition in the Act is a noise that is harmful to a person's health, or interferes with the rest or repose of an individual. Under the definitions to the POEA noise includes sound and vibration.
Because wind farms are not scheduled under the POEA the responsibility for noise lies with the local Council, in that if wind farms were scheduled they would be the responsibility of the DECCW/OEH ("Department of Environment, Climate Change and Water/Office of Environment and Heritage").

The various publications concerning noise criteria issued by the NSW EPA/DECCW identify the concept of offensive noise and utilise the design target for industrial noise sources of background + 5 dB(A) when assessed as a Leq level over 15 minutes. This target is described as the "intrusive" noise target.

Under the Industrial Noise Policy document issued by the NSW Environment Protection Authority industrial noise in rural areas considers as a starting point a background level of 30 dB(A) irrespective of the ambient background noise (when below 30 dB(A)). The background level used for assessment purposes as discussed above is the rating background level which is determined for noise data below 5 m/s and therefore at the present time does not cater for the concept of the sliding background level as presented in the SA EPA Guidelines.

The application of 30 dB(A) for rural environments subject to industrial noise impact has generally been related to daytime activities not necessarily at night.

The conflict between offensive noise and the current minimum background level of 30 dB(A) for rural areas needs to be resolved for the application of wind farms in NSW. Under industrial noise assessments in NSW there is a requirement to consider noise propagation under prevailing weather conditions and to include temperature inversion where the number of inversions at night (on a seasonal basis) exceeds 30%.

The occurrence of temperature inversions in rural areas at night results in a significantly more stringent noise criteria for large-scale developments due to the substantial enhancement of sound that can occur under temperature inversion conditions.

The siting of wind farms on elevated parcels of land that may be subject to thermal gradients that permit the turbines to operate, but not have an effective wind through the areas where dwellings may be located, requires a more comprehensive assessment procedure for the analysis of wind farms.

6.0 A TEST CASE – CAPITAL WIND FARM

The deficiencies identified above strongly suggest that the Flyers Creek Wind Farm will result in the generation of intrusive and offensive noise. In order to test this hypothesis, sound monitoring has been conducted at residential dwellings in proximity to the Capital Wind Farm ("CWF") on the eastern side of Lake George, N.S.W. The Capital Wind Farm was chosen as it is an existing operational wind farm approved subject to similar guidelines and reports. The initial assessment of "potential noise impact" was undertaken by Vipac Engineers and Scientists in an almost identical manner to the assessment which is under scrutiny for the present project. The Capital Wind Farm was completed in 2009 has been operational since November 2009. It is therefore possible to examine the accuracy of the noise impact predictions of the initial acoustic assessments. The results obtained reflect upon the adequacy not only of the initial assessment but of the SA Guidelines in fulfilling their own stated objectives.

Documents pertaining to the acoustic assessment and compliance for the CWF were obtained from the NSW Department of Planning's website. The ambient background monitoring material that formed part of the Environmental Assessment (being Appendix H1) is available - *Background Noise Monitoring Report, Vipac Engineers and Scientists, Reviewing Engineer Peter Teague, 27 April 2005.* The acoustic assessment (being Appendix H2) is not available on the website. The Noise Assessment is contained in Chapter 10 of the Environmental Assessment which is on the website and from which extracts of predicted noise levels and criteria have been extracted.

These documents confirm monitoring for a proposed configuration of up to 65 2.1 MW wind turbines in a predominantly rural area. Useful background noise levels were recorded by Vipac at 8 receiver sites over a two to three week period in February 2005. Using simultaneously recorded wind data, a regression analysis of the noise-wind data for each site was performed and used to determine noise criteria. The available references included the 2003 SA Guidelines and the Australian Standard AS 1259-1990.

The Assessment concluded (10.11) *"Predictions of sound levels from the operation of the wind farm have been made using an accurate predictive noise model based on the validated and accepted Concawe algorithm for noise propogation in different meteorological conditions.....The predicted sound contribution levels at relevant receivers were found to be acceptable under all wind speeds at all relevant residences except for those shown in Table 10.3. Given the small degree of predicted exceedance and the conservative nature of the noise prediction model used, it is possible that the actual wind farm noise levels at all relevant receivers will be within the criterion."*

Acoustic compliance testing since operation has apparently been undertaken by Vipac. There is reference to the "Technical review of the Capital Wind Farm Noise Compliance Assessment Report" by an officer of the Department. However the actual compliance test reports are not on the website. The Department's report identifies the wind farm complies with the conditions of consent pertaining to noise.

Capital Wind Farm Testing – Preliminary Measurements

The house chosen for both attended and unattended measurements at the CWF is the house identified as G 13 in the Environmental Assessment. The ambient monitoring location with respect to house G13 in the initial documents is Sunnybrook - G8.

Predicted Noise Levels at G13

The noise levels predicted by the initial Environmental Assessment and Vipac Report (2005) are set out below.

Appendix B1 is an extract from Chapter 10 of the Environmental Assessment to indicate the relationship of the (then) proposed turbines with respect to residential properties.

Appendix B2 is an expanded section of the previous page to show the relationship of ambient monitoring location (Sunnybrook) G8 with respect to house G13.

Appendix C1 shows the noise contours provided by Vipac at the maximum power speed of the turbines, whilst Appendix C2 is an expanded view with respect to house G13.

The noise contours indicate the maximum noise level from the proposed wind farm at house G13 would be between 32 and 36 dB(A).

Immediately following the expanded noise contours in Appendix C1 is a portion of the table showing **the predicted level at maximum power speed of the turbines would be 32 dB(A).**

Appendix D1 shows the background measurement/regression line analysis from Appendix H1 of the Environmental Assessment where for the background noise monitoring report Sunnybrook is identified as location 3 with page 7 of that report identifying that the location was a sheltered location and could have a lower background than to nearby houses but is considered representative of those nearby houses.

The regression line indicates that at the cut-in speed of 3 m/s the background level is around 26 dB(A) and if extrapolated down to 0 wind speed suggests a background level of around 22 dB(A). However as noted in previous sections it would appear the noise floor of the logger used for the background level measurements would be around 23 dB(A) and therefore the regression analysis for the lower wind speeds could well be lower than shown in the figure.

The background noise/regression line for Sunnybrook indicates that at the cut-in speed of 3 m/s on an intrusive noise basis **an intrusive limit of 31 dB(A) would be appropriate to ensure the annoying noise is of a marginal significance**.

Actual Noise Levels at G13

For this report, preliminary testing was carried out at house G13 between 9th November and 19th November 2011 utilising unattended loggers. The results demonstrate that on ten and a half days monitored, the L90 (background) noise levels as measured on the A

weighted scale significantly exceeded the 32 dB(A) nominated in the Environmental Assessment.

Whilst the compliance testing/noise limit is expressed in a Leq level (being an energy average) if one takes a conservative view of just considering the background level then on 9 out of 10 ½ days, the CWF was not compliant with a 32 dB(A) predicted level.

In addition to the logger measurements, attended measurements at night found significant infrasound and low frequency noise in the residence.

A-Weighted Scale

Appendix E provides a series of noise level results from unattended sound level meters that is correlated with a graph of the output power of Capital Wind Farm and Woodlawn Wind Farm.

Where Appendix E provides three graphs the upper graph shows the 10 minute statistical results obtained from a Bruel & Kjaer Sound Level Meter Type 2260 which has a lower noise floor than the ARL logger used to obtain the results shown in the middle graph.

Both instruments were checked prior to and after measurements for reference calibration by a Brüel & Kjær Sound Level Calibrator Type 4231 and exhibited no system drift.

The microphone for the ARL logger was a standard ARL logger installation by use of a fibreglass extension rod into the top of the logger case. The microphone was fitted with a standard 100mm B & K windscreen.

The B & K 2260 microphone was located 2 metres to the north of the ARL logger microphone and had a standard 100mm B & K windscreen over the microphone. The microphone with windscreen was located in a Challis outdoor noise monitoring windscreen to provide further attenuation of any wind noise/affects on the microphone.

Both microphones were located in the front yard of the property approximately 10-12 metres from the front facade of the dwelling and in a clear open area.

In both noise monitoring graphs the lowest line (green in the upper graph and purple in the middle graph) provide the L90 levels which is normally expressed as the background noise.

Examination of the graphs in Appendix E reveal the B & K 2260 meter to provide ambient background levels lower than the ARL logger. At times the background level shown in the upper graph dropped to 21 – 22 dB(A), whilst at the same time the ARL Logger was identifying a background level of around 28 – 29 dB(A). This difference highlights the error in determining the background level by using instrumentation that has too high a noise floor for use in rural areas.

The bottom graph on each page shows the power output of Capital Wind Farm and Woodlawn Wind Farm over the same 24 hour period, as both of these wind farms impact upon house G13.

Examination of the bottom graph on each page of Appendix E shows that typically when the wind farm was generating an electrical output that the background level increased and when the wind farm reduced generating electrical output the background reduced. The influence of the wind on the background level at the receiver location is not known at the time, although comparison of the background levels before and after the wind farm power output peaks does not maintain an elevated background level.

As there was no correlation material between the wind induced background level at the receiver location versus the met tower wind speed in the Noise Assessment Report, and house G13 is in a valley below the turbines, for the preliminary assessment of the unattended logger the comparison of the background level versus the wind farm power output identifies a measureable impact (see comments in relation to supplementary testing).

Examination of the background levels in the noise graphs with respect to the power generating graph reveals the operation of the wind farm to be significantly greater than the 32 dB(A) nominated in the Environmental Assessment for the maximum output of the wind farm.

Unfortunately there does not appear to be any website access to ascertain the wind speed or wind direction at the meteorological tower on the Capital Wind Farm.

Attendance at the sound level meters in the early hours of the morning of 9th November 2011 observed no wind at the residential site and no turbines operating with a background level of 32 dB(A) recorded at house G13.

At 11pm on the same day there was no wind observed at the residential site but the turbines were operating and gave rise to a background level of 39 dB(A). The turbines were clearly audible and by reference to the predicted levels of around 30 dB(A) for house G13 with speeds above the cut-in and a predicted level of 32 dB(A) at 8m/s it would appear that the predicted levels are in error and that the operation of the wind farm exceeds the permitted level of 35 dB(A) for wind speeds less than 6 m/s.

Low Frequency Noise and Infrasound

For the purpose of our preliminary assessment simultaneous measurements were undertaken for a microphone located in proximity to the external sound level meters identified above, and a second microphone located in a bedroom of the residence.

The bedroom has a top hung window which was slightly open during the course of the measurements.

Both of these microphones (Bruel & Kjaer Type 4189) were connected to Bruel & Kjaer preamps Type 2669, and then to a Bruel & Kjaer Pulse System Type 3560C to undertake real-time analysis. The Pulse system was set to simultaneously record 1/3 octave band analysis and FFT analysis.

Appendix F provides screen snapshots of the results for the two microphones where on page F1 are the measurement results in the early hours of the morning of 10.11.11 when the turbines were not operating, whilst page F2 shows the situation some 24 hours later when the turbines were operating.

As the Guidelines are expressed in dB(A) the preliminary analysis utilised the high pass filter of 22.4 Hz for each channel as the default mode on the Pulse system.

With the turbines operating there was a noticeable fluctuation in the low frequency 1/3 octave band components which in a generic sense are attributed to infrasound. However no noise associated with the turbines could be detected inside the dwelling because the sound pressure levels recorded in those bands are below the nominal threshold of hearing for those frequencies.

Appendix F3 shows an exponential average over 30 seconds for narrowband FFT analysis that show peaks around 10 Hz and 22 Hz.

As the sound pressure level in the low frequency spectrum was found to vary at a relatively fast rate, short sample measurements over 100 seconds were undertaken to show the variation in level and also provide a preliminary statistical analysis of noise (as shown in Appendix G) for the turbines in operation.

The concept of a time varying signal requires one to show the variation over time. Appendix G1 shows in the upper graph the statistical variation over the short sample for one third octave band analysis. The CPB analyser was set to use fast response exponential averaging at 50ms sampling rate for the hundred seconds. The lower figure shows the variation in the 10Hz 1/3 octave band and the dB(A) over the sample period.

The lower figure in Appendix G1 reveals the 10 Hz 1/3 octave band to vary by nearly 30dB over the 100 second sample, whilst the A-weighted level varied up to 15 dB(A) during the same period of time.

The general assessment of the spectral component of noise utilises constant percentage bandwidths (1/1 octave and 1/3 octaves) that looks at the frequency range on a logarithmic basis. Another form of frequency analysis is to consider constant frequency bands which results in a linear view of the frequency domain. The linear/constant bandwidth is often used to determine tonal components and for modern instrumentation uses a Fast Fourier Transform ("FFT") analysis.

Appendix G2 shows the FFT analysis for the exact same sample (as for Appendix G1) with the turbine operating with the upper graph showing the statistical variation over the hundred second sample. The total frequency bandwidth is 250Hz.

The second graph in Appendix G2 shows the FFT spectra recorded with the turbine operating and then compared with the turbine not operating on the previous night. The comparison of the L90 on and off traces reveal a noticeable difference in the area between 7 Hz and 25 Hz. The Leq level reveals noticeable differences below 20 Hz.

The preliminary attended testing at house G13 was for only one day in that the instrumentation is not capable of being left on site for automatic (unattended) measurements.

Some sound level meters when providing Linear (un-weighted) information may have a high pass filter in the region of 20 Hz whilst other meters may have a lower filter. To address frequencies below 20 Hz Appendix H shows a series of graphs recorded in December 2011 where 1/3 octave band measurements were undertaken at the same time as FFT analysis at house G13. For these measurements the high pass filter was set for 7Hz for the outdoor and one indoor (bedroom) microphone, with the second indoor microphone set to 22.4 Hz.

Appendix H1 provides 1/3 octave band results on the left hand side with FFT results for the frequency range of 1 – 10 Hz. The middle graph identifies the noticeable frequencies inside the bedroom that are not as apparent when viewing the upper graph for the outside location. The lower (blue) graph is for the same location as the middle graph but with the high pass filter at 22.4 Hz.

Appendix H2 provides 1/3 octave band results on the left hand side with FFT results for the frequency range of 0 Hz – 2kHz, which is sometimes a typical bandwidth for FFT analysis. However, in this case because of the bandwidth the low frequency peaks in the spectra are not evident.

Various acoustic indices have been proposed for assessing low frequency noise. Broner N, *A Simple Criterion for Low frequency Noise Emission Assessment* (Journal of Low Frequency Noise, Vibration and Active Control Vol 29 No 1, 2010) proposes that where the C-weighted value is above 30 dB(A) a LFN (Low Frequency Noise) limit of dB(A) + 30 should apply and if there are fluctuations in the level a + 3 dB penalty should also apply.

The NSW EPA use the difference between dB(C) and dB(A) of 15 dB to determine if there is a low frequency noise present.

ISO 7196:1995 "Acoustics – Frequency-weighting characteristics for infrasound measurements" provides the weighting values to determine the dB(G) value.

Salt, Alec N and Hullar Timothy E *Responses of the ear to low-frequency sound, infrasound and wind turbines,* Hearing Research 268(2010) 12-21 cites the outer hair cells (OHC) of the cochlea are displacement-sensitive and respond to infrasonic frequencies at levels up to 40 dB below that that are heard. Salt has proposed the calculated level for OHC stimulation is 60 dB(G).

To provide an insight into the various descriptors proposed for low frequency sound/infrasound the 1/3 octave data in Appendix G for the bedroom of house G13 has been analysed. The high pass filter slope of 60 dB/decade has been taken into account when determining the following statistical levels:

Table 2: 100 second sample Bedroom House G13

	dB(A)	dB(C)	dB(Lin)	dB(G)	dB(C)*	dB(G)*
L1	33	51	59	64	63	77
L10	28	49	57	62	61	75
Leq	25	48	55	60	60	73
L90	20	45	51	57	57	71

where * indicates without 22.4 Hz high pass filter

Whilst the turbines were not audible in the bedroom the EPA INP assessment would say **there is low frequency noise present**. The LFN concept from Broner would say **there is low frequency noise present and the OHC criteria from Salt would say the resident would be subject to the influence of infrasound**.

Conclusions from Capital Wind Farm Preliminary Testing

Notwithstanding the limited data as a result of the preliminary investigation the results of the testing at house G13 found the **Capital Wind Farm is generating noise above that permitted on the consent and the wind farm is generating low frequency noise and infrasound that could impact upon residents at that house**.

These conclusions are consistent with the recorded experiences of the resident of the home. The resident at house G13 has complained of headaches following the commissioning of the wind farm and provided a submission to the Federal Senate Inquiry held earlier in the year. The resident complained of sleep disturbance, disrupted sleep and at times pressurisation that is felt in the head.

The simple results on a dB(A) basis for one house raise questions as to the accuracy of the computer model, or the source data or the assumed propagation constants used for the Capital Wind Farm assessment. The measurement results show the outside dB(A) measurements do not provide the real picture of the noise impact, nor does the external A-weighted level address the low frequency noise/infrasound that may be present inside a dwelling.

Appendix I provides a copy of Wind News issued by the Clean Energy Council and distributed to residents of Bungendore in the last two weeks of November.

Under the heading of "Frequently Asked Questions" the following is stated:

> **Are wind farms noisy?** NSW controls on wind farm noise are amongst the strictest in the world. Before it can operate, a wind farm has to demonstrate that noise levels at neighbouring residences will meet strict noise limits. These limits are designed to ensure that noise from a wind farm is not intrusive for the average person.

Based on the preliminary measurements at House G13 the above statement is incorrect in that the Capital Wind Farm would appear to not meet "strict noise limits". Furthermore it would appear from the deficiencies outlined above and exposed by the preliminary measurement at Capital Wind Farm that it is incorrect to state the noise limits are designed to ensure, or are effective in ensuring, that wind farm noise is not intrusive.

On the contrary by way of the EPA's definition of intrusive noise being 5 dB(A) above the background level it is impossible for a 35 dB(A) level (permitted by the SA Guidelines) in a background of 20 – 25 dB(A) to be "not intrusive for the average person".

The preliminary measurements strongly suggest that the wind farm is not operating in accordance with the initial noise modelling. This in turn supports the conclusion that the noise modelling for Flyers Creek is insufficient and likely to be inaccurate. Further, the preliminary measurements support the argument that the external testing required by current Guidelines will not accurately reflect the noise impacts of operating wind farms and will not protect the amenity of the surrounding community from adverse impact.

Additional attended and unattended measurements

Following the preliminary measurements and analysis of those results, further testing has been carried out at houses G13, G16, H20 and H25.

Appendix J provides the results of unattended logging at house G13 and house G16. The monitoring at house G13 used an ARL logger whilst for house G16 the logging was conducted using a SVAN 957 sound level meter.

House G16 is elevated above house G13 and is more exposed to the surrounding area and wind. The results show G16 to experience higher background levels than G13 when the wind farms were producing power.

For these measurements a weather station at 10 metres above the ground was installed at house G16 to reveal for the majority of the monitoring period the wind was from the NE/E, thereby having the Woodlawn wind farm controlling the background level at house G16.

On 11th and 12th December the wind reverted to the NW/W leading to Capital wind farm controlling the background level at house G13.

The change in wind direction leads to variations in the noise levels between the two locations but the general trend with the background level increasing with the operation of the wind farms is still evident, with background levels well above 32 dB(A).

Appendix K provides the results of supplementary attended monitoring at houses.

Appendix K1 shows the 1/3 octave band graphs for both external and in the bedroom for house G16 recorded in the evening period. The prevailing wind at the time of the measurements was from the NE and noise from the Woodlawn wind farm was clearly audible inside the bedroom as can be seen from the graphs.

Using the same sample methodology for the preliminary testing but utilising a 7 Hz high pass filter the following results were obtained.

Table 3: 100 second sample House G16

	External				Internal			
	dB(A)	dB(C)	dB(Lin)	dB(G)	dB(A)	dB(C)	dB(Lin)	dB(G)
L1	40	61	90	75	23	48	72	62
L10	37	56	83	69	20	45	66	58
Leq	35	53	79	66	20	43	63	56
L90	33	48	64	58	19	39	54	51

Appendix K2 shows the 1/3 octave band graphs for both outside and in the bedroom of house H25 recorded in the day. At house H25 the prevailing wind at the time of the measurements was from the S/SW at a very low speed in that not all turbines were operating. Occasionally noise from the turbines was audible external to the dwelling.

Using the same sample methodology for the preliminary testing but utilising a 7 Hz high pass filter the following results were obtained.

Table 4: 100 second sample House H25

	External				Internal			
	dB(A)	dB(C)	dB(Lin)	dB(G)	dB(A)	dB(C)	dB(Lin)	dB(G)
L1	50	51	80	63	38	47	75	60
L10	45	50	71	60	32	44	67	57
Leq	41	48	68	59	30	42	62	54
L90	31	47	57	56	18	38	54	50

Testing at House H20 found the dwelling to be a corrugated iron cladding to a timber frame with the house supported on stumps, whereas the other houses tested were on concrete slabs. House H20 would not be dissimilar to many rural properties in existence and typical of shearing sheds/staff accommodation and the like.

House 20 was found to exhibit resonant peaks when persons were walking around the house and therefore the dwelling would in acoustic terms be considered "live" and readily excited from external energy.

Noise from the Capital Wind Farm could be detected externally to the house H20 and occasionally audible inside the building. In view of the potential for excitation of the dwelling under adverse weather conditions (temperature inversions or winds from the west) the degree of disturbance inside house H20 could be severe and warrants further investigation.

The supplementary testing, although limited in the extent of testing, has found low frequency noise to be detected inside the dwellings with measureable increases above the background levels. It is noted that the dwellings are light weight structures and provide minimal attenuation from outside to inside (to that obtained from brick veneer and cavity brick dwellings).

The additional testing supports the results of the preliminary testing at house G13.

7.0 CONCLUSIONS

The Flyers Creek Wind Farm should not be approved.

- The Background Noise Monitoring report is flawed. The noise data does not truly reflect ambient background levels. Logger positions with respect to residences entry has not been adequately identified to enable assessment. There are unexplained discrepancies in wind speed data and there is no evidence in relation to essential wind speed correlations. There is no evidence that wind direction has been analysed or correlated to background levels.

- There is no analysis in relation to noise emitted from the windfarm taking into account various weather conditions, and in particular the presence of temperature inversions with and without downwind effects

- The Noise Impact Assessment fails to deal adequately with the lack of data for the type of turbines assumed.

- The computer prediction provides tolerances greater than that nominated in the predicted levels, which therefore presents concerns in relation to the adequacy of the assessment.

- There is no adequate, specific examination of substation noise, construction noise or transmission line noise.

- There is no analysis of the noise impact of the windfarm as a whole. Such an analysis is required by the Director-General's Requirements and by the principles contained in the SA legislative framework. Insofar as the Assessment uses the WHO guidelines in relation to wind turbines and sleep, these guidelines are outdated and insufficient to deal with sleep disturbance from wind turbines in rural areas.

- The South Australian Guidelines are inconsistent and contradictory within their own legislative framework and failed to meet their own objectives.
- The SA guidelines permit noise from a windfarm that is intrusive. The NSW INP defines intrusive noise limit is background +5 dB(A). The base level from the SA Guidelines is 35 dB(A). Where one has a background level below 25 dB(A) and a limit of 35 dB(A) then noise at the “strict noise limit” must by definition be intrusive.

- The Acoustic Assessment for the proposed Flyers Creek Wind Farm is very similar to that for the Capital Wind Farm proposal. Both proposals purport to indicate there will be no acoustic issues. Further measurements and testing are required at Capital Wind Farm to provide additional data to the preliminary testing. However the preliminary testing undertaken to obtain measurement

data assessment suggests that the assessment and its predictions are incorrect. It suggests there is valid foundation for complaints in relation to the noise impact of that windfarm.

- There is no doubt that the acoustic environment inside residential dwellings in rural areas is different to that outside. The use of an acoustic criterion expressed in terms of the A-weighted level is inadequate for assessment purposes when assessed external to the dwelling and totally inadequate for assessing the noise level obtained inside a dwelling.

- The assumptions made as to outside inside attenuation for a typical suburban dwelling do not apply for rural dwellings subject to the impact of noise/energy generated by wind farms.

- It is impossible to predict from available data what buffer zones would be required to give protection from noise impacts to the residents affected by the FCWF.

THE ACOUSTIC GROUP PTY LTD

STEVEN E. COOPER

ANNEXURE A: Curriculum Vitae

STEVEN E. COOPER. - DIRECTOR

DATE OF BIRTH: 15 June 1952

QUALIFICATIONS:

Bachelor of Science Engineering (Electrical) 1978, University of NSW

Master of Science (Architecture) 1990, University of Sydney

MEMBERSHIPS:

Member, Australian Acoustical Society

Fellow, Institution of Engineers, Australia
Chartered Professional Engineer

Member, Institute of Noise Control Engineering

Member of Committee AV/10 – Whole Body Vibration (1986 to present), Committee EV/11 – Aircraft & Helicopter Noise (1986 to present), AV/4 – Architectural Acoustics (1996 – 1999), and Committee EV/10/4 – Railway Noise (1998 to 2007)

NSW Division, Australian Acoustical Society
Membership Committee since 1978 to 1997

EXPERIENCE:

The Acoustic Group Pty Ltd
Incorporated in 2003

Steven Cooper Acoustics Pty Ltd
Incorporated in 1995

James Madden Cooper Atkins Pty Ltd
Incorporated in 1981

James A. Madden Associates Pty Ltd
Appointed Associate Director 1980
Appointed Associate 1979
Appointed Engineer 1978

THE ACOUSTIC GROUP

20-22 FRED STREET, LILYFIELD, 2040, NSW, AUSTRALIA
ph: (612) 9555 4444 fx: (612) 9555 4442 tag1@acoustics.com.au
A.B.N. 73 082 704 701

The Acoustic Group was formed to provide specialised services and research in Acoustics and Vibration and draws on the considerable experience of Mr. Cooper from his position from 1982-1995 as Principal and Partner of James Madden Cooper Atkins and from 1995-2003 as Principal of Steven Cooper Acoustics. His particular areas of acoustical expertise include machine and vibration monitoring, acoustical design of auditoria, studios and entertainment venues, traffic and helicopter noise, laboratory instrumentation, precision analysis system, legal assignments and expert witness.

He has considerable experience in vibration measurement and assessment in industry for both Machinery Operating Condition and Occupational Exposure Levels.

His experience in the measurement and assessment of noise emission from industry and licensed premises is extensive having produced numerous assessment reports and noise control designs for clients, statutory bodies and courts. He has been an invited Guest Lecturer on Noise Assessment to NSW Policy Academy for their Noise Familiarisation Course run by the State Pollution Control Commission, a guest lecturer for the Faculty of Architecture at the University of NSW, and a lecturer on noise issues for seminars/workshops run by the Australian Industries Group, the Australian Environment Network and NEERG Seminars.

He is the acknowledged leader in the measurement, assessment and design of helipad/heliport operations, military aircraft noise assessments, and is a major contributor to various Australian Standards. Mr. Cooper is the recipient of an Engineering Excellence Award in the Environment Category from the Institution of Engineers in 1997 for the TRW No. 2 Forge Project.

Projects in which he has been involved include the ICI Botany Complex (Noise and Vibration), APM Matraville Paper Mill (Site noise control), Manildra Flour Mill, Sydney CBD, Granville & Gosford Heliports, ANEF Validation and NPD testing for F111, FA-18, JSF aircraft, Iroquois, Squirrel, Sea King, Sea Hawk, Blackhawk, Super Seasprite, Tiger and MRH90 helicopters, acoustical assessments for Licensed Premises, Studios, Auditorias etc.

PAPERS & PUBLICATIONS

"Design for Noise Reduction – Dual Occupancies" 5th Annual Conference, Local Government Planners Association of NSW, November 1979

"Is Exposure to High Levels of 'Rock' Music a Major Health Hazard to Patrons and Staff" 10th International Congress on Acoustics – Sydney, July, 1980

"Hornsby Shire's General Sound Insulation Code for Residential Flat Buildings" 10th International Congress on Acoustics – Sydney, July, 1980

"Archiving Reproducing Piano Rolls" 10th International Congress on Acoustics – Sydney, July, 1980

"Road Traffic Noise and Local Government Controls", Graduate School of the Built Environment, University of NSW, February, 1981
"Noise Levels of Rock Music and Possible Effects on Young People's Hearing" Scientific Meeting NSW Division, Australian Acoustical Society, April, 1981

"Noise Assessment of Licensed Premises" NSW Police Noise Familiarisation Course, Policy Academy Sydney, July, 1981

"Noise Effects on Staff in Entertainment Venues" Australian Live Theatre Council, May, 1983

"Noise Pollution" Shout – August 1987, Journal of the Registered Clubs Association of NSW

"The Roles and Needs of Expert Witnesses", Development, Local Government and Environmental Seminar for Sly & Russell, Sydney, November, 1987

"Noise Limits for Helicopters", "Helicopters Noise and the Community", "Flight Techniques to Reduce Noise", Helicopter Noise Seminar – NSW Branch of the Helicopter Association of Australia, April, 1988

"Intensity Measurements of the Ampico/Duo Arts Parts 1 & 2" The AMICA News Bulletin (USA), Vol 25 No. 4, July, 1988

"Community Perceptions, Case Studies and Control of Noise" – Australian Conservation Foundation – Sydney Branch, September, 1988

"Helicopter Noise Assessment", Australian Acoustical Society Conference, Victor Harbour, South Australia, November, 1988

"Noise Considerations for the Establishment of Helipads/Heliports", Rotortech '89, Sydney, October, 1989

"An Investigation of the Alternatives to Sabine's Equation in the Determination of Absorption Coefficients using the Room Method", Master of Science Thesis, University of Sydney, March, 1990

"Noise Control – Decibels per dollars. A Practical Approach", The Stock Feed Manufacturers', Association of Australia Conference, Canberra, March, 1990

"Community Response to Aircraft & Helicopter Noise – Proposed PhD Research", Technical Meeting of the Australian Acoustical Society, NSW Division being a Review of Acoustics Research at Sydney University, May, 1991

"A Practical Method for the Assessment of Noise Controls for Aircraft Noise Intrusion", Second Sydney Airport Coalition Public Meeting, Petersham Town Hall, Sydney, September, 1991

"Are Regulatory Noise Limits in Australia Exterminating the Helicopter Industry?", Inter-Noise 91, Sydney, December, 1991

"Consideration of Alternative Acoustic Criteria for Assessment of Aircraft Noise in Wilderness & National Park Areas", Progress Report of Noise Criteria Working Group, Blue Mountains Fly Neighbourly Advice, July, 1994

"Are Regulatory Noise Limits in Australia Exterminating the Helicopter Industry?", Second Pacific International Conference on Aerospace Science & Technology, Melbourne, March, 1995

"Sound Proofing of a Forge", Acoustics Australia, Vol 26 (1998), No 2

"AS2021 – What Does it Mean Now?", Australian Mayoral Aviation Council Conference 1998

"Upgraded Plants and Retrospective Application of Modified Noise Criteria – Case Studies", Australian Industry Group, January, 1999

"Revision of Australian Standard AS2021", Airport Operators Conference, Melbourne, May, 1999

"Living with Your Neighbour's Noise", Neighbourhood Disputes Seminar, LAAMS, Sydney, May, 2000

"What Triggers the New EPA Noise Policies – Tips & Traps", Australian Environment Business Network Noise Pollution Seminar, June, 2001

"Practical Environment Management – Noise Issues", Australian Environment Business Network Environment Management Practitioners Workshop, August 2002, November 2002, February 2003, May 2003, August 2003

"Environmental Issues Management – Noise", Australian Industries Group Practical Methods and Technologies Seminar, October, 2002

"The INM Program is a much better program than HNM for helicopter modelling, but ….", SAE A-21 Helicopter Noise Working Group Meeting, Las Vegas, March, 2004

"Noise Certification, is the Helicopter Industry selling itself short?", HeliExpo 2004, Las Vegas, March, 2004

"Derivation & Use of NPD Curves for the INM", Helicopter Noise Workshop, American Helicopter Society Conference, June, 2005

"Problems with the INM: Part 1 – Lateral Attenuation", Noise of Progress Acoustics Conference 2006, New Zealand

"Problems with the INM: Part 2 – Atmospheric Attenuation", Noise of Progress Acoustics Conference 2006, New Zealand

"Problems with the INM: Part 3 – Derivation of NPD Curves", Noise of Progress Acoustics Conference 2006, New Zealand

"Problems with the INM: Part 4 – INM Inaccuracies", Noise of Progress Acoustics Conference, 2006, New Zealand

"Reviewing the Role of the Expert in Land & Environment Court Cases", NEERG Seminars, Sydney, August 2007

"JSF Aircraft Noise Issues for Australia", F35 ESOH Working Group Meeting, Washington, September 2007

"Acoustic Experts - Noise Under Pressure?" Getting it Together in the Land & Environment Court: Compiling Joint Expert Reports, NEERG Seminars, Sydney, October 2007

"What can go wrong acoustically", NEERG Seminar Dealing with DAs in 2009, Sydney, May 2009

"Community Response to Impulse Noise & Vibration", Training Area Noise & Vibration Workshop, Department of Defence, Canberra, June 2009

"Acoustics & Noise". Regulations & Implementation of DAs & SEPP65, NEERG Seminars, Sydney, March 2010

"INM Getting it to work Acoustically", 20th International Congress on Acoustics, Sydney, August 2010.

"Military Aircraft Noise in the Community", 20th International Congress on Acoustics, Sydney, August 2010.

"Sound Therapy Restores hearing – Fact or fiction? A personal experience of an acoustician", 20th International Congress on Acoustics, Sydney, August 2010.

"Alternative Aircraft Metrics – Useful or like moving the deck chairs on the Titanic", 20th International Congress on Acoustics, Sydney, August 2010.

"Issues arising from Incorrect Acoustic Conditions", Getting it Just Right, NEERG Seminars, Sydney, September 2010

"Avoiding/repairing acoustic disasters in DAs", Managing the DA Process from Go to Whoa, NEERG Seminars, Sydney, March 2011

"Aircraft Noise Measurements can be fun", Australian Acoustical Society NSW Division, August 2011

"INM Problems, Military Operations and AS2021 and the JSF", Australian Acoustical Society Victorian Division, September 2011

SPONSORED TECHNICAL REPORTS (Brief Selection only):

Noise Radiation and Reduction on a Fibreglass Minesweeper – HMAS Rushcutter for Carrington Slipways P/L, JMCA Report 16.1650.R1

Occupational Vibration Exposure Levels on Euclid Dump Trucks and Coal Haulers at Utah Blackall Mine Queensland, JMCA Report 16.1648.R1-R3

Thermal Expansion and Misalignment on a Gas Turbine Alternator at Shell Clyde Refinery, JMCA Report 17.1716.R1-R3

Acoustic Appraisal and Control – ABC Perth TV & Radio Studio Complex, JMCA Report 17.1607.R3

Southern Arterial Route – Pyrmont to St. Peters for NSW Department of Main Roads, JMCA Report 16.1647.R1

Building Structure Vibration Department of Social Security, East Point Centre Computer Installation, JMCA Report 15.1542.R2

Blower House Acoustic Controls (Building and Silencer Designs) St. Marys, Quakers Hill, Glenfield, Macquarie Fields and Hornsby Heights Pollution Control Plants, JMCA Reports 10.1014 & 14.1416

The Application and Use of ANEF Contours for Aircraft Noise Control, SCA Report 25.3127.R3 for Submission to the Senate Inquiry into Aircraft Noise at KSA

An Acoustical & Vibration Investigation into Freight Rail Operations in the Hunter Valley, SCA Report 26.3387.R1-R41

TRW No 2 Forge Noise Minimisation Study, SCA Reports 26.3314.R12-R19

Acoustical Assessment, Proposed Extension of Dock Hours, Westfield Shoppingtown, Parramatta SCA Reports 28.3766.R8-R12

Noise Impact Assessment, Proposed Service Centre, Cnr Cowpasture Road & Hoxton Park Road, Hoxton Park, SCA Report 30.3934.R1

Acoustical Assessment, Proposed Extension of Operating Hours, Westfield Shoppingtown Hornsby, SCA Report 30.3928.R3

Acoustical Assessment Aircraft Operations, RAAF Williamtown and Salt Ash Weapons Range, SCA Report 32.4190.R6

Acoustical Assessment Pollution Reduction Program No. 7, Shoalhaven Starches Plant, Bombaderry, SCA Report 32.3849.R17

HMAS ALBATROSS 2013 ANEF, Derivation of NPD Curves, SCA Report 33.4185.R11

Acoustical Assessment, Proposed Residential Development, Glenning Valley, Wyong, SCA Report 33.4303.R1

Acoustic Assessment, Proposed Groundwater Cleanup Project, Botany Industrial Park, TAG Report 34.4372.R3

Acoustic Design Report, Stage 1 Development Application for Bathurst Hospital, TAG Report 35.4477.R2

Acoustic Assessment, SCT Freight Complex - Stage 1, Brolgan Road, Parkes, TAG Report 36.4523.R1

Noise Disturbance in Residential Apartments as a Result of Building Expansion/Contraction, Bluewater Point Apartment Complex, Minyma, Queensland, TAG Report 36.4578.R1

Acoustic Design Report, Westfield Centrepoint Refurbishment, TAG Report 37.4472.R5

Construction Noise and Vibration Impact Assessment, Westfield Sydney City Refurbishment, TAG Report 37.4472.R6

Proposed Shao Lin Temple Development Site Near HMAS Albatross: Noise Assessment Report, TAG Report 37.4586.R1

TIGER ARH NPD Curves, TAG Report 37.4510.R15

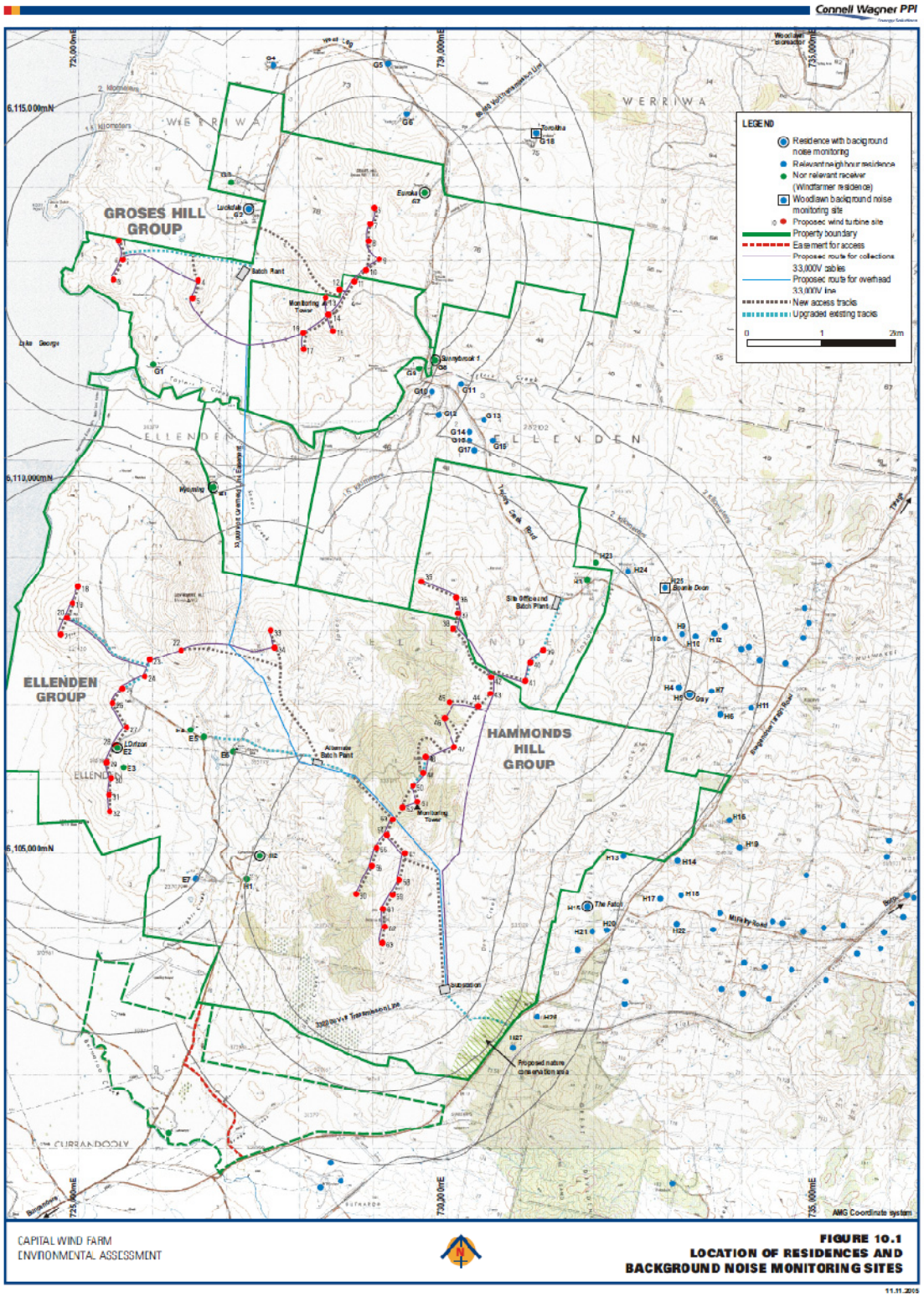
Acoustical Assessment, Point Piper Marina, TAG Report 38.4705.R9

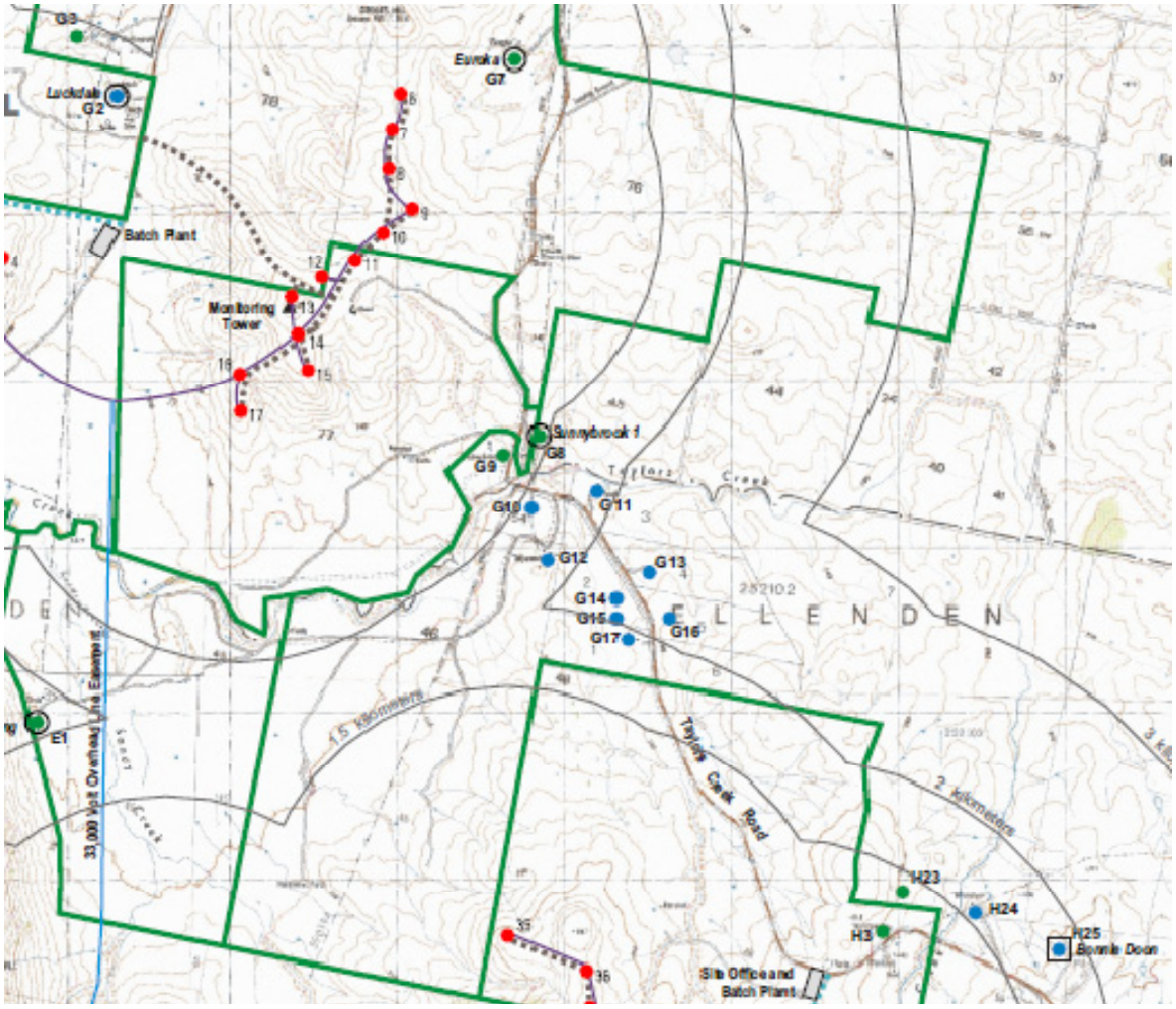
Rail Traffic Noise Impacts, Residential Sub-division, Isedale Road, Braemar, TAG Report 40.4865.R1

Acoustic Compliance Testing, New Buildings, RMAF BASE Butterworth, TAG Report 40.4386.R3

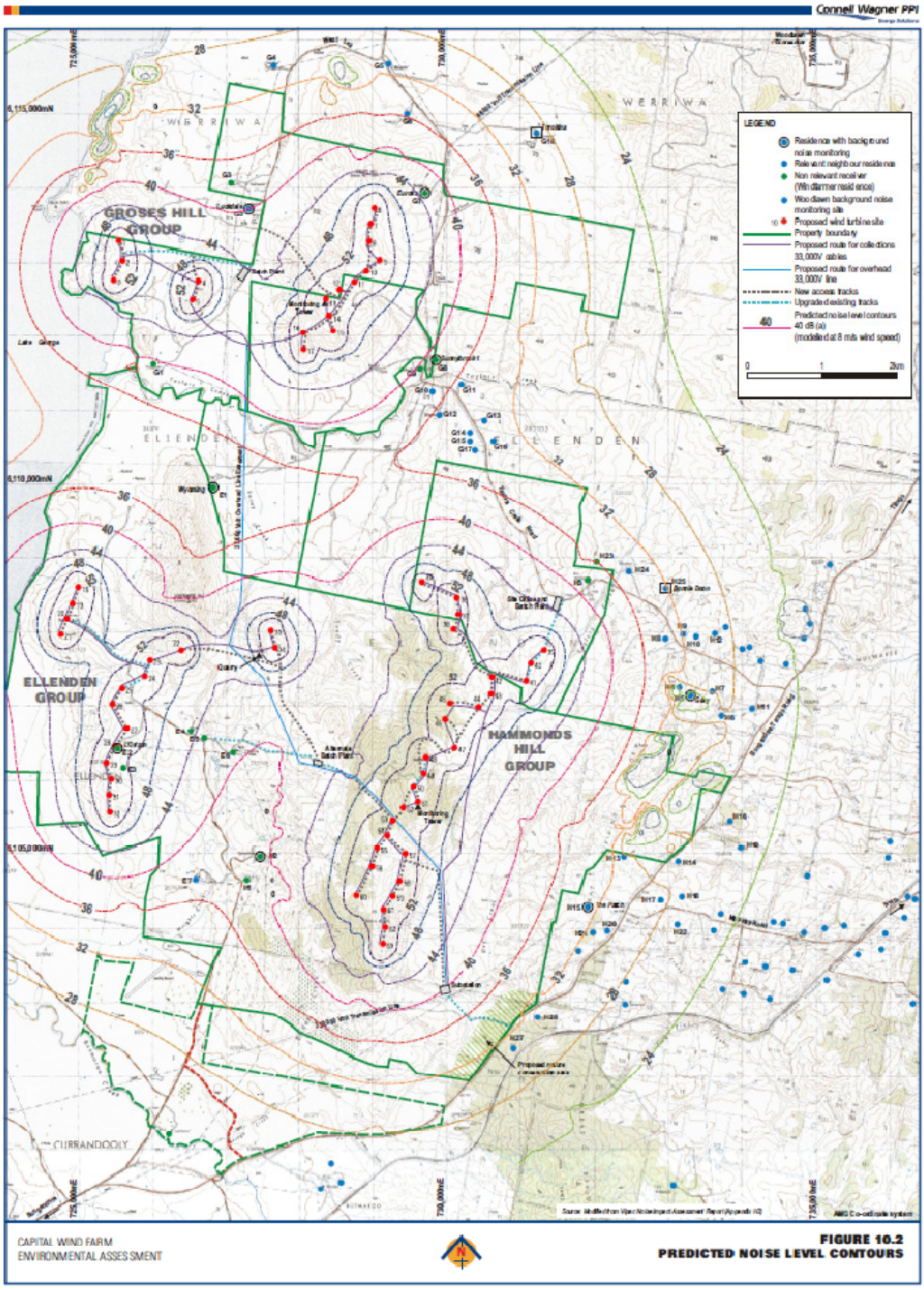
Acoustic Compliance Assessment, RAAF Base Williamtown – Off Base NMT Calibration, TAG Report 40.4421.R18

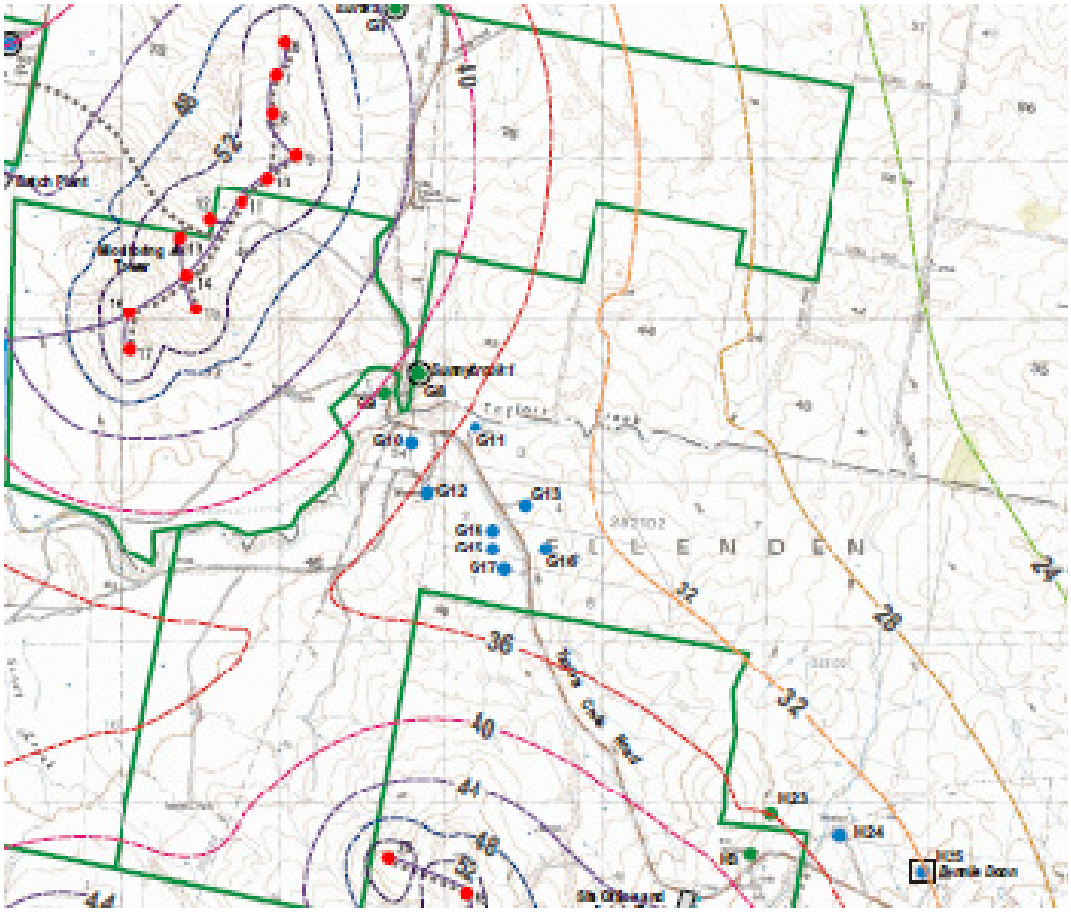
APPENDIX B: Capital Wind Farm Site (from EA) in relation to houses




G3
Lucindale
G2
Batch Plant
Monitoring Tower
Eureka
G7
Sunnybrook 1
G8
G9
G10
G11
G12
G13
G14
G15
G16
G17
ELLENDEN
E1
33,000 Volt Overhead Line Easement
1.5 kilometers
Taylors Creek Road
2 kilometers
H23
H24
H3
H25
Bonnie Doon
Site Office and Batch Plant

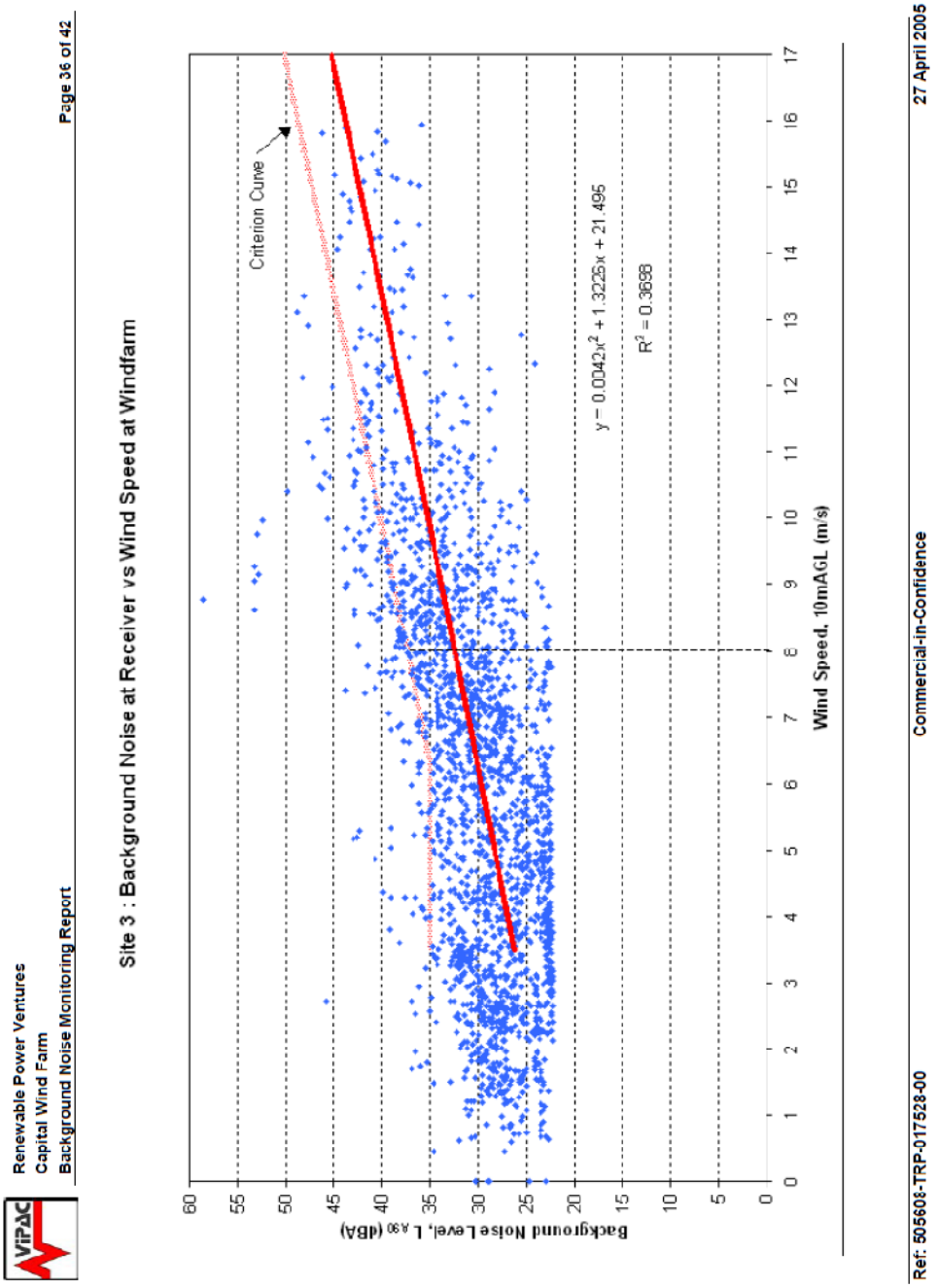
APPENDIX C: Predicted Noise Contours





Relevant Receiver	Wind speed ms^{-1}								
	4	5	6	7	8	9	10	11	12
Criterion : Luckdale (G2)									
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*	*44*	*46*
G2* Luckdale	**36**	**37**	**38**	38	39	39	39	39	39
G4 Lakoona	23.5	24.5	26	26	26.5	26.5	27	27	26.5
Criterion : Euroka (G7)									
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*	*41*	*43*
G5 Bernallah	25	26	27	27.5	27.5	27.5	28	28	27.5
G6* Widgemore	31.5	32	33.5	34	34	34	34.5	34.5	34
Criterion : Sunnybrook1 (G8)									
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*	*42*	*43*
G10 LaGranja	34	34.5	**36**	**36**	36.5	36.5	37	37	36.5
G11	32	33	34	34.5	35	35	35	35	35
G12 Narine Green	32	33	34	34.5	35	35	35	35	35
G13	29.5	30.5	31.5	31.5	32	32	32	32	32
G14	30	31	32	32.5	33	33	33	33	33
G15	30	30.5	32	32	32.5	32.5	32.5	32.5	32.5
G16	29	29.5	31	31	31.5	32	32	32	32
G17	29.5	30.5	32	32	32.5	32.5	33	33	32.5

APPENDIX D: Background Levels (from Vipac background report) for Location G3 (in background report) which is G8 (in Assessment report)



APPENDIX E: dB(A) Measurements at House G13

The following pages show three graphs for 10/11, 12/11, 13/11 18/11 & 19/11.

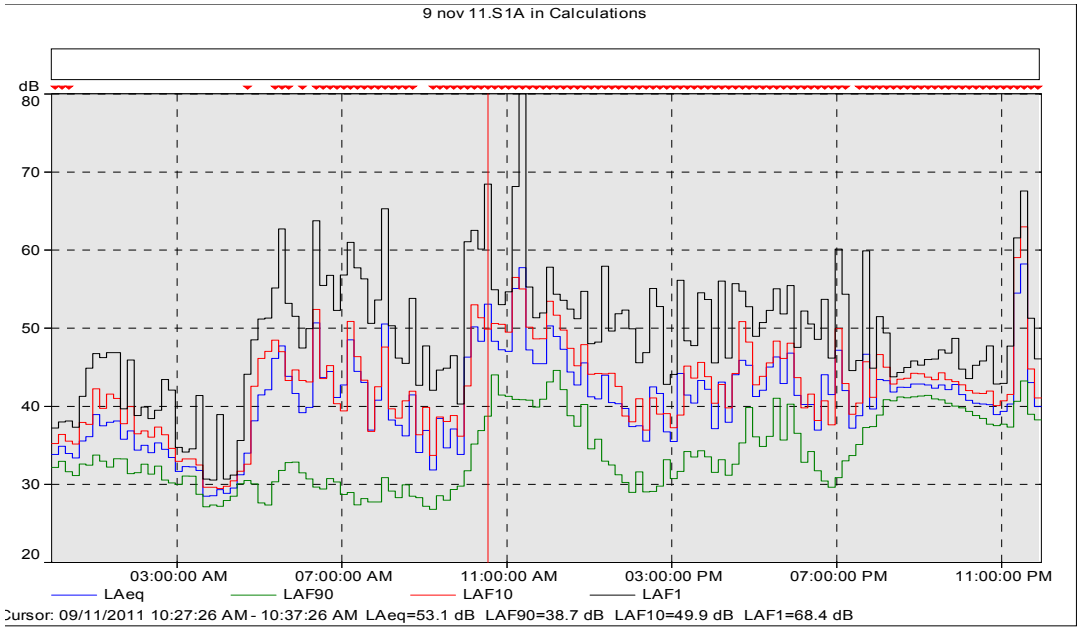
The first graph shows a 24 hour period using a Bruel & Kjaer 2260 Modular Sound Level Meter. The meter was set to record the 10 minute statistical levels and the graph provides the L90, Leq, L10 and L1 level for each ten minute period.

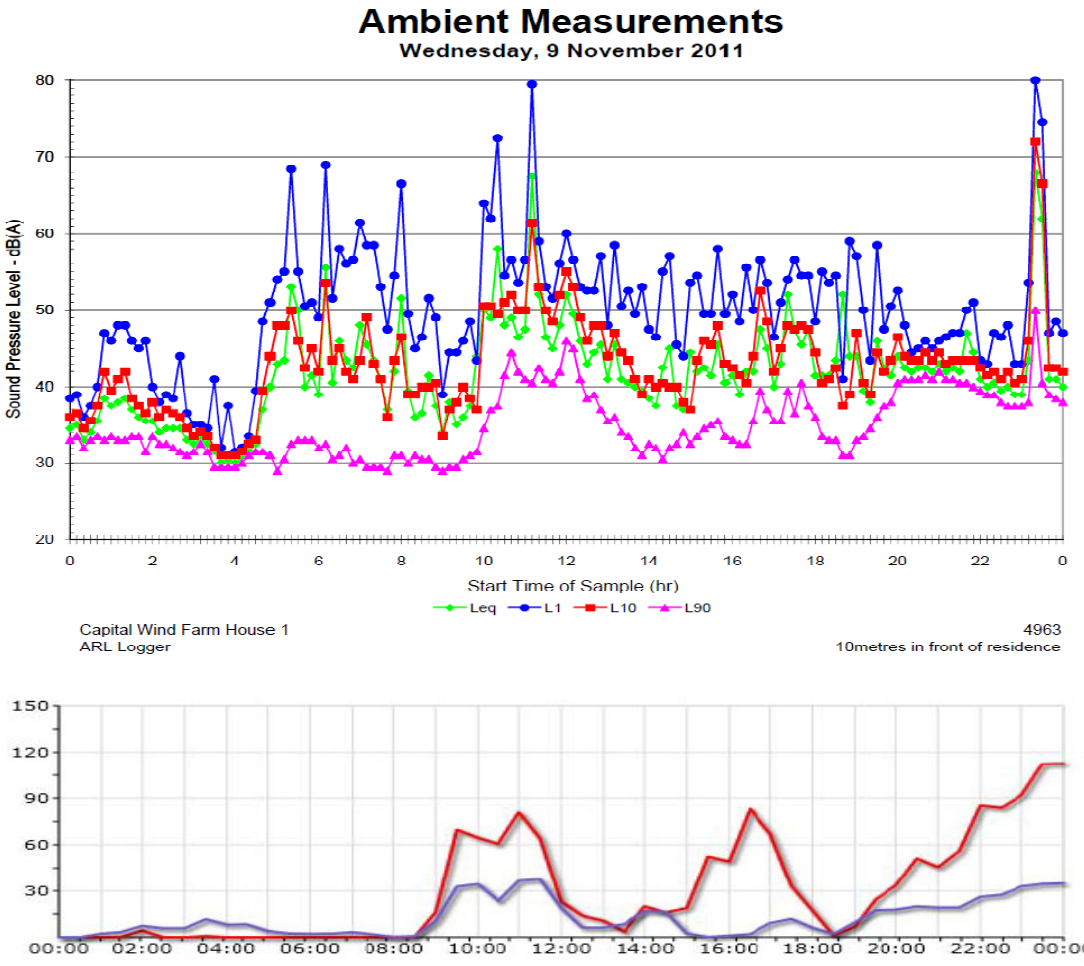
The second graph shows a 24 hour period using a ARL EL 215 logger. The logger was set to record the 10 minute statistical levels and the graph provides the L90, Leq, L10 and L1 level for each ten minute period.

In both the first two graphs the lower trace is the L90 (background level) – green in the top graph and purple in the middle graph.

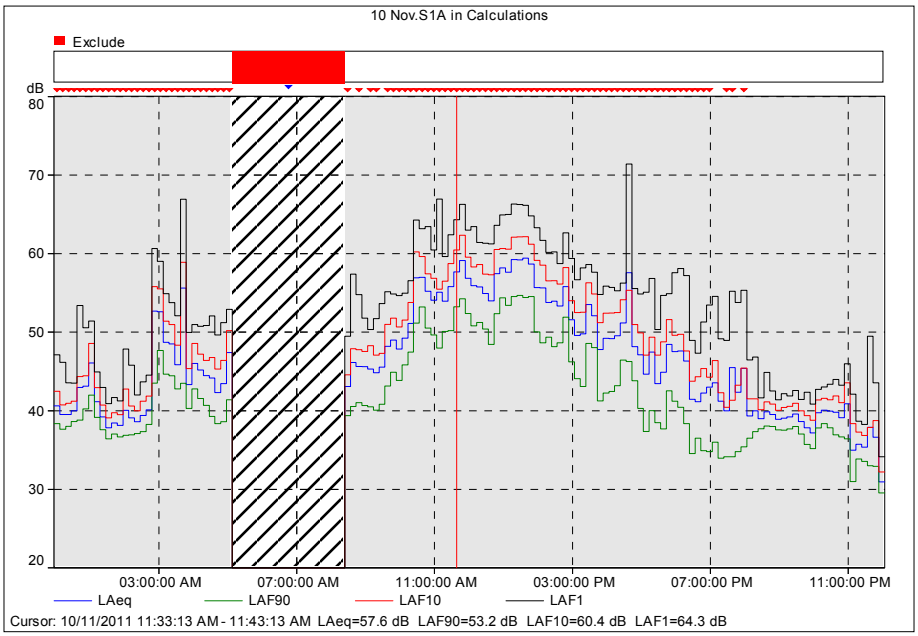
The lower graph is the power output of Capital wind farm (red line) and Woodlawn wind farm (blue line) obtained from the Wind Energy in Australia website under Wind Farm Performance.

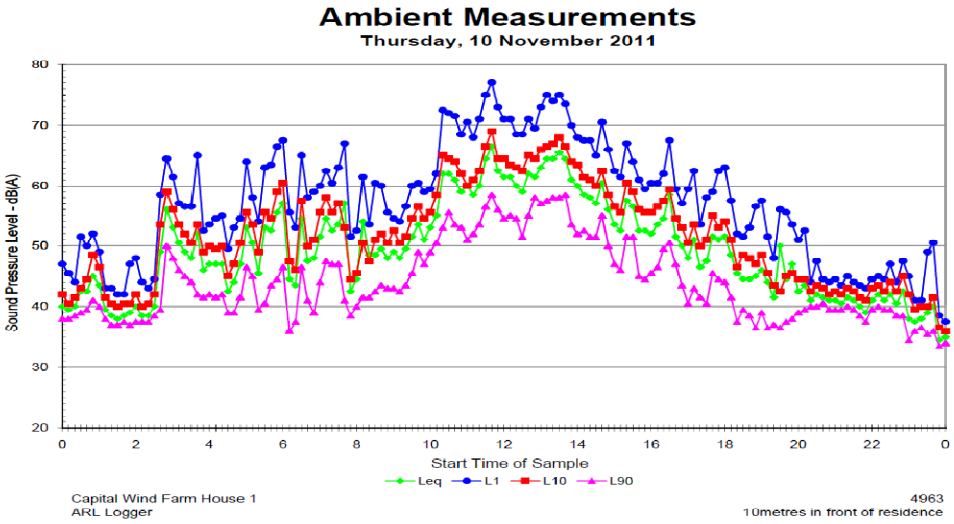
For the 14/11, 15/11, 16/11 & 17/11 the data shown is for the ARL logger and the wind farm output.

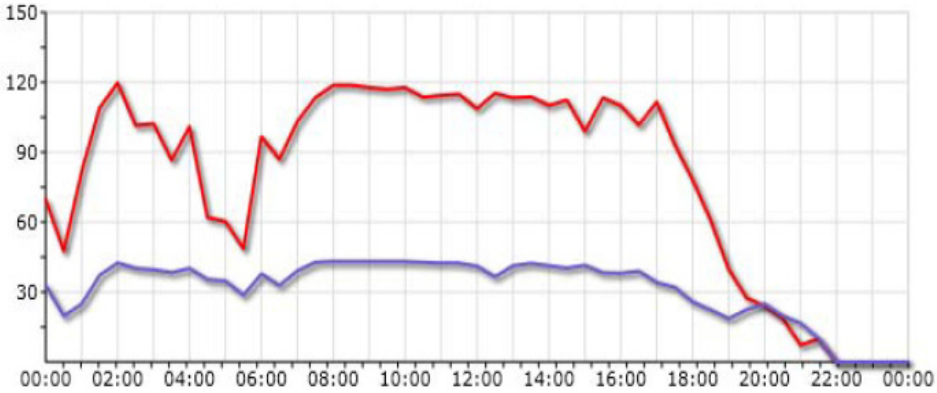

9 nov 11.S1A in Calculations
dB
80
70
60
50
40
30
20
03:00:00 AM
07:00:00 AM
11:00:00 AM
03:00:00 PM
07:00:00 PM
11:00:00 PM
LAeq
LAF90
LAF10
LAF1
Cursor: 09/11/2011 10:27:26 AM - 10:37:26 AM LAeq=53.1 dB LAF90=38.7 dB LAF10=49.9 dB LAF1=68.4 dB

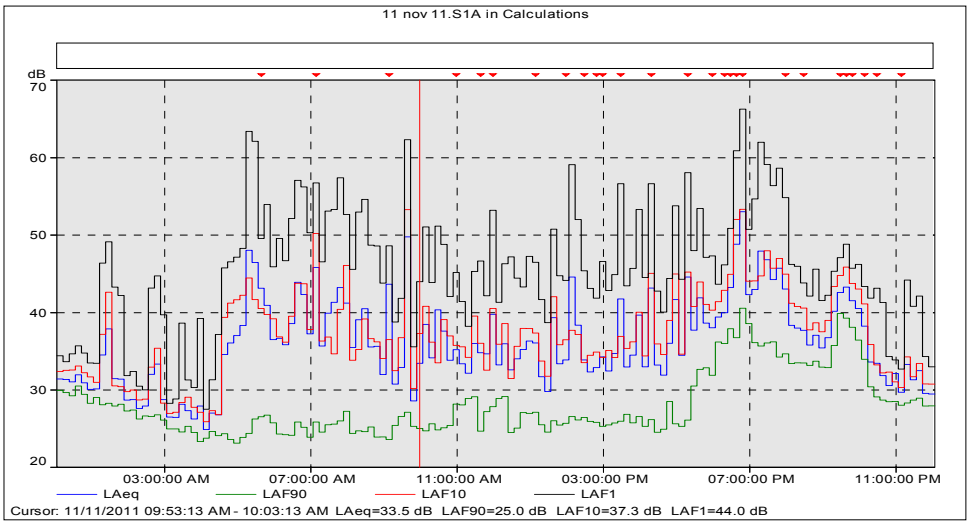

Ambient Measurements
Wednesday, 9 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample (hr)
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

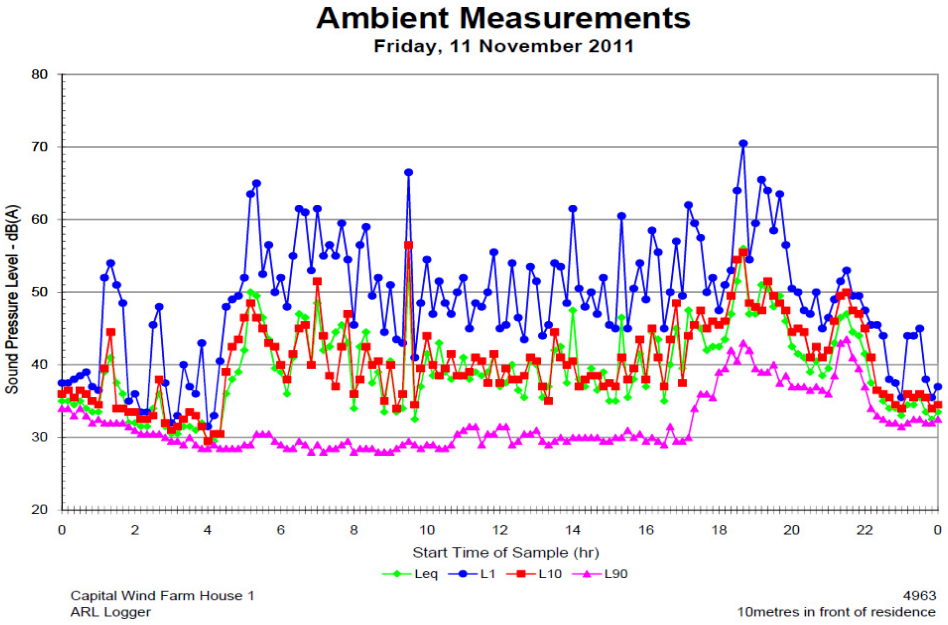
150
120
90
60
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

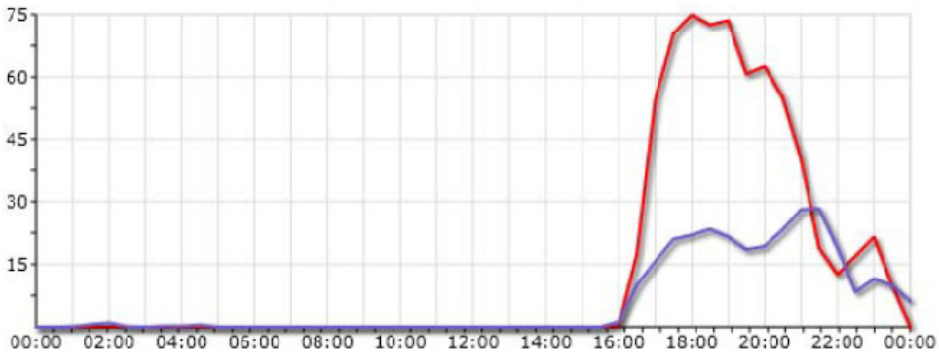

10 Nov.S1A in Calculations
Exclude
dB
80
70
60
50
40
30
20
03:00:00 AM
07:00:00 AM
11:00:00 AM
03:00:00 PM
07:00:00 PM
11:00:00 PM
LAeq
LAF90
LAF10
LAF1
Cursor: 10/11/2011 11:33:13 AM - 11:43:13 AM LAeq=57.6 dB LAF90=53.2 dB LAF10=60.4 dB LAF1=64.3 dB

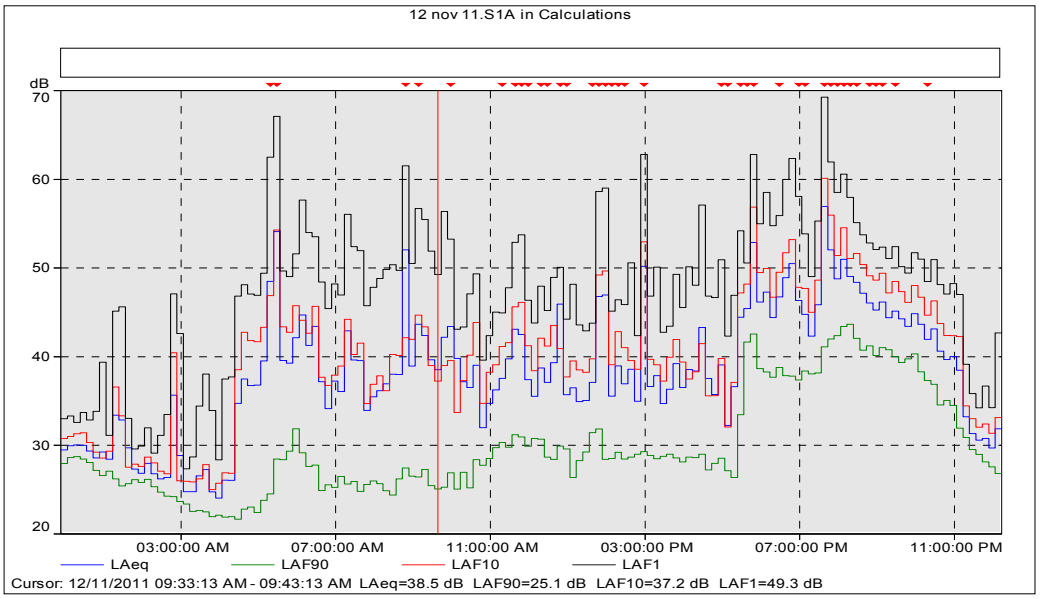

Ambient Measurements
Thursday, 10 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

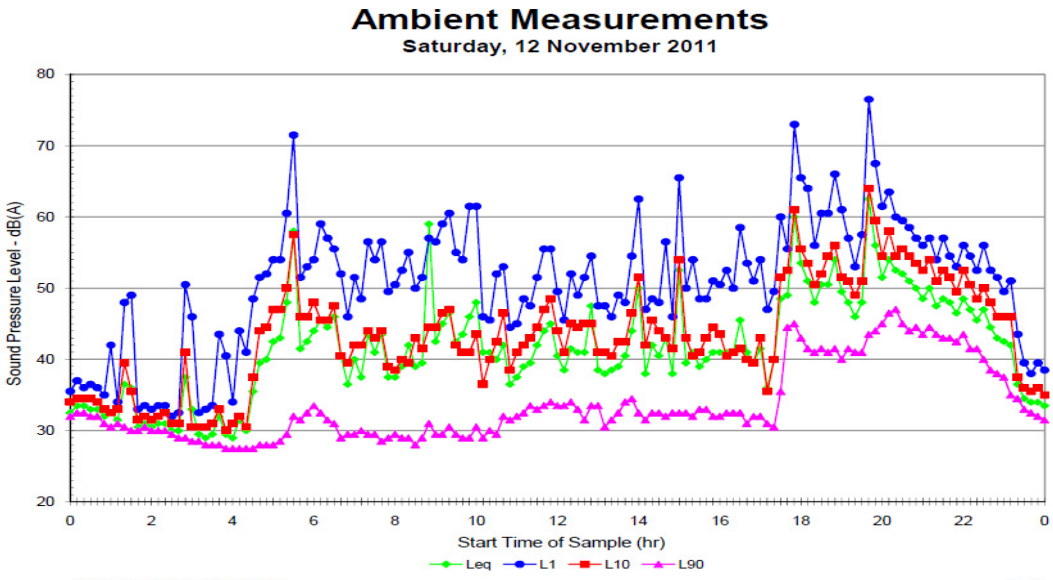

150
120
90
60
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

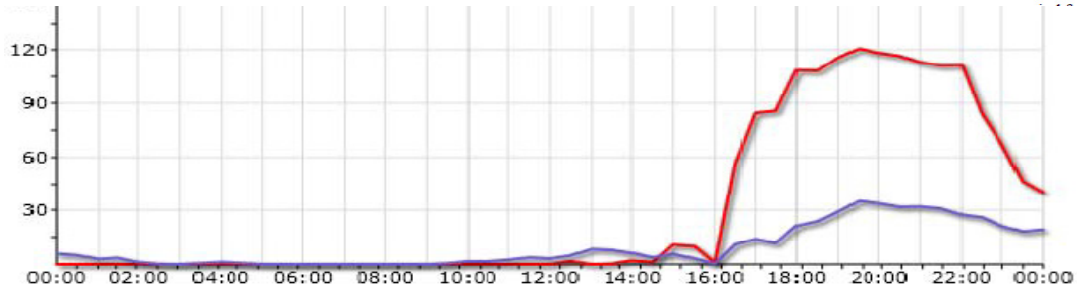

11 nov 11.S1A in Calculations
dB
70
60
50
40
30
20
03:00:00 AM
07:00:00 AM
11:00:00 AM
03:00:00 PM
07:00:00 PM
11:00:00 PM
LAeq
LAF90
LAF10
LAF1
Cursor: 11/11/2011 09:53:13 AM - 10:03:13 AM LAeq=33.5 dB LAF90=25.0 dB LAF10=37.3 dB LAF1=44.0 dB

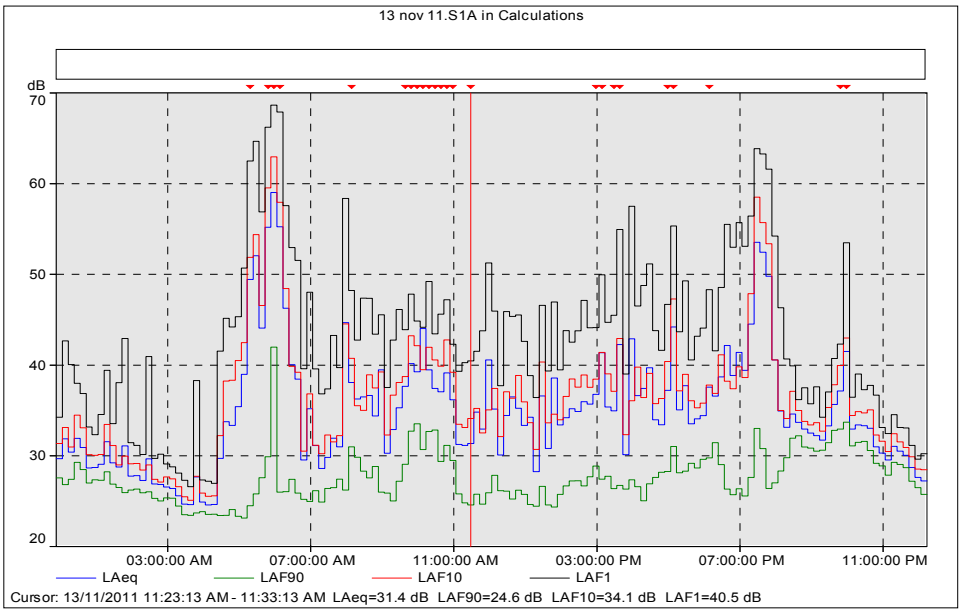

Ambient Measurements
Friday, 11 November 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence


75
60
45
30
15
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


12 nov 11.S1A in Calculations
dB
70
60
50
40
30
20
03:00:00 AM
07:00:00 AM
11:00:00 AM
03:00:00 PM
07:00:00 PM
11:00:00 PM
LAeq
LAF90
LAF10
LAF1
Cursor: 12/11/2011 09:33:13 AM - 09:43:13 AM LAeq=38.5 dB LAF90=25.1 dB LAF10=37.2 dB LAF1=49.3 dB

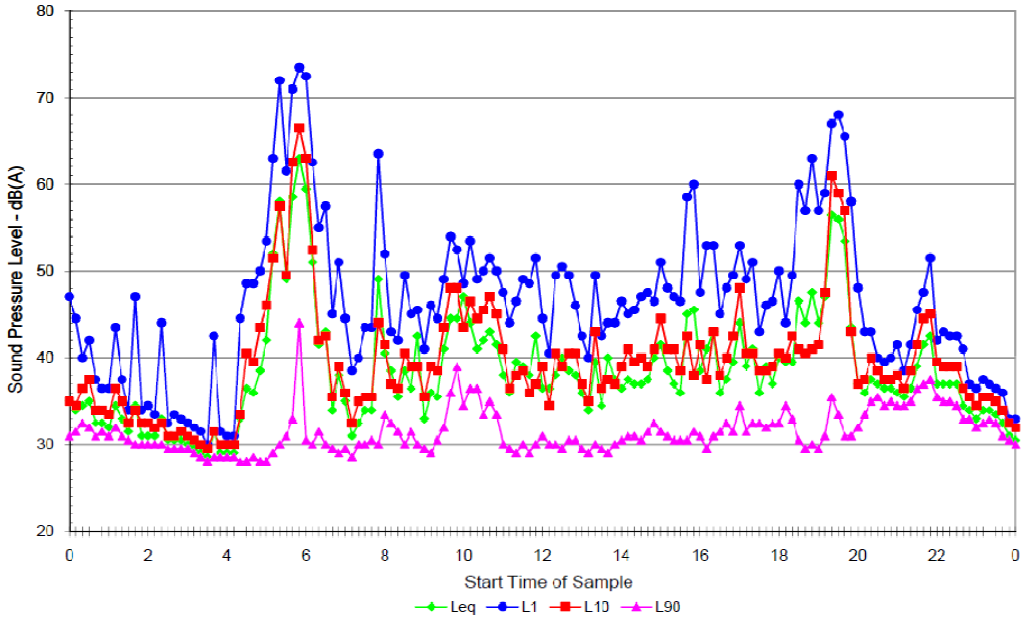

Ambient Measurements
Saturday, 12 November 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence


120
90
60
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00



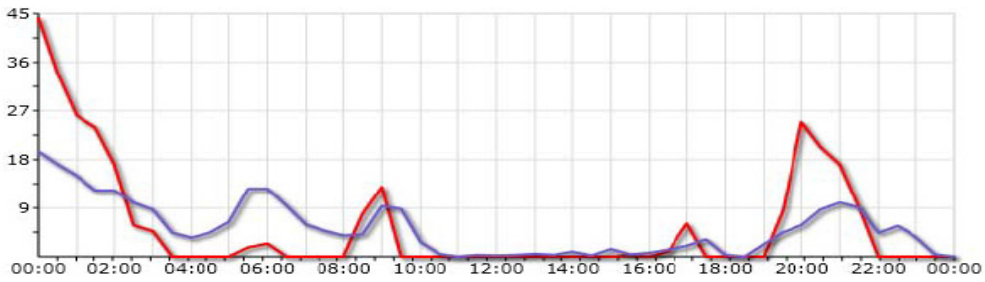
Ambient Measurements

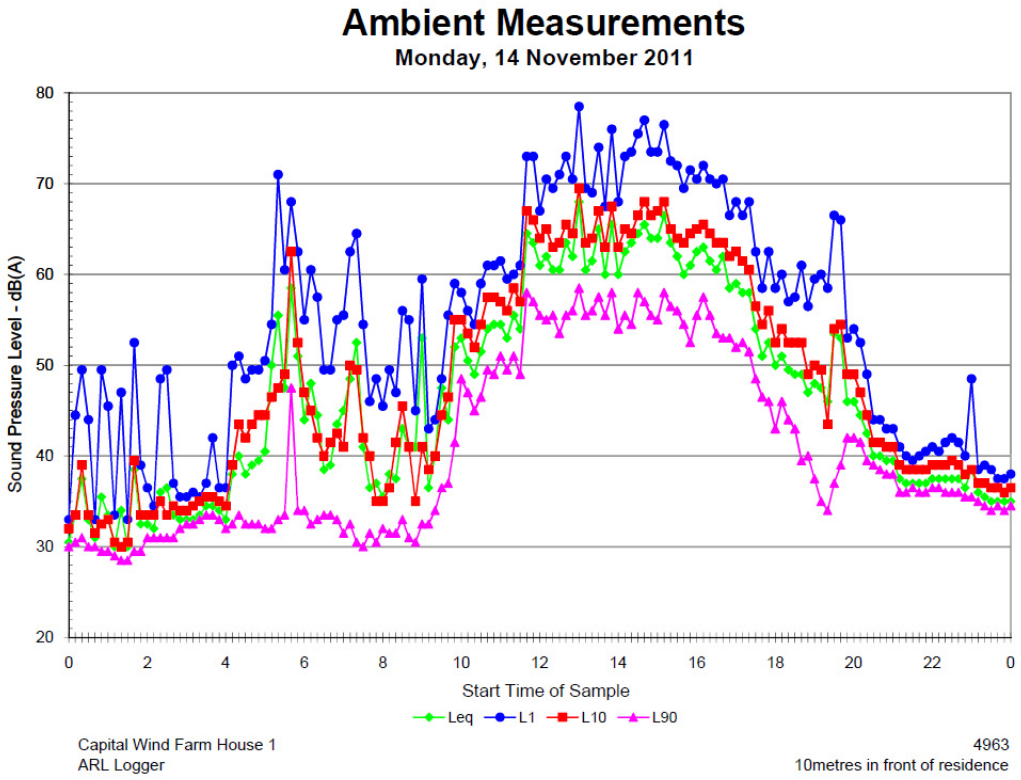
Sunday, 13 November 2011

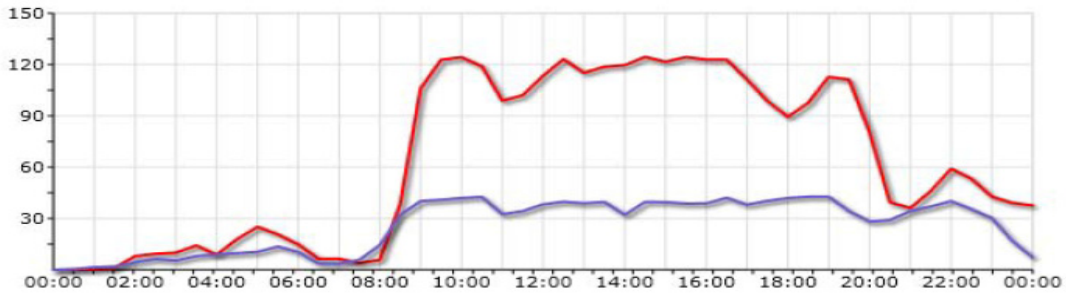


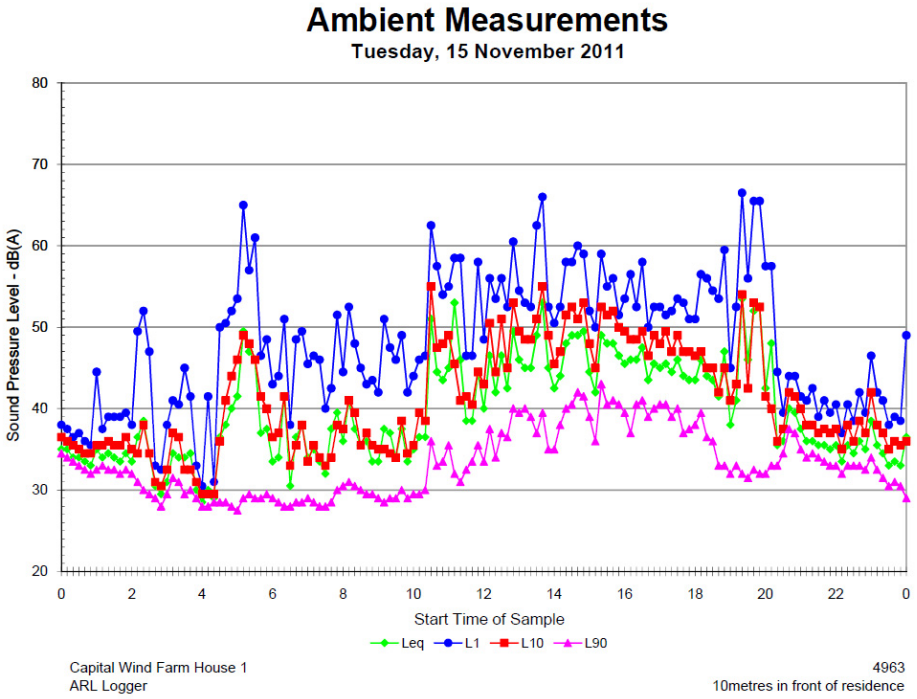
Capital Wind Farm House 1
ARL Logger

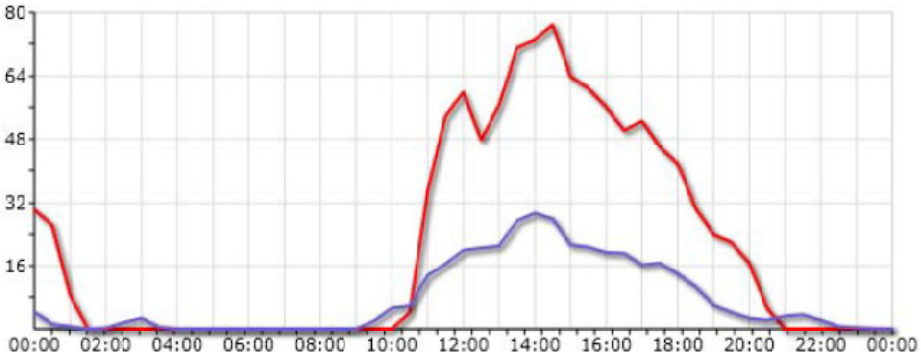
4963
10metres in front of residence

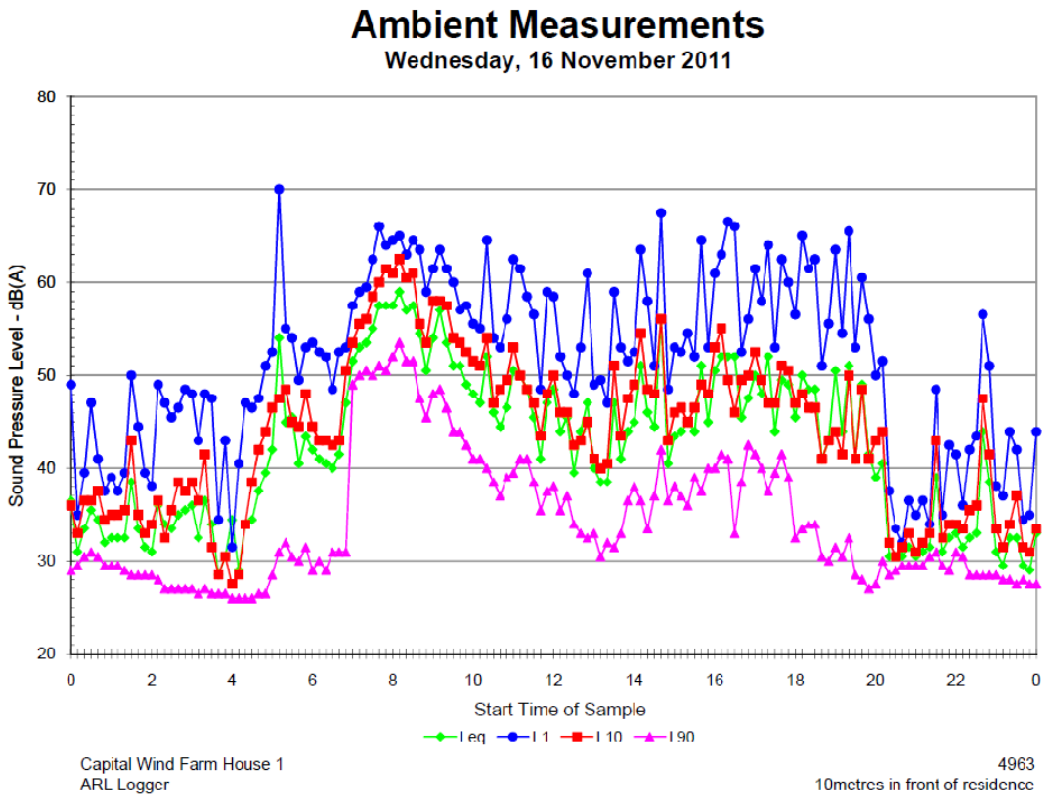


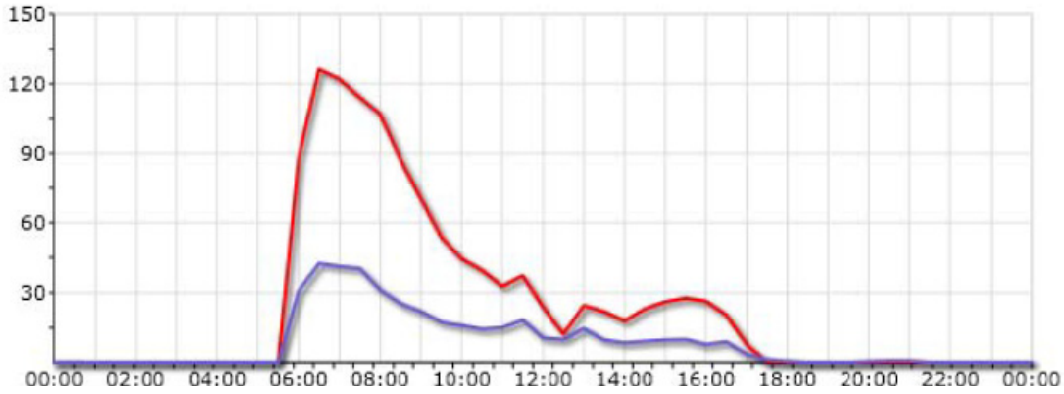

Ambient Measurements
Monday, 14 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

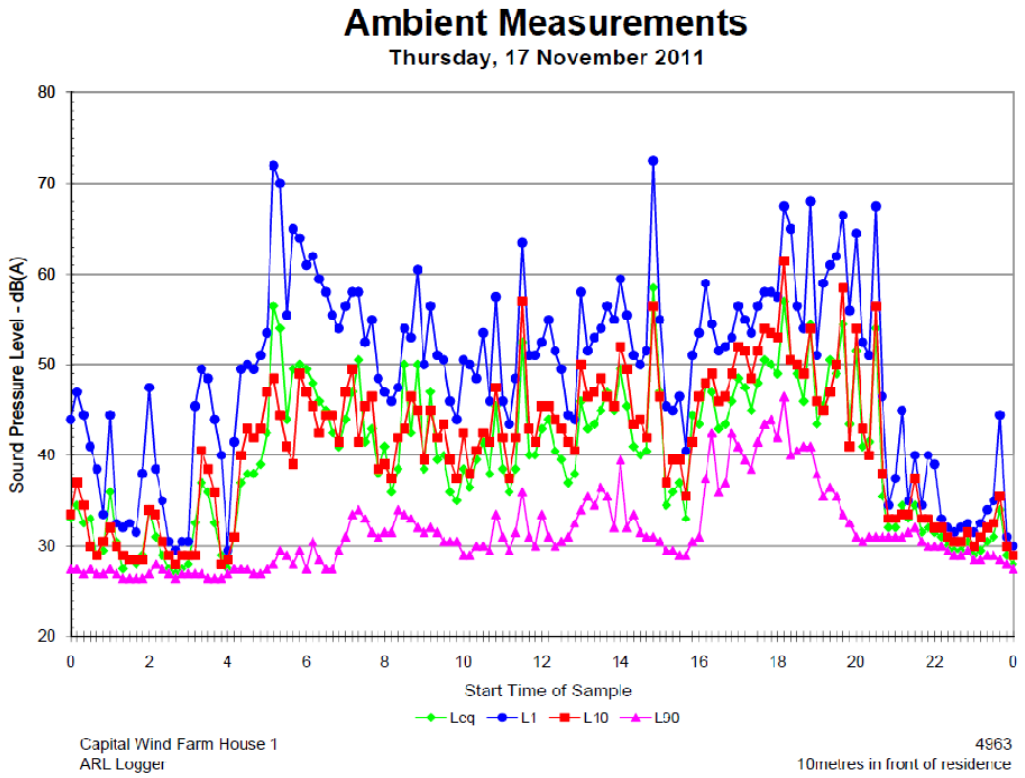

150
120
90
60
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

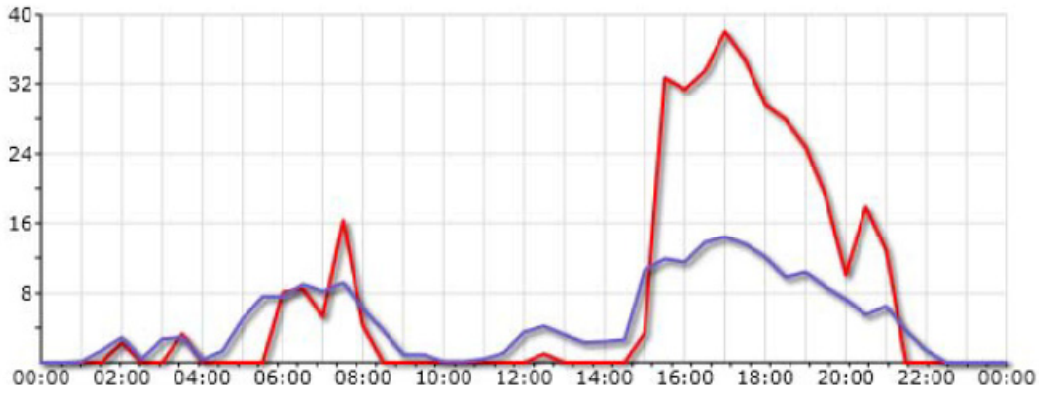

Ambient Measurements
Tuesday, 15 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

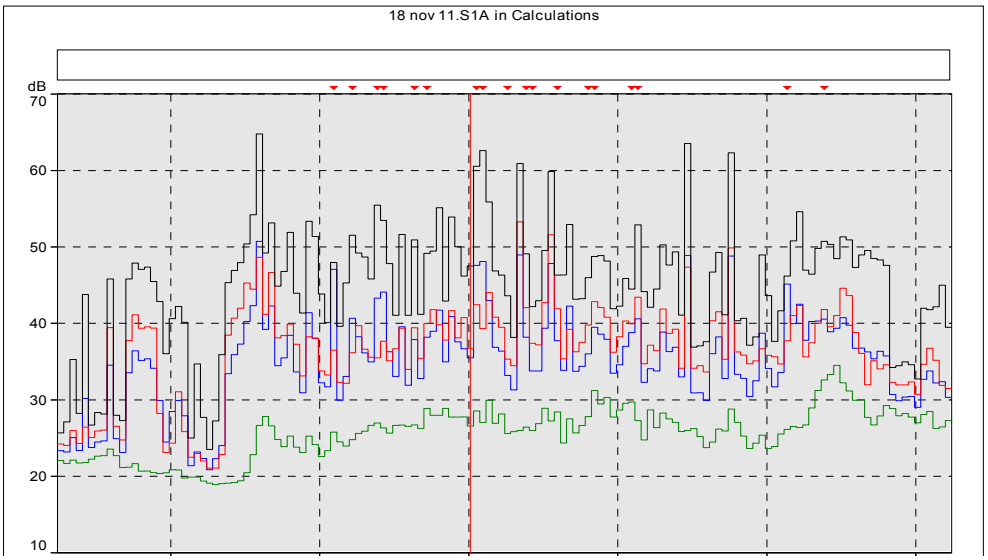

80
64
48
32
16
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

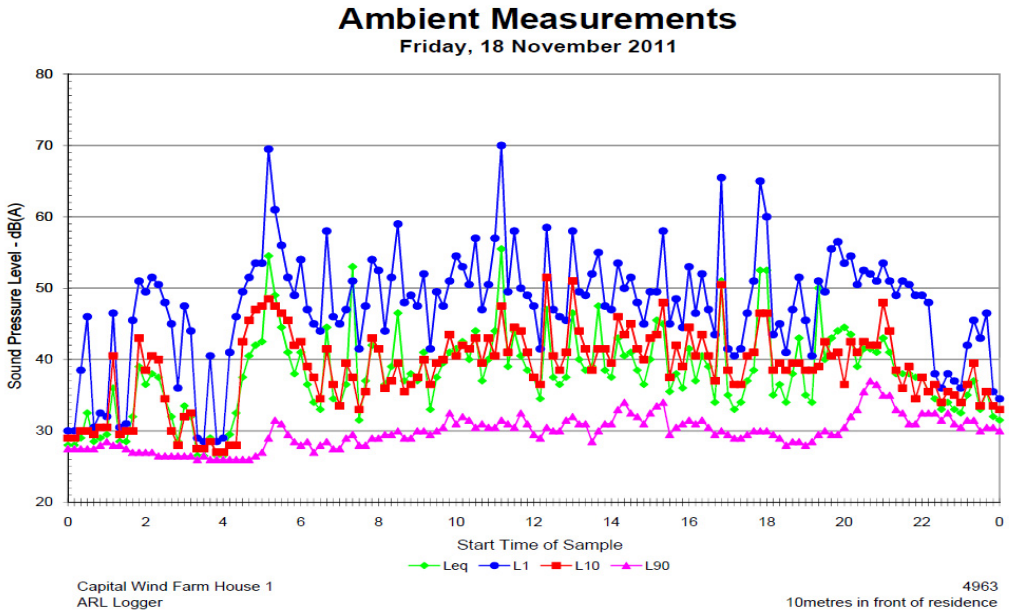

Ambient Measurements
Wednesday, 16 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

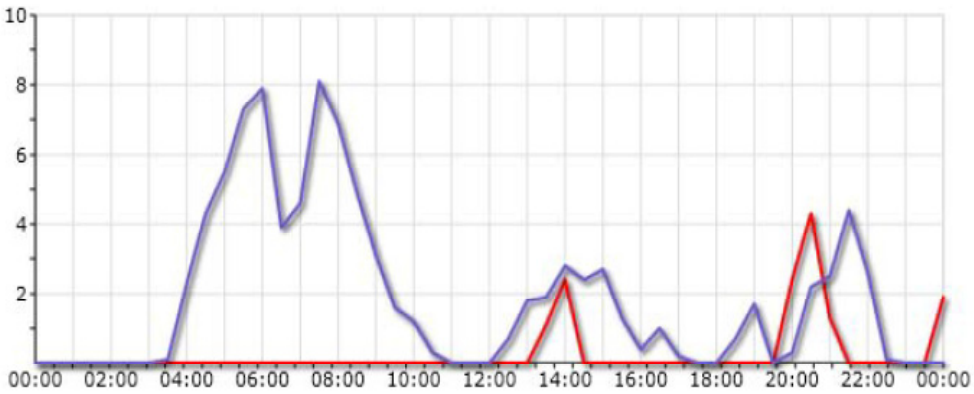

150
120
90
60
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

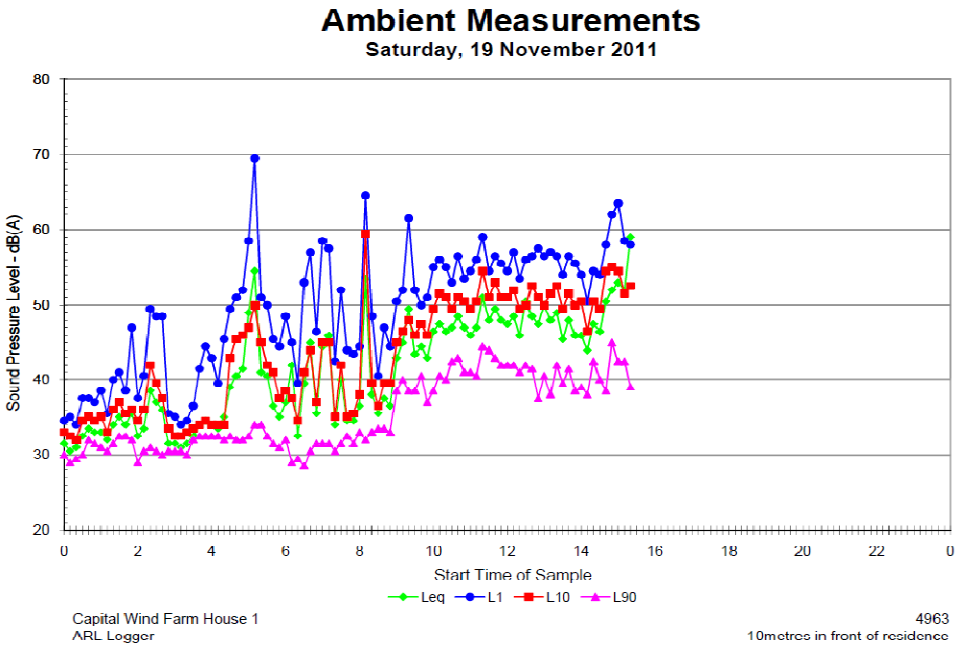

Ambient Measurements
Thursday, 17 November 2011
Sourd Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence

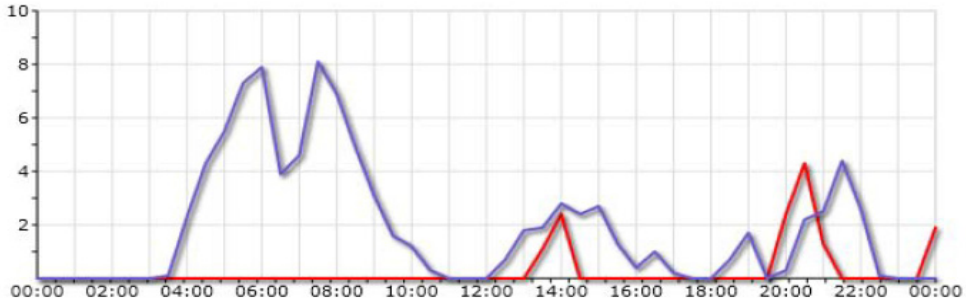

40
32
24
16
8
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


18 nov 11.S1A in Calculations
dB
70
60
50
40
30
20
10


Ambient Measurements
Friday, 18 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence


10
8
6
4
2
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


Ambient Measurements
Saturday, 19 November 2011
Sound Pressure Level - dB(A)
80
70
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
22
0
Start Time of Sample
Leq
L1
L10
L90
Capital Wind Farm House 1
ARL Logger
4963
10metres in front of residence


10
8
6
4
2
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

APPENDIX F: Pulse Screen Snapshots

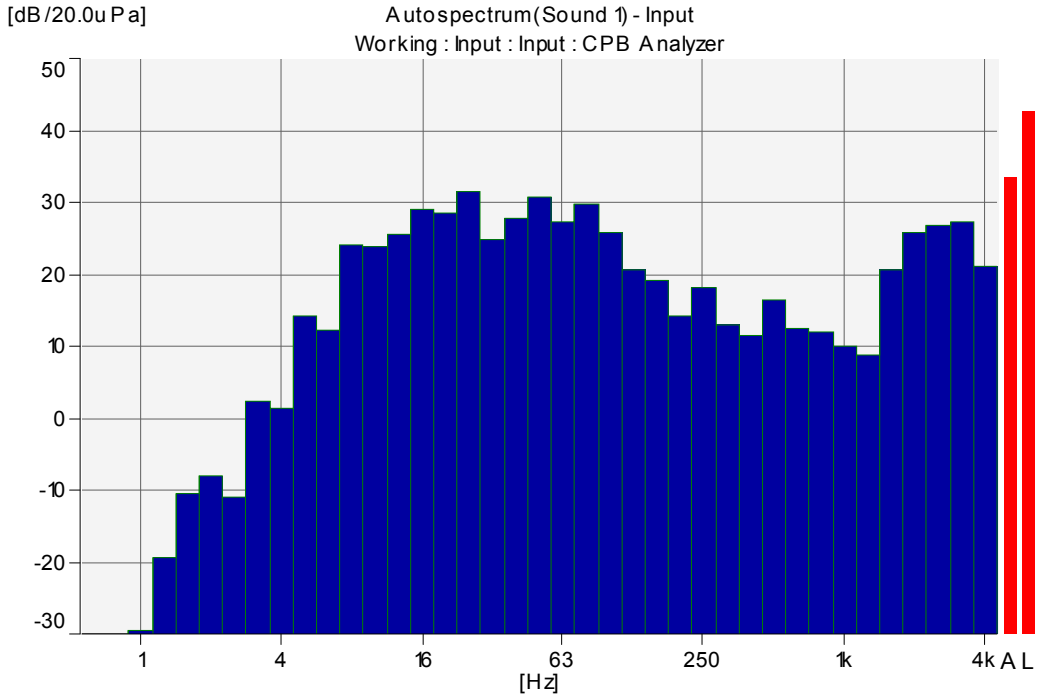


Fig 1: outside no windfarm noise (turbine stopped) – 1am 9.11.11

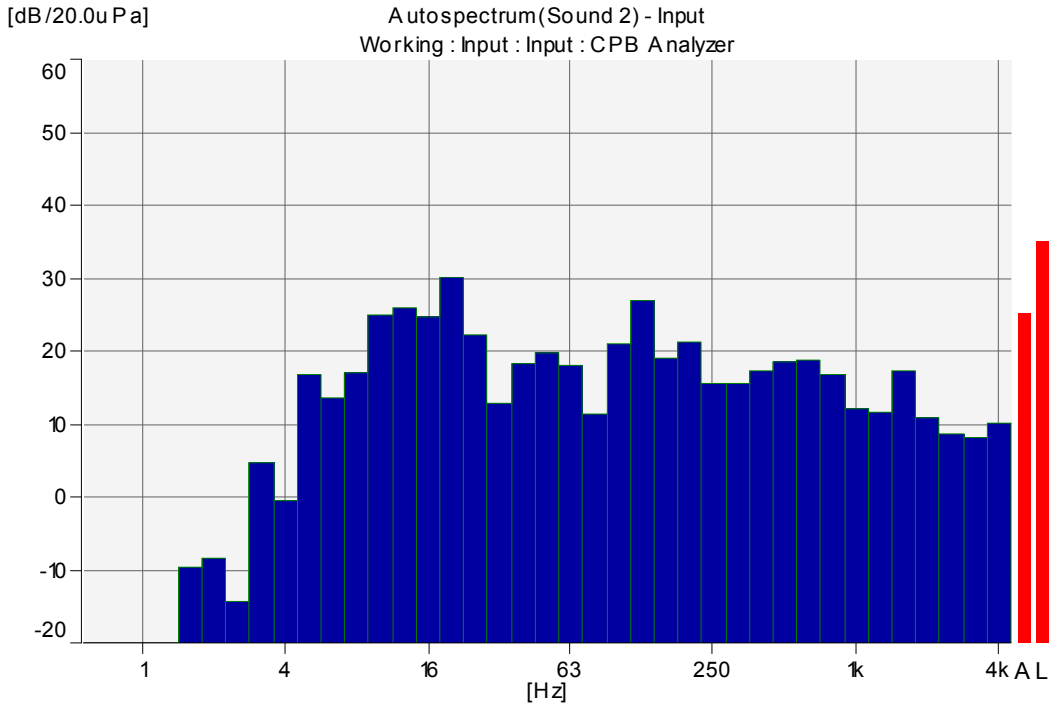


Fig 2: inside no windfarm noise (turbine stopped) 1am 9.11.11

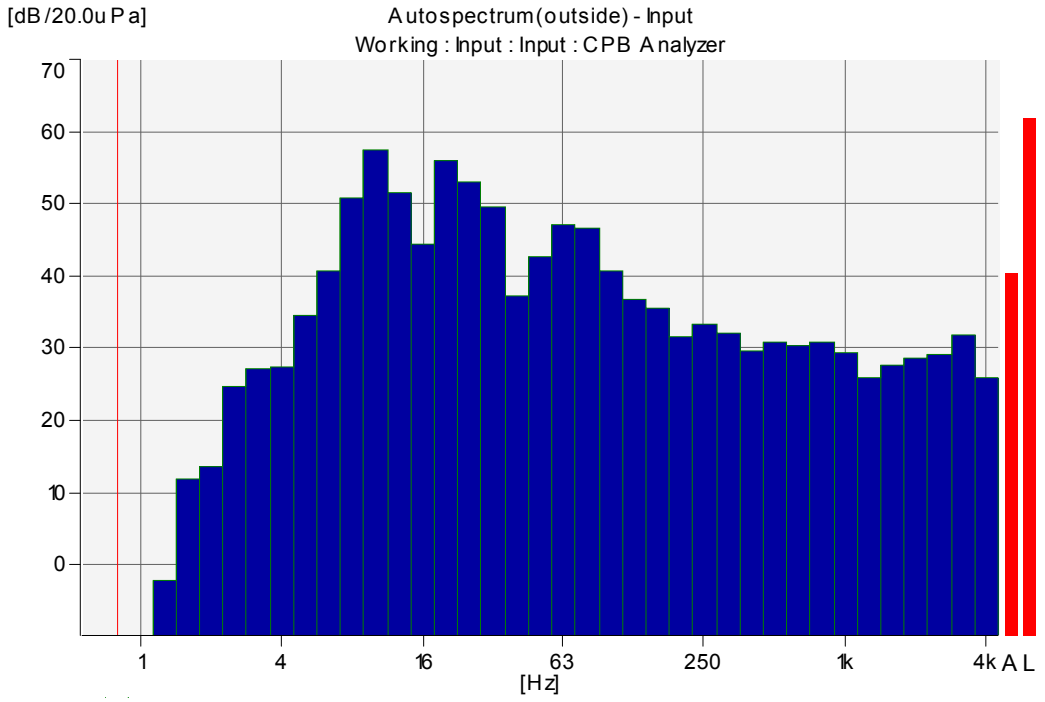


Fig 3: Outside turbines operating no wind at receiver locations 1.30 am 10.11.11

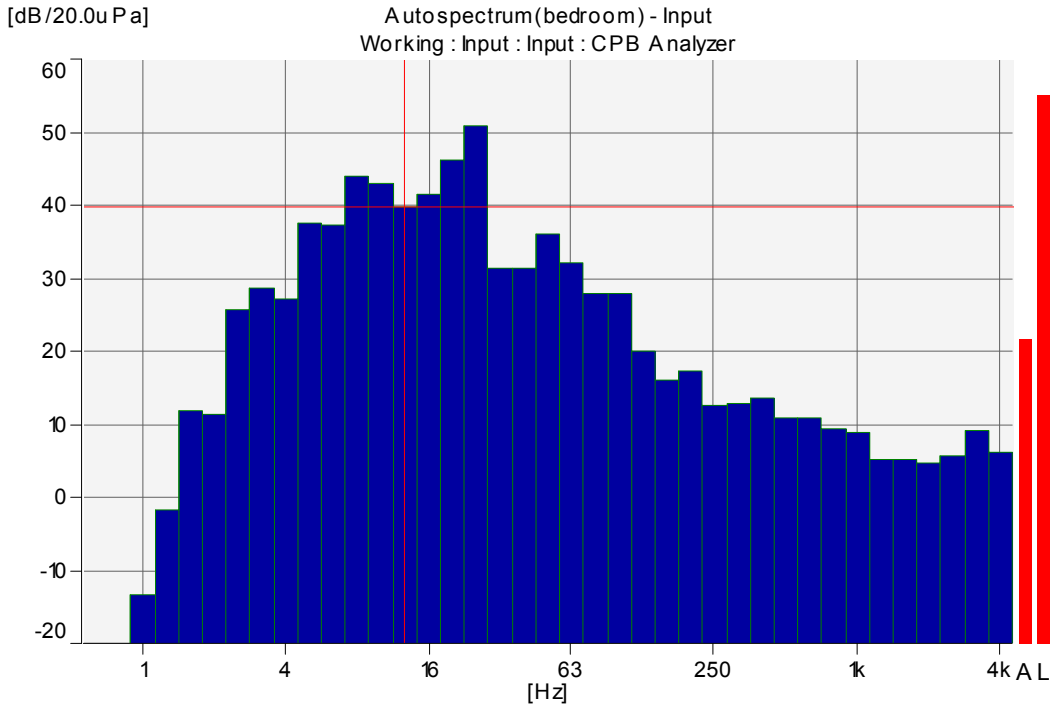


Fig 4: Inside - turbines operating no wind at receiver locations 1.30 am 10.11.11

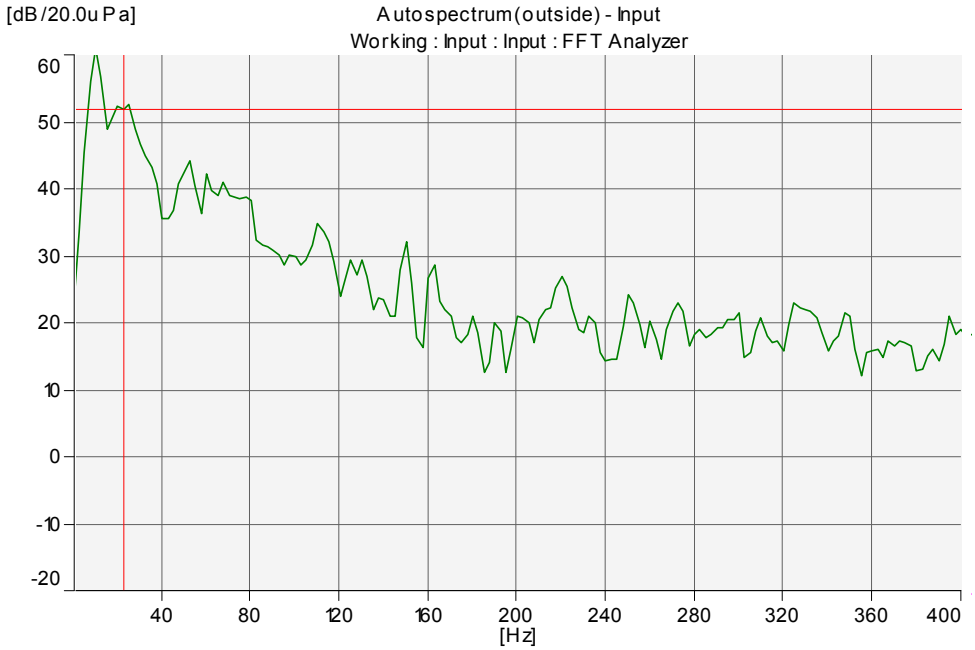


Fig 5: Outside turbines operating no wind at receiver locations 1.30 am 10.11.11

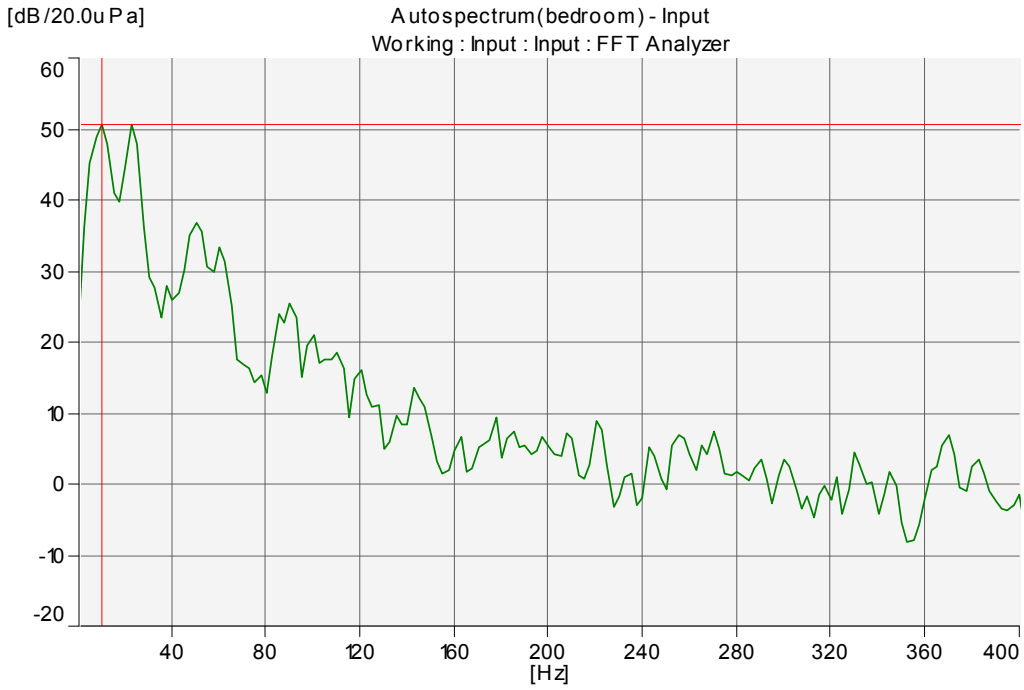
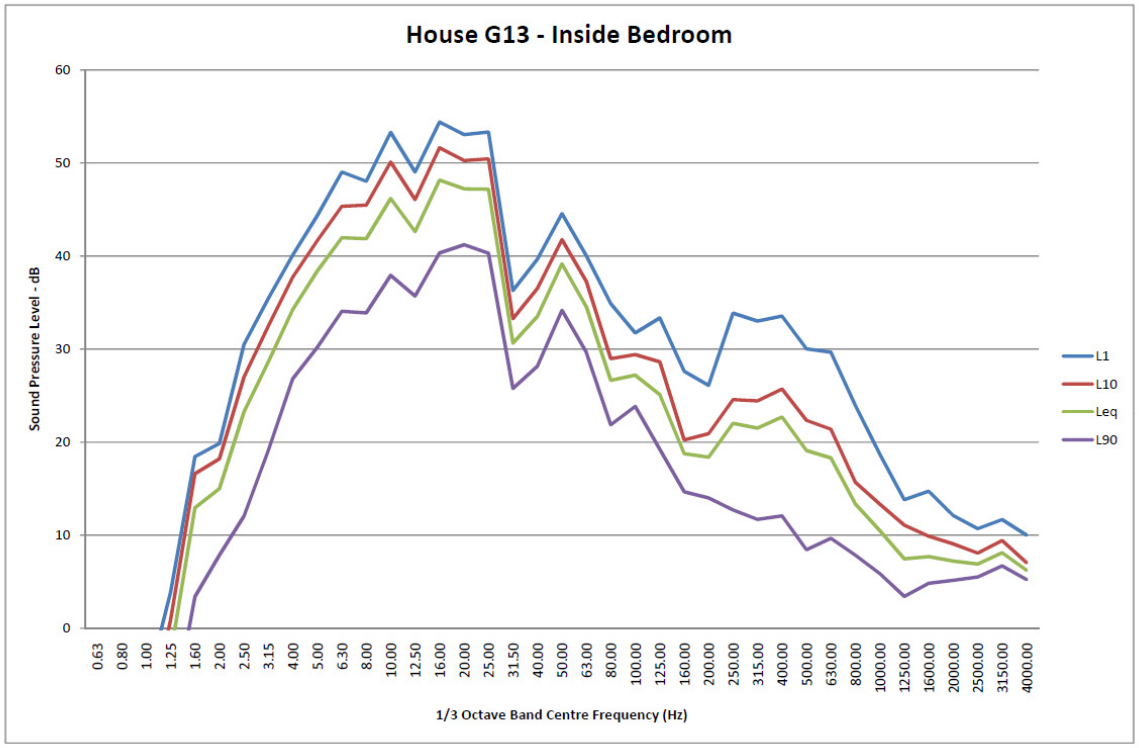
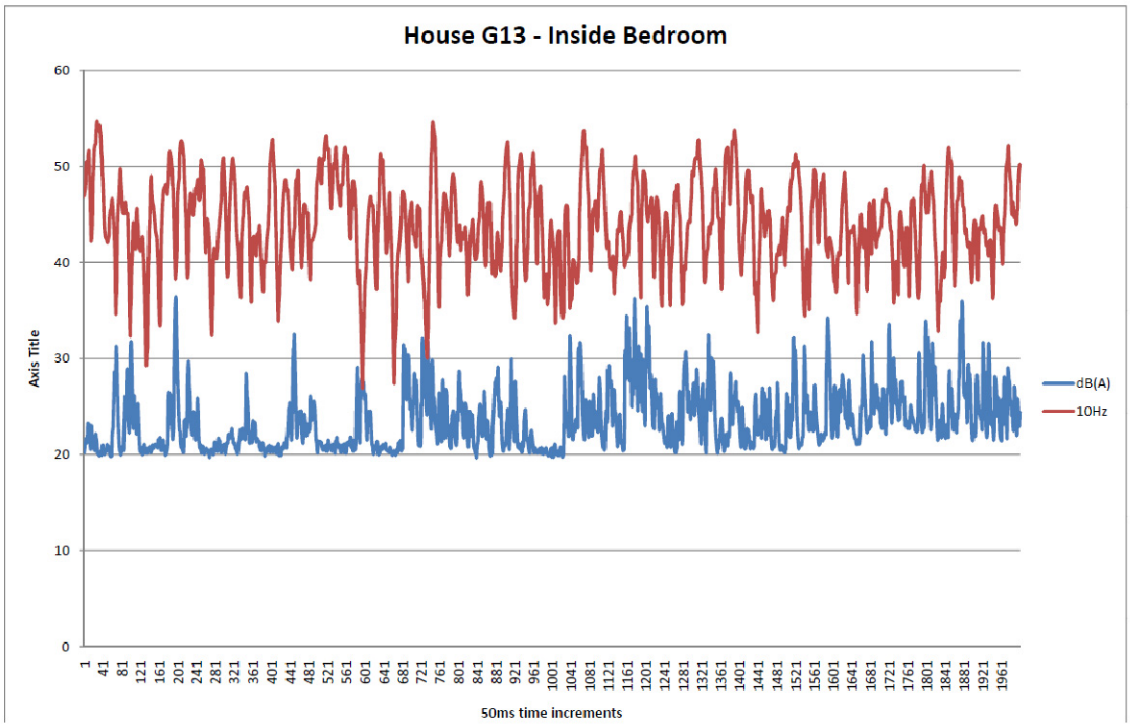
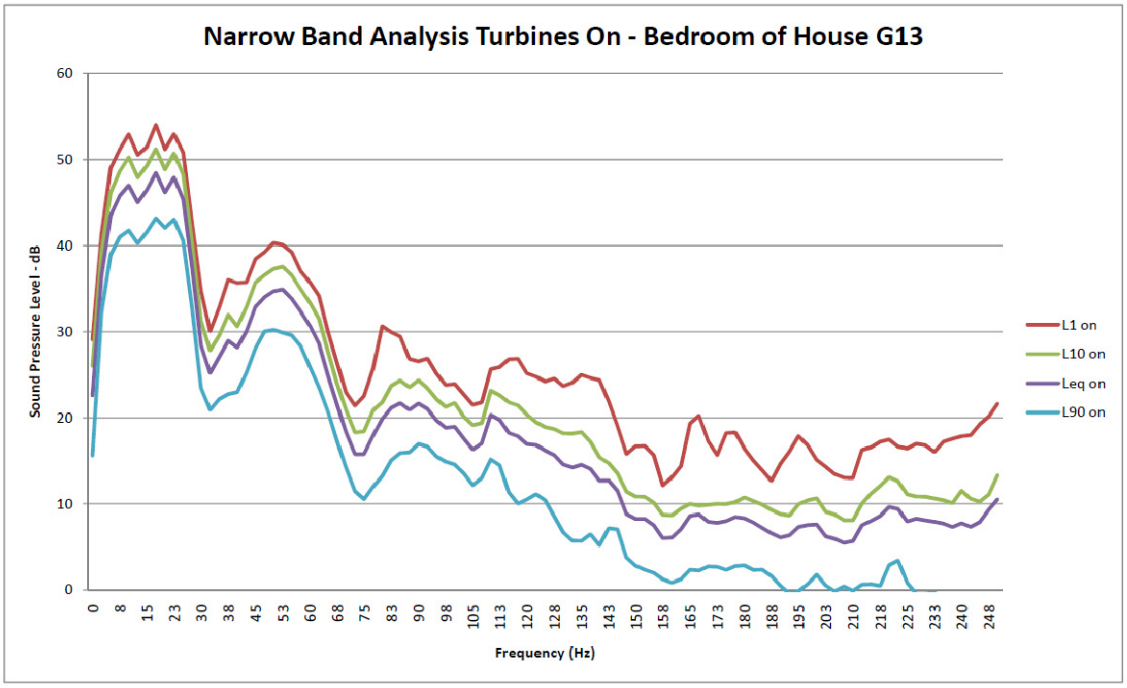


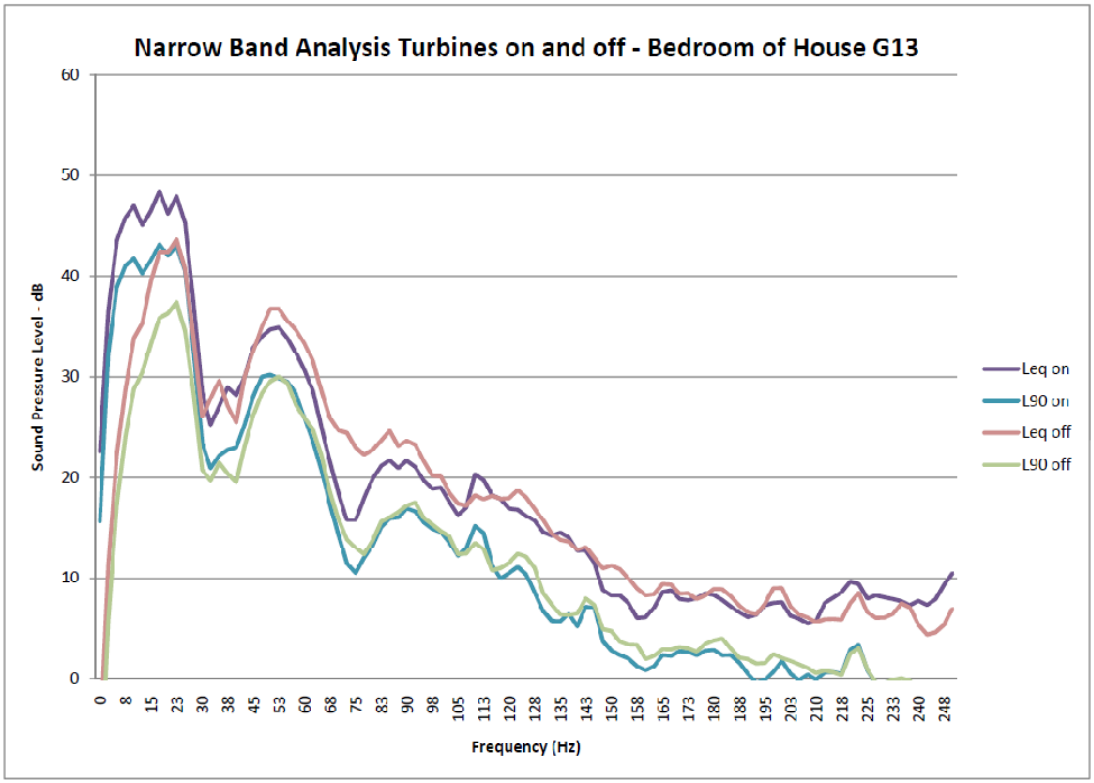
Fig 6: Inside turbines operating no wind at receiver locations 1.30 am 10.11.11

APPENDIX G: Pulse Time Analysis (24.4 Hz high pass filter)

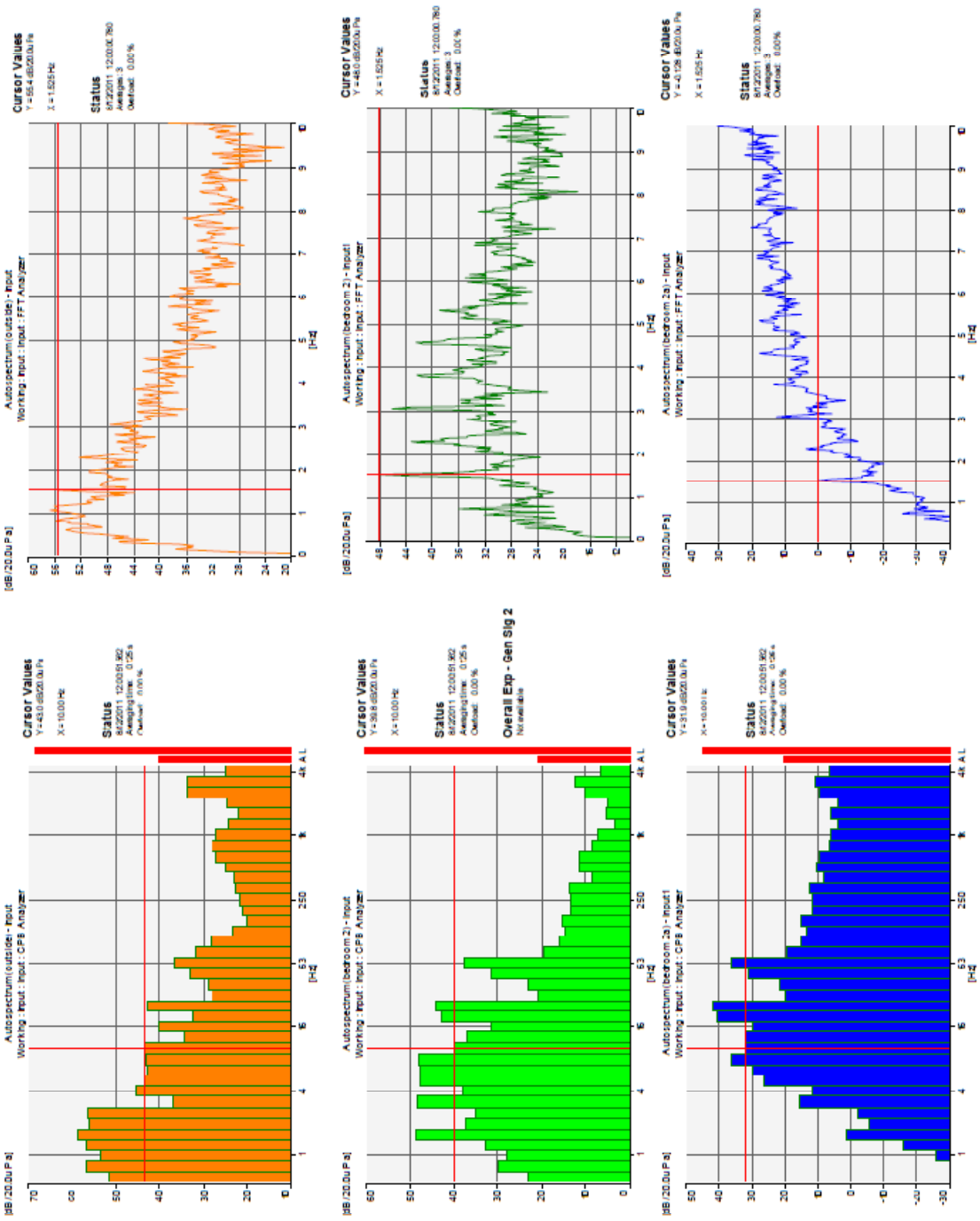


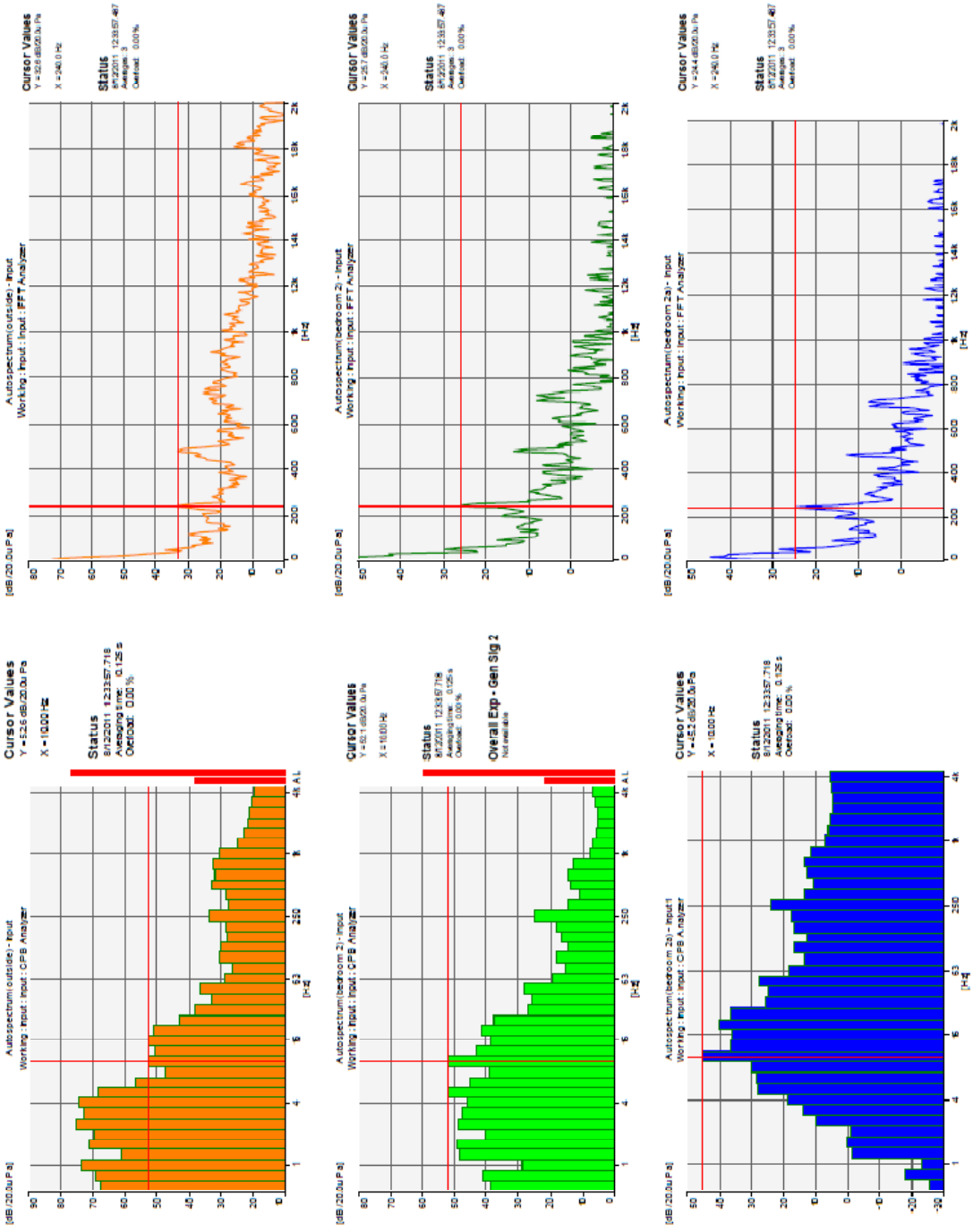



Narrow Band Analysis Turbines On - Bedroom of House G13
Sound Pressure Level - dB
Frequency (Hz)
L1 on
L10 on
Leq on
L90 on


Narrow Band Analysis Turbines on and off - Bedroom of House G13
Sound Pressure Level - dB
Frequency (Hz)
Leq on
L90 on
Leq off
L90 off

APPENDIX H: 1/3 Octave Band and FFT Analysis




Cursor Values
Status
Autospectrum(outside) - Input
Working : Input : Input : FFT Analyzer
Autospectrum(bedroom 2) - Input
Working : Input : Input : FFT Analyzer
Autospectrum(bedroom 2a) - Input
Working : Input : Input : FFT Analyzer
Cursor Values
Status
Overall Exp - Gen Sig 2
Autospectrum(outside) - Input
Working : Input : Input : CPB Analyzer
Autospectrum(bedroom 2) - Input
Working : Input : Input : CPB Analyzer
Autospectrum(bedroom 2a) - Input1
Working : Input : Input : CPB Analyzer

APPENDIX I: Recent Flyer to Residents in Bungendore

Wind News

Clean Energy Council

Facts and Frequently Asked Questions

Get the facts about wind energy

The NSW Government has developed a range of materials and commissioned research to assist people to find out the facts:

- The wind energy fact sheet: http://www.environment.nsw.gov.au/resources/climatechange/10923windfacts.pdf
- Preliminary assessment of the impact of wind farms on surrounding land values in Australia - NSW Department of Lands: http://www.lpma.nsw.gov.au/__data/assets/pdf_file/0018/117621/t0L51WT8.pdf
- Climate Institute Clean Energy Jobs in Regional Australia: http://cleanenergyjobsmap.climateinstitute.org.au/#/nsw
- Community Attitudes to wind farms and renewable energy November 2010: http://www.environment.nsw.gov.au/resources/climatechange/10947WindFarms_Final.pdf

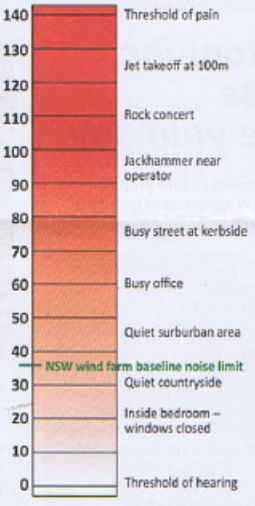
Health claims

The Clean Energy Council takes concerns about the health impacts of wind turbines seriously. With decades of successful wind turbine operation globally there has been ample opportunity for any negative effects to be identified. In fact, there are now more than 100,000 turbines installed globally, and some of these have been in place for more than 20 years.

There is no credible peer-reviewed evidence showing a direct link between wind turbines and negative health effects. This supports the prevailing view that wind power is one of the safest ways of generating electricity.

A recent article provides some interesting discussion on the lack of scientific or medical evidence in relation to health issues. ***Wind farms will make your children hate school, apparently: by Simon Chapman, Professor in Public Health at the University of Sydney. http://www.crikey.com.au/2011/07/06/windfarms-will-make-your-children-hate-school-apparently/***

The level of common sounds



NSW Office of Environment and Heritage: The wind energy fact sheet.

Frequently Asked Questions

Are wind farms noisy? NSW controls on wind farm noise are amongst the strictest in the world. Before it can operate, a wind farm has to demonstrate that noise levels at neighbouring residences will meet strict noise limits. These limits are designed to ensure that noise from a wind farm is not intrusive for the average person.

Do wind farms need additional generators as back-up? NSW wind farms do not need additional fossil fuel generators as 'back-up' when there is no wind. When the wind blows, the output of wind farms displaces output from coal or gas plants. When the wind is not blowing, electricity can be sourced from hydro, coal, gas plants or other renewable energy generators.

Do wind farms take up farming space and are they bad for the environment? Not only do they coexist easily with other land uses (eg grazing, crops) but they have a smaller footprint than other energy generation such as coal and gas plants. If wind farms are decommissioned, the landscape can be returned to its prior condition.

Do wind turbines harm the local habitat? Potential impacts of the local environment (eg plants, animals, soils) are part of the environmental assessment for each wind farm proposal. Turbine locations and operations are often modified as part of the approval process to avoid or minimize impacts on threatened species or communities and their habitats.

Are livestock impacted by wind turbines? Experience in Australia and overseas shows that livestock will graze right up to the base of wind turbines and often use them as rubbing posts or for shade.

Can wind turbines kill birds? Studies indicate that the main human-induced threats to birds and other species are habitat destruction from land clearing, pets, cats, buildings, cars, powerlines and climate change. The specific risks to birds and bats are considered as part of the development assessment and approval process.

Do wind turbines get struck by lightning? Wind farms can be struck by lightning, just like tall buildings, but they are equipped with comprehensive lightning protection systems that transfer high voltages and currents safely to the ground.

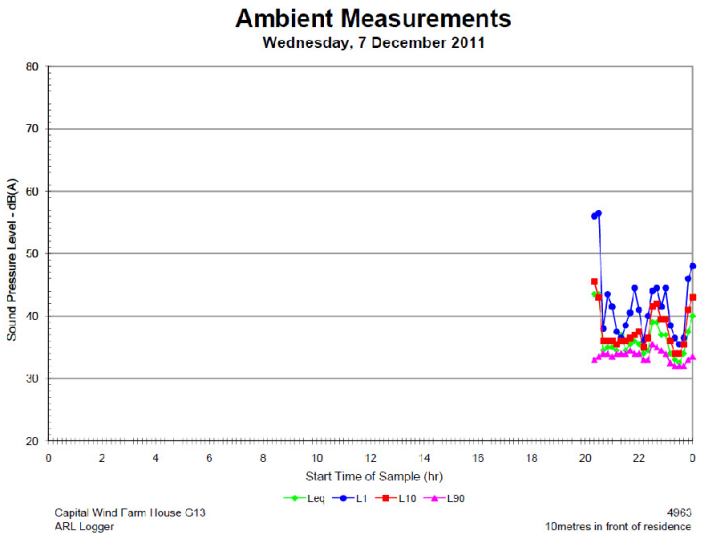
Response to Frequently Asked Questions source: NSW Office of Environment and Heritage: The wind energy fact sheet. http://www.environment.nsw.gov.au/resources/climatechange/10923windfacts.pdf

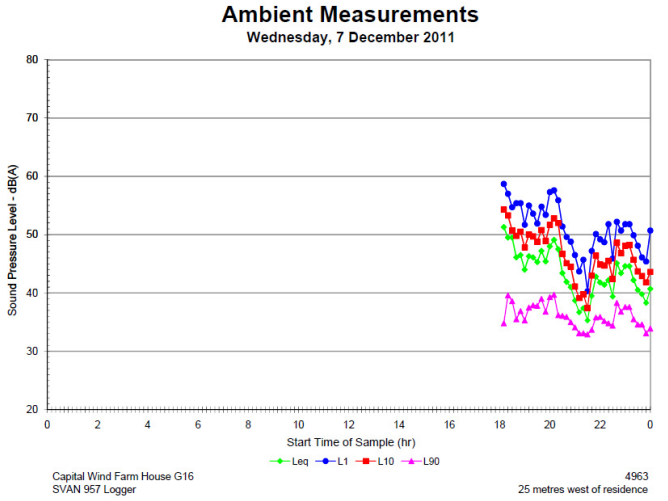
Wind farms reduce greenhouse gases. Every unit of energy fed into the NSW grid cuts greenhouse gas emissions and reduces our reliance on fossil fuels.

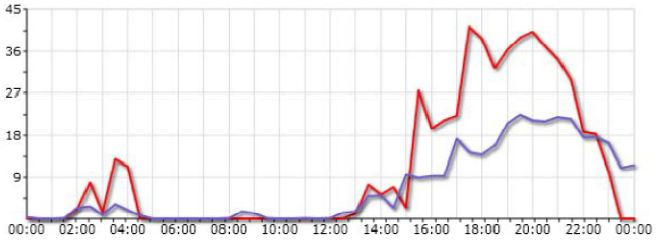
The Clean Energy Council is the peak body for the clean energy sector. It is a not-for-profit organisation that provides a unified voice for more than 550 solar, wind, hydro, wave, bioenergy, geothermal, cogeneration and energy efficiency companies. It is funded through membership fees.

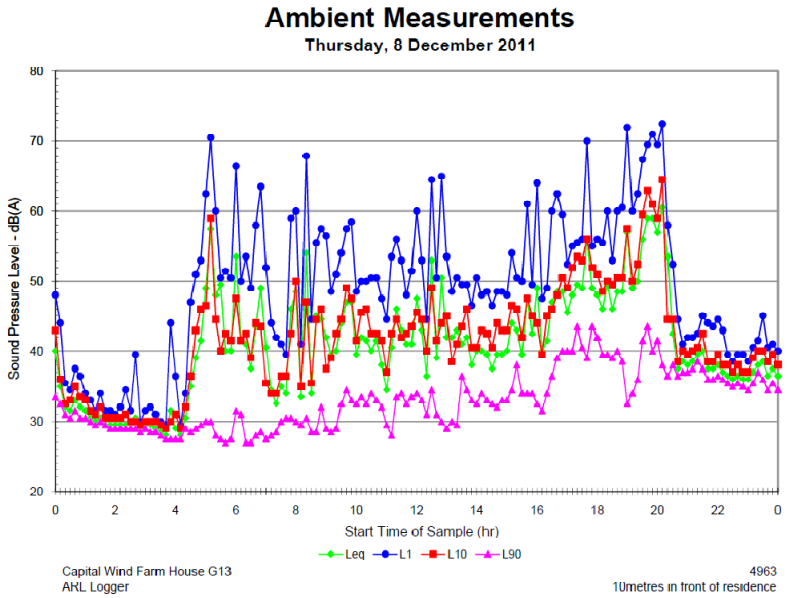
visit www.cleanenergycouncil.org.au

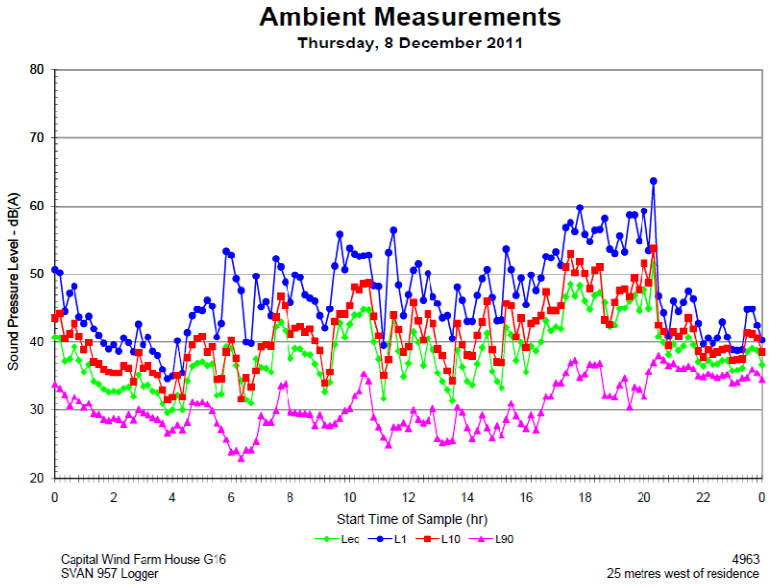
APPENDIX J: Supplementary Unattended Noise Logging

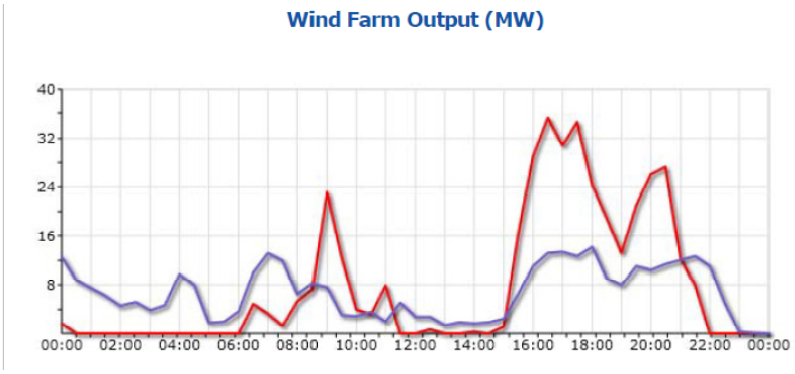


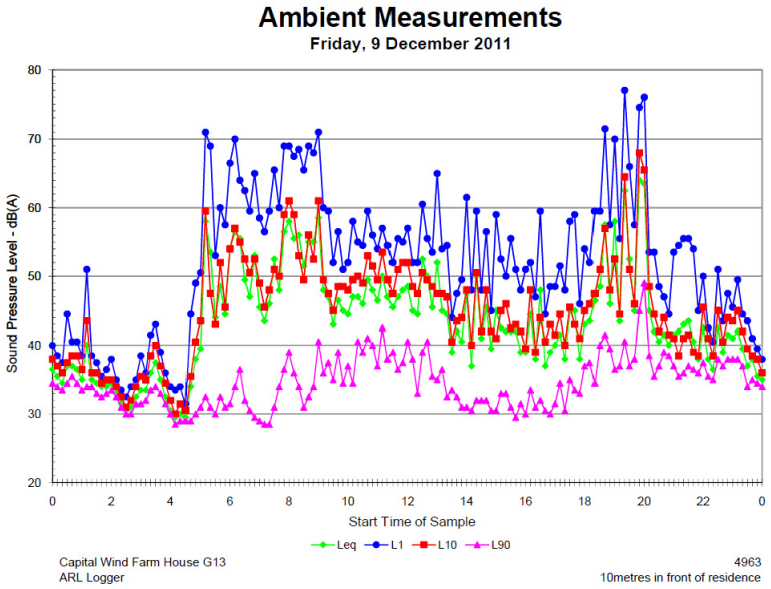


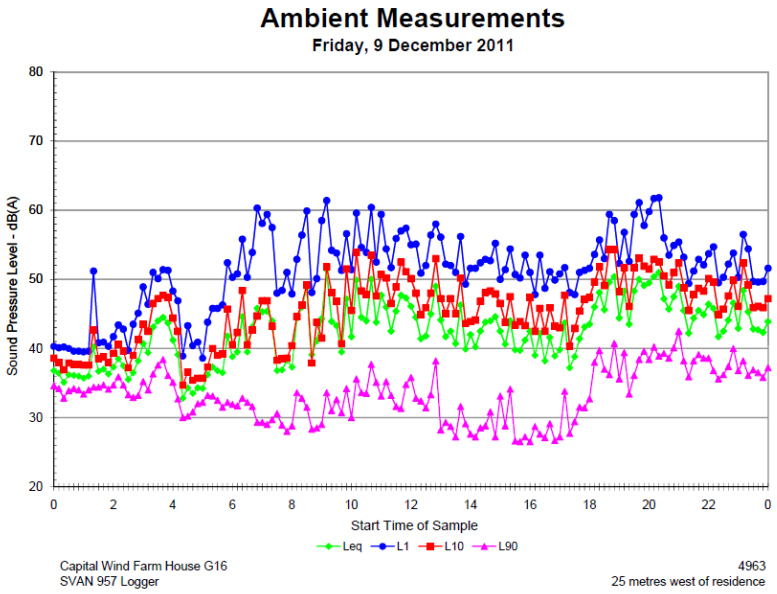


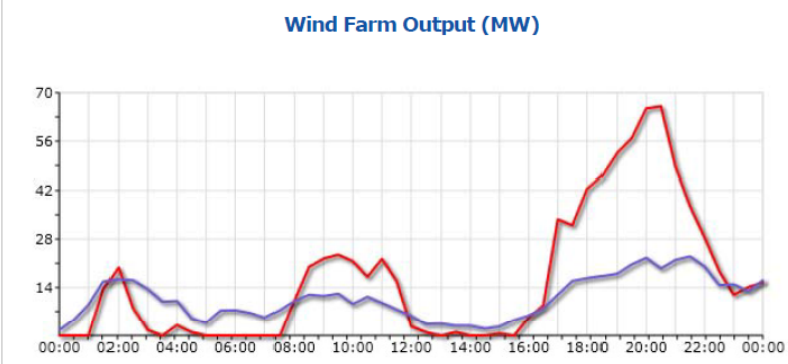

Ambient Measurements
Thursday, 8 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence

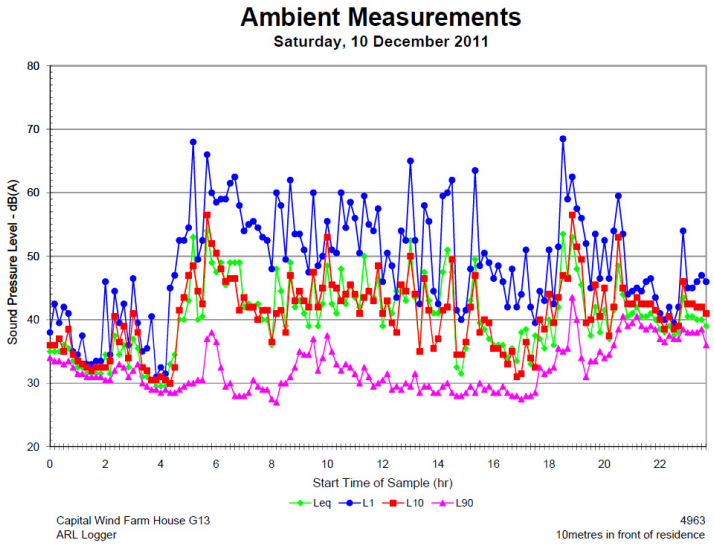

Ambient Measurements
Thursday, 8 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

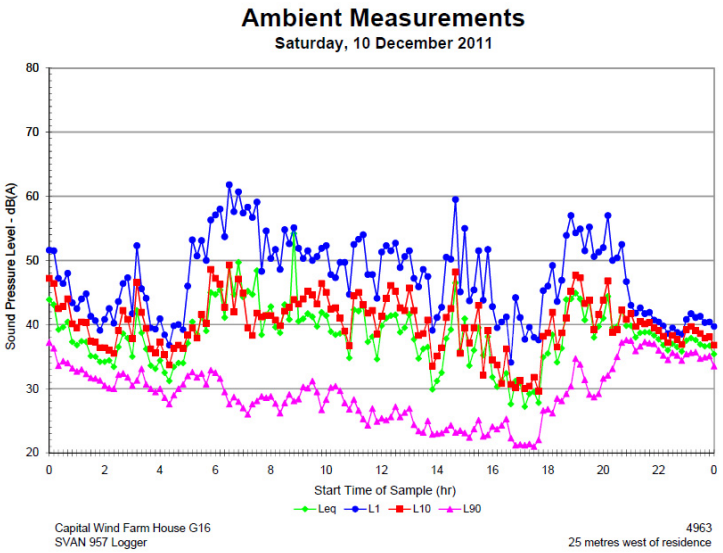

Wind Farm Output (MW)

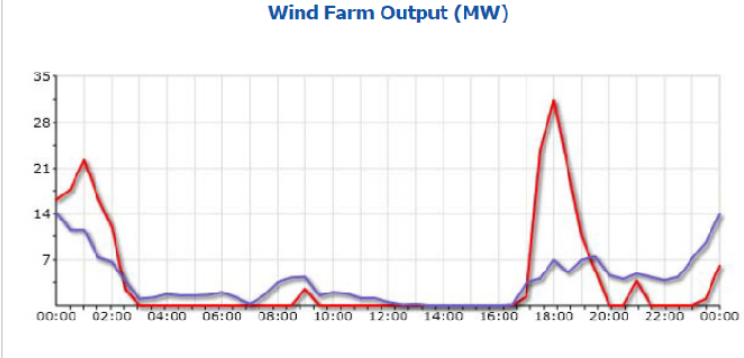

Ambient Measurements
Friday, 9 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence

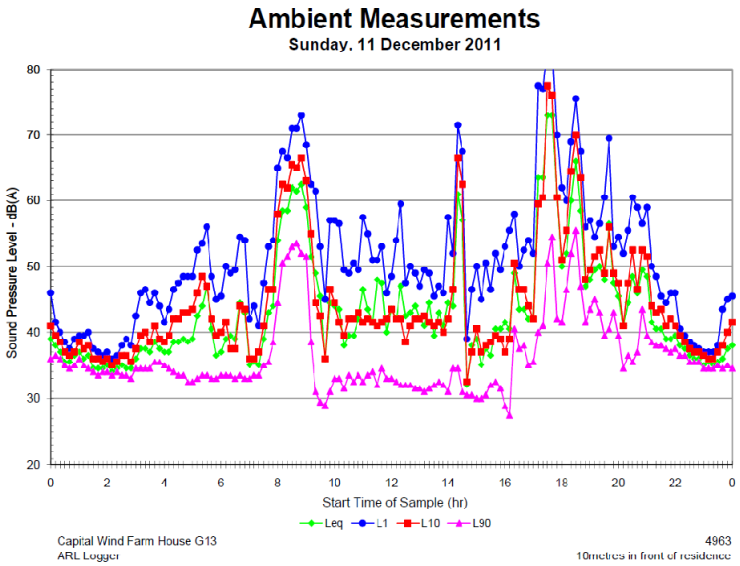

Ambient Measurements
Friday, 9 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

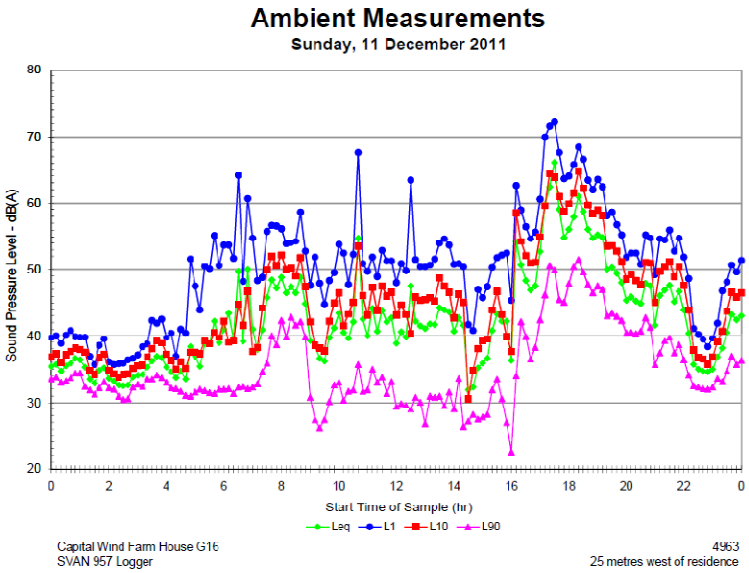

Wind Farm Output (MW)

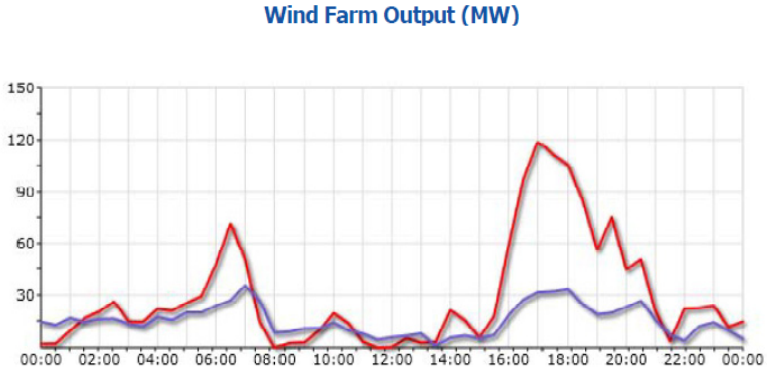

Ambient Measurements
Saturday, 10 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence

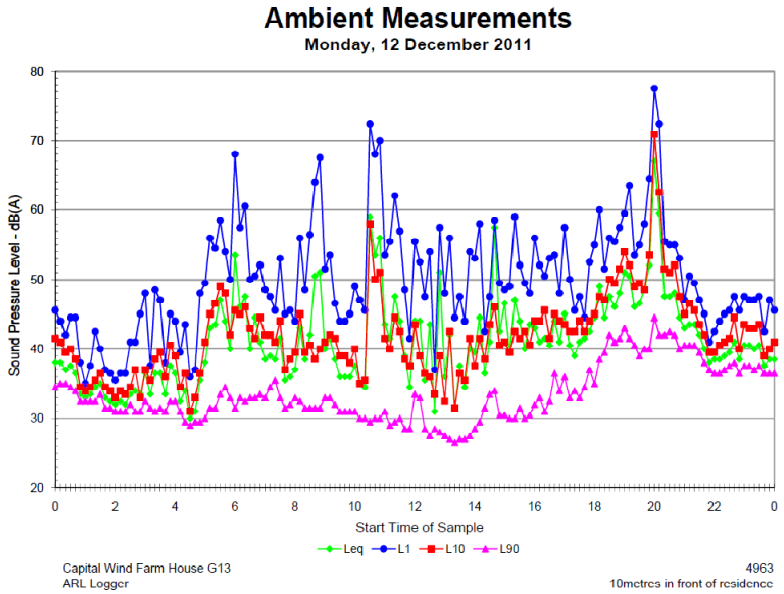

Ambient Measurements
Saturday, 10 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

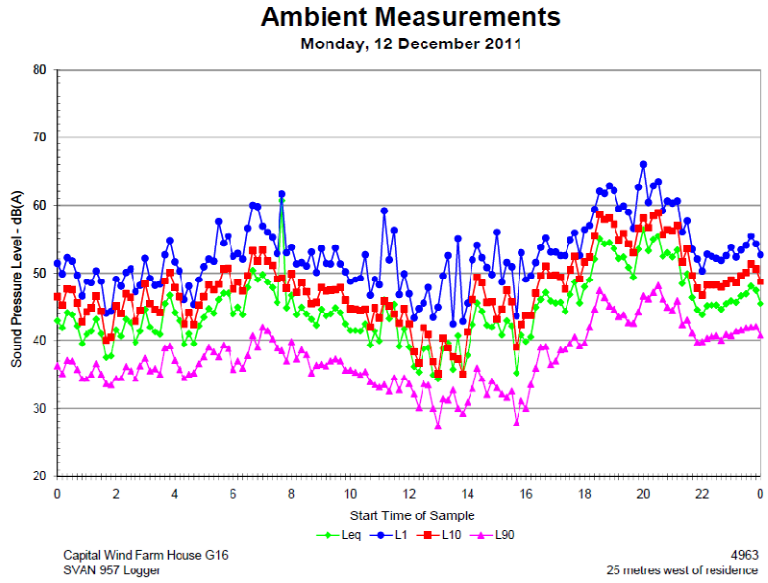

Wind Farm Output (MW)

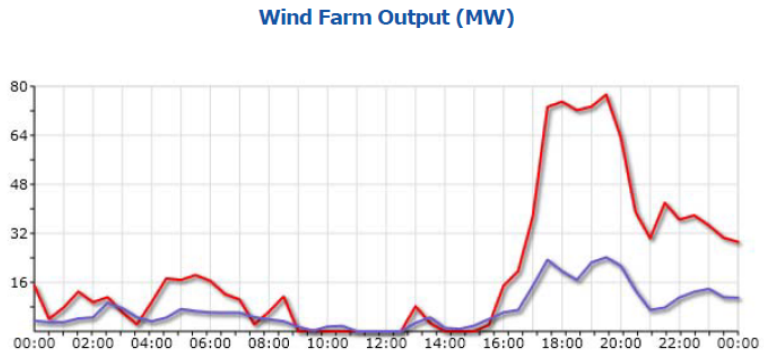

Ambient Measurements
Sunday, 11 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence

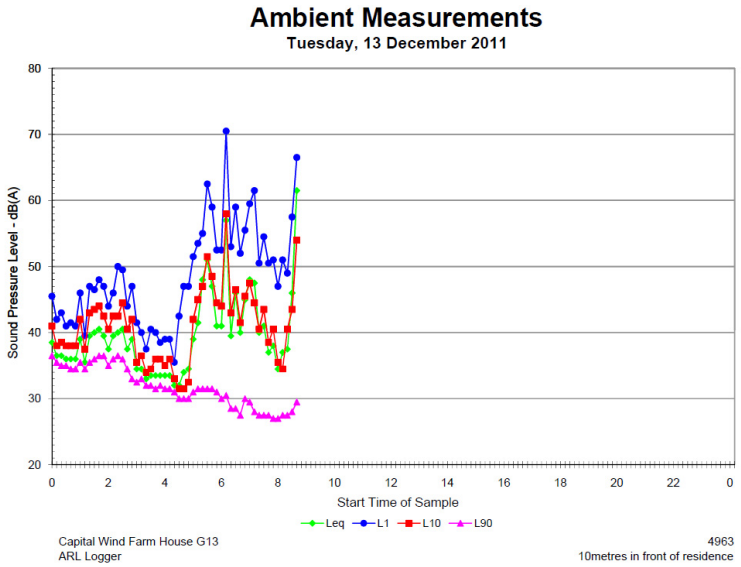

Ambient Measurements
Sunday, 11 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample (hr)
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

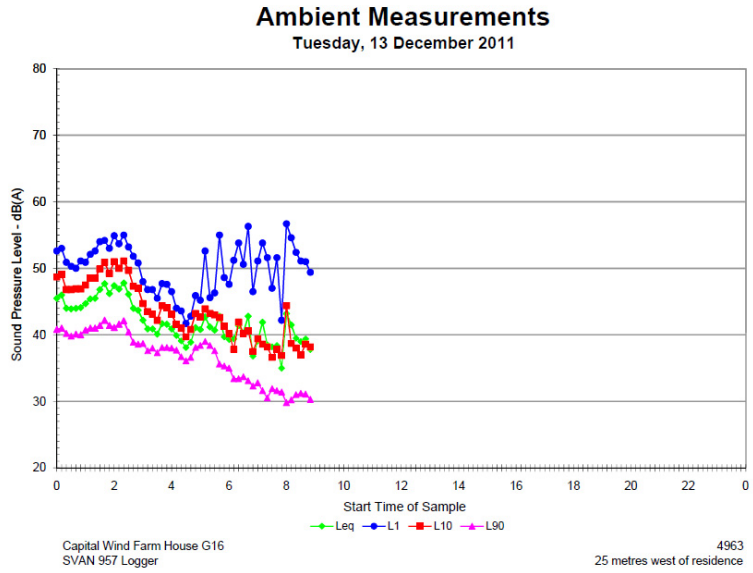

Wind Farm Output (MW)
150
120
90
60
30
00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00

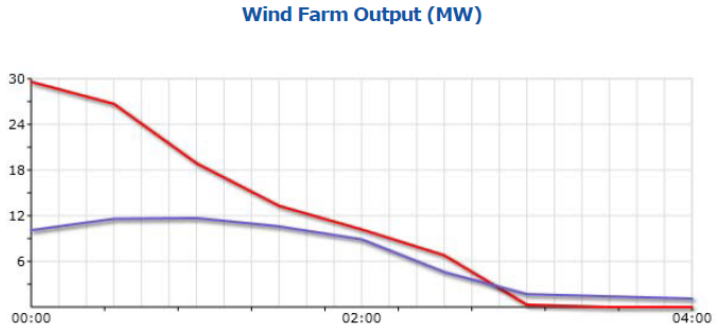

Ambient Measurements
Monday, 12 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence


Ambient Measurements
Monday, 12 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

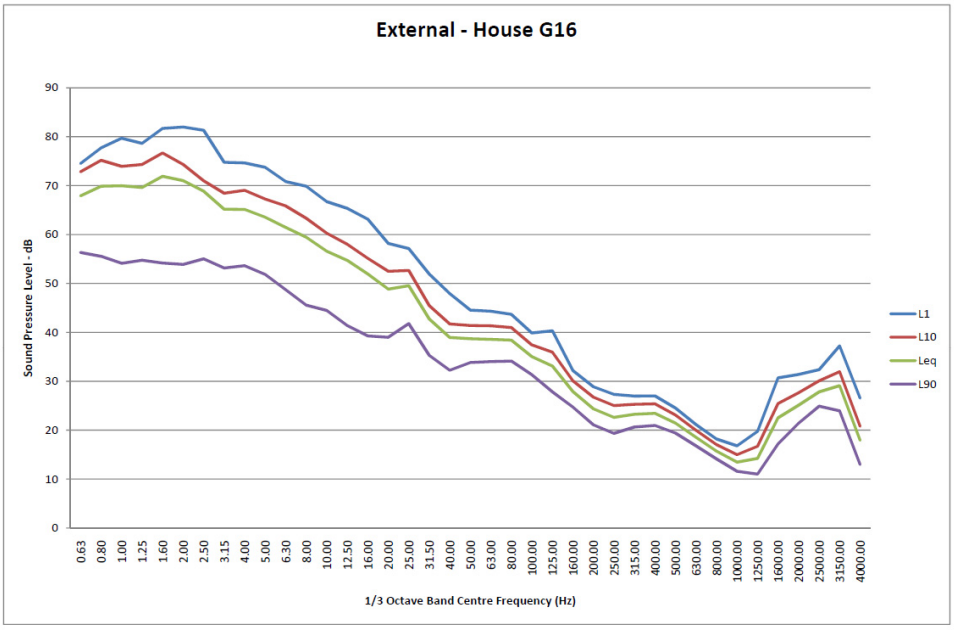

Wind Farm Output (MW)

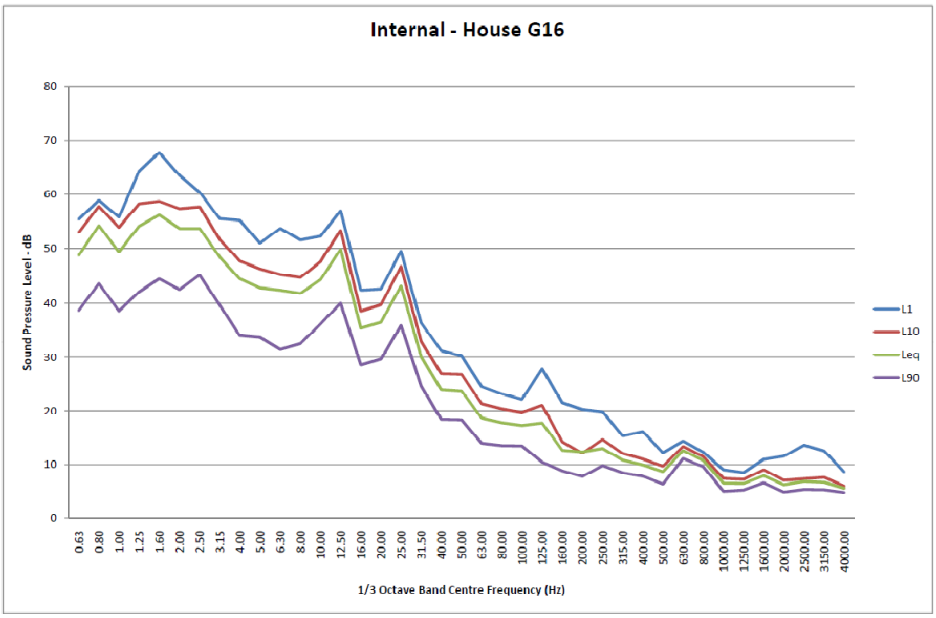

Ambient Measurements
Tuesday, 13 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G13
ARL Logger
4963
10metres in front of residence

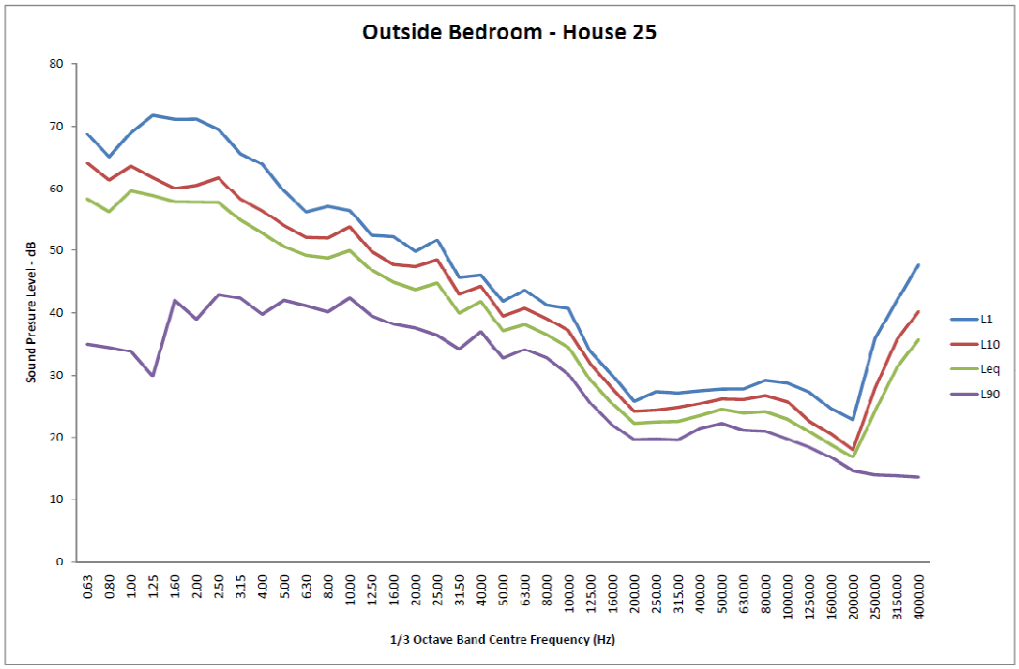

Ambient Measurements
Tuesday, 13 December 2011
Sound Pressure Level - dB(A)
Start Time of Sample
Leq L1 L10 L90
Capital Wind Farm House G16
SVAN 957 Logger
4963
25 metres west of residence

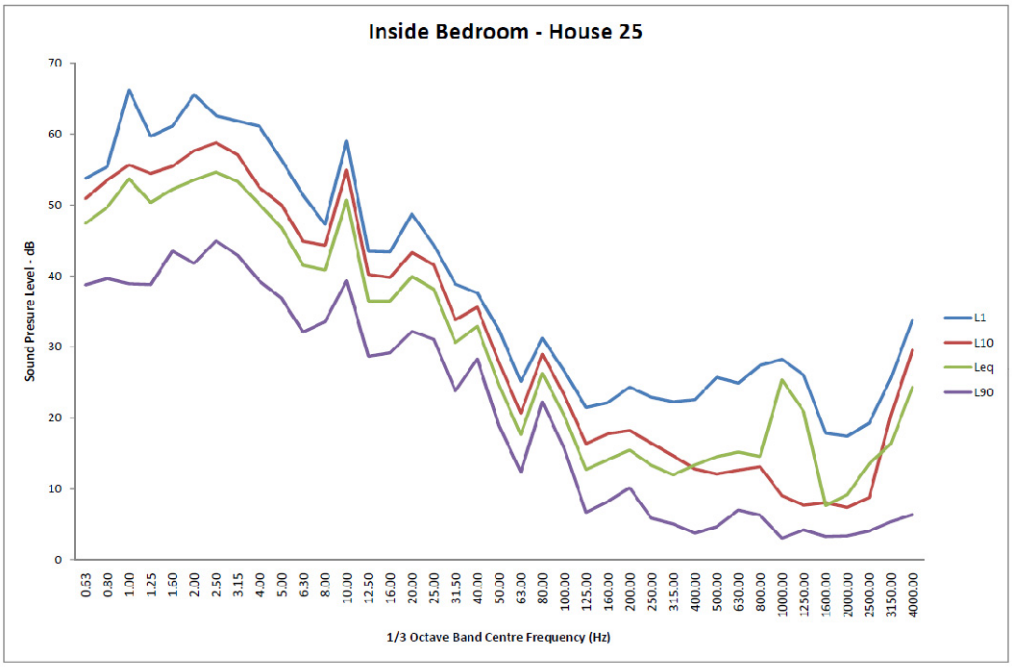

Wind Farm Output (MW)
00:00
02:00
04:00

APPENDIX K: Supplementary Attended Monitoring






Outside Bedroom - House 25
Sound Presure Level - dB
0
10
20
30
40
50
60
70
80
0.63
0.80
1.00
1.25
1.60
2.00
2.50
3.15
4.00
5.00
6.30
8.00
10.00
12.50
16.00
20.00
25.00
31.50
40.00
50.00
63.00
80.00
100.00
125.00
160.00
200.00
250.00
315.00
400.00
500.00
630.00
800.00
1000.00
1250.00
1600.00
2000.00
2500.00
3150.00
4000.00
1/3 Octave Band Centre Frequency (Hz)
L1
L10
Leq
L90


Inside Bedroom - House 25
Sound Presure Level - dB
0
10
20
30
40
50
60
70
0.63
0.80
1.00
1.25
1.50
2.00
2.50
3.15
4.00
5.00
6.30
8.00
10.00
12.50
16.00
20.00
25.00
31.50
40.00
50.00
63.00
80.00
100.00
125.00
160.00
200.00
250.00
315.00
400.00
500.00
630.00
800.00
1000.00
1250.00
1600.00
2000.00
2500.00
3150.00
4000.00
1/3 Octave Band Centre Frequency (Hz)
L1
L10
Leq
L90