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WAUBRA WIND FARM

REVIEW OF REPORT No 1537 Rev 1 JULY 2010

This report is a summary of the review conducted by Sonus of the Waubra Wind Farm Noise Impact Assessment Report No 1537 Rev 1 July 2010

Prepared for:

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Executive Summary

Background

The Waubra Wind Farm Noise Impact Assessment Report No 1537 Rev 1 July 2010 (the report) was prepared by Noise Measurement Services (Dr Bob Thorne) for Mr and Mrs N Dean to determine "*the potential for adverse effects due to activity from the Waubra wind farm while living in their residences and while working on their farms*" (Executive Summary, Paragraph 1, Page 6).

The findings of Dr Thorne's report are repeated:

"My research to date for this investigation indicates "ordinary" wind has a laminar or smooth infrasound and low frequency flow pattern when analysed over short periods of time. Wind farm activity appears to create a "pulsing" infrasound and low-frequency pattern. These patterns are illustrated in sonograms in this Report. My hypothesis at this stage is that wind farm sound has an adverse effect on individuals due to this pulsing nature, as well as audible noise due to the wind turbines. These effects may be cumulative. Research into this hypothesis is described further in this Report.

It is concluded, from the information presented, that Mr Dean has been and is currently adversely affected by the presence and activity of the Waubra wind farm. The effects stated by Mr Dean as affecting his health and statutory declarations from his family and residents in the vicinity of the wind farm attest to adverse health effects. Adverse health effects such as sleep disturbance, anxiety, stress and headaches are, in my view, a health nuisance and are objectionable and unreasonable."

Sonus was engaged by the Clean Energy Council to conduct an independent and expert peer review of the Waubra Wind Farm Noise Impact Assessment Report No 1537 Rev 1 July 2010 (the report).

Relevant Experience

Sonus was formed in 2002 and provides professional consultancy in all areas of acoustic engineering, including environmental noise, building acoustics and occupational noise.

Sonus engineers have been involved in the monitoring, prediction, data analysis, policy development and assessment of environmental noise from factories, road, rail, aircraft, commercial and industrial sources, with extensive experience specifically related to wind farms, in particular:

- Representing the National Environment Protection Council on the Australian Standard Technical Committee EV-016, responsible for the development of the Australian Standard AS4959 – 2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators*;

- Development and implementation of the first jurisdictional response to wind farm noise assessment in the *South Australian EPA Wind Farm Guidelines 2003*, which has been adopted in a number of other States;

- Development of the South Australian *Environment Protection (Noise) Policy 2007* (the Policy) and associated draft User's Guidelines;

- Environmental noise assessment of over 30 wind farms throughout Australia;

- Appearances as expert witnesses in the NSW Land & Environment Court and the South Australian Environment Resources and Development Court for wind farm appeal proceedings; and

- Measurement of infrasound from wind farms in Victoria and South Australia.

Review Findings

The report is fundamentally flawed because it does not incorporate the following minimum elements:

1. A measurement methodology that separates the wind farm noise from other noise in the environment by conducting a wide range of repeatable noise level measurements with and without the wind farm operating under similar meteorological conditions;

2. An infrasound measurement methodology that reduces the influence of wind on the microphone using equipment suitable for the measurement of infrasound;

3. A comparison of the results of the study against established thresholds for adverse health effects and/or against measurements of other typical natural and man made noise sources experienced in rural environments; and

4. The establishment of a link between the measured noise levels and adverse health effects.

The study has been reviewed against the above elements:

1. *A measurement methodology that separates the wind farm noise from other noise in the environment by conducting a wide range of repeatable noise level measurements with and without the wind farm operating under similar meteorological conditions*.

   All of the results, with the exception of one measurement, are a combination of wind farm noise and other noise in the environment. Therefore, fundamentally, the component of noise associated with the wind farm cannot be determined.

   The one measurement result in the study that was made without the wind turbines operating is over a 3 second period and includes an aircraft flyover. Clearly, there are no conclusions regarding “ordinary” wind that can be made from such a measurement. Notwithstanding, the sonogram for the 3 second measurement appears to incorporate a “pulsing” nature and a level of infrasound that is similar to other results, contrary to the findings of the study.

2. *An infrasound measurement methodology that reduces the influence of wind on the microphone using equipment suitable for the measurement of infrasound:*

   The measurement of infrasound at low levels requires a specific methodology, as it is readily affected by wind on the microphone. The study does not establish a specific methodology and measurements appear to be conducted using a standard microphone arrangement above the ground. Such a standard arrangement, even in light breeze conditions and in close proximity to a turbine, would be dominated by the influence of wind on the microphone. The study does not establish that wind on the microphone is not the dominant component of the infrasound results.

   The measurement of infrasound at low levels also requires specific measurement equipment. Both the sound level meter and the microphone would need to have a frequency response down to 1 Hz in order to make the findings of the study. The study does not establish that the meter and microphone arrangement is suitable for the measurement of infrasound.

3. *Comparison of the results of the study against established thresholds for adverse health effects and/or against measurements of other typical natural and man made noise sources experienced in rural environments:*

   The World Health Organisation (WHO) establishes a recommendation of 30 dB(A) inside a bedroom to prevent the potential onset of sleep disturbance effects (WHO, 1999). State and International jurisdictions such as the Queensland Government (DERM) and the UK Department for Environment, Food and Rural Affairs provide a human infrasound perception threshold limit of 85 dB(G) as the acceptable level of infrasound in the environment from a noise source to protect against the potential onset of annoyance. The study does not reference the above objective standards and does not establish why these widely used studies are not relevant.

Notwithstanding, these results (which include all noise sources in the environment) easily achieve the World Health Organisation's recommended noise level for the potential onset of sleep disturbance. In addition, the results easily achieve the infrasound perception threshold limit used by State and International jurisdictions, and therefore the infrasound would not be detectable or be able to be perceived by humans.

The study does not present any measurement results for other typical natural and man made noise sources experienced in rural environments. These levels are expected to be of a similar order to the results of the study and, at times, are expected to be significantly higher. The study does not establish how its findings can be made in the context of other noise sources experienced in a typical rural environment.

4. *Establishment of a link between the measured noise levels and adverse health effects:*

The study "hypothesises" that wind farm noise has adverse health effects. This hypothesis is in contrast to the findings of the American and Canadian Wind Energy Associations (Colby et al, 2009), the Australian Government's National Health and Medical Research Council (NHMRC, 2010) and the Victorian Department of Health (DH) (WorkSafe, 2010). The study does not establish why the findings of these reviews do not apply to the Waubra wind farm. In addition, the study does not investigate other possible causes for adverse health effects including the "nocebo" effect identified in the above works. As such, the report does not provide any evidence to support or establish a link to the hypothesis and is contrary to recent significant reviews.

Based on the above, the study cannot support its findings, and presents evidence that is contrary to those findings. The study does not include any of the minimum elements required to make its findings, and as such, is fundamentally flawed.

Key areas of the report are discussed in further detail below.

1. Separation of wind farm noise from other noise in the environment

The noise measurement methodology and results do not enable the wind turbine noise to be separated from the other noise in the environment.

The ambient noise generated by wind in the trees is often the dominant component of noise at a dwelling in the vicinity of a wind farm and average noise levels of more than 10 dB(A) above those associated with the wind farm are common. Longstanding environmental noise policy procedures indicate that there are no impacts from a noise source in such circumstances, and therefore the masking effect of the ambient environment is a positive and advantageous influence. However, the masking effect presents inherent difficulties in identifying the wind farm noise and complex measurement techniques are required. These techniques have not been employed by the study.

This is despite the Executive Summary of the report noting that the "*identification of sound that can be directly attributed to the sound of the wind farm / turbines, measured as a background sound level, compared to the sound of the ambient environment without the presence of the wind turbines*" is one of "*three distinct issues*" in "*wind farm sound analysis*".

There is only one measurement result in the study that was made without the wind turbines operating. This is a 3 second measurement that includes an aircraft flyover. Its results are of a similar order to other results in the study. Such a measurement is insufficient to enable the wind turbine noise to be separated from other noise in the environment. A suitable methodology would include a series of repeatable measurements with the turbines on and off over similar timeframes and meteorological conditions, including wind speed and direction. This methodology has not been employed by the study.

Therefore, without a specific methodology to identify the wind turbine noise from the other noise in the environment, conclusions regarding the Waubra wind farm cannot be made.

2. Infrasound

The report focuses on noise levels in the infrasound range. Infrasound is generally considered to be noise at frequencies less than 20 Hz (O'Neal et al., 2009).

The measurement of infrasound at low levels requires specific equipment and a specific methodology, as it is readily affected by wind on the microphone.

A microphone mounting method is provided in IEC 61400-11 (IEC, 2002), as shown in the figure below. The method was developed to minimise the influence of wind on the microphone for the measurement of noise in frequencies higher than those associated with infrasound. This is achieved by mounting the microphone at ground level on a reflecting surface and by protecting the microphone with two windshields constructed from open cell foam.

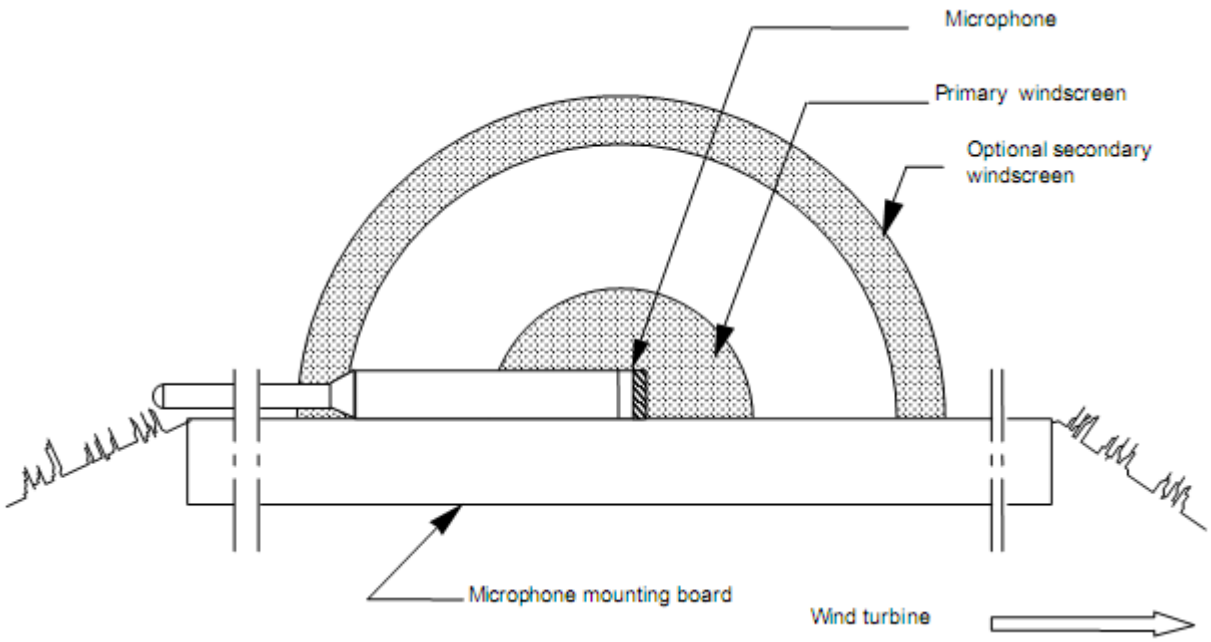

Figure 1 - Mounting of the microphone – vertical cross-section (Reproduced from Figure 1b, IEC 61400-11)

The above method was not developed specifically for the measurement of infrasound, and wind gusts can be clearly detected when measuring in the infrasound frequency range even when using the above method.

The report is based on measurements made above the ground without reference to a specific methodology. Therefore, the study does not establish that the measurements of infrasound are not adversely influenced by wind on the microphone, which would be likely even for a specific methodology such as that provided by IEC 61400-11.

A fundamental element in any methodology associated with infrasound measurements is to establish how the influence of wind on the microphone will be reduced such that the noise source of interest can be identified. These tests would comprise measurements in a similar environment, including wind speed and direction at the microphone, without the influence of wind turbines. Based on experience, such a test, even in light breeze conditions and in close proximity to turbines, would be dominated by the influence of wind on the microphone. This testing has not been conducted as part of the study.

It is also not established that the equipment used is suitable for infrasound measurements. It is noted that some measurements were made with a SVANTEK 957 Type 1 calibrated sound and vibration analyser. Whilst this meter has a measured frequency response to 0.5 Hz, its standard ½" microphone has a measured frequency response to 10Hz. A specific ½" free field microphone with a frequency response to 1 Hz is required for infrasound measurements. The study does not establish whether the meter and microphone arrangement is suitable for measurement of noise levels in the infrasound range.

The central element of the report is the preparation of "sonograms" to highlight what the report terms to be "pulsing" infrasound. Ignoring the fundamental issue of wind on the microphone and the establishment of whether suitable measurement equipment was used, it is not established that the filtering technique used in preparation of the sonograms does not contribute to the "pulsing" effects shown on them. A similar effect can be seen on the sonogram that does not include the influence of the wind turbines, albeit this sonogram being of limited value due to its limited test period. Further testing would need to be conducted including a series of repeatable measurements and sonogram preparation with the turbines on and off over similar timeframes and meteorological conditions, including wind speed and direction. This methodology has not been employed.

Based on the expected significant influence of wind on the microphone for a standard above ground measurement methodology, and the need to establish that suitable equipment was employed, and the need to repeat the preparation of the sonograms under the same test conditions without the turbines operating, the results relating to infrasound cannot be considered as valid for the assessment of the Waubra wind farm.

3. Comparison against recognised standards

Notwithstanding the limitations of the study as outlined above, the noise measurement results are not compared against recognised standards, such as the World Health Organisation recommended levels for annoyance and sleep disturbance, or recognised perception thresholds for infrasound such as that developed by the UK Government and the Queensland Government (DERM).

Therefore, the conclusions that are made in the report are hypotheses by the author that are not proven either through a suitable test methodology (refer to Items 1 and 2 above) or through comparison against established objective standards.

The recent Epuron Pty Ltd & Gullen Range Wind Farm Pty Ltd & Ors vs Parkesbourne / Mummel Landscape Guardians Incorporated (PMLG), NSW Land & Environment Court Proceedings No. 41288 of 2008 judgment includes:

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> *Inserting subjectivity consent requirements based on an individual's or a group of individuals' reaction to the noise from the wind farm, based on their opposition to the development, is entirely alien to the planning system. Whilst, in some areas such as streetscape impact, individual aesthetic considerations may arise and judgments made upon them, we are unaware of any authority to support the proposition that, where there is a rationally scientifically measurable empirical standard against which any impact can be measured and determined to be acceptable at a particular empirically determined level, that there should be some allowance made for a subjective response to the particular impact.*

The judgment confirms that it is important to compare the results of a wind farm study against the applicable empirical standards and guidelines available. Such standards and guidelines are discussed below.

Sleep Disturbance

The World Health Organisation (WHO) establish a recommendation of 30 dB(A) inside a bedroom to prevent the potential onset of sleep disturbance effects (WHO, 1999).

The WHO guidelines indicate a noise level of 30 dB(A) inside a typical bedroom correlates to an external noise level with the windows open of the order of 45 dB(A). The baseline limit criterion of the New Zealand Standard NZS 6808:1998 *Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators* (NZS:1998) of 43 dB(A)[1] is therefore more stringent than the WHO guidelines recommendation of 45 dB(A).

It should be noted that the WHO recommendations are considered conservative in that they consider all available research and then use the most stringent approach to indicate the "potential onset" of sleep disturbance effects, which is not defined as full awakening, but rather as a change in the stage of sleep.

The UK Department of Trade and Industry (ETSU, 1997) recognises the above effect and recommends increasing the allowable noise level for wind farms during the night period, based on sleep disturbance effects. The baseline limit used in the UK for wind farms during the night time is therefore 45 dB(A).

For comparison purposes, the study presents the combined noise levels outside of the dwelling at 377 Stud Farm Road as generally between 35 and 40 dB(A). The combined noise level includes all of the sources in the environment, of which the wind farm is an unknown component. The combined noise level is significantly lower than the World Health Organisation's recommended noise level of 45 dB(A) for the potential onset of sleep disturbance.

[1] The NZS: 1998 provides a base line limit of 40 dB(A) when measured as an L_{A95}. For wind turbine noise, the L_{Aeq} is often taken to be up to 2.5 dB(A) higher than the L_{A95}. Therefore, to provide comparison against the recommended L_{Aeq} noise level used of the WHO, the L_{A95} base line limit of 40 dB(A) has been converted to a L_{Aeq} base line limit of 43 dB(A).

Infrasound

Infrasound is often described as inaudible, however, sound below 20 Hz remains audible provided that the sound level is sufficiently high (O'Neal et al., 2009). The thresholds of hearing for infrasound have been determined in a range of studies (Leventhall, 2003). These thresholds are depicted in graphical form below for frequencies less than 20 Hz (Figure 2).

Non-audible perception of infrasound through felt vibrations in various parts of the body is also possible, however, this is found to only occur at levels well above the audible threshold (Moeller and Pedersen, 2004).

Weighting networks are applied to measured sound pressure levels to adjust for certain characteristics. The A-weighting network (dB(A)) is the most common, and it is applied to simulate the human response for sound in the most common frequency range. The G-weighting has been standardised to determine the human perception and annoyance due to noise that lies within the infrasound frequency range (ISO 7196, 1995).

A common audibility threshold from the range of studies is an infrasound noise level of 85 dB(G) or greater. This is used by the Queensland Department of Environment and Resource Management's (DERM's) draft Guideline for the assessment of low frequency noise as the acceptable level of infrasound in the environment from a noise source to protect against the potential onset of annoyance.

The audibility threshold limit of 85 dB(G) is consistent with other European standards and studies, including the UK Department for Environment, Food and Rural Affairs threshold developed in 2003 (DEFRA., Leventhall, 2003), the UK Department of Trade and Industry study (DTI, Hayes McKenzie, 2006), the German Standard DIN 45680, the Denmark National Standard and independent research conducted by Watanabe and Moeller (Watanabe and Moeller, 1990).

The 85 dB(G) audibility threshold limit is shown in Figure 2 below. Other audibility thresholds have also been overlaid to provide a comparison.

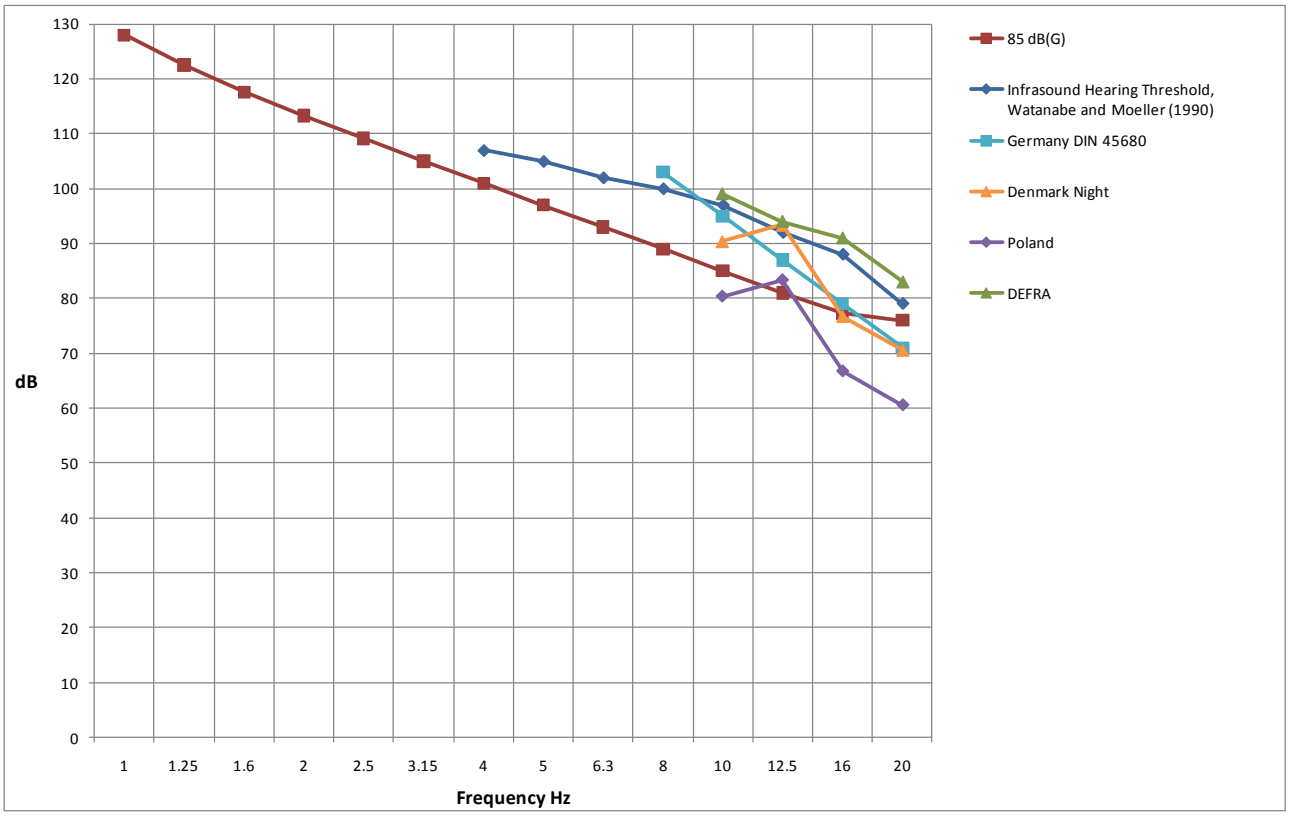

Figure 2 - Audibility Threshold Curves from the Listed Sources

For comparison purposes, the study presents the combined infrasound noise levels outside of the dwelling at 377 Stud Farm Road as generally in the order of 70 dB(G). The combined noise level includes all of the sources in the environment, of which the wind farm is an unknown component. The combined noise level is significantly lower than the established threshold of 85 dB(G) for the perception of infrasound, and would therefore not be detectable to humans.

4. Adverse Health Effects

The report presents the hypothesis that wind farm noise has adverse health effects. In the absence of the minimum elements outlined in items 1 and 2 above, the report does not provide any evidence to support or establish a link to the hypothesis. The hypothesis is contrary to recent significant reviews discussed below.

In 2009, the American and Canadian Wind Energy Associations established a scientific advisory panel (the Panel) comprising medical doctors, audiologists and acoustic professionals from the United States, Canada, Denmark and the United Kingdom to produce "an authoritative reference document for legislators, regulators, and anyone who wants to make sense of the conflicting information about wind turbine sound" (Colby et al, 2009).

The Panel concluded:

> *there is no reason to believe, based on the levels and frequencies of the sounds and the panel's experiences with sound exposures in occupational settings, that the sound from wind turbines could plausibly have direct adverse health consequences.*

The Victorian Department of Health (DH) (WorkSafe, 2010) has examined both the peer-reviewed and validated scientific research and concluded that:

> *the weight of evidence indicated that there are no direct health effects from noise (audible and inaudible) at the levels generated by modern wind turbines.*

The Australian Government's National Health and Medical Research Council (NHMRC, 2010) has examined the "evidence from current literature on the issue of wind turbines and potential impacts on human health" and concludes:

> *There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines (NHMRC, 2010).*

The Panel also investigated and provided information on "the complex factors culminating in annoyance", which includes the nocebo effect (Spiegel, 1997).

The nocebo effect is "an adverse outcome, a worsening of mental or physical health, based on fear or belief in adverse effects. This is the opposite of the well known placebo effect, where belief in positive effects on an intervention may produce positive results" (Colby et al, 2009).

With respect to the nocebo effect, the Panel concludes:

> *..the large volume of media coverage devoted to alleged adverse health effects of wind turbines understandably creates an anticipatory fear in some that they will experience adverse effects from wind turbines. ….The resulting stress, fear, and hyper vigilance may exacerbate or even create problems which would not otherwise exist. In this way, anti-wind farm activists may be creating with their publicity some of the problems they describe (Colby et al, 2009).*

The recent NHMRC review provides consistent conclusions with respect to health:

> *It has been suggested that if people are worried about their health they may become anxious, causing stress related illnesses. These are genuine health effects arising from their worry, which arises from the wind turbine, even though the turbine may not objectively be a risk to health (Chapman, 2009)*

Based on the above, it is essential that studies conducted in the vicinity of wind farms incorporate the following elements to ensure the surrounding community is provided with clear objective information:

- A methodology to identify the wind farm from other noise in the environment; and
- A comparison of the study results against established standards and guidelines and other typical noise sources in the environment that provides a link to the feasibility of adverse effects.

The Waubra Wind Farm Noise Impact Assessment Report No 1537 Rev 1 July 2010 (the report) prepared by Noise Measurement Services does not incorporate these elements.

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