

Technical Review of the Capital Wind Farm Noise Compliance Assessment Report.

Including a review of a Specialist Reports on Noise by Vipac Engineers.

1 Background

The construction and operation of Capital Wind Farm was approved by the Minister for Planning on 7 November 2006 under section 75J of the Environmental Planning and Assessment Act. Construction began in early 2008, with the wind farm becoming fully operational in October 2009.

The wind farm comprises 67 Suzlon S88 2.1MW wind turbines with a total installed capacity of 140.7MW. These turbines have internal controls that monitor the wind direction and speed, with electricity production beginning at winds above 14 km/h (4 m/s). The amount of electricity produced continues to increase until the turbines reach maximum or 'rated' capacity (2.1MW) at wind speeds of around 40 km/h (11 m/s).

Stronger winds do not make the blades turn faster. The blades rotate at a regular 15-18 revolutions per minute and operate at capacity until the wind speed reaches 90 km/h. The turbines automatically shut down and turn out of the wind when the wind speed goes beyond 90 km/h. Condition 58 of the Project Approval requires that a Noise Compliance Assessment be prepared which assesses the performance of the wind farm against noise limits outlined in Condition 53.

2 Methodology

It was a Condition of Approval that post construction noise measurements and analysis be undertaken in accordance with the Capital Wind Farm Operations Phase, Noise Compliance Assessment Plan (NCAP). The NCAP outlines that measurements are to be undertaken according to the SA Environment Protection Authority 2003 guidelines for wind farm noise. All measurements, analysis and assessments for background noise at the Capital Wind Farm are to be undertaken according to this guideline.

The proponent commissioned Vipac to conduct the noise compliance assessment.

The Department assessed the noise monitoring reports produced by Vipac against the Approval requirements and reviewed the monitoring for technical content, appropriate methodology, and ability to achieve objectives of assessing compliance of the Capital Wind Farm to criteria set in the Conditions of Approval. A site inspection was undertaken during the compliance period to familiarise the Department's officers with the methodology being followed and to assess the techniques being employed. In this respect the measurement techniques being adopted were observed as being appropriate and discussions with the noise consultants gave confidence that whilst the measurement task was difficult, appropriate equipment and staff knowledge was being utilised.

Comments in this review are based on the experience of the reviewer in the preparation and assessment of technical papers and are limited to a review of information supplied in the compliance documentation.

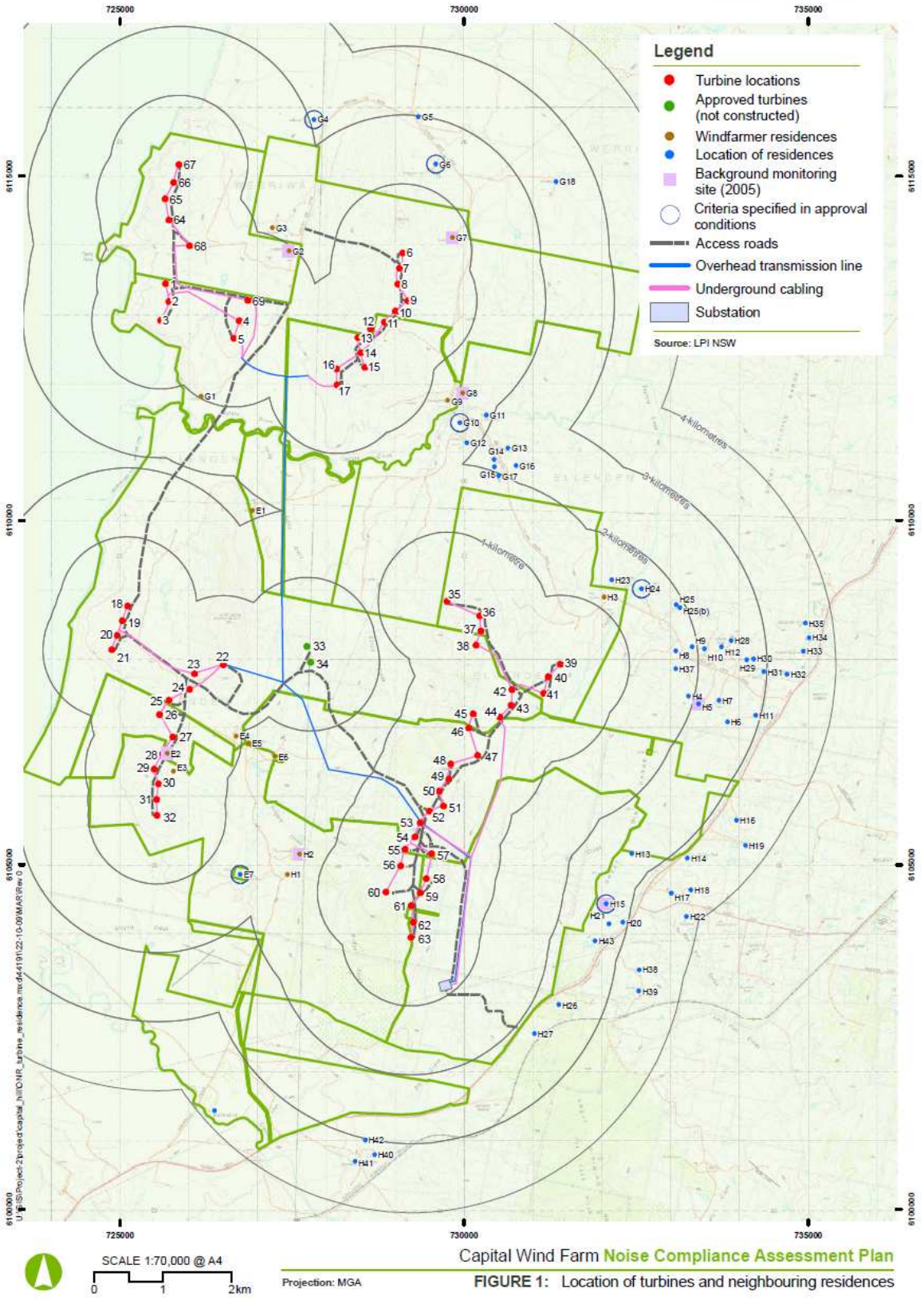


Figure 1. Location of wind turbines and monitoring sites.

3 Assessment of Noise Monitoring Reports

Monitoring undertaken in Stage 1 of the monitoring program involved collecting data at the 2005 background sites. This was not a mandatory requirement, however it was agreed between the company and the Department that it would allow development of a good understanding of how the operational wind farm was influencing the surrounding noise catchment. Furthermore it was believed that the Stage 1 monitoring would assist in confirming the accuracy of the noise model used to predict the wind farm's noise impacts.

Mandatory monitoring was undertaken during the Stage 2 monitoring program and consisted of compliance monitoring at specific neighbouring residence locations where the Project Approval Conditions defined compliance criteria (referred to as compliance sites). The subsequent monitoring results for Stage 2 were reported separately but have been reviewed together in this document. It is noted that the Patch (H 15) represents both a background site and a compliance site.

3.1 Stage 1 Noise Monitoring Report

The Stage 1 Report relates to the completion of monitoring for six of eight sites where background noise monitoring was undertaken in 2005. While background monitoring was previously undertaken at eight sites, one of these, Wyoming (E1), a wind farmer residence, was not included and a second, the Gray Property (H5) was not included due to the landowner not agreeing to have further noise monitoring undertaken at their property. The Department is aware of this and has agreed to these omissions for the Stage 1 monitoring.

Shut Down Measurements

The NCAP provides for the collection of measurements before, during and after periodic shut downs to demonstrate the variation between noise levels at a specific residence with and without the wind farm operating. Shut down measurements were undertaken at background sites H2, H15, G2, G7 and G8. The shut down results were used to complement the compliance assessment undertaken using the regression analyses method and were arranged at times where conditions were favourable for assessing the worse case impact at a residence, namely wind blowing from the wind farm towards the residence and with wind speeds of an order where the wind farm impact was most likely to be evident. It is recognized that logistically this is not an easy exercise to undertake and that considerable effort was required to coordinate the presence of wind farm operational staff and noise monitoring specialists. Departmental officers visited sites and observed Vipac engineers undertaking measurements and the shut down procedures being followed.

Results of all shut down monitoring is provided in the compliance report and is of variable usefulness due to the masking of wind turbine noise, for example by other wind induced noise. At the best results such as those shown in Figure 2 are achieved.

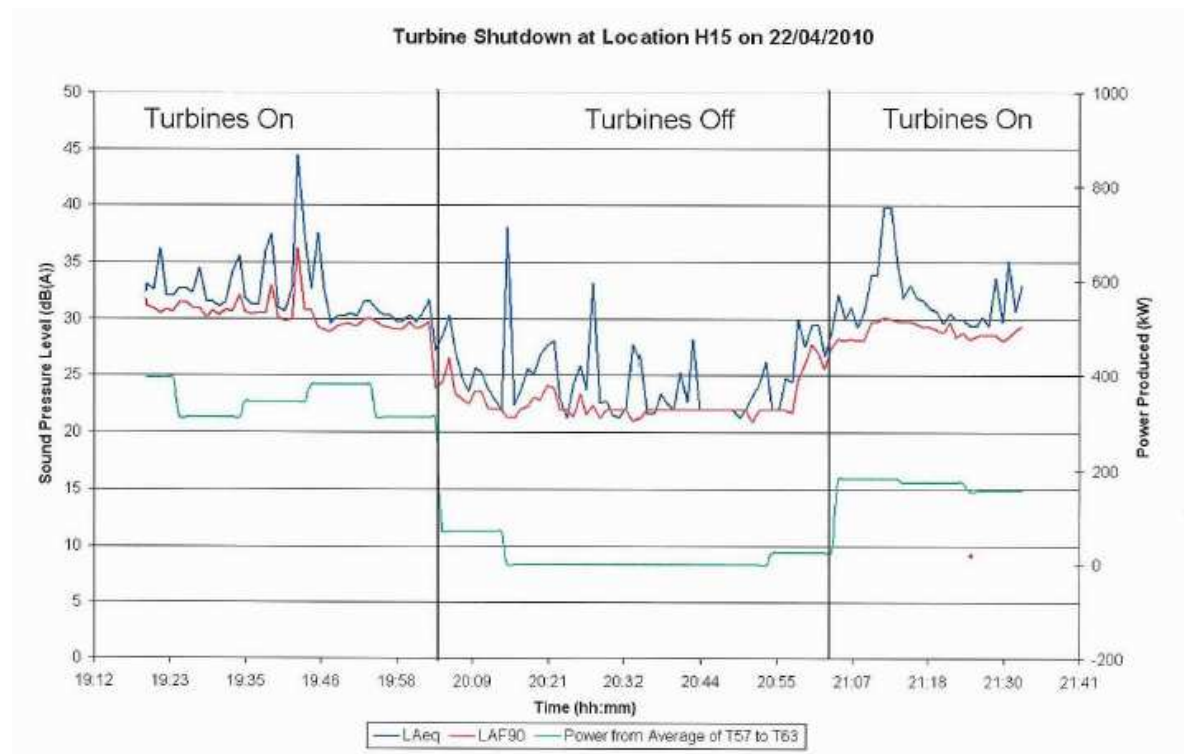


Figure 2. Example of turbine shut down (H15)

Table 7-6: H15 Shut Down Noise Summary

	Turbines on Before Shut Down	Turbines on After Shut Down	Average Level when Turbines on	Turbines Shut Down	Impact of Wind Farm ($L_{on} - L_{off}$)
Average L_{Aeq} dB(A)	32.5	31.9	32.2	24.5	7.7
Average L_{A90} dB(A)	30.4	29	29.7	22.4	7.3

Figure 3. Example of shut down noise summary (H15)

In this case it can be seen that noise levels (L_{90}) dropped on average 7.3dB(A). The report notes that this shows that the wind farm is audible and affects the noise levels at this location at this very low wind speed on this occasion. The large drop in noise levels recorded when the turbines were shut down indicates that when operational, the turbines were completely dominating the noise catchment. For this monitoring period it is therefore reasonable to assign all noise impacts to the wind farm and accept these levels as being representative of the noise generated by the wind farm.

It is noted that average L_{90} level of 29.7dB(A) with the turbines operating correlates well with the predicted noise levels of 30dB(A) at 4m/s wind speed.

Wind Turbine Noise

As can be seen from Figure 4, the sound power of a wind turbine only increases slightly (a little over 2 dB(A)) from the start up speed of around 4m/s to when the rated capacity is reached at around 11m/s. The shape of this power band is important when interpreting noise monitoring data from compliance sites as it demonstrates that whilst 'wind noise' will continue to rise with any increase in wind speed, the noise of a wind turbine will plateau out at speeds greater than 9m/s. The maximum turbine generated noise reached is around 0.5 dB(A) greater than the level measured at 7m/s.

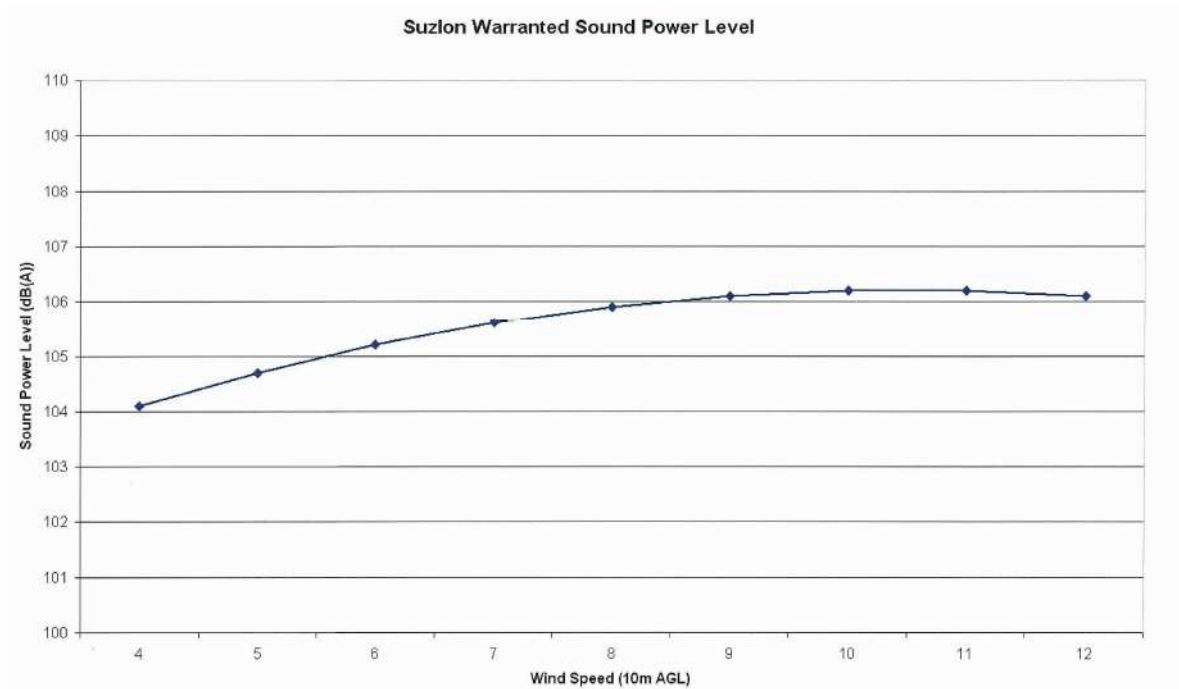


Figure 4. Sound power level bands of a Suzlon turbine

Summary of Stage I Monitoring

Based on the noise monitoring report supplied by Vipac, the Department is comfortable that Stage I noise monitoring and analysis has been completed in accordance with agreed procedures and has been found to support predictions made in the noise model at the background sites where access was available.

Monitoring shows that all noise levels measured (when the background noise was subtracted from the wind farm operational noise) agree with the modelled/predicted results, within the expected tolerance range of +2dB.

It is noted that there are small exceedances of the predicted noise levels at higher wind speeds (>9m/s), however the Department accepts that these exceedances are likely to be mainly due to wind induced noise, and not noise generated by the wind farm. This conclusion is based on the observation that the noise output of the wind turbines does not change significantly at wind speeds above 9m/s. Consequently it is not expected that noise levels due to WTG noise at the receivers increases at the same rate as would appear to be the case from the total noise measured at the receiver locations.

The Department accepts the conclusion of the Stage I report that:

- The measured post-construction noise levels at the six former background monitoring sites agree with the modelled/predicted noise levels (within accepted tolerances for uncertainty).

Furthermore the Department concurs with the additional information collected as part of the Stage I report as providing additional support to conclusions made in the Stage 2 Compliance Report.

3.2 Stage 2 Noise Monitoring (Compliance) Report

The Stage 2 monitoring represented the mandatory component of demonstrating compliance. As consistent with Stage 1 reporting, monitoring for Stage 2 was undertaken by Vipac in accordance with the SA Environment Protection Authority 2003 Guidelines for Wind Farm Noise.

For Stage 2, noise measurements were conducted at five residential sites in the vicinity of the wind farm, known as compliance sites. These sites were identified as G04, G06, G10, H24 and E07. Data from site H15 which is both a background and compliance site was previously reported in Stage 1.

It is recognised that it is difficult to confidently compare the predicted noise levels to the regression data at the Stage 2 measurement sites as the actual background noise at each site (measured before the wind turbine generators had been installed) was not obtained during the earlier baseline gathering stage. Notwithstanding, the compliance report shows that attended measurements mostly indicated that turbine noise was not subjectively audible at the compliance sites. Instances where turbines were audible were in line with expectations or generally less than the predicted levels.

Shut down measurements indicated that at most sites the noise from the wind farm was less or similar in level to the ambient background noise in a worst case situation. Where the wind farm was found to be the dominant or influencing noise source, the overall contribution was either below the predicted noise levels, or the noise levels of the operating wind farm were found to be less than 5dB greater than the noise levels whilst the wind farm was not operating, and therefore complying with the SA EPA noise guidelines.

Summary of Stage 2 Monitoring

A good indication of how much the wind farm contributes to the noise catchment is a comparison of the noise levels at a residence while the wind farm is operating, to the noise levels whilst the wind farm is shut down in worst case environments (i.e. when wind is blowing direct from source to receiver). These shut down tests were performed at five of the six compliance sites and at most residence locations the impact of the wind farm when operating was less than 5dB above the noise levels with the wind farm shut down.

Although at high wind speeds for most of the sites the regression noise levels are above the criteria and above the predicted noise levels in the predictive noise model, it can be shown in the shut down measurements and attended noise measurements, that the main contributor to this noise is wind induced noise, and pre-existing background noise (which was not quantified before the construction of the wind farm at these sites). Additionally, the regression noise levels do not follow the typical Suzlon S88 turbine noise curve for the range of wind speeds, and therefore indicate that the noise (especially for higher wind speeds) is not dominated by noise from the wind turbines.

G4

The uncorrected regression line of data collected is below the criteria for speeds below 8m/s indicating compliance by a likely substantial margin. Above these speeds the regression line does not follow the sound power levels generated by wind turbines which have been shown to plateau at these speeds. This is indicative of extraneous noise unassociated with the wind turbines. It is therefore reasonable to conclude site G4 is complying with noise criteria at all operational wind speeds.

Shut down measurements at this site show a maximum impact of the wind farm being a 1.1 dB(A) increase in the L90 at 4m/s which supports a conclusion that the site is in compliance.

G6

Data collected for this site is not representative of wind turbine noise. Attended monitoring did not indicate any audibility of wind turbines and it can therefore only be assumed that extraneous noise is dominating the noise catchment of this site.

Shut down measurements at this site show a maximum impact of the wind farm being a 0.7 dB(A) increase in the L90 at 4m/s which supports a conclusion that the site is in compliance.

G10

The corrected regression line of data collected is below the criteria for speeds below 7m/s indicating compliance. Above these speeds the regression line does not follow the sound power levels generated by wind turbines which have been shown to plateau at these speeds. This is indicative of extraneous noise unassociated with the wind turbines. It is therefore reasonable to conclude site G10 is complying with noise criteria at all operational wind speeds.

Shut down measurements at this site show a maximum impact of the wind farm being a 2.8 dB(A) increase in the L90 at 8m/s which supports a conclusion that the site is in compliance.

H24

The corrected regression line of data collected is below the criteria for speeds below 6.5m/s indicating compliance. Above these speeds the regression line does not follow the sound power levels generated by wind turbines which have been shown to plateau at these speeds. This is indicative of extraneous noise unassociated with the wind turbines. It is therefore reasonable to conclude site H24 is complying with noise criteria at all operational wind speeds.

No shut down measurements were taken at the site due to extraneous noise from vegetation. Attended measurements and field notes indicate that the turbines were only audible for about half the time which supports a conclusion that the site is in compliance.

E7

The uncorrected regression line of data collected is below the criteria for speeds below 7m/s indicating compliance. Above these speeds the regression line does not follow the sound power levels generated by wind turbines which have been shown to plateau at these speeds. This is indicative of extraneous noise unassociated with the wind turbines. It is therefore reasonable to conclude site E7 is complying with noise criteria at all operational wind speeds.

Shut down measurements at this site show a maximum impact of the wind farm being a 0.9 dB(A) increase in the L90 at 4.5m/s which supports a conclusion that the site is in compliance.

H15

Due to additional vegetation at the original monitoring site, compliance monitoring was undertaken in close proximity but at a position less prone to extraneous noise interference.

The uncorrected regression line of data collected is below the criteria for speeds below 7m/s indicating compliance. Above these speeds the regression line follows the sound power levels generated by wind turbines which have been shown to plateau at these speeds. This is indicative of the wind turbine noise dominating the noise catchment.

Background noise data for this site was limited which restricts corrected regression data to speeds of between 6 – 8m/s. At these speeds the noise attributed to the wind farm is in the order of 8 dB(A) below the criteria which is a level that would be expected to be maintained for other wind speeds.

Shut down measurements at this site show an average of the wind farm being a 7.3 dB(A) increase in the L90 which supports a conclusion that wind turbine noise is dominating the noise catchment.

It is therefore reasonable to conclude site whilst noise from wind turbines is dominating the noise catchment of H15, the level of noise generated is below the established noise criteria at all operational wind speeds.

Based on the data collected and presented in the Stage 2 report, the Department accepts that the wind farm is performing within noise limits for all compliance locations when operating at low speeds. At higher speeds, the exclusion of extraneous wind noise is difficult however it is likely that the wind farm continues to meet noise criteria at these higher wind speeds even though the turbines may be inaudible and masked by the high wind noise. Distance and atmospheric attenuation of sound will ensure that sensitive noise receivers further removed than the compliance sites will receive less noise impacts than will the compliance sites.

4 Overall Summary of Compliance Stage 1 and Stage 2 Compliance Reports

Based on all data collected and analysed in Stage 1 and Stage 2 of the NCAP, the Department is satisfied that there is demonstrated evidence supporting the conclusions that:

- a. Adequate assessment has been performed and further stages of NCAP monitoring are not required,
- b. That the measured noise levels agree with the predictive noise model (within the acceptable tolerances),
- c. Attended measurements at the receiver locations showed that wind farm noise is often inaudible or faintly audible.
- d. For low wind speeds, the 2010 regression noise levels for most sites is below the noise objectives
- e. Noise levels measured at higher wind speeds can exceed noise objectives, however it is unlikely that wind turbine noise is a dominant source or is cumulatively or independently causing an exceedance of the noise goals. The Department agrees with the conclusion that such high levels of noise are due to wind induced noise rather than turbine noise, as the noise levels do not follow Suzlon S88 sound power output.
- f. The main contributor to the overall noise (at higher wind speeds) is wind induced noise.

5 Conclusion

The Department has undertaken a review of compliance reports for both Stage 1 and Stage 2 of the Capital Wind Farm including a site visit undertaken during the compliance monitoring period. This site visit indicated that the compliance monitoring was being undertaken using trained staff and following appropriate procedures. Whilst it is recognised that the collection of data is made difficult because of the low signal-to-noise ratio, there is confidence that the data presented in the two compliance reports allows for a representative assessment of the noise catchments and the impacts of Capital Wind Farm on these catchments.

In summary, based on data and information contained in the Stage 1 and Stage 2 Compliance Reports, the Department concludes that the measured noise levels at all non-wind farm associated residences, including all the compliance sites, complied with the operational noise criteria in the project approval.

Reviewed by:

Jeff Parnell
7 March 2011