

Department of Transport, Planning
and Local Infrastructure

**Macarthur Wind Farm Noise
Compliance Assessment**

Peer Review

236351/00/R01

Issue | 16 June 2014

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Job number 236351/00

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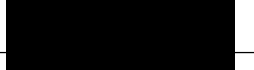
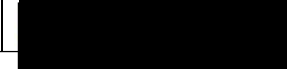


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Contents

	Page
1 Introduction	1
2 Information Reviewed	2
3 Planning Requirements	4
3.1 Macarthur WEF Permit Conditions	5
4 Compliance Monitoring Methodology	6
4.1 Compliance Monitoring Methodology	6
4.2 Wind speed/background noise level correlation update	6
4.3 Measurement Considerations	6
5 Noise Compliance Assessment	8
5.1 Background Noise measurements	8
5.2 Compliance Measurements	9
5.3 Wind Speed Adjustment	10
5.4 Data Exclusion	10
5.5 Number of Measurements	10
5.6 Measurement Data and Regression Analysis	10
5.7 Determination of Compliance	11
5.8 Assessment of SACs	12
5.9 Noise Complaints and Evaluation Procedure	12
5.10 Data Review	13
6 Discussion and Conclusions	14

Appendices

Appendix A

Extract from Planning Permit PL-SP/05/0283 relating to Noise Standards and Compliance Assessment

1 Introduction

AGL Energy Limited (AGL) has developed a wind farm with one hundred and forty 3 MW wind turbines at Macarthur in western Victoria. The development of the wind farm was subject to conditions imposed under the planning permit issued by the Minister for Planning on 26 October 2006 which included compliance with noise conditions.

Arup has been requested by the Victorian Department of Transport, Planning and Local Infrastructure, to provide a peer review of the noise compliance assessment documentation submitted on behalf of AGL by AECOM.

This review includes a detailed technical peer review of the post construction noise assessment documentation, calculations and analysis of the project data supplied, to provide an independent assessment of the compliance with the noise standards and compliance provisions of the planning permit for the project.

2 Information Reviewed

The following primary project documentation has been reviewed;

- *Macarthur Wind Farm, Noise Compliance Monitoring Methodology*, AECOM report 60279731-003 Rev 3, 3 April 2013
- *Macarthur Wind Farm, Noise Compliance Assessment*, AECOM report 60279731 Rev 0, 26 April 2013
- *Macarthur Wind Farm, Background Noise Monitoring*, AECOM report A11C01RP-03 Rev 3, 26 April 2013
- *Macarthur Wind Farm, Background Noise Monitoring*, AECOM report A11C01RP-03 Rev 2, 20 March 2013

These reports document the background noise level measurements carried out at the 25 locations identified around the wind farm.

In addition, the following reports documenting 'additional operational monitoring' undertaken at 20 properties not subject to the noise compliance conditions have also been reviewed;

- *Macarthur Wind Farm, Operational Noise Monitoring – O17A February 2013*, AECOM report dated 19 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – O17A March 2013*, AECOM report dated 20 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – O18A March to April 2013*, AECOM report dated 25 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – O23A February to March 2013*, AECOM report dated 23 May 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – Q20A February 2013*, AECOM report dated 23 May 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – Q20A March 2013*, AECOM report dated 23 May 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – R21A March to April 2013*, AECOM report dated 25 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – R21B March to April 2013*, AECOM report dated 25 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – R26B February to March 2013*, AECOM report dated 23 May 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – S26A February to March 2013*, AECOM report dated 28 May 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – S26B March to April 2013*, AECOM report dated 19 June 2013
- *Macarthur Wind Farm, Operational Noise Monitoring – T12A March to April 2013*, AECOM report dated 25 June 2013

- *Macarthur Wind Farm, Operational Noise Monitoring – T12B April to May 2013, AECOM report dated 19 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – T26A March to April 2013, AECOM report dated 25 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – U21A March to April 2013, AECOM report dated 19 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – V21A March to April 2013, AECOM report dated 25 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – W14A March to April 2013, AECOM report dated 25 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – W26A February to March 2013, AECOM report dated 23 May 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – X16A April to May 2013, AECOM report dated 19 June 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – Y16A February 2013, AECOM report dated 14 May 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – Y16A March 2013, AECOM report dated 23 May 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – Y18A February 2013, AECOM report dated 23 May 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – Y18A March 2013, AECOM report dated 23 May 2013*
- *Macarthur Wind Farm, Operational Noise Monitoring – Y21A February to March 2013, AECOM report dated 23 May 2013*

As these locations are not subject to the permit conditions, the results of these compliance measurements are not considered in detail for this review.

Finally, the supporting data provided in the following files has been reviewed;

- Reference Location Data, locations P22A, Q15A, T25A, V16A
- Met Data, 8 Feb – 25 March 2013
- Noise Level Data, locations P22A, Q15A, T25A, V16A
- Turbine Operational Data (Feb-March 2013)
- Predicted Turbine Noise Contributions at assessment locations P22A, Q15A, T25A, V16A

3 Planning Requirements

The operation of wind farms creates noise due to the interaction of the wind turbine blades with the wind and from the mechanical equipment used to generate electricity in the turbines. This noise has the potential to impact on people living or working near to the wind farm, and is required to be assessed as a part of the planning and approval process for wind farm developments. As wind farm noise has particular characteristics, and requires noise measurements to be undertaken in windy conditions, usual measurement and assessment standards adopted in Victoria, such as AS 1055¹ and SEPP N-1² are unsuitable. Specific guidelines such as NZS 6808:1998³ (and more recently NZS 6808:2010⁴) have therefore been developed to address the unique requirements for the prediction, measurement and assessment of sound from wind farms.

The planning policy for wind farms in Victoria is given in *Victorian Planning Provisions for Wind Energy Facilities* Clause 52.32⁵. The application of the planning provisions is described in the general policy and planning guidelines for development of wind energy facilities⁶.

The Victoria Planning Provisions (Clause 52.32) have formerly adopted NZS 6808:1998 to address noise impacts during planning, assessment and commissioning of proposed wind energy facilities in Victoria, and these apply to the Macarthur project.

Currently, the planning provisions require the noise assessment for wind farm projects to be undertaken in accordance with the most recent version of the standard, NZS 6808:2010 (amendment VC78⁷, 15 March 2011). However, wind farm projects with approvals in place prior to the issue of Amendment VC78, such as Macarthur, remain subject to the requirements of NZS 6808:1998.

Nevertheless, there are certainly aspects of NZS 6808:2010 (and other standards and guidelines such as AS 4959, the draft National Guidelines⁸ and the UK ETSU-R-97⁹) that can provide helpful background information and secondary guidance that can also assist with the ongoing assessment of projects with existing approvals under NZS6808:1998, where it does not provide detailed or explicit guidance.

¹ AS 1055.1-1997 *Acoustics - Description and measurement of environmental noise - General procedures*, Standards Australia, 1997.

² *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1*, Victoria Government Gazette No. S31, 1989.

³ New Zealand Standard 6808:1998 *Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators*, Standards New Zealand, 1998.

⁴ New Zealand Standard 6808:2010 *Acoustics – Wind farm noise*, Standards New Zealand, 2010.

⁵ Victorian Planning Provisions, Wind Energy Facility, Clause 52.32.

⁶ Policy and planning guidelines for development of wind energy facilities in Victoria.

⁷ Advisory Note 35, Amendment VC 78 Wind energy facility provisions – Clause 52.32, March 2011.

⁸ *National Wind Farm Development Guidelines – Draft*, Environment Protection and Heritage Council, July 2010.

⁹ *The Assessment and Rating of Noise from Wind Farms*, UK Department of Trade and Industry, ETSU-R-97, September 1996.

In particular, it should be noted that the New Zealand standard states that it does not set limits that provide *absolute* protection for residents from audible wind farm sound, but rather provides guidance on noise limits that are considered *reasonable* for protecting sleep and amenity from wind farm sound at noise sensitive locations.

3.1 Macarthur WEF Permit Conditions

As noted above, the development of the Macarthur wind farm project is subject to conditions imposed under the planning permit PL-SP/05/0283 issued by the Minister for Planning on 26 October 2006.

The noise compliance assessment provisions are provided in Conditions 16–33 (provided in Appendix A). Broadly, the permit requires;

- compliance with the noise limits determined in accordance with NZS 6808-1998 (ie Background (L_{95}) + 5 dBA or 40dBL_{A95} , whichever is the greater, determined separately for day and night (10pm-7am) (16)
- application of a 5 dB penalty for any special audible characteristics (SACs) (16(b))
- further background measurements (subject to the approval of the landowner) (19)
- compliance monitoring at the six reference dwellings, subject to the approval of their owners (22)
- comparison of the operational wind farm with the background noise level measurements to demonstrate that the noise curve falls below the noise criterion curve at all wind speeds (25)
- repeat compliance measurements between 10 and 12 months after the initial compliance monitoring program (26)
- Compliance enforcement actions where any non-compliances are determined (28, 29, 30, 31), and
- Development of a noise complaints evaluation and response process (32,33)

4 Compliance Monitoring Methodology

The *Noise Compliance Monitoring Methodology* report outlines the method proposed to undertake the noise compliance measurements which are subsequently reported in the compliance report.

4.1 Compliance Monitoring Methodology

In particular, the report identifies the contractual requirements for the monitoring and confirms the planning permit requirements (see Section 3 above).

The report identifies the six 'reference' dwellings (with location ID's P22A, Q15A, T25A, V16A, X21A, T20A), as well as 23 additional locations (known as the contract locations) which were within the predicted 35 dBL_{A95} contour as required by the New Zealand Standard.

The six 'reference' dwellings are the closest residential receivers, not 'associated' through a commercial agreement with the wind farm.

In order to meet contractual requirements between the turbine supplier (Vestas) and the developer (AGL), measurements were also undertaken at 20 of the 23 other locations that were not subject to the planning permit conditions (permission was not given by the landowners to conduct monitoring at the remaining 3 properties). These are documented individually in the accompanying reports.

4.2 Wind speed/background noise level correlation update

The methodology includes a detailed and comprehensive re-analysis of the pre-construction background noise level data (undertaken previously by Hayes McKenzie in 2005) to account for potential differences in wind speeds measured on site by the two temporary 'development' met-towers used during the investigation and the six permanent met-towers installed during construction of the project.

Updated background measurements were also undertaken at the reference locations (with the exception of V16A, which was 'decommissioned') to address concerns by the planning panel regarding both the measurements at T20A, and that the height of the anemometer originally used (80 m), was not quite as high as the hub height of the turbines selected (84 m).

4.3 Measurement Considerations

For the updated background noise level measurements, a detailed process has been used to select reasonable and representative locations of the noise loggers.

The noise logger locations are well documented in the report. The instrumentation complies with the requirements of NZS 6808:1998, and was appropriately maintained and calibrated. While the report states that the loggers were calibrated, as required, it does not explicitly say that no significant drift was observed.

We note that Section 7.2 of the report states that wind farm noise measurements would generally not be corrected for background noise, unless it was suspected that ‘background noise has significantly influenced the measurement results’. Where background noise may have influenced the results, the report suggests ‘repeat[ing] the measurements at a position closer to the wind farm’.

The proposed method for determination of the relevant wind speeds – and particularly the careful selection of both met-towers and individual anemometers to avoid the use of potentially wake-affected wind speed data (Section 7.3) appears very comprehensive, and is considerably more advanced than what we have seen adopted on other projects in Australia.

The method proposed for the subjective assessment of Special Audible Characteristics (SACs) is reasonable (Section 8.1), and in accordance with the requirements of the New Zealand Standard. Similarly the objective measurements proposed for Tonality, Amplitude Modulation, and Impulsiveness (Sections 8.2.2, 8.2.3, 8.2.4) are consistent with the requirements of NZS 6808:1998.

5 Noise Compliance Assessment

The *Noise Compliance Assessment* report documents the results of the operational noise level measurements and analysis using the methodology outlined in the *Noise Compliance Methodology* report.

5.1 Background Noise measurements

Background noise level measurements were originally undertaken for the project by Hayes McKenzie in 2005. Due to the long period between the measurements and the development of the site, noise levels were re-measured by AECOM in 2011.

As noted in Section 4.2 above, the follow-up measurements were also undertaken at the reference locations (with the exception of V16A, which was 'decommissioned') to address concerns by the planning panel regarding both the accuracy of measurements at T20A and that the height of the anemometer originally used (80 m) was not quite as high as the hub height of the turbines selected (84 m).

As noted above, due to the fact that the two temporary 'development' met-towers used during the investigation of the site were replaced with six permanent met-towers, AECOM have undertaken a detailed and comprehensive re-analysis of the pre-construction background noise level data, based on correlations between the development met-towers, and the permanent met-towers.

The re-analysed results are documented in the updated *Background Noise Monitoring* report dated 26 April 2013.

The re-analysis pays meticulous detail to determining a correlation between the two 'development' met-towers and the six permanent met-towers installed on the site, based on wind speed measurements over 13 months, and to selecting non-wake-affected data from individual anemometers.

Once the turbines become operational, the particular arrangement and location of the met-towers in relation to the wind turbines means that wind from particular directions can result in some of the permanent met-towers being positioned downwind from turbines, and potentially being wake affected. AECOM therefore undertake an analysis to determine which permanent mast is in the best position to provide non-wake affected wind speed data, for particular wind directions, and correction factors to account for the different measurement locations used. These are documented in Appendix G of their report. It is apparent that, in any case, the corrections are usually relatively small, and rarely differ by any more than about 5% of the originally determined wind speed. It is also apparent that the correction can sometimes result in slightly higher wind speeds or slightly slower wind speeds than originally determined.

The background noise level measurements themselves have been carried out with appropriate equipment, in accordance with the requirements of NZS 6808 and generally in accordance with AS 1055. Based on the photographs and descriptions of the measurement locations that have been selected, they appear to be reasonable for determining both the background sound and wind farm noise levels.

We note the presence of dogs in the noise logger location photographs at location X21A, however this is a not reference location. While the dogs are likely to have been unavoidable, depending on their behaviour, noise from barking has the potential to increase background noise levels, and create spurious results during the operational measurements. In addition, measurement locations for T12B and X23A are particularly close to large fences that may increase the measured noise level due to reflection off the fence.

Measurements at location Q15A were not undertaken by AECOM, but by a 3rd party acoustic consultant employed by the landowner. As such, no detailed calibration or measurement information has been provided.

Measurements at location V16A is not reported, as it was acquired by the operators and 'decommissioned'.

The monitoring periods appear generous, and more than 10-days data as recommended by the Standard seems assured. Nevertheless, we would have expected that the number of wind-speed/noise level data pairs would have been stated explicitly for each measurement location (as it is for the operational compliance measurements).

The wind-speed/noise level data correlations have been undertaken for both day and night ('all-time'), and night-time separately, as required by the conditions. Polynomial regressions up to 3rd order have been used. While the resulting correlation coefficients are often relatively low (generally less than 0.5, which is preferred), the number of measurements appears to be sufficient¹⁰, and the correlations themselves appear reasonable, particularly during the night-time.

On this basis the background noise measurements are fit for purpose.

5.2 Compliance Measurements

The operational compliance measurements were undertaken at four of the six 'reference' locations (P22A, Q15A, T25A and V16A). Compliance measurements were not undertaken at T20A or X21A because the dwelling at T20A was removed, and the resident at X21A denied access. While background measurements were undertaken at location V16A, operational noise was not reported because that dwelling was also decommissioned.

The equipment used for the compliance measurements is in accordance with the New Zealand standard, and the setup of noise loggers is reasonable. The measurement locations chosen for the compliance measurements are based on those used for the background noise measurements, and appear reasonable, given the practical constraints.

There appear to have been some issues with noise logger batteries going flat, and some other unexplained intermittency of the equipment. While clearly it would be better if these issues didn't occur, in practice, these types of failures occur reasonably often.

¹⁰ The New Zealand Standard takes a practical approach to noise level measurements, and only insists on a reasonable measurement period (10-14 days). It makes no requirement for the correlation coefficient which must be achieved.

The compliance measurements therefore meet the requirements of the New Zealand Standard, although only 3 of the 6 reference locations have been measured.

5.3 Wind Speed Adjustment

As noted previously, the determination of wind speeds for use in the assessment has been subject to a meticulous analysis to ensure that it is not adversely affected by either the wind turbines or the meteorological masts themselves.

The measured wind speeds for the compliance measurements have also been selected from the nearest met-tower that is not downwind of a turbine, for a given wind direction, to ensure the data is not wake-affected. In addition, upwind anemometers have been selected to determine the wind speed to avoid wake from the mast itself.

Care has been taken to ensure that the 10-minute wind speed data has been synchronised correctly with the noise level data, particularly depending on whether the noise loggers timestamp the data at the beginning or end of the measurement period.

5.4 Data Exclusion

Wind-speed and noise level data has been excluded where wind turbines have not been fully operational due to maintenance, faults or alarms, or limitations on energy production by the grid operator (AEMO). This has been determined by examining the SCADA run-time logs recorded by the turbine manufacturer.

For each measurement location, data has only been excluded where turbines that contribute significantly to the predicted noise level (generally those closest to the measurement location) have not been fully operational.

This appears to be a reasonable approach.

5.5 Number of Measurements

Table 3, Section 4.3 of the *Compliance Assessment* report documents the number of wind-speed and noise level measurement pairs recorded at each location. Between 1,700–5,600 data pairs have been recorded at the reference locations.

This is generally much greater than the minimum number of data points (1,440) recommended in the New Zealand Standard and on this basis exceeds the NZS requirements

5.6 Measurement Data and Regression Analysis

The results of the regression analysis of the measured wind-speed/noise level data are provided in Section 7 of the *Compliance Assessment* report. The data is separated by 24hr data, and night-time only data as required by the permit conditions. The operational data is helpfully displayed over the background noise data at the same location. It must be kept in mind that the operational noise levels have not been corrected for background noise level, and are therefore conservative

because they include both the operational noise from the turbines and the prevailing background noise at the measurement locations.

At location P22A, the measurement data seems to demonstrate a higher scatter than was evident during the background noise level measurements, particularly in the 3–10 m/s wind speed range. This also occurs at Location T25A. This may also be due to changes in vegetation during the intervening period.

The opposite is true for location Q15A, where the range of operational noise levels appears to be much lower than during the background noise level measurements.

The regression analysis of the wind-speed/noise level data pairs has been undertaken in accordance with the requirements of the standard, using a polynomial regression.

As noted for the background measurements (refer Section 5.1), the correlation coefficient (R^2) for the correlations is generally lower than desirable (< 0.5). Nevertheless, this can be taken as demonstrating that the noise levels measured at the receiver locations are relatively uncorrelated with the prevailing wind speed at the turbines. This is not particularly unusual, and would tend to indicate that the measured noise levels are being influenced more by local ambient sources, than by the wind turbines.

While not required by the New Zealand standard, it would be helpful to provide a comparison between the measured wind roses showing the extent of wind directions and speeds measured during the operational noise survey period, compared to the prevailing wind directions.

5.7 Determination of Compliance

Compliance is determined where the operational noise levels determined by the polynomial curve fits shown in Figures 3–8 is below the noise limits determined as the higher of 40 dB(A) or the background (L_{A95}) noise level +5 dB.

This is demonstrated to be the case between 3–10 m/s for all three ‘reference’ locations that are considered (P22A, Q15A and T25A). However, due to the wider scatter in post-operational wind-speed/noise level data measured at locations P22A and T25A, the polynomial fit for the night-time operational noise level does exceed the background +5 dB limit above 14 m/s at Location P22A, and above 11 m/s at location T25A.

The *Compliance Assessment* report states that this must be due to elevated levels of background noise affecting the measurements at these wind speeds, on the basis that the turbine sound power output has been determined by the manufacturer not to increase further above the noise levels at 10 m/s wind speeds, where it generates its full rated power output.

Turbine sound power data from most manufacturers, including Vestas, confirms that the above assumption is reasonable. Once the turbine is generating its full rated electrical output (typically between 9–12 m/s, depending on the turbine), the sound power generated by the wind turbine itself does not tend to increase further at higher wind speeds.

We agree that the measurement data is likely to be significantly influenced by ambient noise sources at these higher wind speeds. Therefore, the likelihood is that the wind farm is compliant with the conditions of consent, even at these higher wind speeds. Nevertheless, we understand that there may be some residual concern about the whether the turbine noise is compliant where the regression analysis, including the ambient noise, results in the regression of the data indicating a higher operational noise level than the criteria (background + 5 dB).

Notwithstanding the practical difficulties in undertaking such testing, further evidence could be provided by undertaking ‘on-off’ testing of the wind farm at these two locations, at these higher wind speeds. Alternatively, the proponent could undertake measurements at a position closer to the wind farm (as suggested in Section 7.2 of the *Noise Compliance Monitoring Methodology* report) and use the measurement results to derive the noise level at the receiver location.

In addition, it may be helpful for the proponent to estimate and document the self-noise of the noise logger microphone wind-shields, for example, using the empirical relationship determined by Cooper et.al.¹¹

5.8 Assessment of SACs

The assessment of special audible characteristics has initially been undertaken subjectively, based on five separate measurement periods at each of the reference locations for a range of wind conditions between 2–16 m/s, and a range of downwind, upwind and crosswind conditions.

The subjective assessment has determined that the wind farm is generally inaudible or only just audible at the reference locations, and that it does not exhibit any special audible characteristics. This type of subjective assessment is acceptable under the New Zealand standard, and is intended as a ‘gateway’ to preclude the need to undertake long-term, complicated and otherwise unnecessary objective measurements.

Nevertheless, there are several objective tests which could be applied, reasonably cost-effectively, to the measurement data, by using automated signal analysis routines to ‘screen’ the recorded noise level data. This could enable a larger proportion of operational time to be examined, and provide additional confirmation that SACs are not present. This approach was adopted for analysis of longer-term data from the Waubra wind farm.

In particular, RenewableUK have recently released open-source software¹² to enable the consideration of Amplitude Modulation in recorded wind farm noise.

5.9 Noise Complaints and Evaluation Procedure

The environmental management plan (EMP) for the project has not been reviewed as part of this peer review process.

¹¹ Cooper, J., Leclercq, D. And Stead, M., *Wind induced aerodynamic noise on microphones from atmospheric measurements*, Proc. 20th International Congress on Acoustics, Sydney, Australia, 2010.

¹² RenewableUK OAM software, available at <http://www.renewableuk.com/en/OAMsoftware/index.cfm>

Therefore, it should be verified that the noise complaints evaluation and response process is documented, as required by the permit conditions (32,33), in the EMP.

5.10 Data Review

The raw measurement data for noise levels, turbine operation and information has also been reviewed. It appears reasonable to form the basis for the analysis of the wind-speed and noise level data provided in the *Noise Compliance Assessment*.

However, because the detailed calculations are proprietary, we have not been provided with sufficient detailed calculations (eg spreadsheets) to enable us to determine whether the procedure described in the *Compliance Monitoring Methodology* and *Noise Compliance Assessment* reports has been applied appropriately to the data. It is expected that AECOM's compliance with the requirements of ISO 9001 is sufficient to ensure adequate internal checking and review of the calculation procedure.

6 Discussion and Conclusions

The operational noise compliance assessment and documentation prepared by AECOM for the Macarthur Wind Farm has been reviewed.

In general, the assessment has been undertaken in accordance with the requirements of NZS 6808:1998, as required by the permit conditions and the Victorian Planning Provisions.

The background and operational noise level measurements that have been undertaken by AECOM are adequately documented, and also comply with the requirements of the New Zealand standard. AECOM have also undertaken comprehensive data analysis to eliminate potentially wake-affected wind speed data, and to exclude measurement data where the turbines have not been operational due to maintenance, faults or alarms, or other operational restrictions.

The number of individual measurements used to perform the data regression is more than adequate. Nevertheless, the regression coefficient is relatively poor at most locations ($R^2 < 0.5$), indicating that the measured sound level is not strongly correlated with the wind speed at the turbines. This is clearly evident in the scatter-plots of noise level against wind-speed.

The operational noise levels determined from the regression analysis indicate that the wind farm noise levels are below the relevant criteria curve (the higher of 40 dB(A) or the background (L_{A95}) + 5 dB) at all of the reference locations for wind speeds between 3–10 m/s. However, at locations P22A and T25A, the polynomial fit for the night-time operational noise level does exceed the noise level limits above 14 m/s and 11 m/s respectively.

This could be considered non-compliant with Condition 25, which states that '*Compliance is demonstrated by the noise curve for the operational wind farm falling below the noise criterion curve at all wind speeds*'.

However, it is apparent that the higher noise levels at these wind speeds is due to ambient or background noise sources, and is not likely to be due to the wind-turbine. This is because the sound power output of the turbines does not increase further above that produced at 10 m/s when the turbines are operating at their full rated electrical output.

We accept this analysis, and conclude that the wind farm is compliant with the *intention* of the permit conditions.

To reduce any risk associated with the above approach and possible non-compliance or public complaint, the council may seek further assurance that the wind farm noise level is compliant with permit conditions in high wind speeds, by requesting either 'on-off' noise level measurements at these two locations, or undertaking measurements at a derived location, nearer to the turbines, as recommended in AECOM's *Noise Compliance Monitoring Methodology* report.

Appendix A

Extract from Planning Permit
PL-SP/05/0283 relating to Noise
Standards and Compliance
Assessment

Planning and Environment Regulations 2005 Form 11

Section 97F

**PLANNING PERMIT GRANTED BY THE MINISTER UNDER
DIVISION 6 OF PART 4 OF THE PLANNING AND ENVIRONMENT ACT 1987**

- f) a timetable for implementation of all landscaping works; and
 - g) a maintenance and monitoring program.
14. The use and development must be carried out in accordance with the endorsed On-site and Off-site Landscape Plans.
15. A copy of the approved Landscape Plan must also be given to those landowners of land where planting is proposed to be included in the Landscape Plan. Where non-contracted landowners elect to defer a decision on planting until after the wind turbines have been constructed, the development plans shall be amended to include any such agreed planting, and resubmitted to the responsible authority for approval

NOISE STANDARD

16. The operation of the wind energy facility must comply with the New Zealand Standard 'Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators' (NZS 6808:1998) (the 'Standard'), at any dwelling existing in the vicinity of the wind energy facility as at 7 February 2006. In determining compliance with the Standard, the following shall apply:
- a) The sound level from the operating wind energy facility, measured outdoors within 10 metres of a dwelling at any relevant nominated wind speed, shall not exceed the background level (L_{95}) by more than 5dBA or a level of 40dBA L_{25} , whichever is the greater. This 'background sound level' shall be determined by the method specified in NZS 6806:1998. Compliance shall be determined separately for all time data and for night time data. Night time is defined as 10pm to 7am.
 - b) If sound has a special audible characteristic the measured sound level of the source shall have a 5 dB penalty applied. The EMP must provide detail on how special audible characteristics are to be determined and the penalty is to be applied
17. Condition 16 does not apply to any dwelling on land on which part of the wind energy facility is erected. That exemption shall be given effect through an agreement with the landowner that shall apply to any occupant of the dwelling and must be registered on the title to the land.
18. Prior to any construction work commencing a detailed investigation shall be carried out at the background noise monitoring location identified as 'Location 7' being at the dwelling identified as 'T20A', to ascertain the apparent extraneous noise sources that prevented a reliable determination of background noise being achieved at this site. The location is identified in Report No 03.543-01 in Supplement A of the Planning Permit Application Report dated July 2005.
19. The existing data shall either be corrected, if that is possible and provides sufficient number of data points, or further background noise measurements made, subject to the approval of the owner, with those extraneous noise sources excluded. The Preliminary Environmental Management Plan dated 3 March 2006 provides further detail on this matter.

Planning and Environment Regulations 2005 Form 11

Section 97F

**PLANNING PERMIT GRANTED BY THE MINISTER UNDER
DIVISION 6 OF PART 4 OF THE PLANNING AND ENVIRONMENT ACT 1987**

NOISE COMPLIANCE ASSESSMENT

20. A post-construction noise monitoring and compliance assessment program must be undertaken by the wind energy facility operator. This must be to the satisfaction of the responsible authority with regard to timing, program design, determination of compliance, any necessary remedial action, and information dissemination. The PEMP provides more detailed requirements on this.
21. The initial compliance noise monitoring program must commence within 2 months of the commissioning of the last turbine in the wind energy facility or, if the facility is constructed in groups of turbines, separate programs within 2 months of the commissioning of each group. The date at which 'commissioning' has been deemed to occur and the extent of the noise compliance monitoring shall be agreed between the responsible authority and the wind energy facility operator.
22. After the complete wind energy facility is commissioned the monitoring shall be carried out at all six reference dwellings used to measure background sound levels, subject to the approval of their owners.
23. The location shall be monitored concurrently, and with the wind turbines operating in their normal mode. As far as possible the noise meter calibration and noise monitoring program shall be carried out by organisations accredited with the National Association of Testing Authorities (NATA).
24. The design of the program and the evaluation of the acoustic data must be carried by an independent expert who has had experience in the analysis, interpretation and presentation of acoustic data from wind turbines, and who is preferably a member of a recognised professional association in that field.
25. Compliance at noise reference locations is determined by comparing the curve of the operational wind farm noise results, to which has been arithmetically added the 5 dB penalty for any special audible characteristics should such be required, with the noise criterion curves for each site and for each time period. Compliance is demonstrated by the noise curve for the operational wind farm falling below the noise criterion curve at all wind speeds.
26. Should compliance be demonstrated by the program above the compliance noise monitoring program must be repeated commencing not less than 10 months and not greater than 12 months after the commencement of the initial compliance noise monitoring program for the whole site. Should that further monitoring program demonstrate compliance with the noise criteria no further noise compliance monitoring shall be required at those locations unless otherwise determined by the responsible authority.
27. The responsible authority may require noise compliance monitoring at a dwelling or dwellings other than those reference dwellings of condition 22 above on the basis of a reasonable belief that noise criteria may not be being complied with.

NOISE COMPLIANCE ENFORCEMENT

28. If the initial monitoring of any stage of the wind energy facility of the complete facility shows non-compliance with the noise criterion for any location or time period

Permit No.:PL-SP/05/0283

Page 12 of 18

Planning and Environment Regulations 2005 Form 11

Section 97F

**PLANNING PERMIT GRANTED BY THE MINISTER UNDER
DIVISION 6 OF PART 4 OF THE PLANNING AND ENVIRONMENT ACT 1987**

the operator will, within 30 days of submitting the compliance monitoring report, provide to the responsible authority, and make publicly available a detailed plan, including time lines, of actions proposed to be taken to secure compliance. Details on what might be included in such a plan should be provided in the EMP.

29. Within 60 days of approval by the responsible authority of the plan to remedy any such breach of environmental noise criteria, the operator will implement those actions that are possible within the time period and any additional interim actions, pending longer term modifications, to bring the wind energy facility into noise compliance.
30. Within 30 days of completing all the noise reduction actions in condition 29 above the operator must commence a further noise monitoring program as described in conditions 20 to 27 above, but only at those sites and for those time periods for which compliance had not been demonstrated.
31. Reports of the noise monitoring and investigation programs shall be provided to the responsible authority and made publicly available within 60 days of the completion of each monitoring stage or investigation program. The reports will be written so as to be accessible by lay persons, with appendices as needed to contain the more technically detailed material. Detail on this provision of information must be provided in the BMP.

NOISE COMPLAINTS

32. Before commissioning the first group of turbines of the wind energy facility a complaints evaluation and response process must be developed by the wind energy facility operator, and be submitted to the responsible authority for approval. The draft of the proposed process must be made available for comment to occupiers of dwellings within 5km of the nearest wind turbine.
33. The specific matters that should be included in the complaints, evaluation and response process must be provided in the EMP.

BLADE SHADOW FLICKER

34. Shadow flicker from the wind energy facility must not exceed 30 hours per annum at any dwelling existing prior to 26th October 2006.

This condition does not apply to any dwelling on land on which part of the wind energy facility is erected. (This exemption will be given effect through an agreement with the landowner that will apply to any occupant of the dwelling).
35. Before the use starts, details of a complaint evaluation and response process must be submitted to and approved by the Minister for Planning to assess any alleged breach of Condition 34. Thereafter, the use must be carried out in accordance with the approved process and alleged breaches identified by this process must be addressed to the satisfaction of the Minister for Planning.

TELEVISION RECEPTION AND INTERFERENCE

36. A pre-construction survey shall be offered to residents at all dwellings up to 3kms from a wind turbine to determine television reception strength. The proponent shall