Waddi Wind Farm

Noise Monitoring Program

S4802C10A

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GLOSSARY

A-weighting	Frequency adjustment representing the response of the human ear
Background noise assessment	Sonus report *S4802C9A* detailing the background noise levels and subsequent noise limits for the Project at each dwelling
Background noise level	The ambient noise level which excludes intermittent noise sources
Compliance Locations	Noise sensitive receptors listed in Table 16.3 of the development application
dB(A)	A-weighted noise level measured in decibels
L_{A90}	The A-weighted sound pressure level that is exceeded for 90 percent of a 10 minute time period. Represents the background noise level.
L_{Aeq}	The A weighted equivalent continuous noise level – the level of noise equivalent to the energy-average of noise levels occurring over a 10 minute time period.
Planning Approval	The current *Notice of Planning Approval* as issued by the Shire of Dandaragan
Project	Waddi Wind Farm project
Non-Associated dwellings	Dwellings outside the Project boundary for which an agreement has not been made with the respective landowner
Associated dwellings	Dwellings within the Project boundary and/or dwellings for which an agreement has been made with the respective landowner
Relevant Authority	Shire of Dandaragan

1 INTRODUCTION

The proposed Waddi Wind Farm (the **Project**) is to be located approximately 15 kilometres north-west of the township of Dandaragan and approximately 150 kilometres north of Perth and will comprise 18 Vestas V162-6.0 wind turbines.

A *Notice of Planning Approval* (the **Planning Approval**) has been issued by the Shire of Dandaragan (the **Relevant Authority**) for the Project and includes a number of conditions relating to environmental noise emissions (Conditions 12 to 17). The post-construction Noise Monitoring Program (**NMP**) defined in this report has been developed to address Condition 16 of the Planning Approval, re-iterated as follows:

> *The proponent shall develop and implement a post-construction noise monitoring program at the noise sensitive receptors listed in Table 16.3 of the development application to assess compliance of the operational Wind Farm with the noise criteria. The post-construction noise monitoring program shall be conducted at the same time of year as when the background noise measurements were recorded. Results of the program shall be forwarded to the relevant authority.*

This NMP provides details of how the post-construction compliance testing will be conducted to meet the requirements of the Planning Approval.

2 THE ENVIRONMENTAL NOISE GUIDELINES

Condition 12 of the Planning Approval refers to the South Australian EPA *Environmental Noise Guidelines for Wind Farms* dated February 2003 (the **2003 Guidelines**). It should be noted that the 2003 Guidelines have since been superseded by the SA EPA *Wind Farms Environmental Noise Guidelines*, originally issued in July 2009 and subsequently updated in November 2021 (the **2009 Guidelines**). The Western Australian Department of Planning, Lands and Heritage's *Position Statement: Renewable energy facilities* (published March 2020) states that the 2009 Guidelines should be referenced for assessment purposes. As such, the NMP developed in this report has been written in accordance with the 2009 Guidelines (November 2021).

Table 1 lists the Section of the NMP that addresses each relevant requirement of the 2009 Guidelines.

Table 1: Noise Requirements Sections of 2009 Guidelines and NMP

Noise Requirement	NMP Section	2009 Guidelines Section
Data acquisition	3.2	4.1
Data analysis	3.2.3	4.2
Wind farm noise level determination	3.2	4.3
Background noise subtraction	3.2.3	4.4
Alternative measurement techniques	3.2.4	4.5
Tonality testing	3.2.5	4.6
Reporting	3.2.6	5.3

3 POST-CONSTRUCTION NOISE MONITORING PROGRAM

3.1 Noise Limits

Background noise monitoring has been conducted at the noise sensitive receptors listed in Table 16.3 of the development application (the **Compliance Locations**), as described in Condition 16 of the Planning Approval. The Compliance Locations are shown in Table 2.

Table 2: Compliance Locations

Dwelling ID	Associated (Y/N)	EPSG:7850		Lot/Plan	CT	Address
		Easting	Northing			
R063	N	356111	6620587	Lot 43 in DP070842	2832/919	Unnamed Road (off Koonah Road), Badgingarra
R048	Y	367141	6620422	Lot 51 in DP027545	2210/674	1735 Badgingarra Rd, Badgingarra
R018a	Y	356304	6609206	Lot 105 in DP59027	2685/985	271 Mullering Rd, Cooljarloo
R035a	N	361205	6604002	Lot 1 in DP061936	1611/473	456 Walyering Rd, Dandaragan
R002	N	365758	6609578	Lot 3792 in DP208691	1850/243	645 Wolba Rd, Dandaragan

Sonus report *S4802C9A* (the **background noise assessment**) details the background noise levels for 1m/s wide wind speed bins (between the wind speed at cut-in and wind speed at rated power) in accordance with the 2009 Guidelines. The noise limits for the Project at each dwelling and integer wind speed were determined based on Condition 13 and Condition 14 of the Planning Approval, that being:

- For dwellings in which an agreement has been made with the respective landowner (**Associated** dwellings), and for dwellings within the Project boundary: 45 dB(A) or 5 dB(A) above background noise level, whichever is the greater.
- For dwellings outside the Project boundary, for which an agreement has **not** been made with the respective landowner (**Non-Associated** dwellings): 35 dB(A) or 5 dB(A) above background noise level, whichever is the greater.

The noise limits for each of the dwellings (as determined in the background noise assessment, based on the most representative Compliance Location) are produced in Appendix B.

3.2 Compliance Testing

3.2.1 Locations

Compliance testing will be conducted at each Compliance Location, as shown in Table 2. Photographs of each location are shown in Appendix A.

The location of the equipment will be consistent with the positions documented in the background noise assessment, subject to any changes to the local conditions that might result in modified results such as the construction of structures, change in vegetation or the installation of pumps or air conditioning units. The changes will be documented and the rationale for any changes provided.

3.2.2 Equipment

Sound level meters with a noise floor no greater than 20 dB(A) will be used. The equipment will be either Class 1 or Class 2 sound level meters in accordance with *AS IEC 61672.1-2004 Electroacoustics – Sound Level Meters*. Where applicable, the lower limit of the measurement range will be selected in order to minimise the noise floor of the instrument.

All sound level meters will be field calibrated on site both before and after measurement with a sound level calibrator that conforms with *AS IEC 60942:2017 Electroacoustics – Sound calibrators*. Any significant drift (greater than 0.5 dB) will be noted.

All data acquisition acoustic equipment will hold a current National Association of Testing Authorities, Australia (**NATA**) accredited laboratory calibration certificate from within a 24-month period before the time of use.

A wind shield with a diameter of at least 100mm will be used to minimise wind noise on the microphone and avoid adversely affecting the noise measurement data.

3.2.3 Data

Data points “adversely affected” by rain or wind on the microphone will be removed based on a weather logger placed at an equivalent location to one of the noise loggers.

Data is adversely affected where rain occurs in a 10 minute period or where a wind speed greater than 5 m/s is exceeded for 90% of a 10 minute period.

Noise monitoring may be undertaken at a suitable intermediate location between the Project and a Compliance Location for the purpose of data filtering. The intermediate location must be selected such that noise emissions from the wind farm are controlling, and no other extraneous noise sources adversely affect the data collected at that location. Data filtering may then occur where the noise data at the intermediate location suggests that the dominant source of the noise at a Compliance Location is not the wind turbines. For example, noise data collected in a particular 10 minute interval at a receptor may be removed:

- if the noise measured in the same period at the intermediate location (closer to the turbines) is at a lower noise level than the Compliance Location
- if the frequency content of the noise at the intermediate location is not consistent with the frequency content at the Compliance Location

The compliance testing will collect L_{A90} data to enable comparison against the Project criteria. The measurements will be made continuously over 10 minute intervals for either a period which enables 500 downwind points to be collected within 6 weeks, or for 6 weeks. A downwind data point is considered to be 45° on either side of the direct line between the nearest wind turbine and the relevant receptor, in accordance with the 2009 Guidelines.

The resultant noise data for each monitoring location will be correlated with the sheared wind speed data measured at the nearest meteorological mast location for an indicative hub height of 99m for each 10 minute period. The correlated noise data will be allocated to the appropriate wind speed bins (1 m/s width bins), which are centred on the integer wind speeds between cut in and rated power. The arithmetic average noise level for each wind speed bin will then be determined to give the noise level at each integer wind speed.

Where applicable, the wind farm noise contribution at the dwelling will be derived in accordance with Section 4.4 of the 2009 Guidelines by logarithmically subtracting the background noise level (derived from downwind conditions) from the level generated by the compliance testing data for each of the wind speed bins.

3.2.4 Testing Methodology

The derived wind farm noise levels will be compared against the Project noise limits (see Section 3.1).

The test method of Section 3.2 cannot be used in all circumstances to demonstrate compliance. This is primarily related to changes in local conditions or extraneous noise sources when compared to the conditions and noise sources that existed at the time of the original testing regime.

Where the test method of Section 3.2 (the **primary test method**) cannot be used to demonstrate compliance, then the following secondary test method in accordance with Section 4.5 of the 2009 Guidelines "Alternative compliance checking procedures" will be applied at that dwelling. The secondary test method will require "on/off" compliance testing, and will be conducted as follows:

- Only at dwellings where the primary test method cannot be used to demonstrate compliance.
- Only at integer wind speeds where the primary test method cannot be used to demonstrate compliance.
- With the noise monitoring equipment at the same position where the primary test had been conducted, or if that position is considered to be a factor in the inability of the primary test to demonstrate compliance, at an equivalent position with respect to turbine noise at the dwelling, but which has a higher turbine to background noise level ratio.
- Over a minimum interval of 2-minutes with the wind farm operational, then a measurement over the same interval with the wind farm shut off to obtain the background noise level.
- Monitoring the wind speed and direction over the measurement intervals to identify the comparable "on" and "off" measurements.
- Repeating the above "on" and "off" process to collect at least 3 intervals with comparable wind speed and direction conditions at each integer wind speed of interest. The wind farm noise will be determined by an arithmetic average of noise measurements at each integer wind speed after background noise (the "off" measurement) has been subtracted.

The supplementary "on/off" test method cannot be used in all circumstances to demonstrate compliance. This would occur where it is not practicable to consistently achieve comparable wind conditions between the on and off conditions.

Where the supplementary testing cannot be used to demonstrate compliance, an alternative method such as measurement at an intermediate location and extrapolation of the results will be developed and submitted to the Relevant Authority for approval.

3.2.5 Testing Methodology – Tonality

The tonality testing shall be conducted in two stages, with the first stage conducted close to a turbine, in general accordance with *IEC 61400-11 Ed. 3 (2012)* (**IEC 61400**) and the second stage conducted at a residence if required.

Stage 1

The first stage shall be conducted in general accordance with the tonality testing method of IEC 61400, including the requirements for measurement location (close to turbines), length of measurements, and adjustment of background noise. The test shall be conducted at a minimum of two wind turbines (to be representative of all turbines).

Where the testing indicates that the *Tonal Audibility Magnitude* ($\Delta L_{a,k}$) of the turbine is 0 dB or less (in accordance with IEC 61400), no penalty for tonality shall be applied and no further testing is required.

Where the testing indicates that the *Tonal Audibility Magnitude* of the turbines exceeds 0 dB at any integer wind speed, Stage 2 testing shall be conducted.

Stage 2

Where required, Stage 2 testing shall occur at the Compliance Location with the highest predicted noise level. Stage 2 testing shall occur at the same time as compliance testing over a period of at least 2 weeks.

For each 10 minute period, the narrowband test for tonality shall be conducted in accordance with IEC 61400, except that the measurement location shall be at the residence and no adjustment shall be made for background noise. The narrowband test shall only be conducted for tonal frequencies identified in Stage 1. Where the narrowband test shows a *Tonal Audibility Magnitude* exceeding 0 dB (in accordance with IEC 61400) and there is no evidence (such as an audio recording) that the tone is from a source unrelated to the wind farm, the associated 10 minute period shall be deemed to exhibit tonality.

A 5 dB(A) penalty shall be added to the measured noise level for wind speed bins exhibiting tonal characteristics for at least 10% of the total number of 10 minute periods in that bin.

Where a penalty is applied to a Compliance Location, the tonality testing will be extended to the "next closest location" (being the Compliance Location with the next highest predicted noise level). The tonality testing will continue until a location is found that does not require a penalty for tonal characteristics.

3.2.6 Testing Schedule

The primary testing will commence within one year from the date of the completion of commissioning, at the same time of year as when the background noise measurements were recorded (i.e. Spring), for each Compliance Location.

The results will be provided to the Relevant Authority within 2 months following the completion of the testing. The results will be in a report format that is consistent with Section 5.3 of the 2009 Guidelines (the **final test report**).

The proposed testing schedule will be extended if specific weather conditions are required or there is the need for supplementary "on/off" noise compliance testing or any other alternative compliance testing regime.

The proposed testing schedule will be extended if the primary and secondary testing indicate the Project criteria are exceeded. The procedure in such a circumstance is provided in Section 3.3 below.

3.3 Noise Reduction Methodology

Where the results of the primary and supplementary testing indicate that the Project criteria are exceeded, the following actions will be taken:

1. Inspect the turbines to determine if a maintenance related issue or mechanical defect is the cause of excessive noise generation. Where such issues are found, resolve the issue and conduct noise compliance testing as per Step 7 below.
2. Review the turbine manufacturer's near field[1] sound power level results. If the actual sound power level results differ from that used in the modelling, implement Step 4.
3. If a penalty is applied for tonality, consider the application of acoustic treatment to eliminate the tonality at the dwellings and repeat the noise compliance testing. If the tonality is not eliminated, implement Step 4.
4. Determine the potential noise management system based on the test results, which may include the curtailment of turbines for particular meteorological conditions.
5. Conduct noise modelling with the Step 4 noise management system options implemented to ensure that compliance can be achieved. The noise modelling is to include any differences in the installed turbine sound power levels (as determined in Step 2) and the effect of any penalties (if the penalties could not be removed in Step 3).
6. If the modeled noise levels exceed the Project criteria, then repeat steps 4 and 5.
7. Confirm noise compliance of the wind farm through testing in accordance with Section 3.2 at the relevant dwellings.
8. Document the final noise management system and test results in accordance with Section 5.3 of the 2009 Guidelines.

The final test report will be provided to the Relevant Authority. The wind farm will operate in accordance with the report.

[1] The turbine manufacturer will confirm the sound power level through measurements of the installed wind farm.

APPENDIX A: SITE PHOTOS OF COMPLICANCE LOCATIONS

Appendix A.1: R063

Appendix A.2: R048

Appendix A.3: R018a

Appendix A.4: R035a

Appendix A.5: R002

APPENDIX B: NOISE CRITERIA

ID Code	Receptor Status	Nearest Logging Location	Noise Criterion [dB(A)] at Integer Wind Speeds (m/s)										
			3	4	5	6	7	8	9	10	11	12	13
R006a	Host - Associated	R048	45	45	45	45	45	45	45	45	45	45	45
R006d	Host - Associated	R048	45	45	45	45	45	45	45	45	45	45	45
R013	Host - Associated	R063	45	45	45	45	45	45	45	45	45	45	45
R015	Host - Associated	R002	45	45	45	45	45	45	45	45	45	46	49
R016c	Host - Associated	R002	45	45	45	45	45	45	45	45	45	46	49
R021	Host - Associated	R063	45	45	45	45	45	45	45	45	45	45	45
R036	Host - Associated	R002	45	45	45	45	45	45	45	45	45	46	49
R044	Host - Associated	R063	45	45	45	45	45	45	45	45	45	45	45
R007b	Neighbour - Associated	R048	45	45	45	45	45	45	45	45	45	45	45
R018a	Neighbour - Associated	R018a	45	45	45	45	45	45	45	45	45	46	48
R020	Neighbour - Associated	R018a	45	45	45	45	45	45	45	45	45	46	48
R048	Neighbour - Associated	R048	45	45	45	45	45	45	45	45	45	45	45
R002	Non-Associated	R002	35	35	35	36	37	38	39	40	43	46	49
R016a	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R016b	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R026a	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R032a	Non-Associated	R018a	35	35	35	35	35	35	35	39	42	46	48
R032b	Non-Associated	R018a	35	35	35	35	35	35	35	39	42	46	48
R032c	Non-Associated	R018a	35	35	35	35	35	35	35	39	42	46	48
R032d	Non-Associated	R018a	35	35	35	35	35	35	35	39	42	46	48
R032e	Non-Associated	R018a	35	35	35	35	35	35	35	39	42	46	48
R035a	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R035b	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R037	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R038	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R039	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38

ID Code	Receptor Status	Nearest Logging Location	Noise Criterion [dB(A)] at Integer Wind Speeds (m/s)										
			3	4	5	6	7	8	9	10	11	12	13
R040a	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R041	Non-Associated	R063	35	35	35	35	35	35	35	35	35	37	38
R042	Non-Associated	R063	35	35	35	35	35	35	35	35	35	37	38
R047	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R053a	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R063	Non-Associated	R063	35	35	35	35	35	35	35	35	35	37	38
R064	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R065	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R066	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R067	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R068	Non-Associated	R063	35	35	35	35	35	35	35	35	35	37	38
R072	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R076	Non-Associated	R002	35	35	35	36	37	38	39	40	43	46	49
R077	Non-Associated	R002	35	35	35	36	37	38	39	40	43	46	49
R078	Non-Associated	R002	35	35	35	36	37	38	39	40	43	46	49
R116	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38
R117	Non-Associated	R063	35	35	35	35	35	35	35	35	35	37	38
R118	Non-Associated	R048	35	35	35	35	35	35	35	37	40	42	43
R120	Non-Associated	R035a	35	35	35	35	35	35	35	36	36	37	38