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Attention: Stuart Mallinson
Project Manager
Murra Warra Wind Farm Pty Ltd
Ailsa Wheat Road
Murra Warra, Victoria 3393

Date: September 17th, 2021

Dear Mr. Mallinson,

Review of the post-construction environmental noise assessment – Murra Warra Wind Energy Facility Stage 1 Round 3

Thank you for your request to provide a review of the revised Murra Warra Wind Farm noise compliance assessment conducted by Marshall Day Acoustics.

Following a noise compliance assessment dated January 25th 2021 which did not conclude on noise compliance of the Murra Warra facility at stage 1 with full turbine operation, Marshall Day Acoustics has completed a supplementary assessment of noise compliance for the full operation. This report is the subject of this noise compliance assessment review. The noise limits as stipulated in the New Zealand Standard - *Acoustics – Wind Farm Noise* (NZS 6808: 2010) and the planning permits nos. PA1600127(A) and PA1600128(B) issued by Horsham and Yarriambiack councils and amended on January 11, 2019 are addressed.

I have found the ***Murra Warra Wind Farm Acoustic Compliance Report Stage 1, Round 3*** (Rp006 R01 20181019) provided by Marshall Day Acoustics, dated 16 September 2021, complies with the relevant noise requirements stated above, in particular the Standard NZS 6808:2010 Acoustics Wind Farm Noise.

I confirm that I have no conflicts of interest and no involvement in the Murra Warra Wind Farm development. I am happy to further detail my findings at your request. The details of this review are provided in the accompanying report.

Yours sincerely

Dr. John Cumming
Director
Infotech Research
Auditor pursuant to the Environment Protection Act (2017)

Post-construction Noise Assessment Review



Murra Warra Wind Farm

Stage 1, Round 3

Ailsa-Wheat Road, Murra Warra, Victoria 3393



Dr. John Cumming
Infotech Research

17 Clowes Street, South Yarra, Victoria 3141

September 17th, 2021

Summary

The Murra Warra wind farm has been operating in a restricted mode since its full operations commenced in mid-January 2020. These restrictions have compromised the ability of noise monitoring to confirm the compliance of the wind farm to the planning approval requirements under full operation.

Marshall Day Acoustics provided a noise compliance assessment on January 25th 2021 which was the subject of an audit (CARMS 78450-3). The audit confirmed compliance with the Standard (NZS 6808:2010) but could not confirm noise level compliance for the full wind farm operation due to turbine curtailment.

Marshall Day Acoustics has now provided a further noise assessment for full operation of the Murra Warra wind farm by using a supplementary noise analysis method. This utilizes the predicted noise at noise sensitive locations for the un-curtailed turbines and compares this with the predicted noise for the fully operating wind farm. If the difference is small (<1 dB) then the data point is used, if it is greater than 1 dB the point is rejected.

Using this method, the total number of ten minute data points has reduced for the three noise sensitive locations from over 9,000 to 4,000 for H41, 3,800 for H155 and 1,334 for H161. The Standard states that 1,440 all-time data points should be accumulated for a satisfactory regression analysis.

Using the accepted data points the regression analysis showed compliance with a clear margin for all-time and night-time for all three noise sensitive locations with the Standard limit of 40 dB L_{A90} albeit with reduced data points.

I have reviewed this report and confirm that it complies with the Standard. Details of this review are provided in the following report.

Review of – Murra Warra Wind Farm noise assessment Stage 1 Round 3 – John Cumming

Report details

Item	Description
Reviewer	John Cumming
Name of person requesting review	Stuart Mallinson
Relationship to premise/location	Project Manager, Murra Warra Wind Farm
Current land use zoning	FZ1 Farming
Street name	Ailsa- Wheat Road
Suburb	Murra Warra
Postcode	3393
GIS coordinates of centroid	
Latitude (GDA94)	142.317580
Longitude (GDA94)	-36.432623
Site area (in square meters)	21,000,000
Historic land use	Farming
Current land use	Farming
Proposed future land use	Farming

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Background:

This review has been undertaken at the request of Stuart Mallinson, Downer Group, to confirm the noise compliance assessment for the wind farm conducted by Marshall Day Acoustics supplementary to their initial Round 3 assessment provided in January 2021 for the fully operating Murra Warra Wind Farm.

The Stage 1 Murra Warra Wind Farm is situated at Murra Warra, 25 km north of Horsham. The first turbine became operational on April 9, 2019. The full Stage 1 turbine array became operational by mid-January 2020. This third round of noise monitoring occurred between March 25th and June 2nd 2020 for a period of 10 weeks was undertaken when all turbines were available to generate electrical energy.

The Round 3 noise assessment (provided on January 25, 2021) concluded that the wind farm was compliant with the required noise limits over the period of the noise monitoring. However, this compliance was assessed when the wind farm turbines were not fully operating due to power restrictions from the market authority AEMO¹, shutdowns due to unfavourable market prices and for turbine maintenance. At Round 3 monitoring which covered ten weeks of continuous operations during which the average operating time for turbines was ~70% and the turbines were subject to regular curtailment.

It appeared that this situation hadn't changed. Further monitoring showed that turbine curtailment was being practiced after the monitoring period through to the end of 2020.

It could be argued that the Murra Warra Wind Farm was operating "normally" over the Round 3 monitoring period, but the Standard² is assumed to require full operation of the turbines for noise compliance assessment. When the full operation condition was applied very few 10 minute data points were found.

The random chance of gaining 10 minute data points for full operation of 61 turbines with a 70% operational level over 10 weeks is approximately 1 in 280,000 rendering further monitoring unlikely to add any value to the noise assessment. In line with the Noise Compliance Test Plan (November 21 2019) Marshall Day adopted an approach to accept data points where turbines far enough away from the noise sensitive location being monitored were discounted if they had been curtailed during the 10 minute period. This released insufficient data points for full turbine operation compliance assessment.

A supplementary approach was proposed by Marshall Day Acoustics and provided to the Downer Group in a method statement on June 18, 2021. In this method the power output of each turbine was monitored to determine whether it had been curtailed or not. The combined predicted noise level of all un-curtailed turbines was calculated and compared with the predicted noise level of the wind farm with all turbines un-curtailed. The noise difference between the two was termed the *curtailment effect criterion* and data points were adopted points where this difference was less than 1 dB. Sufficient monitoring data points were then available to assess noise compliance of the wind farm at full operation of all turbines.

¹ AEMO – Australian Energy Market Operator can set the operational output of the Murra Warra wind farm to suit market conditions.

² The Standard – NZS 6808:2010 Acoustics – Wind farm noise
The compliance standard set by the planning permits for this wind farm.

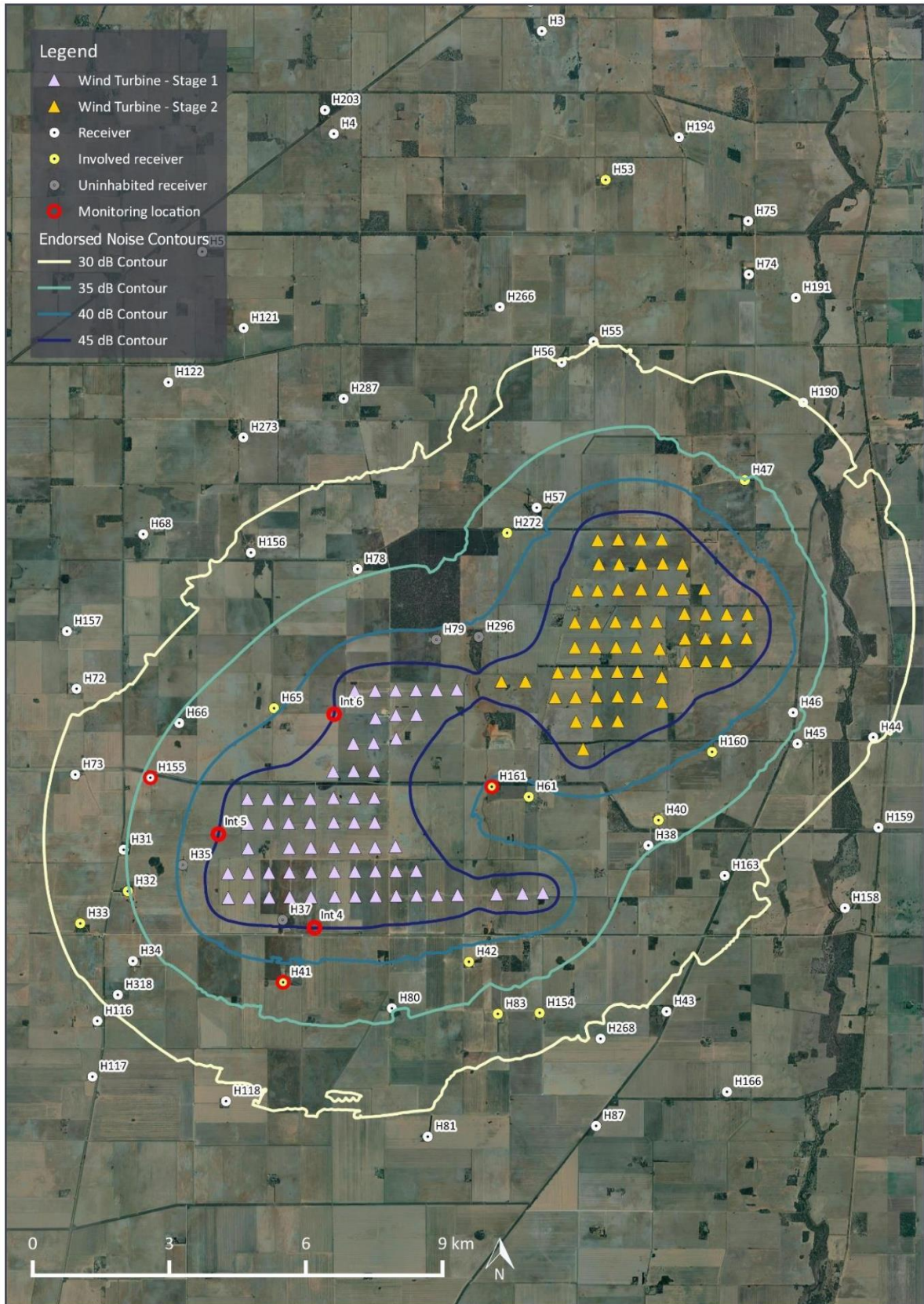


Figure 1. Noise monitoring points for Stage 1 (in red)

Review objectives

To assess the compliance of the Wind Farm Post-Construction Noise Assessment Report for Stage 1 Round 3 of the Murra Warra wind farm, revised in August 2021, with the requirements set out in:

1. Planning permits nos.PA1600127A and PA1600128B issued by the councils of Horsham and Yarriambiack on November 21, 2016 (amended January 11, 2019).
2. New Zealand Standard: Acoustics – Wind Farm Noise NZS 69808:2010 (The Standard).

Scope:

The scope of this review is limited to consideration of the noise monitoring of the Murra Warra Stage 1 wind farm operations within its first year of full operation. The data was previously reviewed in an audit report dated January 25, 2021 (CARMS ref. 78450-3).

The compliance elements examined herein relate to the level of A weighted L90 (10 minute) data recorded at three noise sensitive locations and 3 intermediate locations as given in Figure 1.

Activity	Wind energy facility (WEF) - operation
Element	Noise from turbine blades, the generators, gearboxes and hydraulics
Segment	Site environs surrounding the WEF as positioned at Murra Warra, Victoria Centroid Latitude: -36.432623 Longitude: 142.317580 Area of site: 2,100 Ha (Stages 1 and 2) In particular, the noise sensitive locations as defined in the standard: <i>NZS 6808:2010 Acoustics- Wind Farm Noise.</i>
Elements	Air (noise)
Beneficial uses	Of relevance to noise: Human habitation and wellbeing
Time period	March 25, 2020 to June 2, 2020 (the noise monitoring period for Stage 1 Round 3.)

Table 1. Scope of works

Criteria:

NZS 6808:2010 Noise limits

- *Section 5.2 – Acceptable limit (40 dB $L_{A90}(10min)$, or background + 5 dB³ if higher)*
- *Section 5.4 - Special Audible Characteristics (tonal, impulsiveness, or amplitude modulation) receive a maximum +6 dB penalty added to the noise level.*
- *Section 5.3 - High Amenity Areas (35 dB $L_{A90}(10min)$, or background + 5 dB if higher) to be considered.*

These noise limits produced in the Standard apply to all times of the day and night.

Review method:

The noise assessment report was examined with reference to the compliance criteria. Explanations were sought from the author of the acoustic compliance report. The proponents of the wind farm were interviewed and provided further information to support the noise compliance assessment report.

³ The terms dB and dB $L_{A90}(10min)$ are used interchangeably in this report.

Documents examined:

1. NZS 6808:2010 Acoustics - Wind Farm Noise
2. Shire of Horsham and Shire of Yarriambiack Planning Permits PA1600127A and PA1600128B issued on November 21, 2016 amended January 11, 2019 (noise conditions)
3. Murra Warra Pre-construction Noise Assessment - Sonus report S4453C25 (August 2017)
4. Murra Warra Wind Farm – Stage 1 Acoustic Compliance Report Round 3 – Rp 006 20181019 (January 25th, 2021)
5. Murra Warra Wind Farm – Stage 1 Acoustic Compliance Report Round 3 – Rp 006 20181019 (September 2nd, 2021)
6. Murra Warra Noise Compliance Test Plan – Rp 003 R01 20181019 (November 2019)

Review findings

Construction and commissioning

The Murra Warra Wind Farm uses Senvion 3.7M144 wind turbines with a rotor diameter of 144 m. at a hub height of 139 m. above the ground level. The turbines have a rated power wind speed of 12 m/s (cut in wind speed of 3.5 m/s and a cut-out wind speed of 26 m/s).

Construction and commissioning of the total 61 turbines in Stage 1 were completed by mid-January 2020. The positions of all 61 Stage 1 turbines are given in Figure 1.

Analysis of the turbine operations during the third noise monitoring period revealed that none of the turbines were fully operational over the period. The turbines were operating normally for generally less than 70% of the time during the monitoring period and at no monitoring time were all turbines operating normally due to grid restrictions and repairs.

Cumulative effects

As previously reported in the Round 2 and 3 audit reports there are no cumulative noise impacts from other proposed wind farms in this area.

Operational Noise assessment

The noise monitoring for Round 3 commenced on March 25, 2020 and finished on June 2, 2020 when all 61 turbines were operational. The positioning of the noise monitoring equipment was the same as for the background and Rounds 1/2 monitoring for H161, but had moved about 20-30m for Round 3 at H41 and H155 (due to occupier requests). The monitoring time period of 69 days was in excess of the minimum time period of ten days of continuous monitoring giving 1440 ten minute data points required by the Standard.

Due to the high level of turbine curtailment Marshall Day Acoustics used the analysis of the ten minute data points such that at the particular noise sensitive location the relevant turbines were checked for operation and not the irrelevant turbines that contribute a predicted⁴ noise level 15 dB or less below the total predicted noise level at the monitoring location. If any relevant turbines (in the range of 48 to 52 turbines) were curtailed the data point was rejected.

This selection system allowed more data points but not sufficient to meet the 1440 requirement of the Standard. A supplementary analysis procedure was added: the impact of curtailment was calculated as the difference between the predicted noise of all un-curtailed turbines and the predicted noise level if all turbines were operating un-curtailed. If the difference was 1dB or less the data point was accepted. This analysis indicates a systematic error on the noise monitored of up to + 1 dB.

⁴ Noise level predictions were undertaken using ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2 General Method of Calculation which is accepted by the Standard.

Review of – Murra Warra Wind Farm noise assessment Stage 1 Round 3 – John Cumming

The supplementary screening of data points did indeed yield the required 1440 data points for two of the three noise sensitive locations and 1334 data points for the other (H161) all-time results.

Wind speed data has been revised by DNV-GL to correct for an error in wind directions leading to calculation revisions for wake-free wind speeds. This re-assessment has led to various wind speed changes depending on wind direction, but adding approximately 0.76 m/s on average. The revised wind speed time series was used by Marshall Day Acoustics to re-establish sound pressure vs wind speed graphs. Regression analysis was used to determine the wind farm compliance between 3 and 12 m/s wind speed at the three noise sensitive locations chosen to check Stage 1 compliance. This again showed poor levels of fit of the regression analysis with the data. R² values for the goodness of fit varied between 0.026 and 0.18 for noise sensitive locations H41, H155 and H161 (where a perfect fit gives an R² value of 1.0) and a better data fit for nighttime data points.

Data modelling	R ² all-time	R ² night-time	Wind speed range
H41	0.0255	0.4486	3 to 12 m/s
H155	0.0365	0.3320	3 to 12 m/s
H161	0.1789	0.2775	3 to 12 m/s

Table 2. Regression analysis data fit

Improvement in night-time regression analysis correlation with data may indicate less extraneous noise at night from activities such as farm works, insects, birds and road traffic.

Revised results from the regression analysis for the noise sensitive locations H41, H155 and H161, found that none exceeded the compliance level of 40 dB_{L_{A90}}. The worst case noise results for the sites monitored in Round 3 are given in Table 3. The monitored receptors H41, H155 and H161 are the closest noise sensitive locations to Stage 1 and are all within the 35 dB contour for the full project (Stage 1 and Stage 2).

Intermediate positions, Int 4., Int. 5, and Int 6., were used at or near the 45 dB contour to give a closer and clearer indication of the contribution of wind farm noise and to match this against the prediction of 45dB at these locations.

Receptor Site	Highest trend line noise level (dB L _{A90(10 min)})	Noise limit (dB L _{A90(10 min)})	Compliance margin (dB L _{A90(10 min)})	Comment
H41 (south of stage 1 – involved)	33.4	40.0 This limit does not strictly apply to an involved receptor	6.6	1.6 km to nearest operating turbines. High noise scatter with extraneous noise
H155 (west of stage 1 – uninvolved)	31.3	40.0	8.7	2.1 km to nearest operating turbine. High noise scatter.
H161 (east of stage 1 – unoccupied)	33.3	40.0	6.7	2.4 km to the nearest operating turbines. High noise scatter.

Table 3. Receptor compliance for Stage 1 Round 3- all time (from regression analysis)

The intermediate locations are set on the predicted 45 dB contour between the nearest turbines and the noise sensitive locations to enable more accurate assessment of the wind farm noise. The results for intermediate locations Int.4, Int.5 and Int.6 showed a rise in noise with wind speed that plateaued near 12 m/s in line with the turbine sound power output.(Appendices K, L and M Intermediate Data)

The correction of errors in the wind speed and direction can be seen in the wind direction and speed chart that correlates better with the historic wind direction and speed chart. The predominant

direction of the wind is from the southwest which agrees with historic data much better than previously recorded for Round 3 monitoring at Murra Warra.

As with Round 2 it can be concluded from this analysis that none of the monitored noise sensitive locations H41, H155 and H161 were modelled by the regression analysis to exceed the 40 dB $L_{A90(10 \text{ min})}$ limit. In addition, the intermediate monitoring locations where wind farm noise was more readily detected were under the predicted noise level of 45 dB for the period of monitoring, confirming the predicted noise contours as conservative estimates.

This analysis is again compromised by the significant scatter of data points (wind speed vs recorded noise) leading to the poor correlation factors for the regression analyses. This has been put down to extraneous noise interfering with and obscuring the wind farm noise.

High Amenity Areas

No high amenity areas were identified and no penalties have been applied. This is consistent with the land zoning as Farming (FZ1) and the permits.

Average background noise levels during the evening or nighttime at noise sensitive locations H41, H155 and H161 are considerably less than the 8dB below the wind farm noise (total night-time noise) at wind speed of 5 m/s as required by the Standard to consider high amenity (Sec 5.3.1 of the New Zealand Standard NZS 6808:2010).

This was further detailed in the noise compliance assessment for Round 3 (January 25, 2021).

Special Audible Characteristics (SACs)

Attended monitoring observations on March 25, April 23 and June 2 included a subjective assessment of the wind farm noise at the noise sensitive locations revealed no evidence of special audible characteristics (SACs) as previously concluded. The wind farm was audible on some of these occasions at the noise sensitive locations. No further investigation of SACs was considered necessary and no penalties to noise criteria were applied.

Noise from substations

(See audit report January 25, 2021 CARMS: 78450-3)

Error analysis

The earlier audit report estimated random error at ± 2.7 dB.

The supplementary assessment method in which the effect of curtailed turbines is discounted giving a systematic error of low noise results for the fully operating wind farm. As data points were accepted if up to a 1dB difference was calculated, a -1 dB error could be applied to the noise data points to maintain a conservative approach to noise compliance.

With random and systematic errors applied to the regression analysis of calculated wind farm noise at the three noise sensitive locations, the compliance margin is reduced from 6.6 to 8.7 dB to a worst case 2.9 to 5.0 dB. This is still considered to represent a low risk of non-compliance at full wind farm operation.

Conclusions

The wind farm operator, RES and site management reported⁵ that no noise complaints were received over the full operating period to September 2021.

The supplementary noise assessment provided by Marshall Day Acoustics adds confidence that the wind farm noise levels are compliant for full operation of the wind farm turbines.

The noise compliance assessment shows compliance with the Standard required by the planning approvals.

High amenity areas or special audible characteristics could have an effect on compliance with the Standard. None of these were found at the location affected by the Murra Warra wind farm, but will need to be monitored as operations progress.

Recommendations

The following recommendations are provided to ensure compliance can be further assessed for the completed Stage 1 Murra Warra wind farm:

1. The revised noise compliance assessment is issued to the regulatory authority in support of the compliance of the Murra Warra wind farm.
2. This independent review of the noise compliance assessment is provided to the regulatory authority.
3. Noise complaints are addressed according to the noise management plan if received in the future.
4. This reporting should be made publicly available.



John Cumming
Auditor pursuant to the Environment Protection Act (2017)
September 17th, 2021

⁵ RES private communication 24th August 2021
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