

**In the matter of the
Ryan Corner Wind Farm and Hawkesdale Wind Farm
Amendment Applications**

**Planning Panels Victoria
Proponent: Ryan Corner Development Pty Ltd**

**Expert Witness Statement of
Christophe Frederic Delaire**

Expert of Ryan Corner Development Pty Ltd

1 Name and address

CHRISTOPHE FREDERIC DELAIRE
Co-CEO
Marshall Day Acoustics Pty Ltd
6 Gipps Street, Collingwood.
Victoria 3066

2 Area of expertise

For over 15 years I have worked in the field of acoustics and noise control. I have a special interest in environmental noise and have gained extensive experience in the noise assessment of wind farms since 2005.

I am a member of the Australian Acoustical Society (MAAS) and the Association of Australian Acoustical Consultants (AAAC) Wind Farm Subcommittee.

My qualifications and experience are detailed in Annexure A.

I am sufficiently expert to make this statement because I have been involved in environmental noise impact assessments for major environmental projects such as power stations, wind farms and other industrial plants.

My experience extends to all aspects of wind farm noise, including predictions, background noise monitoring, post-construction noise monitoring and sound power level testing. This is demonstrated by my involvement in over fifty (50) projects across Australia, providing expert witness evidence for eleven (11) Victorian wind farms and presentation of multiple papers at international conferences.

3 Scope

3.1 Instructions

The Ryan Corner Wind Farm has been approved for development with planning permit No. 20060222 having been issued on 21 August 2008 (the Ryan Corner Planning Permit).

The Hawkesdale Wind Farm has been approved for development with planning permit No. 20060221 having been issued on 12 August 2008 (the Hawkesdale Planning Permit).

Marshall Day Acoustics Pty Ltd (MDA) was commissioned by Ryan Corner Development Pty Ltd (the Proponent) to prepare an updated noise assessment for both the Ryan Corner Wind farm and the Hawkesdale Wind Farm.

The purpose of the updated assessment was to account for proposed amendments to each project and changes to Victorian noise assessment standards in the time since the planning permits were issued. In particular, updated assessments were conducted in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010), as required by the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016 (the Victorian Guidelines).

These noise assessments are presented in the following documents:

- MDA Report Rp 001 R02 2014362ML *Ryan Corner Wind Farm - NZS 6808:2010 Noise Assessment* dated 21 April 2017 (the Ryan Corner Report), issued as Appendix A of the MDA letter Lt 001 R02 2014362ML dated 21 April 2017 (the Ryan Corner Letter)
- MDA Report Rp 002 R04 2014362ML *Hawkesdale Wind Farm - NZS 6808:2010 Noise Assessment* dated 21 April 2017 (the Hawkesdale Report), issued as Appendix A of the MDA letter Lt 002 R04 2014362ML dated 21 April 2017 (the Hawkesdale Letter).

Both letters were exhibited in Volume 5 of the respective Modification Applications dated April 2017.

I adopt the Ryan Corner Report and the Hawkesdale Report (the MDA Reports) as the basis for my expert witness statement and evidence.

I have been instructed by Herbert Smith Freehills (HSF) on behalf of the Proponent to prepare a witness statement and give expert evidence at the panel hearing based on the findings presented in the MDA Reports.

This statement provides a summary of the noise assessment detailed in the MDA Reports, together with a response to key submissions raising issues relating to noise.

3.2 Reports reviewed to prepare initial study or statement

The documents I have reviewed and referenced in the MDA Reports and this statement are listed in Annexure B.

3.3 Persons assisting with this work

My colleagues Justin Adcock, Alex Morabito and Daniel Griffin have assisted with the calculations and review of calculations, reporting and this statement of evidence.

4 Proposed amendments

Condition 3 of both the Ryan Corner Planning Permit and the Hawkesdale Planning Permit details the specifications of each wind farm, including the number and scale of the turbines. The permits originally specified the tower height of the wind turbines at 78 metres, with an overall height of 121.5 metres above ground level (AGL).

On 12 August 2010, the Minister for Planning approved a minor amendment to the specifications of the wind turbines for both wind farms to allow a tower height of 80 metres and overall height of 126.3 metres AGL.

In 2013, MDA was commissioned by the Proponent to prepare a noise impact assessment for each of the subject wind farms at the request of the Department of Transport, Planning and Local Infrastructure (now the Department of Environment, Land, Water & Planning). It was specifically requested that the noise impact assessment be carried out in accordance with NZS 6808:2010 and the results of the assessment were detailed in the following reports:

- MDA Report Rp 004 2010165ML dated 11 September 2013, issued as Appendix B of the Ryan Corner Letter
- MDA Report Rp 003 2010165ML dated 11 September 2013, issued as Appendix B of the Hawkesdale Letter

Approval is now sought by the Proponent to further vary the turbine specifications detailed in the permit. The following amendments are proposed:

- An increase of the tip height to 180 metres AGL, resulting in an overall increase in height of up to 53.7 metres from natural ground level
- Micrositing of a number of turbines and realignment of access tracks
- Reduction of the Ryan Corner wind farm layout from sixty-eight (68) approved turbines to fifty-six (56) turbines
- Reduction of the Hawkesdale Wind Farm layout from thirty-one (31) approved turbines to twenty-six (26) turbines.

The proposed amendments listed above were addressed in the updated assessments presented in the MDA Reports.

5 Noise assessments

The noise assessments for the proposed amendments to the permitted Ryan Corner Wind Farm and Hawkesdale Wind Farm presented in the MDA Reports are summarised herein.

5.1 Noise criteria

5.1.1 NZS 6808:2010

At the time of approval of the subject wind farms, wind farm noise was assessed in accordance with the New Zealand Standard 6808:1998 *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS 6808:1998). The existing planning permits require that compliance with the NZS 6808:1998 criteria be achieved at *any dwelling existing on land in the vicinity of the wind energy facility as at 11 April 2007, to the satisfaction of the Minister for Planning*, as detailed in Condition 17 of the Ryan Corner Planning Permit and Condition 21 of the Hawkesdale Planning Permit (the Noise Limit Conditions).

In the time since the planning permits were issued, the Victorian Guidelines were updated and refer to the revised version of the New Zealand standard. Specifically, the current version of the Victorian Guidelines, dated January 2016, refers to NZS 6808:2010 as the applicable assessment standard for new wind farm developments in Victoria.

Accordingly, the updated assessments presented in the MDA Reports were undertaken in accordance with NZS 6808:2010,

5.1.2 High amenity

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} is *appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*. It goes on to note that high amenity areas may require additional consideration:

[...] In special circumstances at some noise sensitive locations a more stringent noise limit may be justified to afford a greater degree of protection of amenity during evening and night-time. A high amenity noise limit should be considered where a plan promotes a higher degree of protection of amenity related to the sound environment of a particular area, for example where evening and night-time noise limits in the plan for general sound sources are more stringent than 40 dB $L_{Aeq(15 min)}$ or 40 dBA L_{10} . A high amenity noise limit should not be applied in any location where background sound levels, assessed in accordance with section 7, are already affected by other specific sources, such as road traffic sound.

Section 5.3 of NZS 6808:2010 provides details of high amenity noise limits that apply to noise sensitive locations that are deemed to be located within a high amenity area as defined in Sections 5.3.1 and 5.3.2 of the standard. The high amenity limit specifies that wind farm noise levels (L_{A90}) during evening and night-time periods should not exceed the background noise level (L_{A90}) by more than 5 dB or 35 dB L_{A90} , whichever is the greater, for wind speeds below 6 m/s at hub height. High amenity noise limits are not applicable during the daytime period.

In Section 5.1.2.a, the Victorian Guidelines states the following:

Under section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels applies in special circumstances. All wind farm applications must be assessed using section 5.3 of the Standard to determine whether a high amenity noise limit is justified for specific locations, following procedures outlined in clause C5.3.1 of the Standard. Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm.

The definition of a high amenity area provided in NZS 6808:2010 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria. As recommended in the Victorian Guidelines, it is therefore appropriate to follow the guidance detailed in the *Cherry Tree Wind Farm Pty Ltd v Mitchell Shire Council* decisions¹.

Paragraph 53 of the *Cherry Tree Wind Farm* Decision states the following:

The Tribunal does not accept that the permit conditions need to refer to the High Amenity Area provisions of the New Zealand standard because it has not been established that any such area could reasonably be identified within the environs of this wind energy facility. [...]

Further justification for the above statement was provided in Paragraphs 107 to 109 of the *Cherry Tree Wind Farm* Interim Decision:

107. *We were invited by the respondents to treat the subject land and the locality as a high amenity area. This invitation meets with the immediate conundrum that the language of the standard is not translatable to the Victorian planning framework. The “plan” referred to in section 5.3 is a plan as defined by the Resources Management Act of New Zealand. Section 43AA of that Act defines “plan” to mean “a regional plan or a district plan”. No such animals exist under the Victorian legislation.*
108. *Applying the standard mutatis mutandis to the Victorian experience we treat the plan referred to in the standard as a planning scheme approved under the Planning and Environment Act 1987. The Mitchell Planning Scheme does not anywhere expressly or by implication “promote a higher degree of protection of amenity related to the sound environment of a particular area”. Approaching the matter by a process of elimination it can be seen with certainty that the controls contained within the Farming zone, which includes most of the locality, do not answer this description. The purpose of the Farming zone is to encourage agricultural use, which is not an inherently quiet land use. In fact reference to the zone purposes confirms that agricultural use is to be preferred to residential use if there is potential conflict between the two.*
109. *Accordingly the Tribunal concludes that the subject land and its locality is not capable of designation as a high amenity area because it does not possess the necessary characteristics of such an area as specified in the NZ standard.*

As detailed in Paragraph 108, for the land surrounding the wind farm to be considered a high amenity area, the zoning of the land must be identified in the relevant planning scheme as *promoting a higher degree of protection of amenity related to the sound environment*.

The area surrounding the subject wind farms is generally zoned Farming Zone with a Township Zone covering the townships of Yambuk (south west of the Ryan Corner Wind Farm) and Hawkesdale (north east of the Hawkesdale Wind Farm).

Consistent with the findings of the *Cherry Tree Wind Farm* decision, the Moyne Planning Scheme dated 25 May 2017 provides definitions relating to the Farming Zone and *does not anywhere expressly or by implication “promote a higher degree of protection of amenity related to the sound environment of a particular area”*.

¹ *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors* [2013] VCAT 521 (Interim Decision) and *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors* [2013] VCAT 521 (Final Decision).

Similarly, in relation to the Township Zone, the Moyne Planning Scheme does not expressly or by implication promote a higher degree of protection of amenity. Further, the general noise limits of NZS 6808:2010 are stated to be appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations. The Moyne Planning Scheme definition of the Township Zone does not provide any indication that residential locations in this zone designation should be considered as one of the special circumstances in NZS 6808:2010 to consider the relevance of high amenity limits. That is, there are no clauses or provisions to suggest that a residential location in a Township Zone should be protected to a higher degree than the general provisions of NZS 6808:2010 which are appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations.

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the latest version of the Victorian Guidelines, the high amenity noise limit detailed in NZS 6808:2010 is therefore not considered to be applicable for noise sensitive locations in the vicinity of the subject wind farms.

In addition to the land zoning indicating that the high amenity noise limit is not applicable, predicted noise levels presented in Section 5.3.5 demonstrate that the Yambuk and Hawkesdale Township Zones are outside the 35 dB predicted noise contour and therefore considerations relation to the application of high amenity limits are not relevant for the subject sites.

5.1.3 Stakeholders

For stakeholders, it is not proposed to amend the part of the Noise Limit Conditions specifying the following:

[The Noise Limit Condition] does not apply if an agreement has been reached with a landowner through which the landowner accepts predicted noise levels or otherwise agrees to implement appropriate acoustic attenuation measures to ensure a reasonable level of acoustic amenity in relation to the indoor habitable areas of their dwelling(s), and acknowledges that the operation of the wind energy facility may still generate noise in outdoor areas at the dwelling(s) which may from time to time exceed the standard

Properties with a noise agreement would therefore be exempt from noise limits according to the Noise Limit Conditions.

A recommended base noise limit of 45 dB L_{A90} is referenced in Section 6.2 of the MDA Reports for stakeholders. This base noise limit is provided for informative purposes and is consistent with recommendations from the final report by *The European Working Group on Noise from Wind Turbines* (ETSU-R-97) which is commonly referenced for wind farms in Victoria and Australia.

5.1.4 Applicable noise limits

In accordance with NZS 6808:2010, the operational noise from turbines at noise sensitive locations should not exceed 40 dB L_{A90} or the background noise (L_{A90}) by more than 5 dB, whichever is the greater.

Background noise levels were previously measured in accordance with NZS 6808:1998 at selected noise sensitive locations in the vicinity of the permitted wind farms in 2006. However, owing to differences in the methodologies of the 1998 and 2010 version of the standard, and the time that has lapsed since these surveys were undertaken, this data is not suitable for the purpose of setting background noise related limits in accordance with the current guidelines.

Accordingly, for the purpose of this assessment, the NZS 6808:2010 base noise limit of 40 dB L_{A90} at all wind speeds has been used for all noise sensitive locations. This provides a conservative assessment since the base noise limit represents the lowest value of the noise limits which could be applied in accordance with NZS 6808:2010.

Separate noise limit values apply when an agreement is in place between the Proponent and a neighbouring landowner. We have been advised by the Proponent that, if required, noise agreements will be established with the landowners of properties referenced as *stakeholder properties* in this statement of evidence, once the final turbine model has been selected. As such, the base noise limit of 45 dB L_{A90} has been used for noise sensitive locations within stakeholder properties.

5.1.5 Cumulative assessment

NZS 6808:2010 specifies that the noise limits apply to the total noise resulting from all wind farms, as stated in Section 5.6.1:

The noise limits [detailed in Section 5.1.1 above] should apply to the cumulative sound level of all wind farms affecting any noise sensitive location.

Section 5.6.4 of the standard then goes on to note that the potential cumulative noise introduced by a new wind farm does not need to be considered at locations where the noise level is sufficiently below that of other surrounding wind farms, stating:

For the purposes of 5.6.1, if predicted wind farm sound levels for a new wind farm are at least 10 dB below any existing wind farm sound levels permitted by any resource consent or plan, then the cumulative effect shall not be taken into account.

An assessment of potential cumulative noise levels is presented in Section 5.3.4.

5.2 Site layout

5.2.1 Candidate turbine models

The three (3) following candidate turbine models have been considered for the noise assessment in accordance with NZS 6808:2010:

- Vestas V126 with a rated power of 3.3 MW and a rotor diameter of 126 m
- Senvion 3.0M122 with a rated power of 3.0 MW and a rotor diameter of 122 m
- GE 3.2-130 with a rated power of 3.2 MW and a rotor diameter of 130 m.

5.2.2 Ryan Corner Wind Farm

The permitted Ryan Corner Wind Farm is located to the north west of the township of Port Fairy in Victoria.

The Proponent has identified one-hundred and eleven (111) noise sensitive locations, existing before the 11 April 2007, in the vicinity of the permitted wind farm, including nine (9) stakeholders.

I am not aware of any additional noise sensitive locations which have been identified in the vicinity of the permitted wind farm since 11 April 2007.

Noise levels have been predicted above 35 dB L_{A90} at twenty-two (22) of the one-hundred and eleven (111) identified noise sensitive locations in the vicinity of the wind farm, including eight (8) of the nine (9) stakeholders, based on the candidate turbine model providing the highest noise levels. As such, fourteen (14) noise sensitive locations have been considered in this assessment..

The proposed layout is presented in Annexure C.

5.2.3 Hawkesdale Wind Farm

The permitted Hawkesdale Wind Farm is located to the south east of the township of Hawkesdale, Victoria, between Hamilton and Warrnambool.

The Proponent has identified one hundred and sixty-six (166) noise sensitive locations, existing before the 11 April 2007, in the vicinity of the permitted wind farm, including six (6) stakeholders.

I have been advised that one (1) dwelling has been built in the vicinity of the permitted wind farm residential since 11 April 2007. This dwelling (House 170) has been included in this assessment.

Noise levels have been predicted above 35 dB L_{A90} at fifteen (15) of the one hundred and sixty-six (166) identified noise sensitive locations in the vicinity of the wind farm, including five (5) of the six (6) stakeholders, based on the candidate turbine model providing the highest noise levels. As such, ten (10) noise sensitive locations have been considered as in this assessment.

The proposed layout is presented in Annexure C.

The Proponent has advised that there is one other permitted wind farm in the vicinity of the Hawkesdale Wind Farm. The Woolsthorpe Wind Farm, being developed by Wind Farm Developments, consists of twenty (20) turbines and is located to the south-east of the Hawkesdale Wind Farm. The separation distance between the nearest turbine from each wind farm is approximately 1,100 m. A map showing the location of the Woolsthorpe Wind Farm in relation to the Hawkesdale Wind Farm is provided in Annexure C.

The Woolsthorpe Wind Farm received planning approval in 2008. On 21 May 2017 the planning permit (20060220) was amended by the Minister for Planning as follows:

Permit amended under Section 97J of the Planning and Environment Act 1987 – to increase turbine height [from 135 m to 168 m], increase tower height [from 90 m to 98 m], increase the blade length [from 50 m to 70 m], provide a new site entrance, introduce a secondary consent mechanism, and require noise to be compliant with the 2010 version of the New Zealand noise standard, and other minor changes.

5.2.4 Operating and approved wind farms within the Moyne Shire Council

As detailed in the Moyne Shire Council submission dated 27 July 2017, nine (9) wind farms are either operating or have received planning approval within the Moyne Shire Council area:

A map showing the location² of these wind farms is presented in Annexure C,

Table 1 presents the minimum distance between the nearest turbine of each site in relation to the Hawkesdale Wind Farm and the Ryan Corner Wind Farm.

Table 1: Approximate distance between nearest wind turbines, km

Wind Farm	Status	Distance to the nearest Ryan Corner wind turbine	Distance to the nearest Hawkesdale wind turbine
Codrington and Yambuk	Operating	5.8	34
Dundonnell	Approved	60	56
Macarthur	Operating	14	13
Mortlake South	Approved	61	38
Mortons Lane	Operating	37	31
Salt Creek	Approved	67	41
Woolsthorpe	Approved	22	1.1

Due to its close proximity to the Hawkesdale Wind Farm, the cumulative contribution of the Woolsthorpe Wind Farm has been assessed in Section 5.3.4.

In all other instances, the separating distances between the subject wind farms and the surrounding wind farms are too great for cumulative noise to be a consideration, whether in terms of perceived noise levels or compliance with NZS 6808:2010. In particular, at noise sensitive locations near to the surrounding wind farms, the predicted noise levels of the subject wind farms would be significantly below the threshold at which NZS 6808:2010 states that cumulative noise no longer needs to be considered (i.e. 10 dB below the level of the surrounding wind farms). Conversely, at noise sensitive locations in the vicinity of the subject wind farms, the predicted noise levels of surrounding wind farm would also be significantly below the threshold where cumulative noise influences no longer need to be considered.

² Turbine layouts were sourced from publically available documents

5.3 Predicted noise levels

5.3.1 Methodology

Operational noise levels from the subject wind farms have been predicted using the international standard ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996) as implemented in version 7.4 of SoundPLAN.

The following key details are noted:

- Turbine hub height: 117 m for the Vestas V126 and Senvion 3.0M122 models and 110 m for the GE 3.2-130 model
- Receiver heights: 1.5 m
- Ground characterisation: $G = 0.5$
- Atmospheric conditions: $T = 10^{\circ}\text{C}$ and $\text{RH} = 70\%$
- Terrain elevation in 10 m height intervals provided by the Proponent.

Further details concerning the choice and suitability of the prediction method are provided in Appendix D of the MDA Reports.

5.3.2 Ryan Corner Wind Farm

Predicted noise levels at the twenty-two (22) assessed noise sensitive locations for the three (3) candidate turbine models are provided in Table 1, corresponding to the wind speeds which give rise to the highest noise emissions (sound power levels) for each turbine model.

Table 1: Predicted noise from the Ryan Corner Wind Farm, L_{A90} dB

House	Vestas V126	Senvion 3.0M122	GE 3.2-130	Applicable base noise limit	Compliance with the applicable base noise limit?
4 (S)	34.7	33.1	35.4	45	Yes
5 (S)	34.9	33.3	35.6	45	Yes
6	36.4	34.8	37.1	40	Yes
7	37.9	36.3	38.5	40	Yes
8 (S)	40.4	38.9	41.0	45	Yes
9	39.2	37.7	39.8	40	Yes
10	38.2	36.7	38.8	40	Yes
11	39.4	37.9	40.0	40	Yes
24 (S)	35.3	33.7	36.0	45	Yes
25	35.8	34.2	36.5	40	Yes
26	38.7	37.2	39.4	40	Yes
27	39.2	37.6	39.8	40	Yes
28 (S)	41.0	39.5	41.6	45	Yes
29	39.4	37.9	40.1	40	For two (2) of the three (3) candidate turbine models
30 (S)	38.6	37.0	39.2	45	Yes
31	38.0	36.4	38.6	40	Yes
32	37.4	35.8	38.0	40	Yes
33	34.9	33.3	35.6	40	Yes
38	34.9	33.2	35.5	40	Yes
77	36.0	34.4	36.7	40	Yes
78 (S)	40.8	39.3	41.5	45	Yes
79 (S)	40.1	38.6	40.7	45	Yes

(S) Stakeholder

The following conclusions can be made from the results detailed in Table 1:

- Predicted noise levels from the Ryan Corner Wind Farm comply with the applicable NZS 6808:2010 base noise limit at all assessed noise sensitive locations using two (2) of the three (3) candidate turbine models (Vestas V126 and Senvion 3.0M122)
- Predicted noise levels from the Ryan Corner Wind Farm marginally exceed the applicable NZS 6808:2010 base noise limit, by up to 0.1 dB, at one (1) assessed noise sensitive locations (House 29) using the GE 3.2-130 candidate turbine model.
- Predicted noise levels at all noise sensitive locations within stakeholder properties comply with the 45 dB base noise limit for all candidate turbine models.

Wind farm noise at all other noise sensitive locations not listed in Table 1 are predicted to be lower than 35 dB L_{A90} and therefore also comply with the lowest possible NZS 6808:2010 noise limit at all wind speeds.

These conclusions indicate that noise would need to be considered as part of the selection and configuration of the final turbines to be operated at the site. For example, in the event that the GE 3.2-130 turbine model was selected, the layout may need to be adjusted or reduced noise emission modes may need to be selected for a number of the turbines that are nearest to House 29. Conversely, the selection of other commercial turbine options with emissions that are comparable to the Vestas and Senvion candidate turbine models considered in this assessment could be selected.

5.3.3 Hawkesdale Wind Farm

Predicted noise levels at the twenty-two (22) assessed noise sensitive locations for the three (3) candidate turbine models are provided in Table 2, corresponding to the wind speeds which give rise to the highest noise emissions (sound power levels) for each turbine model.

Table 2: Predicted noise from the Ryan Corner Wind Farm, L_{A90} dB

House	Vestas V126	Senvion 3.0M122	GE 3.2-130	Applicable base noise limit	Compliance with the applicable base noise limit?
48 (S)	34.4	32.8	35.0	45	Yes
53	36.4	34.9	37.0	40	Yes
58	35.8	34.3	36.4	40	Yes
59	37.4	35.9	38.0	40	Yes
60	37.2	35.6	37.8	40	Yes
61 (S)	38.9	37.4	39.5	45	Yes
62	36.1	34.6	36.8	40	Yes
89	37.7	36.2	38.3	40	Yes
90 (S)	41.4	39.9	42.0	45	Yes
101	38.2	36.7	38.8	40	Yes
164 (S)	38.9	37.3	39.4	45	Yes
165	37.7	36.2	38.3	40	Yes
166 (S)	39.0	37.4	39.5	45	Yes
169	38.9	37.4	39.5	40	Yes
170	35.9	34.4	36.5	40	Yes

(S) Stakeholder

It can be seen from the above table that predicted noise levels from the Hawkesdale Wind Farm comply with the applicable NZS 6808:2010 base noise limit at all assessed noise sensitive locations for all three (3) assessed candidate turbine models.

Predicted noise levels at all noise sensitive locations within stakeholder properties comply with the recommended 45 dB base noise limit for all candidate turbine models.

Wind farm noise at all other noise sensitive locations not listed in Table 2 are predicted to be lower than 35 dB L_{A90} and therefore also comply with the lowest possible NZS 6808:2010 noise limit at all wind speeds.

5.3.4 Cumulative assessment

The Department of Environment, Land, Water and Planning provided the Proponent the following documents for the purposes of undertaking a cumulative assessment:

- Resonate Acoustics letter A16008LT1 *Woolsthorpe Wind Farm – Review of Woolsthorpe Wind Farm Acoustic Assessment* dated 17 May 2016
- Wind Farm Developments report *Revised noise assessment for Woolsthorpe Wind Farm: For peer review* dated 27 April 2016 (the Woolsthorpe Wind Farm Noise Assessment)

Details of the Woolsthorpe Wind Farm, including turbine layout, turbine sound levels and noise sensitive locations, used to inform the cumulative assessment of noise levels were sourced from these documents.

Noise levels from both the Hawkesdale and Woolsthorpe Wind Farms have been predicted in accordance with NZS 6808:2010, using the highest sound power level of the turbine models considered for each site, and are detailed in Table 10 of Appendix F of the Hawkesdale Wind Farm Report.

The cumulative assessment for the Hawkesdale and Woolsthorpe wind farms concluded that noise contribution from each site did not affect the compliance outcome of the each site when assessed individually.

Specifically, predicted noise levels of the Hawkesdale Wind Farm are generally more than 10 dB below that of the Woolsthorpe Wind Farm in the vicinity of noise sensitive locations near the Woolsthorpe Wind Farm. That same is also generally true of the Woolsthorpe Wind Farm at noise sensitive locations near the Hawkesdale Wind Farms. The levels are therefore generally below the threshold at which NZS 6808:2010 indicates that cumulative noise levels need to be considered. The exception is at intermediate locations in the area between the two wind farms, however these locations cannot be simultaneously downwind of each wind farm and therefore cumulative effects cannot increase the predicted noise levels.

5.3.5 Township zones

The noise contours showing the highest predicted wind farm noise levels, using the GE 3.2-130 turbine model, presented in MDA Reports have been reproduced in Annexure D together with a zoning map³ of the area surrounding the Township Zones in the vicinity of the subject sites.

It can be seen from Annexure D that predicted noise levels from the Ryan Corner Wind Farm and the Hawkesdale wind Farm are below 35 dB L_{A90} within the Township Zone of Yambuk and Hawkesdale, respectively.

³ The zoning map was downloaded from the Department of Environment, Land, Water & Planning *Planning Maps Online* website on 8 August 2016.

5.4 Comparison of predicted noise levels

The key requirement of the Planning Permit with respect to operational noise is that the wind farm must achieve compliance with the noise criteria determined in accordance with NZS 6808:2010, irrespective of the predicted noise levels that have been presented previously for the project.

Accordingly, the predicted noise level of the wind farm may be higher or lower than presented previously as a result of differences in the noise emissions of the final turbine model selected for the site. Importantly, these differences can occur for turbine selections that fit within the permitted height envelope of the wind farm, irrespective of the height variation that is proposed. The increases or decreases in noise level that occur as a result of these types of differences are acceptable provided that the total predicted noise levels remain within the noise limits defined by the Planning Permit.

However, at the request of the Department of Transport, Planning and Local Infrastructure (now the Department of Environment, Land, Water & Planning), a comparison of predicted noise levels is presented in the following sections for reference purposes.

The differences represent the net effect of changes in the noise emissions of the turbine models and the turbine layout considered in the assessment.

When considering the three candidate turbine models, wind farm noise levels have been predicted to change as follows depending on the turbine model and the assessed noise sensitive location:

- Reduction of up to 3.7 dB and increase of up to 2.1dB for the Ryan Corner Wind Farm
- Reduction of up to 2.1 dB and increase of up to 2.3 dB for the Hawkesdale Wind Farm.

These differences are comparable to the magnitude of variations that can be expected to occur as a result of the selection of alternative turbines that are within the existing permitted envelope of the wind farm.

5.5 Comments on amended conditions

I have reviewed the proposed permit conditions submitted in Volume 1 of the Modification Applications.

It is my opinion that the amendments made to the existing permit conditions do not follow the intent of the model permit conditions provided in Attachment B of the Victorian Guidelines and permit conditions recently issued after similar amendment applications.

Based on the permit conditions⁴ issued on 20 March 2017 for the Lal Lal Wind Farm, I recommend that the Noise Limit Conditions be reworded as follows:

Except as provided below in this condition, the operation of the wind energy facility must comply with New Zealand Standard 6808:2010 Acoustics – Wind farm noise in relation to any dwelling existing on land in the vicinity of the wind energy facility as at 11 April 2007, to the satisfaction of the Minister of Planning. In determining compliance with the standard, the following requirements apply:

a) The sound level from the wind energy facility, when measured outdoors within 10 metres of a dwelling at any relevant nominated wind speed, must not exceed the background level (L_{A90}) by more than 5 dB or a level of 40 dB L_{A90} , whichever is the greater;

b) Compliance at night must be separately assessed with regard to night time data. For these purposes the night is defined as 10.00pm to 7.00am; and

c) Where special audible characteristics, including tonality, impulsive sound or excessive amplitude modulation occur, the measured noise level with the identified special audible characteristics will be modified by applying a penalty of up to +6 dB L_{A90} in accordance with Section 5.4 of the Standard.

This condition does not apply if an agreement has been reached with a landowner through which the landowner accepts predicted noise levels or otherwise agrees to implement appropriate acoustic attenuation measures to ensure a reasonable level of acoustic amenity in relation to the indoor habitable areas of their dwelling(s), and acknowledges that the operation of the wind energy facility may still generate noise in outdoor areas at the dwelling(s) which may from time to time exceed the standard.

I do not have any objection with the proposed amendments for the Noise Compliance Assessment permit conditions.

5.6 Conclusion

The noise assessments detailed in the MDA Reports have demonstrated that predicted noise levels from the Ryan Corner Wind Farm and the Hawkesdale Wind Farm can comply with the applicable noise limits at all assessed noise sensitive locations with the proposed layout.

The revised noise assessments demonstrate the viability of the permitted wind farm to satisfy the acoustic requirements of the Victorian Government's Policy and planning guidelines for development of wind energy facilities in Victoria.

Revised noise modelling will be required during the turbine procurement phase, and should be based on the most current measurement data for octave band sound power levels and tonality.

⁴ Permit No. PL-SP/05/0461/A

6 Response to key submissions

I have reviewed key submissions that raise issues relating to noise. These issues and my response are provided in Table 4.

Table 4: Response to key submissions

Issue raised	Comment
Construction noise	Noise associated with construction of the subject wind farms will be managed through the Environmental Management Plan required to be submitted to the Minister for Planning as detailed in Condition 13 of the planning permits.
Quarry noise	Noise from the quarry associated with the construction of the subject wind farms is not covered within NZS 6808:2010. The relevant guidelines for noise from industrial operations, such as quarrying activities, in regional Victoria are the EPA Publications 1411-1413 <i>Noise from Industry in Regional Victoria</i> (NIRV). I have not been instructed to undertake such assessment.
Weakened permit conditions	I have reviewed the proposed amendments to the existing noise related permit conditions. These amendments have been made to update the New Zealand Standard reference with the most recent version, as required by the current Victorian Guidelines. Providing that the recommended changes detailed in Section 5.5 above are implemented, it is my opinion that the amended noise related permit conditions will not result in a weakened noise compliance outcome.
Audibility	The Foreword to NZS 6808:2010 states the following: <i>Wind farm sound may be audible at times at noise sensitive locations, and this Standard does not set limits that provide absolute protection for residents from audible wind farm sound. Guidance is provided on noise limits that are considered reasonable for protecting sleep and amenity from wind farm sound received at noise sensitive locations.</i> As stated above, noise from the turbines may be audible at times outside noise sensitive locations in the vicinity of the subject wind farms.
Ground vibration	Section 5.5.1 of NZS 6808:2010 states that <i>claims have been made that low frequency sound and vibration from wind turbines have caused illness and other adverse physiological effects among a very few people worldwide living near wind farms. The paucity of evidence does not justify at this stage, any attempt to set a precautionary limit more stringent than those recommended.</i> Additional information is provided in Annexure E.
Infrasound	Section 5.5.1 of NZS 6808:2010 states that <i>although wind turbines may produce some sound at (ultrasound and infrasound) frequencies considered to be outside the normal range of human hearing these components will be well below the threshold of human perception.</i> Additional information is provided in Annexure E.

7 Response to peer-review

SRL Consulting Australia Pty Ltd (SLR) was commissioned by the Moyne Shire Council to undertake a peer-review of the MDA Reports. Their findings are presented in the following documents:

- Memorandum titled *Ryan Corner Wind Farm – noise review*, dated 31 July 2017
- Memorandum titled *Hawkesdale Wind Farm – noise review*, dated 29 July 2017.

The SLR peer review agrees with the general findings of the MDA reports, stating that appropriate policies and guidelines were used and the noise prediction methodology follows *current best practice*. However, the SLR peer review expresses uncertainty in relation to the subject of high amenity noise limits, stating that the assessment was *potentially incorrect*.

Specifically, the SLR peer review proposes EPA Publication 1411 *Noise from industry in regional Victoria* (NIRV) as a guide to the application of the NZS 6808:2010 high amenity provisions in Victoria. NIRV is a technical publication which provides guidance that is specific to the Victorian planning system and general industry. As acknowledged by the peer review, NIRV is not applicable to the assessment of wind farms – the scope of the NIRV publication specifically excludes its application to wind farms. It is my opinion that this exclusion is based on the distinctly different planning considerations associated with wind farms and other forms of noise generating development.

In contrast, the primary guidance in NZS 6808:2010 on whether to consider the application of high amenity limits is based on land planning definitions that are specific to New Zealand. Technical considerations based on noise level information are secondary to broader land planning definitions.

Assessing a wind farm in Victoria using NZS 6808:2010 is therefore primarily reliant upon addressing the complexity of how to use a provision defined for the New Zealand planning system in the context of the Victorian planning system.

Ultimately, the interpretation of the Victorian planning system in relation to the application of the New Zealand Standard is a planning or legal matter and therefore outside of my area of expertise.

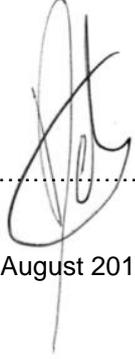
While the primary consideration is based on the planning definitions outlined in the Moyne Planning Scheme, it is noted that the secondary considerations based on noise level information, as detailed in clause C5.3.1 of NZS 6808:2010 states the following in relation to the consideration of high amenity limits:

There is no need to consider noise sensitive locations outside the predicted 35 dB $L_{A90(10 \text{ min})}$ wind farm sound level contour;

As presented in Annexure D, the Township Zones in the vicinity of the subject sites are located outside the predicted 35 dB $L_{A90(10 \text{ min})}$ contour. This supports the conclusion that the high amenity limit is not applicable to the Hawkesdale and Ryan Corner wind farms, irrespective of whether Township Zones are found to be considered as high amenity areas in the context of the Victorian planning system.

8 Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Planning Panel.

Signed

Dated 1 August 2017

Annexure A – Qualifications

Qualifications

M.Eng – Masters’ Degree in Engineering (French Equivalent), France 2001

Professional associations

MAAS – Member of the Australian Acoustical Society

Member of the Association of Australian Acoustical Consultants (AAAC) Wind Farm Subcommittee

Employment history and achievements

2017- Present

Co-CEO

Marshall Day Acoustics Pty Ltd, Melbourne, Australia.

Consultants in acoustics and noise control.

2002- 2017

Associate

Marshall Day Acoustics Pty Ltd, Melbourne, Australia.

Consultants in acoustics and noise control.

Responsibilities include consulting work in industrial noise control, environmental noise impact (including wind farms) and architectural sound insulation.

Noise impact assessments of Victorian wind farm developments at Bald Hills, Berrimal, Berrybank, Challicum Hills, Chepstowe, Coonooer Bridge, Crowlands, Dundonnell, Ferguson, Golden Plains, Hawkesdale, Hepburn, Kiata, Maroona, Moorabool, Mortlake, Mt Gellibrand, Mt Mercer, Newfield, Nhill, Oakland Hill, Penshurst, Portland, Ryan Corner, Sidonia Hills, Spring Hill, Stockyard Hill, Timboon West, Waubra, Winchelsea, Wonthaggi, Yaloak South and Yawong.

2001

Vacation Employment

Marshall Day Acoustics Pty Ltd, Melbourne, Australia

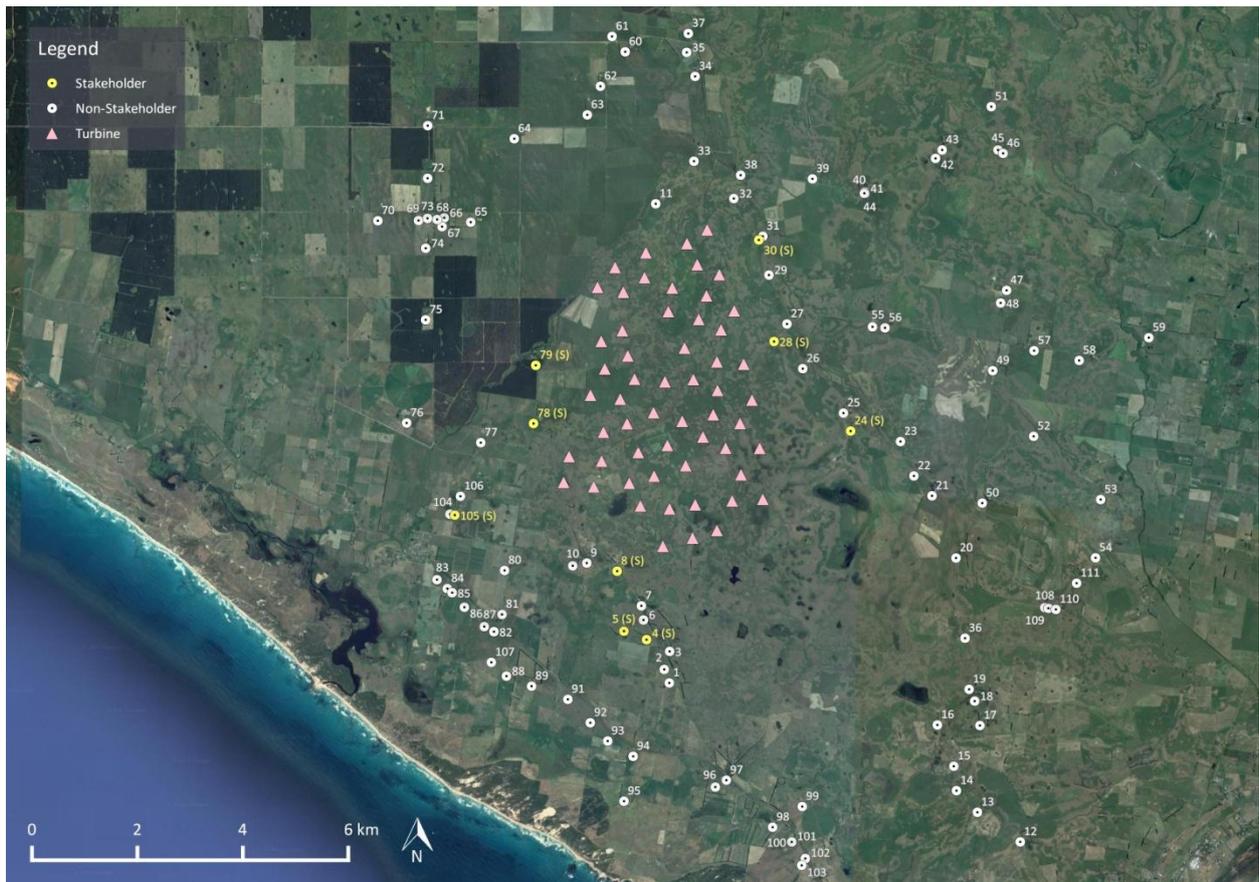
Annexure B – Reports reviewed to prepare this statement

I have reviewed the following documents that are referenced in the noise assessments and this statement of evidence:

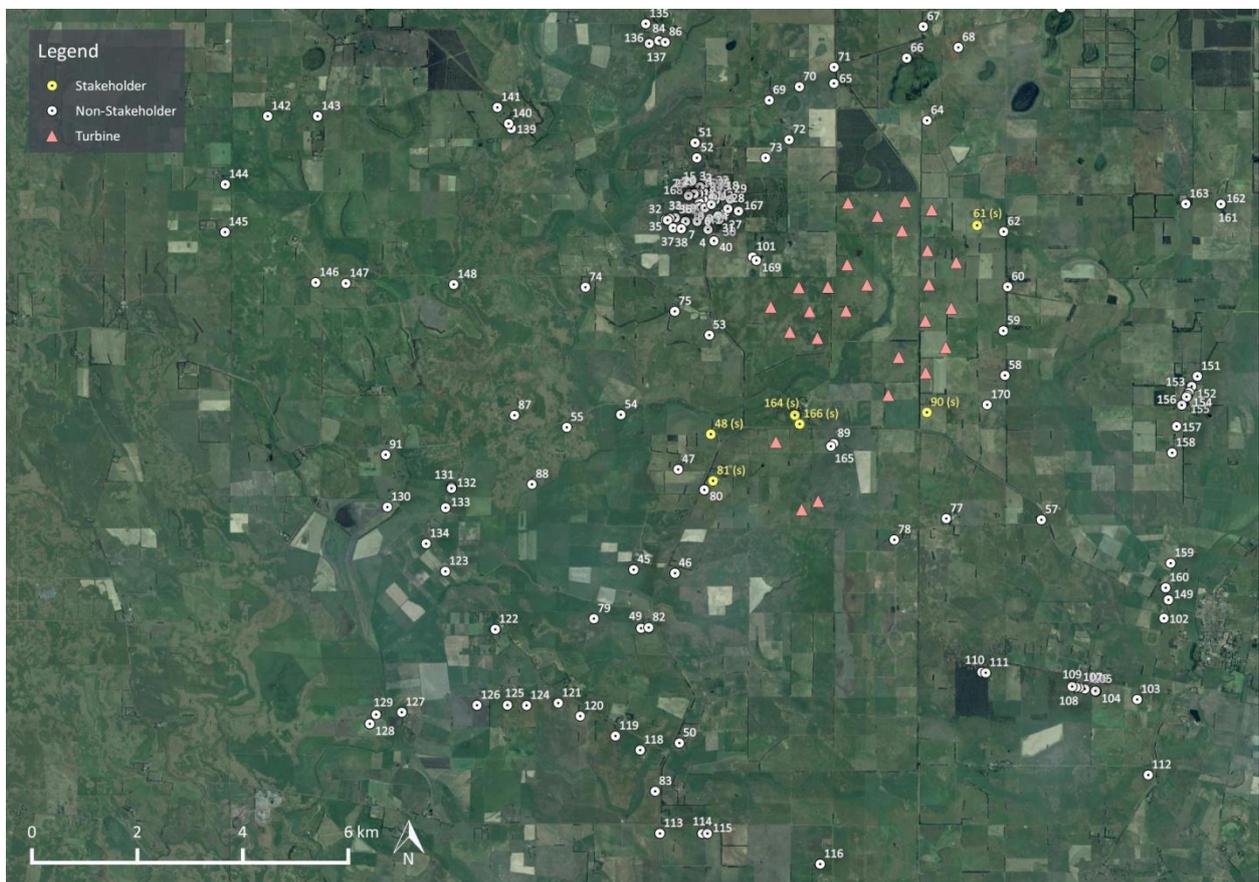
- Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise*
- New Zealand Standard 6808:1998 *Acoustics – The assessment and measurement of sound from wind turbine generators*
- ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996)
- EPA Publications 1411-1413 *Noise from Industry in Regional Victoria* (NIRV)
- Final report by *The European Working Group on Noise from Wind Turbines* (ETSU-R-97)
- *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors* [2013] VCAT 521
- Moyne Planning Scheme dated 25 May 2017
- Ryan Corner Wind Farm planning permit No. 20060222 dated 21 August 2008
- Hawkesdale Wind Farm planning permit No. 20060221 dated 12 August 2008
- Woolsthorpe Wind Farm planning permit No. 20060220/A dated 21 May 2017
- Lal Lal Wind Farm planning permit No. PL-SP/05/0461/A dated 20 March 2017
- MDA Report Rp 001 R02 2014362ML *Ryan Corner Wind Farm - NZS 6808:2010 Noise Assessment* dated 21 April 2017, issued as Appendix A of the MDA letter Lt 001 R02 2014362ML dated 21 April 2017
- MDA Report Rp 002 R04 2014362ML *Hawkesdale Wind Farm - NZS 6808:2010 Noise Assessment* dated 21 April 2017, issued as Appendix A of the MDA letter Lt 002 R04 2014362ML dated 21 April 2017
- MDA Report Rp 004 2010165ML dated 11 September 2013, issued as Appendix B of MDA letter Lt 001 R02 2014362ML
- MDA Report Rp 003 2010165ML dated 11 September 2013, issued as Appendix B of MDA letter Lt 002 R04 2014362ML
- Resonate Acoustics letter A16008LT1 *Woolsthorpe Wind Farm – Review of Woolsthorpe Wind Farm Acoustic Assessment* dated 17 May 2016
- Wind Farm Developments report *Revised noise assessment for Woolsthorpe Wind Farm: For peer review* dated 27 April 2016
- SLR Consulting memorandum titled *Ryan Corner Wind Farm – noise review*, dated 31 July 2017
- SLR Consulting memorandum titled *Hawkesdale Wind Farm – noise review*, dated 29 July 2017

Annexure C – Layouts

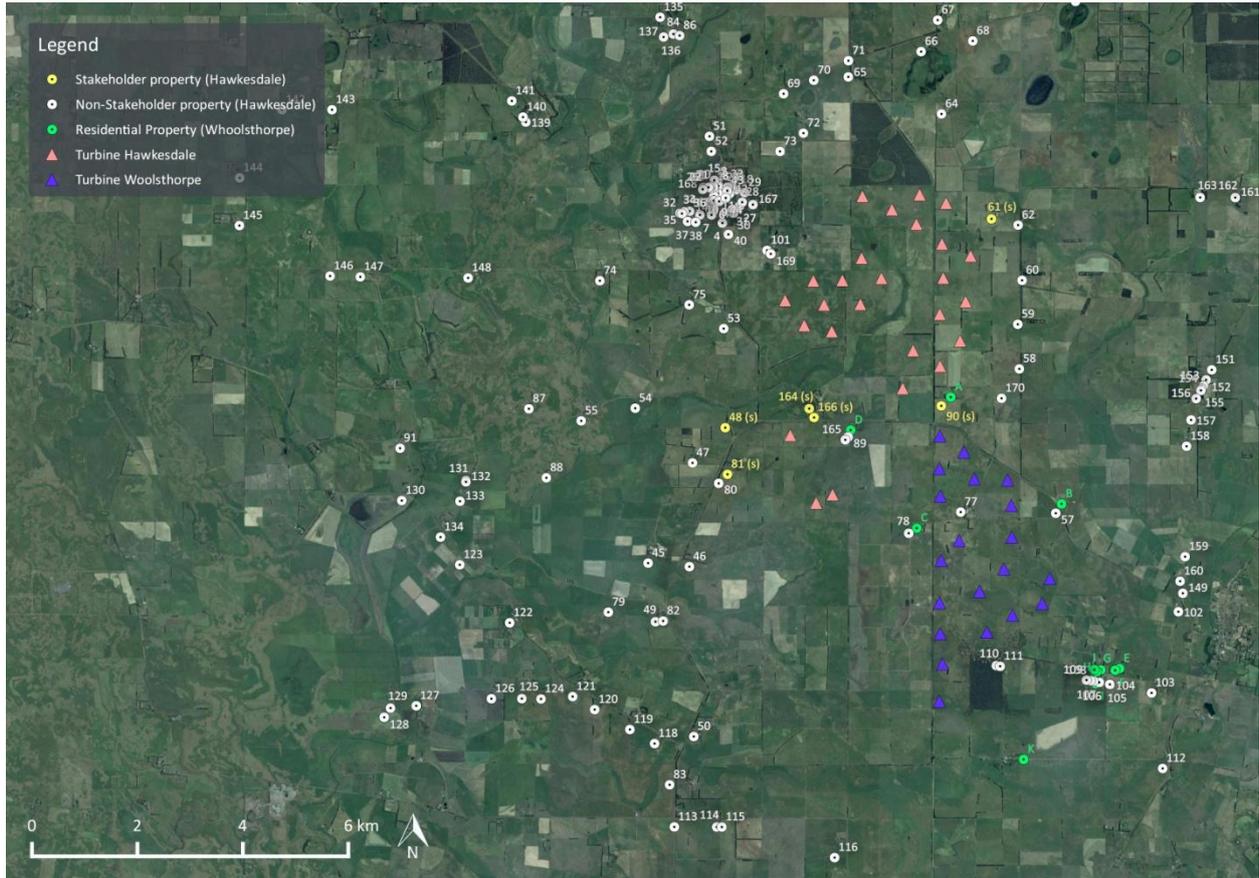
Ryan Corner Wind Farm



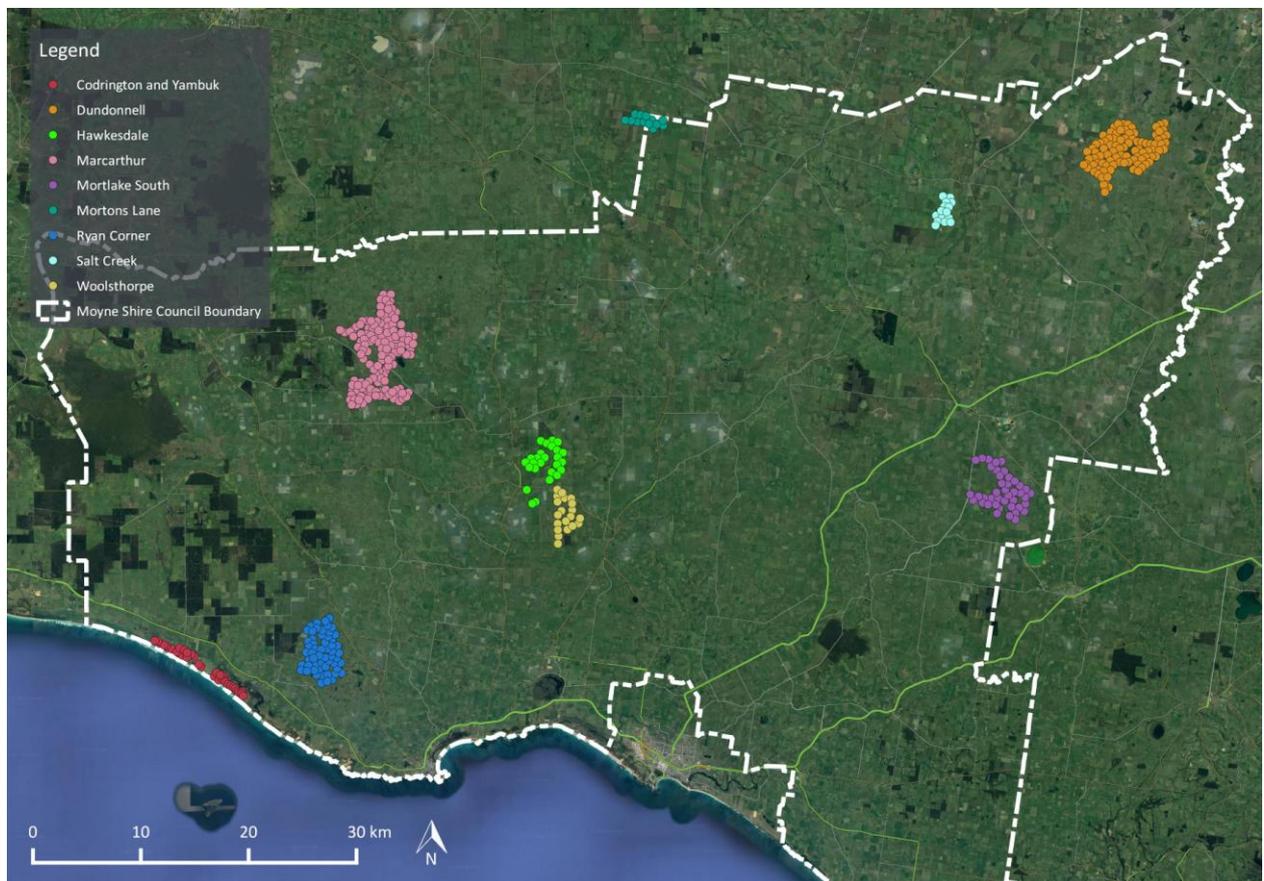
Hawkesdale Wind Farm



Hawkesdale Wind Farm and Woolsthorpe Wind Farm



Operating and approved wind farms within the Moyne Shire Council

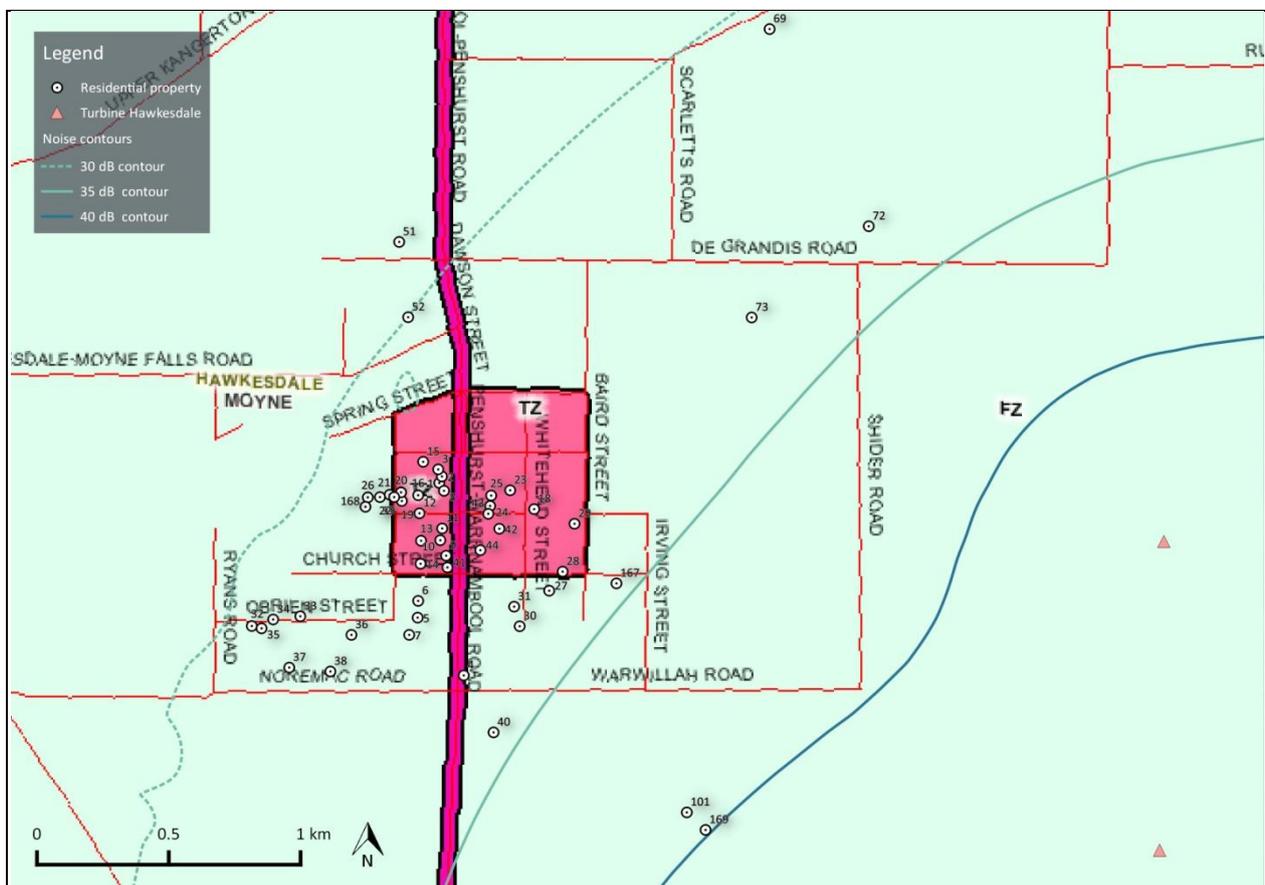


Annexure D – Predicted noise levels within Township Zones

Ryan Corner Wind Farm



Hawkesdale Wind Farm



Annexure E – Additional information in response to key submissions

Effects of Wind Farm Noise

Sound is an important feature of the environment in which we live; it provides information about our surroundings and is a key influence on our overall perception of amenity and environmental quality. Sound is therefore an environmental quality that must be considered as part of any proposal to develop new infrastructure that could influence the sound environment of neighbouring communities.

Excessive or unwanted sound is commonly referred to as noise and can have a range of effects on people, depending on a range of physical and contextual factors. The Guidelines for Community Noise 1999 prepared by the World Health Organisation (WHO) provides a health-based framework of guideline limits and values to address the broad definition of health given as:

A state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity

This broad definition means that effects ranging from community annoyance, sleep disturbance and speech interference, through to direct physiological impacts such as hearing damage, are all identified as potential health considerations. An important aspect of this range of considerations is that some effects will be highly dependent on the listener's perception and attitude to the noise in question, such as annoyance, while other effects are primarily related to the level of sound and the direct physiological risks these may represent, such as hearing damage.

Environmental noise policies, including those applied to wind farms, establish objective noise criteria to address these health considerations. In particular, environmental noise policies define criteria which are chosen to prevent direct physiological risks of sound, and minimise as far as practically possible adverse health considerations such as annoyance and sleep disturbance.

Practically minimising the risks of noise effects related to annoyance and sleep disturbance requires the potential range of responses to sound to be considered. In this respect, it is important to note that individual attitudes and reactions to sound are highly variable, and will depend on a complex set of acoustic and non-acoustic factors. These include the level and character of the sound in question, the time of day the sound occurs, the regularity of the sound, the environment in which the sound is heard, the individuals hearing acuity, and an individual's personal opinion and perception of the sound source or development in question. The latter will in turn depend on other complicating factors such as visual impressions of the source in question and the perceived community benefit, or otherwise, of the source in question.

Due to the complexity and range of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Further, it is usually not feasible or practical to design new development or infrastructure to inaudible noise levels. As a result, minimising the risks of noise effects involves setting criteria which prevents the majority of people from being disturbed. This requires regulatory authorities to strike a balance between amenity and development, setting noise limits which are as stringent as can be practically achieved without preventing new development.

This type of approach to noise policy was outlined by the Victorian Department of Health in their 2013 publication⁵ on wind farm sound and health which states:

Noise standards are used not only for environmental noise (such as wind farms and traffic noise) but also for industry and even household appliances.

Noise standards are set to protect the majority of people from annoyance. The wide individual variation in response to noise makes it unrealistic to set standards that will protect everyone from annoyance. A minority of people may still experience annoyance even at sound levels that meet the standard. This is the case not only for wind farms, but for all sources of noise.

⁵ Victorian Department of Health *Wind farms, sound and health: Community information* dated April 2013

The subject of health effects related to operational wind farms in Australia has been extensively considered by the Commonwealth Government's National Health and Medical Research Council (NHMRC) and the Australian Medical Association; in particular, the NHMRC has undertaken and coordinated a systematic review of evidence related to wind farms and health. The research reviews⁶ and public statements^{7,8} produced by these peak health bodies support that, as with any audible sound, wind farm noise can represent a potential source of annoyance or sleep disturbance for some individuals. Their findings did however indicate that there was no reliable evidence to support a relationship between wind farm noise and direct adverse effects on human health.

These findings lend support to the suitability of the wind farm noise controls applied in Victoria, which are intended to provide reasonable protection of health and amenity at noise sensitive locations. This is consistent with the objectives of NZS 6808:2010. Importantly, the Standard notes that the consensus view of the committee responsible for the development of NZS 6808:2010, including New Zealand representatives from the Ministry of Health and Institute of Environmental Health, was that the Standard provides a reasonable way of protecting health and amenity at nearby noise sensitive locations, without unreasonable restricting the development of wind farm.

Low frequency noise, infrasound and vibration

The limits adopted for the assessment of operational noise from wind farms represent relatively low levels which have been specified in recognition of the quieter rural environments in which wind farms are normally located.

However, consistent with noise policies applied to other forms of development, the criteria are not intended to restrict wind farm noise to inaudible levels. Accordingly, a wind farm which achieves compliance with the criteria may still be audible at surrounding noise sensitive locations on some occasions; this will depend on a range of factors such as the time of day, the speed and direction of the wind, the proximity to turbines, the extent of vegetation around the dwelling, and the degree to which the dwelling is sheltered from prevailing wind conditions. Irrespective of the relatively low levels which operational wind farm noise is restricted to, an individual's judgement of the audible noise from a wind farm is highly subjective and will be influenced by a range of contextual factors.

The subject of wind farm noise and its characteristics has attracted considerable attention. Specific attention has been directed to alleged matters relating to low frequency sound as well as infrasound and vibration. Low frequency sounds are generally regarded as sounds above 20 Hz and extending upwards into the range of 100-200 Hz. The definition of infrasound often varies in different jurisdictions, but is generally accepted to refer to frequencies of sound which lie below 20 Hz. While 20 Hz is commonly cited as the lower bound of audibility, frequencies below 20 Hz can still be audible, provided that the level of the sound is sufficiently high to exceed the threshold of audibility at those frequencies.

In common with many other sources of noise, wind turbines emit infrasound, low frequency sound and ground vibrations. However, what is often overlooked is that these types of sound and vibration are a feature of the everyday environment in which we live and arise from a wide range of natural sources such as the wind and the ocean to man-made sources such as domestic appliances, transportation and agricultural equipment. The important point in relation to wind turbines is that the levels of these types of emissions are low and therefore, in many cases, cannot generally be reliably measured amidst normal background levels.

NZS 6808:2010 provides specific advice concerning infrasound at Section 5.5 noting:

Although wind turbines may produce some sound at (ultrasound and infrasound) frequencies outside the normal range of human hearing these components will be well below the threshold of human perception.

Claims have been made that low frequency sound and vibration from wind turbines have cause illness and other adverse physiological effects among a very few people worldwide living near wind farms. The paucity of evidence does not justify at this stage, any attempt to set a precautionary limit more stringent than those recommend [in the Standard].

⁶ *Systematic review of the human health effects of wind farms 2013*, Adelaide University, commissioned by the NMRC

⁷ NHMRC Statement: *Evidence on Wind Farms and Human Health 2015*, National Health and Medical Research Council

⁸ AMA Position Statement – *Wind Farms and Health 2014*, Australian Medical Association

These types of emissions have been the subject of considerable misrepresentation in media commentary. Notably, the work of Dr Geoff Leventhall, a prominent UK consultant in the field of acoustics and vibration, and researcher in the field of low frequency noise is often cited in some documents which continue to claim concerns about infrasound and low frequency noise from wind turbines. However, Dr Leventhall has regularly made clear statements to assert that there is no significant infrasound from current designs of wind turbines and very little low frequency sound, neither of which are anywhere near the sorts of levels which would represent a direct health risk for neighbouring residents of modern wind farms. An example such publication, co-authored by Dr Leventhall, was published in the UK Institute of Acoustics Bulletin in March 2009⁹. This publication was prepared as an agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed by local councils and community groups campaigning against wind farm developments. The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern.

On the subject of infrasound and low frequency noise, the article notes:

Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles. Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view.

A Portuguese group has been researching 'Vibro-acoustic Disease' (VAD) for about 25 years. Their research initially focussed on aircraft technicians who were exposed to very high overall noise levels, typically over 120dB. A range of health problems has been described for the technicians, which the researchers linked to high levels of low frequency noise exposure. However other research has not confirmed this. Wind farms expose people to sound pressure levels orders of magnitude less than the noise levels to which the aircraft technicians were exposed. The Portuguese VAD group has not produced evidence to support their new hypothesis that infrasound and low frequency noise from wind turbines causes similar health effects to those experienced by the aircraft technicians.

More recent measurements^{10, 11} have demonstrated that infrasound and low frequency sound produced by regularly encountered natural and man-made sources, such as the infrasound produced by the wind or distant traffic, is comparable to that of modern wind turbines, noting that:

Infrasound levels in the rural environment appear to be controlled by localised wind conditions. During low wind periods, levels as low as 40dB(G) were measured at locations both near to and away from wind turbines. At higher wind speeds, infrasound levels of 50 to 70dB(G) were common at both wind farm and non-wind farm sites.

Organised shutdowns of the wind farms adjacent to [sic: measurement locations] indicate that there did not appear to be any noticeable contribution from the wind farm to the G-weighted infrasound level measured at either house. This suggests that wind turbines are not a significant source of infrasound at houses located approximately 1.5 kilometres away from wind farm sites.

⁹ Institute of Acoustics Bulletin – Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall, McKenzie - *Prediction and Assessment of Wind Turbine Noise* – March 2009

¹⁰ Sonus report for Pacific Hydro - *Infrasound measurements from wind farms and other sources* – November 2010 - see http://www.pacifichydro.com.au/media/192017/infrasound_report.pdf

¹¹ Evans, T., Cooper, J. & Lenchine, V., *Infrasound levels near wind farms and in other environments*, South Australian Environment Protection Authority, Adelaide, 2013

Another example of the misrepresentations made in relation to the environmental effects of wind turbines centred around work carried out by Keele University in the UK on ground vibration. Professor Peter Styles and his team at Keele University undertook a study of the effects of wind turbines on the seismic detection array at Eskdalemuir, Scotland. The results of this work were widely misinterpreted and resulted in a statement¹² from Professor Styles:

We are writing to clarify some misconceptions [...] about wind farm noise. Whilst it is technically correct that 'vibrations can be picked up as far away as 10km', to give the impression that they can be felt at this distance is highly misleading. The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect. The Dunlaw study was designed to measure effects of extremely low level vibration on one of the quietest sites (Eskdalemuir) in the world, and one which houses one of the most sensitive seismic installations in the world. Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health. It is, however, an issue for the Eskdalemuir seismic array, as it can detect this level of vibration. It is designed to detect explosions and earthquakes of a low magnitude from all over the world. The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health.

In 2010, the UK Health Protection Agency published a report¹³ on the health effects of exposure to ultrasound and infrasound. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.

[...]

For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects.

Also, a recent State Government of Victorian Department of Health document¹⁴ concludes the following in relation to infrasound from wind farms:

Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents.

These studies all indicate that infrasound levels from wind farms are anticipated to be comparable with existing ambient levels.

In February 2015, the National Health and Medical Research Council (NHMRC) released a statement¹⁵ addressing human health effects of wind farms which includes consideration of noise. Based on consideration and review of over 2,500 publications, the NHMRC was not able to identify any reliable evidence of direct health impacts from wind farm noise.

¹² *Keele University Rejects Renewable Energy Foundation's Low Frequency Noise Research Claims.*
http://www.bwea.com/ref/lfn_keele.html

¹³ Health Protection Agency UK – *Health Effects of Exposure to Ultrasound and Infrasound – Report of the independent Advisory Group on Non-ionising Radiation - 2010*

¹⁴ Victorian Department of Health *Public Statement: Wind Turbines and Health - July 2010*

¹⁵ NHMRC Statement: *Evidence on Wind Farms and Human Health 2015*, National Health and Medical Research Council