GOLDEN PLAINS WIND FARM
PRELIMINARY NOISE ASSESSMENT

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6 Gipps Street
Collingwood 3066 Victoria Australia
T: +613 9416 1855
A.C.N. 006 675 403
www.marshallday.com

Project:	**GOLDEN PLAINS WIND FARM** **Preliminary Noise Assessment**
Prepared for:	**WestWind Energy Pty Ltd** **Office 5, Level 1, Nexus Centre** **12-14 Prince Street** **Gisborne VIC 3437**
Attention:	**Marla Brauer**
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TABLE OF CONTENTS

APPENDIX A GLOSSARY OF TERMINOLOGY

APPENDIX B GOLDEN PLAINS WIND FARM LAYOUT

APPENDIX C ZONING MAPS

APPENDIX D NOISE PREDICTION MODEL

APPENDIX E NOISE CONTOUR MAPS – VESTAS V136-3.6

APPENDIX F DOCUMENTATION

1.0 INTRODUCTION

This report, commissioned by WestWind Energy Pty Ltd, details the results of a preliminary noise assessment for the proposed Golden Plains Wind Farm for the purpose of a referral under the *Environmental Effects Act 1978*.

The assessment has been undertaken in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* as required by the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016.

Acoustic terminology used throughout this report is presented in Appendix A.

2.0 PROJECT DESCRIPTION

2.1 Wind farm layout

The Golden Plains Wind Farm is proposed to be located approximately 60 kilometres north west of Geelong in Victoria and comprise two hundred and thirty-one (231) wind turbines.

A plan of the proposed layout is presented in Appendix B together with coordinates for the wind turbines and nearby residential properties.

2.2 Wind turbines

2.2.1 Turbine type

The proposal for the Golden Plains Wind Farm is based on assessing candidate wind turbines which are representative of the types of turbines presently being considered for the project. The selection of a final turbine model and specification typically occurs at a later stage in the project after planning approvals have been obtained. This subsequent process would be dependent on the outcomes of detailed layout design work (e.g. micro-siting) and a tender process to procure the supply of turbines. The final turbine selection would need to achieve a range of criteria including planning approval requirements concerning noise levels at surrounding noise sensitive receiver locations. The final turbines selection would also normally be subject to additional regulatory approval processes prior to development of the wind farm, such as the preparation of an updated noise compliance assessment for the final turbine selection.

Accordingly, for this preliminary assessment, the candidate turbines referred to in the noise assessment are primarily for the purpose of assessing the viability of the wind farm achieving compliance with the noise limits at surrounding receptor locations. The key objective is to demonstrate that the noise limits can be practically achieved, accounting for typical noise emission levels that are representative of the types of turbine options that may be considered for the site.

WestWind has advised that two (2) candidate turbine models have been selected at this stage in the project. Consistent with contemporary wind turbine design, both candidates are variable speed wind turbines. The speed of rotation and the amount of power generated by the turbines is regulated by control systems which vary the pitch of the turbine blades (the angular orientation of the blade relative to its axis).

The general specifications of the turbines are detailed in Table 1 below.

Table 1: Candidate turbines – general specifications

Detail	Senvion 3.6M140	Vestas V136-3.6
Make	Senvion	Vestas
Model	3.6M140	V136
Rated power (MW)	3.6	3.6
Rotor Diameter (m)	140	136
Hub Height (m)	130	130
Orientation	Upwind	Upwind
Serrated trailing edge	Yes	Yes

2.2.2 Sound power levels

Sound power levels used in the assessment to represent the noise emissions of each candidate turbine model have been sourced from the documents detailed in Table 2.

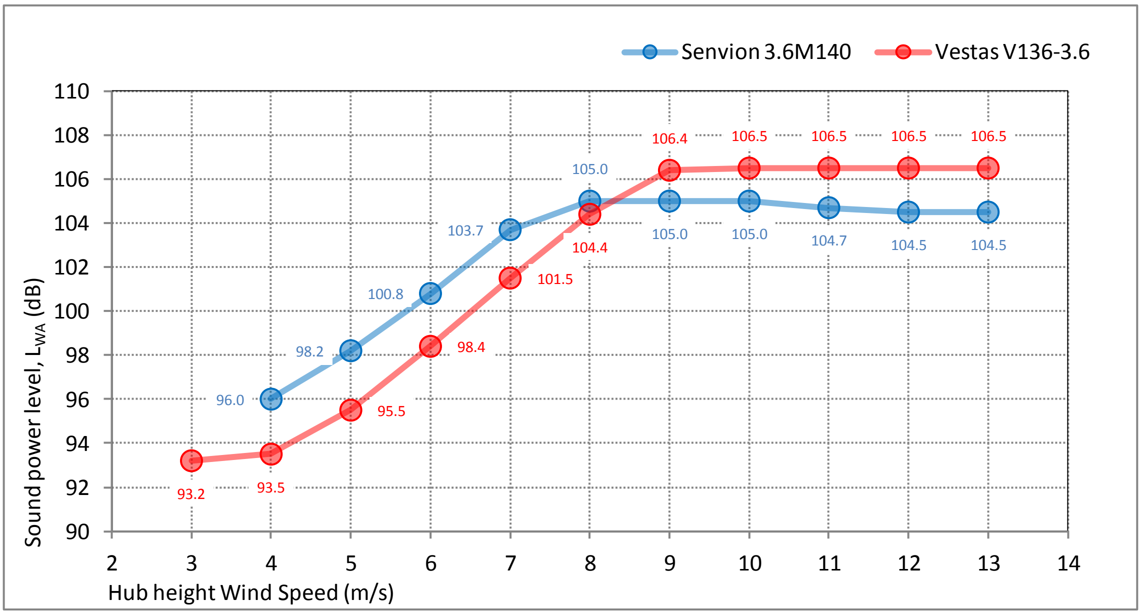
Table 2: Reference documents

Model	Reference document
Senvion 3.4M140	Senvion document No. SD-3.20-WT.PC.00-B-A-EN *Power Curve & Sound Power Level [3.6M140EBC/50Hz/open],* dated 21 September 2016 Senvion document No. GI-3.5-WT.PO.04-A-B-EN *Octave & Third Octave Band Data [3.0M122/50Hz] General Information,* dated 9 December 2015
Vestas V136	Vestas document No. 0056-6306 V01 *Performance Specification V136-3.60 MW 50/60 Hz*, dated 25 January 2017 Vestas document No. 0064-2970_01 *V136-3.6 MW Third octave noise emission*, dated 16 February 2017

For each of the candidate turbines, the sound power level values used for this assessment have been derived from the above documents with the inclusion of a 1 dB margin to account for uncertainties.

The profiles of the A-weighted sound power levels as a function of hub height wind speed are presented in Figure 1 for each of the candidate turbine models. These are the values that have been used in this assessment and correspond to the values specified in the documents listed in Table 2, adjusted by the addition of +1 dB to include a margin for typical test uncertainty values.

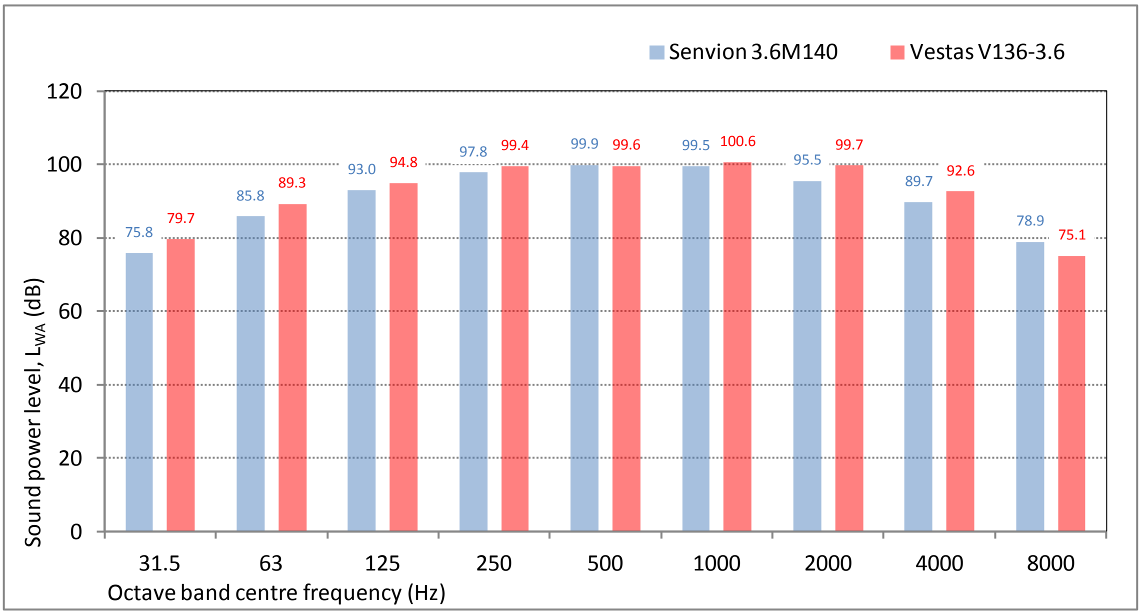
Figure 1: Guaranteed sound power level vs. hub height wind speed



The octave band values provided in the reference documents have been adjusted to the highest sound power level detailed in Figure 1 and are presented in Figure 2 for each of the candidate turbine models.

As the octave band spectral data is not currently available for the Senvion 3.6M140 turbine, we have been advised by the manufacturer that data for the Senvion 3.0M122 should be used to represent the noise emission characteristics of the 3.6M140.

Figure 2: A-weighted octave band sound power level spectra



The sound power levels illustrated Figure 1 and Figure 2 are considered typical of the range of noise emissions associated with comparable multi-megawatt wind turbines. The data is therefore considered appropriate to reference in this assessment as a representation of the apparent sound power levels of the turbines when tested and rated in accordance with International Electrotechnical Commission publication IEC 61400-11:2012 *Wind turbines - Part 11: Acoustic noise measurement techniques* (IEC 61400-11:2012), consistent with the recommendation of NZS 6808:2010.

2.2.3 Tonality

Information concerning potential tonality is generally limited at the planning stage of a project.

The data for the Senvion 3.6M140 indicates that Senvion warrants tonal audibility values $\Delta L_{a,k}$ < 2 dB for wind speeds at 10 m AGL above 6 m/s. In relation to the Vestas V136-3.45, tonal audibility was not available for this turbine model at the time of preparing this document.

The occurrence of tonality in the noise emissions of contemporary multi-megawatt turbine designs is generally limited. The specification is therefore considered typical for the type of turbine being considered for the project.

Notwithstanding the above, based on our experience with other projects of this type, it is likely that the procurement contract for the site would stipulate that the turbines must not produce emissions which would attract a penalty for tonality when assessed in accordance with the relevant noise criteria and any associated conditions of consent.

2.3 Noise sensitive locations

NZS 6808:2010 requires that the noise assessment be undertaken at all noise sensitive locations in the vicinity of the proposed wind farm which it defines as follows:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site.*

Noise sensitive locations therefore include residential dwellings, schools and hotels located outside the wind farm site.

A total of two hundred and twenty (220) buildings have been identified by WestWind within 3 km of the proposed turbines, comprising the following:

- One hundred and thirty-five (135) residential dwellings on properties that are not associated with the wind farm (referred to as neighbour dwellings herein)
- Forty-five (45) residential dwellings on properties that are associated with the wind farm (referred to as host dwellings herein)
- One (1) school
- One (1) child care
- Thirty-eight (38) buildings (sheds, community halls, businesses, etc.) that are not considered as noise sensitive locations in accordance with NZS 6808:2010.

A number of the properties that are associated with the wind farm have more than one dwelling. The forty-five host dwellings noted above therefore include secondary host dwellings (ten in total - typically rental accommodation) that are not the land owner's main place of residence. We have been advised that, as part of the wind farm design process, host property owners were consulted regarding the positioning of wind turbines in the vicinity of secondary dwellings. It is our understanding that WestWind obtained verbal consent from all relevant host property owners to treat the secondary dwellings as if they were not there for wind turbine layout design purposes. WestWind is currently in the process of obtaining written consent to formally document the agreement for secondary dwellings. Noise levels at these secondary dwellings are therefore not assessed as noise sensitive locations as part of this study, however predicted noise level information is provided for reference purposes.

The coordinates of all buildings locations are provided in Appendix B.

3.0 NOISE CRITERIA

Current Victorian government guidelines for the development of new wind energy developments is detailed in the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016 (Victorian Guidelines).

This Victorian Guidelines specify requirements for the control of environmental noise level from new wind farm developments. In particular, Section 5 of the policy outlines the key criteria for the evaluation of the planning merits of a wind energy facility and states the following noise requirements in section 5.1:

> *A wind energy facility should comply with the noise limits recommended for Dwellings and other noise sensitive locations in the New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise (the Standard).*

The following sections provide an overview of the assessment methodology detailed in New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010), along with details of the Victorian Guidelines' requirements in relation to the application of the standard in the Victorian policy context.

3.1 Objective

Section C1.1 of NZS 6808:2010 discusses the intent of the standard, which is:

> [...] *to avoid adverse noise effects on people caused by the operation of wind farms while enabling sustainable management of natural wind resources.*

Furthermore, the *Outcome Statement* of NZS 6808:2010 reads as follows:

> *This Standard provides suitable methods for the prediction, measurement, and assessment of sound from wind turbines. In the context of the Resource Management Act, application of this Standard will provide reasonable protection of health and amenity at noise sensitive locations.*

To deliver on this objective the standard specifies noise criteria which are used to assess wind farm noise.

3.2 Noise limit

Section 5.2 *Noise limit* of NZS 6808:2010 defines acceptable noise limits as follows:

> *As a guide to the limits of acceptability at a noise sensitive location, at any wind speed wind farm sound levels ($L_{A90(10\ min)}$) should not exceed the background sound level by more than 5dB, or a level of 40dB $L_{A90(10\ min)}$, whichever is the greater.*

This arrangement of noise limits requires the noise associated with wind farms to be restricted to a permissible level above background noise, except in instances when both the background and source noise levels are low. In this respect, the criteria indicate that it is not necessary to continue to adhere to a margin above background when the background values are below the range of 30-35 dB.

Compliance with the criteria may result in wind turbine noise being audible at some locations for some of the time. The foreword of NZS 6808:2010 notes that:

> *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.*

3.3 High amenity areas

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} (as detailed in Section 3.2) 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 residential properties 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 decisions[1].

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.* […]

1 Mitchell Shire Council interim decision dated 4 April 2013 (the Cherry Tree Wind Farm Interim Decision) and Mitchell Shire Council decision dated 27 November 2013 (the Cherry Tree Wind Farm Decision)

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 proposed 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 application of the high amenity area for this site is discussed in Section 6.1.

3.4 Special audible characteristics

Section 5.4.2 of NZS 6808:2010 requires the following:

> *Wind turbine sound levels with special audible characteristics (such as tonality, impulsiveness and amplitude modulation) shall be adjusted by arithmetically adding up to +6dB to the measured level at the noise sensitive location.*

Notwithstanding this, the standard requires that wind farms be designed with no special audible characteristics at nearby residential properties while concurrently noting in Section 5.4.1 that:

> [...] *as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.*

While the standard emphasises assessment of special audible characteristics during the post-construction measurement phase of a project, an assessment of tonality is possible pre-construction, using tonality assessments carried out according to IEC 61400-11.

4.0 NOISE ASSESSMENT METHODOLOGY

There are several key stages involved in a noise assessment undertaken in accordance with NZS 6808:2010.

Firstly, preliminary wind farm noise predictions[2] are carried out for all identified noise sensitive locations around the wind farm. The results of the preliminary analysis are used for the following:

- Identification of noise sensitive locations where predicted wind farm noise levels exceed 35 dB L_{A90}
- Identification of selected noise sensitive locations where background noise monitoring should be undertaken, if required.

Section 7.1.4 of NZS 6808:2010 notes the following:

> *If there are no noise sensitive locations within the 35 dB $L_{A90(10\,min)}$ predicted wind farm sound level contour then background sound level measurements are not required.*

Having identified noise sensitive locations where predicted noise levels are predicted at or above 35 dB and carrying out any background noise monitoring that may be required, applicable limits for the wind farm noise are determined.

Once noise limits have been established, further wind farm predictions are carried out.

Compliance is assessed by comparing the predicted wind farm noise levels with the relevant noise limits over a range of wind speeds.

[2] See Section 0

5.0 BACKGROUND NOISE MONITORING

Ninety-one (91) noise sensitive locations have been identified within 3 km of the proposed turbines where predicted wind farm noise levels are higher than 35dB L_{A90} (see detailed results presented subsequently in this report in Table 3 of Section 7.2).

According to Section 7.1.4 of NZS 6808:2010, background noise monitoring *should be carried out where wind farm sound levels 35 dB L_{A90} or higher are predicted for noise sensitive locations*.

However, these measurements are not mandatory and, as detailed in Section 7.1.2 of NZS 6808:2010, a fixed base noise limit can be used at all wind speeds.

Notwithstanding the above, background has been undertaken at selected residential properties where wind farm noise levels have been predicted between 35-40 dB. The properties where background noise data was collected were selected based on their geographical location around the site to provide baseline data for the nearest noise sensitive locations around the site.

It should be noted that Section 7.1.2 requires that base noise limits should only be used when the *wind farm operator agrees to conduct on/off testing if required*. It is our understanding that, in the event that background noise measurements are undertaken prior to the construction of the wind farm, on/off testing would not be required.

6.0 NOISE LIMITS

6.1 High amenity areas

The entire wind farm site and most of the area surrounding the proposed wind farm is predominantly designated as Farming Zone, with a few properties located within a Township Zone and Low Density Residential Zone as shown in the planning maps shown in Section 0 of Appendix B.

The Golden Plains Shire Planning Scheme dated 31 March 2017 does not specify the Farming Zone or any other zone as promoting a higher degree of protection of amenity related to the sound environment. Following guidance from VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Guidelines, the high amenity noise limit detailed in NZS 6808:2010 is therefore not deemed to be applicable for residential properties in the vicinity of the Golden Plains Wind Farm.

6.2 Host properties

Host properties include locations that are within the site boundary, as well as locations outside of the site boundary where land will be used for access or will provide a route for ancillary infrastructure.

In relation to host properties within the site boundary, the definition of a noise sensitive location within NZS 6808:2010 specifically excludes dwellings within the wind farm site boundary.

In relation to host properties located outside of the site property, Victorian planning approvals for new wind farm developments typically specify that the noise limits do not apply at the locations where a noise agreement is in place between the wind farm developer and the land owner.

Accordingly, the base noise criterion of NZS 6808:2010 is not applied to host properties within this assessment. For these properties, it is normal practice to use the recommendations outlined in the final report by *The European Working Group on Noise from Wind Turbines* (ETSU-R-97) which allows for an increased base noise limit of 45 dB L_{A90} in lieu of the 40 dB L_{A90} minimum noise limit.

The increased base noise level has been adopted as a reference level for host dwellings (noise sensitive locations only – secondary host dwellings not assessed) in the assessment presented herein. The final noise criteria applied to these host dwellings would be dependent on the terms of any noise agreement reached with the land owners. It is recommended that these agreements clearly define the noise standard to be achieved in each instance.

6.3 Applicable noise limits

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, as the limit of 40 dB L_{A90} represents the lowest limit which should be applied at a noise sensitive location in accordance with NZS 6808:2010.

The reference level of 45 dB L_{A90} has been used for host dwellings as detailed in Section 6.2.

7.0 NOISE PREDICTIONS

7.1 Methodology

Noise from the Golden Plains Wind Farm has been predicted using 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. Predictions have been carried out using the sound power level data presented in Section 2.2.2.

Section C6.2.1 of NZS 6808:2010 states that, *for the purposes of this Standard, the predicted wind farm* [L_{Aeq}] *at any receiver location is deemed to be equivalent to the* [L_{A90}] *value*.

Calculations have been performed using octave band data from 31.5 Hz to 8 kHz and each wind turbine has been modelled as a point source at hub height. All noise predictions use a receiver height of 1.5 m above ground level (AGL). Possible screening effects from the landscape are considered using 10 m elevation contour information provided by the proponent. Atmospheric attenuation has been modelled using a temperature of 10 °C and 70 % humidity as recommended by NZS 6808:2010.

The characteristics of the ground between the sources and the receivers need to be defined in terms of a ground factor (G) in accordance with ISO 9613-2:1996. Hard ground (G=0) is defined by the standard as reflective surfaces with a low porosity, such as water, ice, and concrete. Porous ground (G=1) is defined as *including ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land*. A third category is defined as Mixed ground, where the surface consists of a mix of hard and porous surfaces, the value of G on values ranging from 0 to 1, the values being the fraction of the region that is porous.

The land around the Golden Plains Wind Farm and in the vicinity of residential receivers is predominantly characterised as porous ground according to ISO 9613-2:1996, being land which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. This would imply that the appropriate ground factor to use for modelling the Golden Plains Wind Farm would be G=1. However, empirical studies have shown that G=1 is not suitable when applying ISO 9613-2:1996 to the source heights and separating distances associated with wind farms. It is for this reason that a mixed ground factor of G=0.5 has been adopted in this assessment, rather than G=1 as suggested by the standard.

This is consistent with the recommendations of NZS 6808:2010 and relevant international guidance on the modelling of wind farm noise levels. Further details regarding the use of ISO 9613-2:1996 for wind farm noise predictions and the use of G=0.5 is presented in Appendix D.

7.2 Predicted noise levels

The noise sensitive receiver locations where operational wind farm noise levels are predicted to be higher than 35 dB L_{A90} are listed in Table 3, along with the predicted noise levels for each candidate turbine model.

The predicted levels correspond to the highest sound power level presented in Section 2.2.2, when the wind farm's noise emissions have reached their highest level (corresponding to hub-height wind speeds of 9 m/s or greater).

Table 3: Noise sensitive locations - highest predicted noise levels - dB L_{A90}

Receiver	Status	Applicable base noise limit	Senvion 3.6M140	Vestas V136-3.6
AA18 - a	Host	45	36.8	38.1
AA27 - a	Neighbour	40	34.4	36.0
AA27 - b	Host	45	33.8	35.4
AB18 - a	Neighbour	40	33.8	35.3
AC18 - a	Neighbour	40	34.1	35.5
AC22 - a	Neighbour	40	36.4	37.7
AC22 - b	Host	45	37.0	38.4
AD23 - a	Neighbour	40	35.9	37.3
AD24 - a	Host	45	36.2	37.5
G35 - b	Host	45	41.6	43.0
H30 - a	Neighbour	40	33.5	35.0
H32 - a	Neighbour	40	36.4	37.7
H32 - b	Host	45	38.3	39.7
H37 - a	Host	45	34.8	36.1
J28 - a	Host	45	39.8	41.1
K27 - a	Neighbour	40	36.4	37.8
K30 - a	Host	45	42.4	43.7
K32 - a	Host	45	41.9	43.2
L26 - a	Neighbour	40	36.0	37.4
L32 - a	Host	45	41.6	42.9
L33 - a	Host	45	41.5	42.8
M34 - a	Host	45	39.6	40.9
M35 - a	Host	45	40.0	41.3
M35 - b	Neighbour	40	35.8	37.1
N25 - a	Neighbour	40	35.3	36.8
N25 - b	Neighbour	40	35.2	36.7
N26 - a	Host	45	40.3	41.6
N28 - a	Host	45	42.9	44.2
N32 - a	Host	45	41.9	43.2
O24 - a	Host	45	34.0	35.6
O30 - a	Host	45	41.2	42.6
O32 - a	Host	45	40.6	42.0

Receiver	Status	Applicable base noise limit	Senvion 3.6M140	Vestas V136-3.6
O34 - a	Neighbour	40	35.1	36.6
O34 - b	Neighbour	40	34.9	36.4
P24 - a	Host	45	34.6	36.1
P24 - b	Host	45	35.5	37.1
P25 - a	Host	45	37.6	39.1
P31 - a	Neighbour	40	37.7	39.1
P31 - c	Neighbour	40	37.7	39.1
Q30 - a	Neighbour	40	38.1	39.5
Q31 - a	Neighbour	40	35.9	37.3
Q31 - b	Neighbour	40	35.2	36.7
Q31 - c	Neighbour	40	34.6	36.2
Q31 - e	Neighbour	40	34.5	36.1
Q31 - f	Neighbour	40	34.6	36.2
Q31 - g	Neighbour	40	34.6	36.2
Q31 - h	Neighbour	40	34.7	36.3
Q31 - i	Neighbour	40	34.8	36.3
Q31 - j	Neighbour	40	34.8	36.3
Q31 - k	Neighbour	40	34.8	36.3
Q31 - l	Neighbour	40	34.8	36.4
Q31 - m	Neighbour	40	35.0	36.5
Q31 - o	Neighbour	40	36.1	37.6
Q32 - a	Neighbour	40	34.3	35.9
Q32 - b	Neighbour	40	34.3	35.9
Q32 - c	Neighbour	40	34.1	35.7
Q32 - d	Neighbour	40	34.0	35.7
Q32 - e	Neighbour	40	33.7	35.4
Q32 - f	Neighbour	40	34.0	35.6
Q32 - g	Neighbour	40	34.3	35.8
R31 - aa	Neighbour	40	35.9	37.4
R31 - ab	Neighbour	40	36.4	37.8
R31 - ad	Neighbour	40	36.8	38.3
R31 - ae	Neighbour (School)	40	36.5	38.0
R31 - af	Neighbour (Childcare)	40	36.4	37.9

Receiver	Status	Applicable base noise limit	Senvion 3.6M140	Vestas V136-3.6
R31 - ai	Neighbour	40	36.7	38.1
R31 - aj	Neighbour	40	36.3	37.8
R31 - ak	Neighbour	40	36.3	37.7
R31 - al	Neighbour	40	36.2	37.6
R31 - am	Neighbour	40	35.9	37.3
R31 - an	Neighbour	40	35.7	37.2
R31 - ao	Neighbour	40	35.6	37.1
R31 - ap	Neighbour	40	36.3	37.7
R31 - aq	Neighbour	40	36.1	37.6
R31 - ar	Neighbour	40	36.2	37.7
R31 - as	Neighbour	40	36.0	37.5
R31 - at	Neighbour	40	36.1	37.6
R31 - av	Neighbour	40	35.9	37.4
R31 - aw	Neighbour	40	35.8	37.3
R31 - ax	Neighbour	40	35.9	37.4
R31 - az	Neighbour	40	35.8	37.3
R31 - b	Neighbour	40	36.1	37.5
R31 - ba	Neighbour	40	36.1	37.6
R31 - bb	Neighbour	40	35.6	37.1
R31 - bc	Neighbour	40	35.7	37.2
R31 - bd	Neighbour	40	35.7	37.2
R31 - be	Neighbour	40	37.3	38.7
R31 - c	Neighbour	40	35.4	36.9
R31 - d	Host	45	36.0	37.4
R31 - f	Neighbour	40	35.7	37.2
R31 - g	Neighbour	40	35.8	37.3
R31 - h	Neighbour	40	35.7	37.2
R31 - j	Neighbour	40	35.5	37.0
R31 - k	Neighbour	40	35.5	37.0
R31 - n	Neighbour	40	35.3	36.8
R31 - q	Neighbour	40	34.3	35.9
R31 - r	Neighbour	40	35.3	36.8
R31 - s	Neighbour	40	35.2	36.7

Receiver	Status	Applicable base noise limit	Senvion 3.6M140	Vestas V136-3.6
R31 - t	Neighbour	40	35.3	36.8
R31 - u	Neighbour	40	35.3	36.8
R31 - v	Neighbour	40	35.4	36.9
R31 - w	Neighbour	40	35.4	36.9
R31 - z	Neighbour	40	35.7	37.1
R32 - a	Neighbour	40	33.5	35.2
R32 - b	Neighbour	40	33.9	35.5
R32 - c	Neighbour	40	34.1	35.7
R32 - d	Neighbour	40	34.2	35.8
U18 - a	Neighbour	40	35.1	36.6
U18 - b	Neighbour	40	36.0	37.4
U18 - c	Neighbour	40	35.7	37.2
V20 - a	Host	45	41.5	42.9
V30 - a	Neighbour	40	36.6	38.0
W17 - a	Neighbour	40	37.2	38.5
W20 - a	Host	45	41.2	42.5
W21 - a	Host	45	41.0	42.3
W21 - b	Host	45	41.2	42.5
W25 - a	Host	45	42.9	44.2
W25 - b	Host	45	42.8	44.1
W28 - a	Neighbour	40	37.1	38.5
X18 - a	Host	45	39.1	40.5
Y28 - a	Neighbour	40	34.0	35.6
Z20 - a	Host	45	41.3	42.6
Z20 - b	Host	45	41.8	43.1
Z25 - a	Host	45	43.0	44.4
Z28 - a	Neighbour	40	33.5	35.1

The following can be seen from Table 3:

- Neighbouring dwellings: predicted noise levels from the Golden Plains Wind Farm comply with the NZS 6808:2010 base noise limit of 40 dB at all neighbour dwellings, the school and child care facility for both candidate wind turbine models
- Host dwellings: predicted noise levels from the Golden Plains Wind Farm achieve the reference level of 45 dB at all locations for both candidate wind turbine models.

Wind farm noise at all noise sensitive locations further from the wind farm will be lower than or equal to 35 dB L_{A90} and therefore also comply with the lowest applicable NZS 6808:2010 noise limit of 40 dB L_{A90} at all wind speeds by at least 5 dB.

As noted in Section 2.3, secondary dwellings on host properties are the subject of a noise agreement between WestWind and the land owners (agreements which are presently being documented), and are therefore not assessed against the NZS 6808:2010 base noise limit or the reference level adopted for host dwellings. However, for completeness, the highest predicted noise levels for secondary host dwellings are provided in Table 4 for reference purposes.

Table 4: Secondary host dwellings - highest predicted noise levels - dB L_{A90}

Receiver	Senvion 3.6M140	Vestas V136-3.6
AA25 - a	44.5	45.9
M28 - a	43.7	45.1
R27 - a	43.7	45.1
T24 - a	44.1	45.4
T27 - a	45.2	46.6
V18 - a	44.9	46.3

Noise contour maps are presented in Appendix E for the highest sound power levels corresponding to the Vestas V136-3.6 turbine, providing the highest predicted noise levels.

If the turbine selection and/or layout are to be changed, compliance with the relevant noise limit will need to be reassessed.

7.3 Special audible characteristics

Based on the information provided in Section 2.2.3, it is considered that a penalty for tonality is not applicable for any of the assessed wind speeds. As modern commercial-scale wind turbines are not considered an intrinsically tonal source of noise, this approach is consistent with accepted practice for wind farm noise assessment.

This approach is also is based on the premise that the turbine procurement contract for the site would normally stipulate that the turbines must not produce emissions which would attract a penalty for tonality when assessed in accordance with the relevant noise criteria and any associated conditions of consent.

8.0 CONCLUSION

The Golden Plains Wind Farm is proposed to consist of two hundred and thirty-one (231) turbines in western Victoria.

A preliminary assessment has been undertaken in accordance with NZS 6808:2010 as required by the current Victorian Guidelines for the purpose of a referral under the *Environmental Effects Act 1978*.

This assessment considered two hundred and twenty (220) properties identified by WestWind Energy within 3 km of the project turbines.

The assessment has been carried out on the basis of representative noise emission data for two (2) candidate wind turbine models (Senvion 3.6M140 and Vestas V136-3.6) which are indicative of the types of turbine which may be considered for the development.

Wind farm noise levels have been predicted using ISO 9613-2:1996 as recommended by NZS 6808:2010. The predicted noise levels for each candidate turbine model have been assessed against a base noise limit of 40 dB L_{A90} for neighbour properties identified as noise sensitive locations in accordance with NZS 6808:2010. The value of 40 dB for the base noise limit was determined from a review of land zoning surrounding the proposed site indicates that high amenity noise limits are not applicable.

For host dwellings, a reference level of 45 dB L_{A90} was considered on the basis of supplementary UK guidance that is commonly referenced in Victoria (ETSU-R-97).

Compliance with the NZS 6808:2010 base noise limit of 40 dB L_{A90} is achieved at all wind speeds at all neighbour dwellings and non-residential noise sensitive locations (a school and a child care facility) identified in the vicinity of the proposed Golden Plains wind Farm for both candidate wind turbine models.

Predicted noise levels at the primary dwellings of host properties (the main place of residence of host land owners) achieve the reference level of 45 dB L_{A90} at all wind speeds for both candidate wind turbine models. Secondary dwellings located on host properties are the subject of agreements between WestWind and host land owners which are presently being documented. Noise levels at these secondary dwellings have therefore not been directly assessed, however predicted noise level information has been provided for these locations for reference purposes.

Once the turbine selection and layout has been finalised, the assessment in accordance with the Victorian Guidelines will need to be revised and compliance with the relevant noise limits will need to be reassessed.

9.0 SUMMARY OF PARAMETERS

Documentation of relevant parameters as required by NZS 6808:2010 is contained in Appendix F.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
dB	Decibel. The unit of sound level.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63 Hz to 8000 Hz (8 kHz). This is roughly equal to the range of frequencies on a piano.
Octave band	Sound, which can occur over a range of frequencies, may be divided into octave bands for analysis. The audible frequency range is generally divided into eight (8) octave bands. The octave band frequencies are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz.

Noise is often not steady. Traffic noise, music noise and the barking of dogs are all examples of noises that vary over time. When such noises are measured, the noise level can be expressed as an average level, or as a statistical measure, such as the level exceeded for 90 % of the time.

L_{A90}	The A-weighted noise level exceeded for 90 % of the measurement period. This is commonly referred to as the background noise level.
L_{Aeq}	The A-weighted equivalent continuous sound level. This is commonly referred to as the average noise level.

APPENDIX B GOLDEN PLAINS WIND FARM LAYOUT

B1 Site layout plans

Figure 3: Site layout – North West

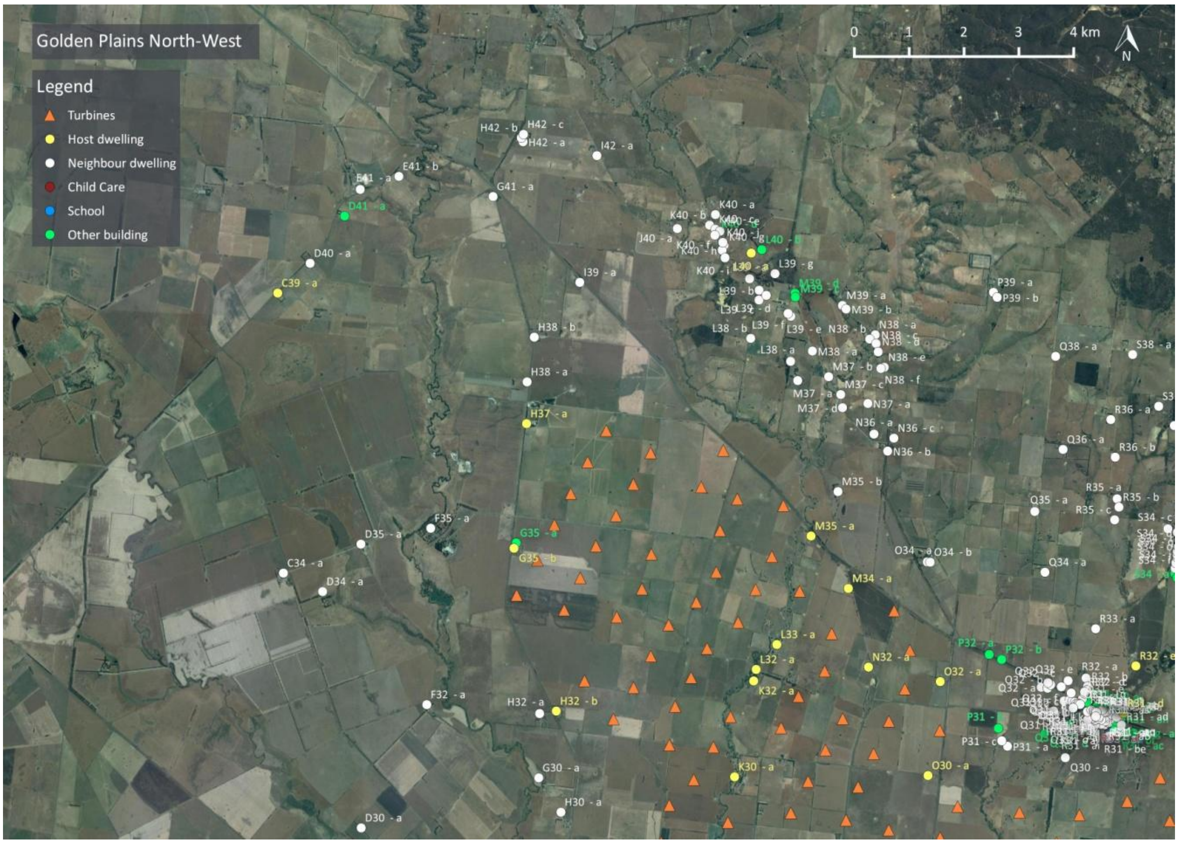


Figure 4: Site layout – North East

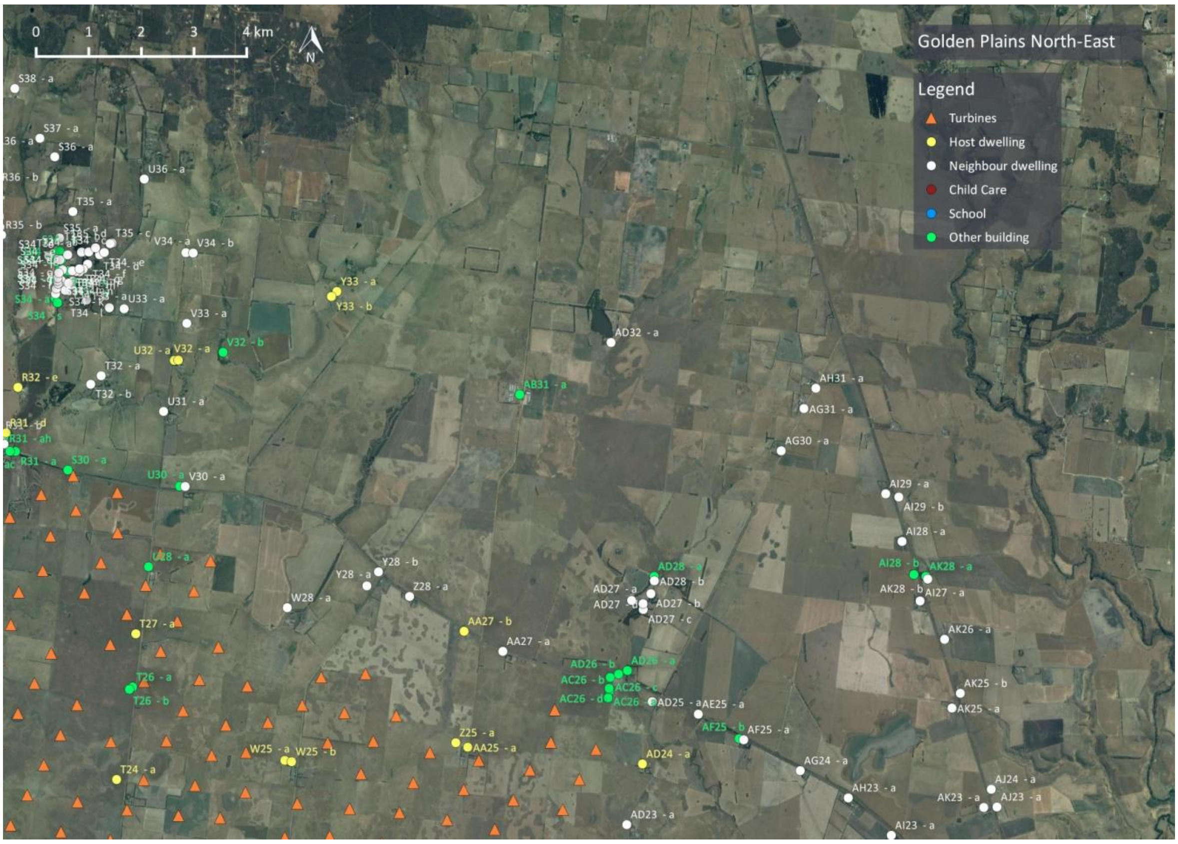


Figure 5: Site layout – South West

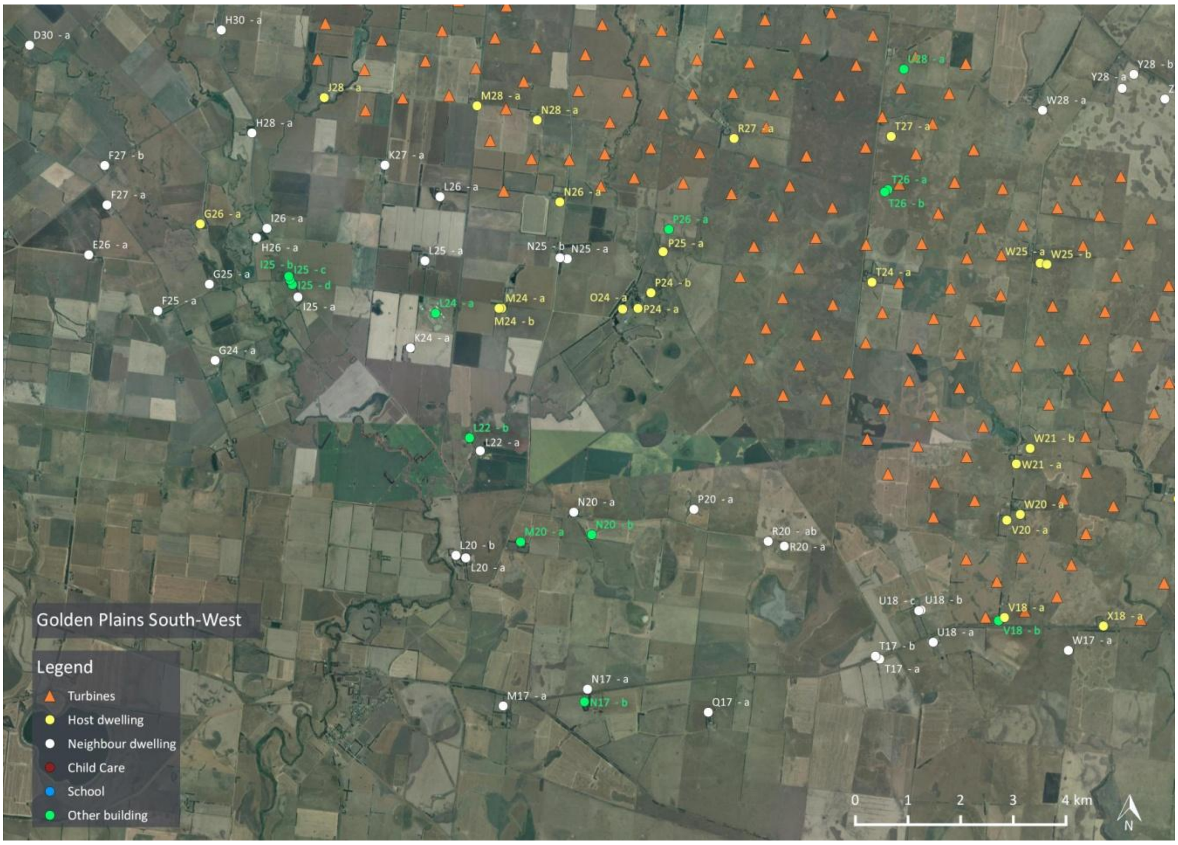


Figure 6: Site layout – South East

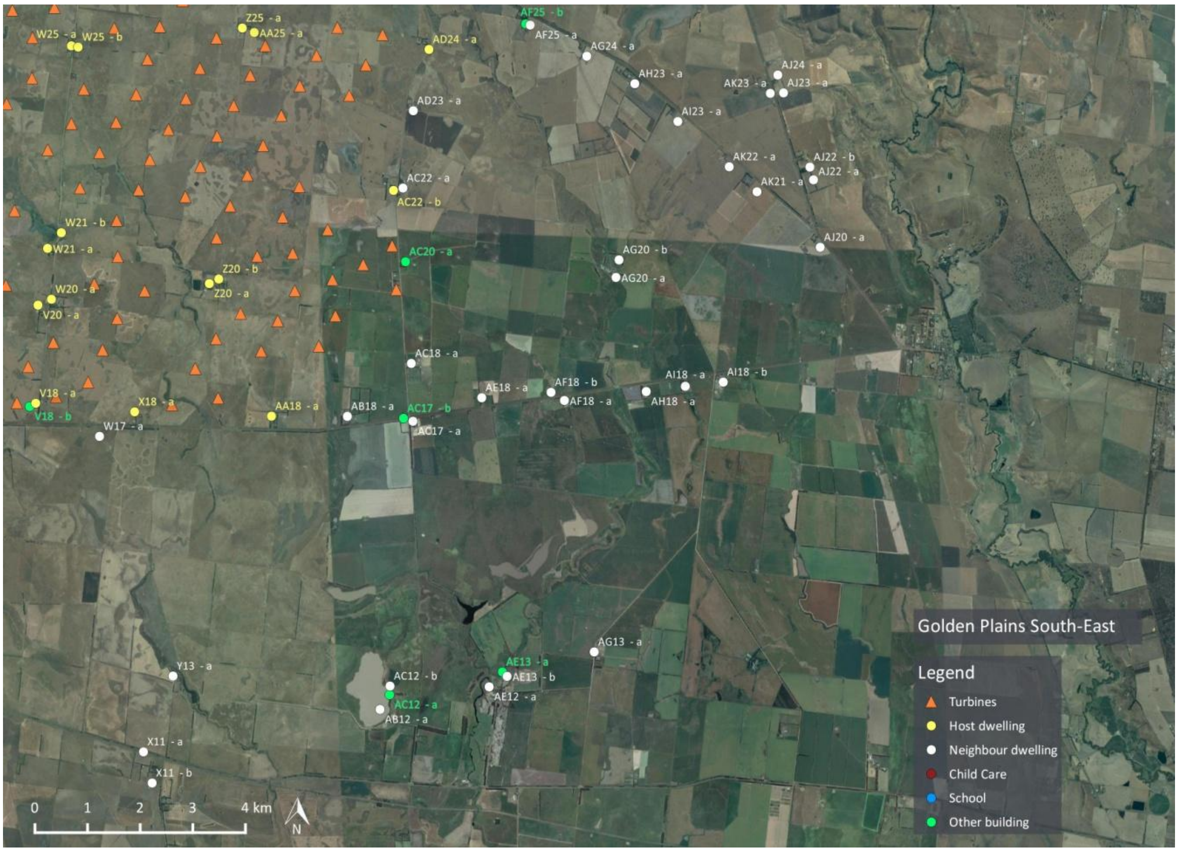


Figure 7: Site layout – Rokewood Township

Figure 8: Site layout – Corindhap Township

B2 Turbine coordinates (MGA94 Zone 55)

Turbine	Easting	Northing	Turbine	Easting	Northing
GP001	728745	5804250	GP117	740984	5793280
GP002	729152	5804867	GP118	741050	5798510
GP003	729492	5805489	GP119	741269	5792022
GP004	729599	5803943	GP120	741326	5793833
GP005	729817	5806040	GP121	741392	5799063
GP006	729867	5802665	GP122	741421	5795685
GP007	729919	5804507	GP123	741496	5797517
GP008	730152	5806596	GP124	741611	5792574
GP009	730232	5805071	GP125	741668	5794385
GP010	730405	5801929	GP126	741734	5799616
GP011	730518	5807148	GP127	741765	5800373
GP012	730551	5803771	GP128	741839	5798069
GP013	730624	5805602	GP129	741631	5791346
GP014	730797	5802482	GP130	742011	5794938
GP015	730966	5806155	GP131	742105	5796790
GP016	731034	5804255	GP132	742118	5793082
GP017	731139	5803035	GP133	742219	5791848
GP018	731171	5799657	GP134	742221	5798598
GP019	731235	5804877	GP135	742296	5793679
GP020	731308	5806708	GP136	742447	5797343
GP021	731349	5800323	GP137	742456	5790495
GP022	731402	5801412	GP138	742476	5795651
GP023	731490	5803582	GP139	742562	5792400
GP024	731540	5802103	GP140	742523	5799175
GP025	731816	5800764	GP141	742638	5794232
GP026	731854	5802614	GP142	742514	5791145
GP027	732013	5803970	GP143	742790	5797895
GP028	732033	5798656	GP144	742819	5796203
GP029	732050	5799421	GP145	742980	5794784
GP030	732171	5803126	GP146	743041	5789672
GP031	732200	5806048	GP147	743070	5792906
GP032	732202	5801338	GP148	743108	5793545

Turbine	Easting	Northing	Turbine	Easting	Northing
GP033	732402	5799963	GP149	743132	5798447
GP034	732403	5804497	GP150	743141	5791600
GP035	732506	5805246	GP151	743157	5796776
GP036	732539	5801869	GP152	743323	5795337
GP037	732635	5806691	GP153	743359	5788564
GP038	732748	5798854	GP154	743254	5790767
GP039	732759	5803571	GP155	743428	5794152
GP040	732848	5805799	GP156	743474	5799000
GP041	733104	5804147	GP157	743483	5792152
GP042	733215	5799528	GP158	743547	5797371
GP043	733429	5804731	GP159	743606	5789228
GP044	733452	5801627	GP160	743620	5795894
GP045	733557	5800081	GP161	743931	5794610
GP046	733634	5798856	GP162	743979	5795364
GP047	733682	5805640	GP163	744061	5796612
GP048	733794	5802180	GP164	744105	5789657
GP049	733899	5800634	GP165	744110	5788640
GP050	733906	5804080	GP166	744168	5793257
GP051	734167	5799355	GP167	744420	5795907
GP052	734241	5801187	GP168	744640	5793725
GP053	734294	5802616	GP169	744732	5788886
GP054	734375	5797973	GP170	744746	5792516
GP055	734454	5803286	GP171	744906	5794357
GP056	734557	5799903	GP172	744933	5790713
GP057	734583	5801739	GP173	745034	5789473
GP058	734588	5797015	GP174	745087	5796204
GP059	734702	5798560	GP175	745149	5793157
GP060	734805	5800492	GP176	745404	5791201
GP061	735063	5799055	GP177	745338	5790047
GP062	735116	5801080	GP178	745415	5791878
GP063	735141	5797594	GP179	745471	5796712
GP064	735327	5799686	GP180	745491	5793710
GP065	735423	5801653	GP181	745538	5795467

Turbine	Easting	Northing	Turbine	Easting	Northing
GP066	735611	5803646	GP182	745860	5792433
GP067	735740	5802224	GP183	745881	5796019
GP068	735861	5797542	GP184	745884	5790539
GP069	735864	5802918	GP185	745896	5794209
GP070	736095	5798839	GP186	746100	5792983
GP071	736258	5799505	GP187	746141	5794859
GP072	736342	5801443	GP188	746312	5789784
GP073	736435	5797016	GP189	746316	5796735
GP074	736538	5797621	GP190	746404	5795457
GP075	736603	5800053	GP191	746479	5793528
GP076	736662	5798211	GP192	746739	5792260
GP077	737026	5798778	GP193	746838	5794091
GP078	737076	5797145	GP194	746777	5789044
GP079	737383	5799342	GP195	746862	5795919
GP080	737419	5797698	GP196	747051	5792809
GP081	737685	5798324	GP197	747128	5794640
GP082	737725	5799895	GP198	747185	5788472
GP083	738001	5797002	GP199	747198	5789584
GP084	738262	5798675	GP200	747298	5791463
GP085	738343	5797555	GP201	747394	5793361
GP086	738376	5799318	GP202	747470	5795193
GP087	738815	5799798	GP203	747582	5792047
GP088	738818	5793047	GP204	747686	5790033
GP089	738910	5796759	GP205	747736	5793914
GP090	738997	5795194	GP206	747936	5792606
GP091	739028	5798660	GP207	748043	5789309
GP092	739101	5793648	GP208	748052	5791084
GP093	739288	5795748	GP209	748079	5794466
GP094	739369	5797339	GP210	748261	5793145
GP095	739370	5799213	GP211	748386	5789861
GP096	739443	5794201	GP212	748391	5795006
GP097	739626	5797979	GP213	748569	5791793
GP098	739681	5796300	GP214	748633	5793690

Turbine	Easting	Northing	Turbine	Easting	Northing
GP099	739698	5800003	GP215	748729	5791106
GP100	739709	5792921	GP216	748735	5790407
GP101	739785	5794754	GP217	748912	5792346
GP102	739805	5798585	GP218	749011	5794225
GP103	740023	5796852	GP219	749142	5789351
GP104	740052	5793475	GP220	749354	5794777
GP105	740127	5795306	GP221	749415	5791518
GP106	740279	5798970	GP222	749460	5790582
GP107	740318	5800401	GP223	749485	5789903
GP108	740366	5797405	GP224	749775	5795280
GP109	740394	5794027	GP225	749940	5794002
GP110	740457	5799615	GP226	750057	5790834
GP111	740470	5795859	GP227	749878	5795889
GP112	740525	5792812	GP228	750283	5794555
GP113	740736	5794580	GP229	750622	5791159
GP114	740812	5796411	GP230	750626	5795107
GP115	740942	5800729	GP231	750686	5790331
GP116	740963	5800075			

B3 Property coordinates (MGA94 Zone 55) – Neighbour properties

Property	Easting	Northing	Distance to nearest turbine (m)*	Property	Easting	Northing	Distance to nearest turbine (m)*
AA27 - a	748,944	5,797,036	1,485	Q32 - c	738,402	5,802,176	2,190
AB18 - a	749,623	5,788,015	1,426	Q32 - d	738,354	5,802,214	2,159
AC17 - a	750,863	5,787,865	2,278	Q32 - e	738,723	5,802,232	2,432
AC18 - a	750,884	5,788,946	1,405	Q32 - f	738,594	5,802,128	2,344
AC22 - a	750,880	5,792,226	1,105	Q32 - g	738,769	5,802,008	2,214
AD23 - a	751,144	5,793,660	1,248	Q34 - a	738,393	5,804,213	2,842
AD25 - a	751,734	5,795,954	1,401	R20 - ab	739,297	5,790,184	2,611
AD27 - a	751,435	5,797,880	2,531	R20 - a	739,599	5,790,079	2,398
AD27 - b	751,807	5,797,990	2,855	R31 - aa	739,526	5,801,566	1,415
AD27 - c	751,647	5,797,700	2,535	R31 - ab	739,349	5,801,407	1,403
AD27 - d	751,648	5,797,808	2,614	R31 - ad	739,657	5,801,387	1,194
AE18 - a	752,191	5,788,243	2,578	R31 - ai	739,170	5,801,275	1,383
AE25 - a	752,600	5,795,678	2,059	R31 - aj	739,146	5,801,363	1,473
AF25 - a	753,439	5,795,155	2,816	R31 - ak	739,292	5,801,418	1,450
D35 - a	725,951	5,805,306	2,989	R31 - al	739,182	5,801,416	1,510
F32 - a	727,015	5,802,349	2,574	R31 - am	739,182	5,801,499	1,585
F35 - a	727,236	5,805,534	1,985	R31 - an	739,132	5,801,532	1,636
G30 - a	728,994	5,800,930	1,734	R31 - ao	739,070	5,801,564	1,688
H28 - a	729,859	5,798,327	1,872	R31 - ap	739,420	5,801,443	1,381
H30 - a	729,369	5,800,291	1,915	R31 - aq	739,450	5,801,493	1,401
H32 - a	729,064	5,802,091	995	R31 - ar	739,402	5,801,462	1,407
H38 - a	729,116	5,808,096	1,697	R31 - as	739,355	5,801,496	1,464
H38 - b	729,285	5,808,898	2,145	R31 - at	739,367	5,801,474	1,439
I26 - a	730,060	5,796,521	2,910	R31 - av	739,381	5,801,528	1,471
I39 - a	730,161	5,809,849	2,728	R31 - aw	739,370	5,801,553	1,498
K27 - a	732,355	5,797,605	1,107	R31 - ax	739,294	5,801,500	1,508
L25 - a	733,029	5,795,769	2,000	R31 - az	739,497	5,801,582	1,444
L26 - a	733,373	5,796,960	1,223	R31 - b	739,619	5,801,552	1,352
L38 - a	733,936	5,808,242	2,029	R31 - ba	739,575	5,801,533	1,361
L38 - b	733,229	5,808,692	2,091	R31 - bb	739,227	5,801,576	1,609
L39 - b	733,422	5,809,554	2,972	R31 - bc	739,220	5,801,563	1,603

Property	Easting	Northing	Distance to nearest turbine (m)*	Property	Easting	Northing	Distance to nearest turbine (m)*
L39 - c	733,411	5,809,378	2,800	R31 - bd	739,214	5,801,548	1,598
L39 - d	733,548	5,809,456	2,914	R31 - be	739,422	5,801,198	1,206
L39 - e	733,978	5,809,056	2,723	R31 - c	739,104	5,801,611	1,718
L39 - f	733,930	5,809,110	2,747	R31 - f	739,045	5,801,510	1,648
M35 - b	734,689	5,805,847	1,036	R31 - g	739,245	5,801,523	1,558
M37 - a	734,049	5,807,888	1,857	R31 - h	739,254	5,801,555	1,575
M37 - b	734,617	5,807,932	2,342	R31 - j	739,397	5,801,638	1,548
M37 - c	734,822	5,807,599	2,270	R31 - k	739,370	5,801,644	1,569
M37 - d	734,842	5,807,361	2,080	R31 - n	739,324	5,801,676	1,622
M38 - a	734,342	5,808,410	2,426	R31 - q	739,009	5,801,990	2,063
N25 - a	735,734	5,795,678	1,516	R31 - r	739,050	5,801,658	1,782
N25 - b	735,596	5,795,705	1,562	R31 - s	739,122	5,801,682	1,757
N36 - a	735,394	5,806,857	2,105	R31 - t	739,160	5,801,671	1,723
N36 - b	735,629	5,806,537	2,148	R31 - u	739,179	5,801,657	1,700
N36 - c	735,753	5,806,766	2,361	R31 - v	739,202	5,801,649	1,679
N37 - a	735,309	5,807,414	2,411	R31 - w	739,214	5,801,639	1,664
O34 - a	736,257	5,804,501	1,079	R31 - z	739,198	5,801,563	1,619
O34 - b	736,310	5,804,493	1,106	R32 - a	739,051	5,802,266	2,258
P20 - a	737,916	5,790,852	2,377	R32 - b	739,072	5,802,112	2,120
P31 - a	737,563	5,801,100	1,222	R32 - c	739,059	5,802,044	2,074
P31 - c	737,462	5,801,204	1,153	R32 - d	739,014	5,802,017	2,080
Q30 - a	738,607	5,800,844	1,074	R33 - a	739,269	5,803,149	2,944
Q31 - a	738,592	5,801,449	1,671	T17 - a	741,311	5,787,868	2,167
Q31 - b	738,434	5,801,699	1,942	T17 - b	741,231	5,787,929	2,224
Q31 - c	738,632	5,801,871	2,085	T32 - a	741,562	5,802,587	1,963
Q31 - e	738,967	5,801,890	2,015	T32 - b	741,355	5,802,435	1,760
Q31 - f	738,733	5,801,881	2,088	U18 - a	742,342	5,788,137	1,110
Q31 - g	738,785	5,801,858	2,064	U18 - b	742,142	5,788,754	1,239
Q31 - h	738,828	5,801,838	2,034	U18 - c	742,095	5,788,744	1,283
Q31 - i	738,852	5,801,805	1,995	U31 - a	742,715	5,801,859	1,768
Q31 - j	738,886	5,801,813	1,988	V30 - a	743,058	5,800,426	1,301
Q31 - k	738,901	5,801,800	1,970	W17 - a	744,900	5,787,864	1,044

Property	Easting	Northing	Distance to nearest turbine (m)*	Property	Easting	Northing	Distance to nearest turbine (m)*
Q31 - l	738,922	5,801,794	1,956	W28 - a	744,889	5,798,050	1,465
Q31 - m	738,791	5,801,735	1,941	Y28 - a	746,420	5,798,391	1,664
Q31 - o	738,965	5,801,387	1,571	Y28 - b	746,653	5,798,644	1,943
Q32 - a	738,225	5,802,138	2,011	Z28 - a	747,222	5,798,153	1,688
Q32 - b	738,341	5,802,115	2,113				

* Based on MDA's calculations

B4 Property coordinates (MGA94 Zone 55) – School and Child care

Property	Easting	Northing	Distance to nearest turbine (m)*	Use
R31 - ae	739,387	5,801,377	1,355	School
R31 - af	739,374	5,801,396	1,377	Child care

* Based on MDA's calculations

B5 Property coordinates (MGA4 Zone 55) – Host properties

Property	Easting	Northing	Distance to nearest turbine (m)*	Property	Easting	Northing	Distance to nearest turbine (m)*
AA18 - a	748,183	5,788,086	1,078	O32 - a	736,392	5,802,326	672
AA25 - a	748,193	5,795,262	348	P24 - a	737,032	5,794,683	2,034
AA27 - b	748,226	5,797,449	2,043	P24 - b	737,293	5,794,965	1,724
AC22 - b	750,698	5,792,190	1,041	P25 - a	737,560	5,795,728	1,354
AD24 - a	751,495	5,794,790	934	R27 - a	739,006	5,797,794	596
G35 - b	728,737	5,805,100	493	R31 - d	739,706	5,801,597	1,350
H32 - b	729,369	5,802,123	747	R32 - e	739,971	5,802,442	1,973
H37 - a	729,072	5,807,342	1,319	T24 - a	741,497	5,794,967	530
J28 - a	731,263	5,798,929	745	T27 - a	741,991	5,797,694	425
K30 - a	732,563	5,800,781	676	U32 - a	742,962	5,802,812	2,720
K32 - a	732,993	5,802,497	785	V18 - a	743,717	5,788,539	382
L32 - a	733,047	5,802,703	921	V20 - a	743,847	5,790,367	727
L33 - a	733,445	5,803,136	822	V32 - a	743,040	5,802,814	2,757
M24 - a	734,445	5,794,808	2,216	W20 - a	744,108	5,790,465	818
M24 - b	734,394	5,794,808	2,219	W21 - a	744,079	5,791,417	955
M28 - a	734,156	5,798,638	566	W21 - b	744,354	5,791,698	916
M34 - a	734,796	5,804,089	883	W25 - a	744,707	5,795,176	763
M35 - a	734,161	5,805,068	757	W25 - b	744,836	5,795,147	782
N26 - a	735,644	5,796,755	827	X18 - a	745,588	5,788,290	1,051
N28 - a	735,286	5,798,317	645	Z20 - a	747,119	5,790,617	824
N32 - a	735,097	5,802,650	782	Z20 - b	747,303	5,790,693	774
O24 - a	736,740	5,794,684	2,317	Z25 - a	747,970	5,795,356	541
O30 - a	736,089	5,800,639	790				

* Based on MDA's calculations

B6 Property coordinates (MGA4 Zone 55) – Other properties

The following locations represent the location of properties or structures that have been confirmed to not be noise sensitive receiver locations.

Property	Easting	Northing	Distance to nearest turbine (m)*	Use
AC17 - b	750,688	5,787,928	2,105	Community Hall
AC20 - a	750,865	5,790,850	414	Shed
AC26 - a	750,938	5,796,205	1,113	Shed
AC26 - b	750,929	5,796,247	1,117	Shed
AC26 - c	750,959	5,796,448	1,223	Shed
AC26 - d	750,902	5,796,064	1,004	Shed
AD26 - a	751,293	5,796,564	1,573	Community Hall
AD26 - b	751,121	5,796,505	1,393	Shed
AF25 - b	753,355	5,795,182	2,733	Shed
G35 - a	728,783	5,805,196	511	Shed
L24 - a	733,185	5,794,772	2,649	Grain Depot
P26 - a	737,689	5,796,142	923	Shed
P31 - b	737,412	5,801,432	1,078	Shed
P32 - a	737,308	5,802,776	1,457	Shed
P32 - b	737,530	5,802,673	1,689	Shed
Q31 - d	738,255	5,801,300	1,507	Shed
Q31 - n	738,687	5,801,439	1,651	Shed
R31 - a	739,870	5,801,236	956	Golf Club
R31 - ac	739,761	5,801,245	1,019	Shed
R31 - ag	739,524	5,801,421	1,299	RSL
R31 - ah	739,659	5,801,506	1,293	Shire Depot
R31 - au	739,424	5,801,504	1,425	Shed
R31 - ay	739,478	5,801,594	1,465	Emergency Facility
R31 - e	739,266	5,801,444	1,487	Shed
R31 - i	739,284	5,801,593	1,583	Petrol Station
R31 - l	739,052	5,801,832	1,915	Church
R31 - m	739,291	5,801,693	1,656	Police Station
R31 - o	739,262	5,801,728	1,701	Church
R31 - p	739,226	5,801,749	1,739	Community Hall

Property	Easting	Northing	Distance to nearest turbine (m)*	Use
R31 - x	739,231	5,801,632	1,648	General Store
R31 - y	739,242	5,801,616	1,628	Health Facility
R31 - bf	739,497	5,801,300	1,224	Shed
S30 - a	740,846	5,800,842	196	Shed
T26 - a	741,883	5,796,695	274	Shed
T26 - b	741,820	5,796,654	341	Shed
U28 - a	742,292	5,798,946	349	Shed
U30 - a	742,955	5,800,436	1,198	Shed
V18 - b	743,600	5,788,483	285	Emergency Facility

* Based on MDA's calculations

APPENDIX C ZONING MAPS

The zoning maps used in the following maps were downloaded from the Department of Environment, Land, Water & Planning *Planning Maps Online* website on May 2017.

Figure 9: Zoning map – North West

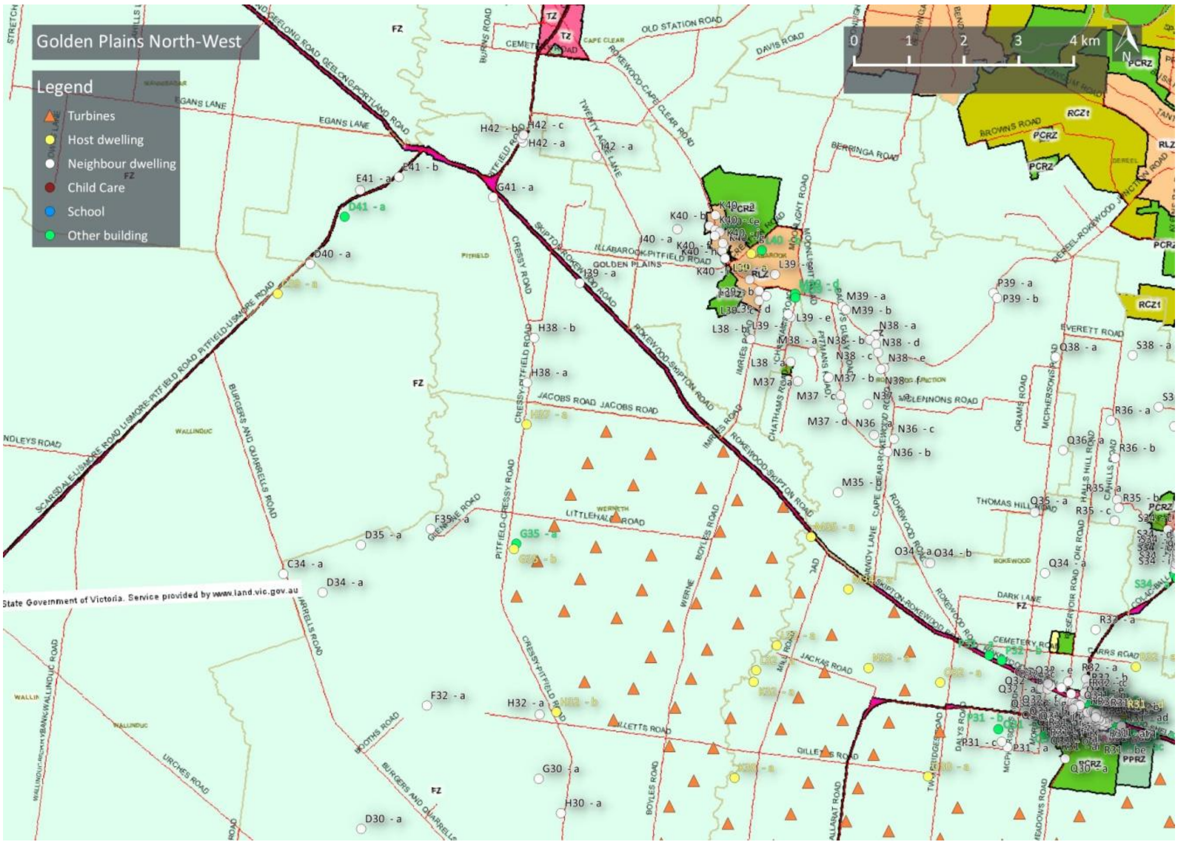


Figure 10: Zoning map – North East

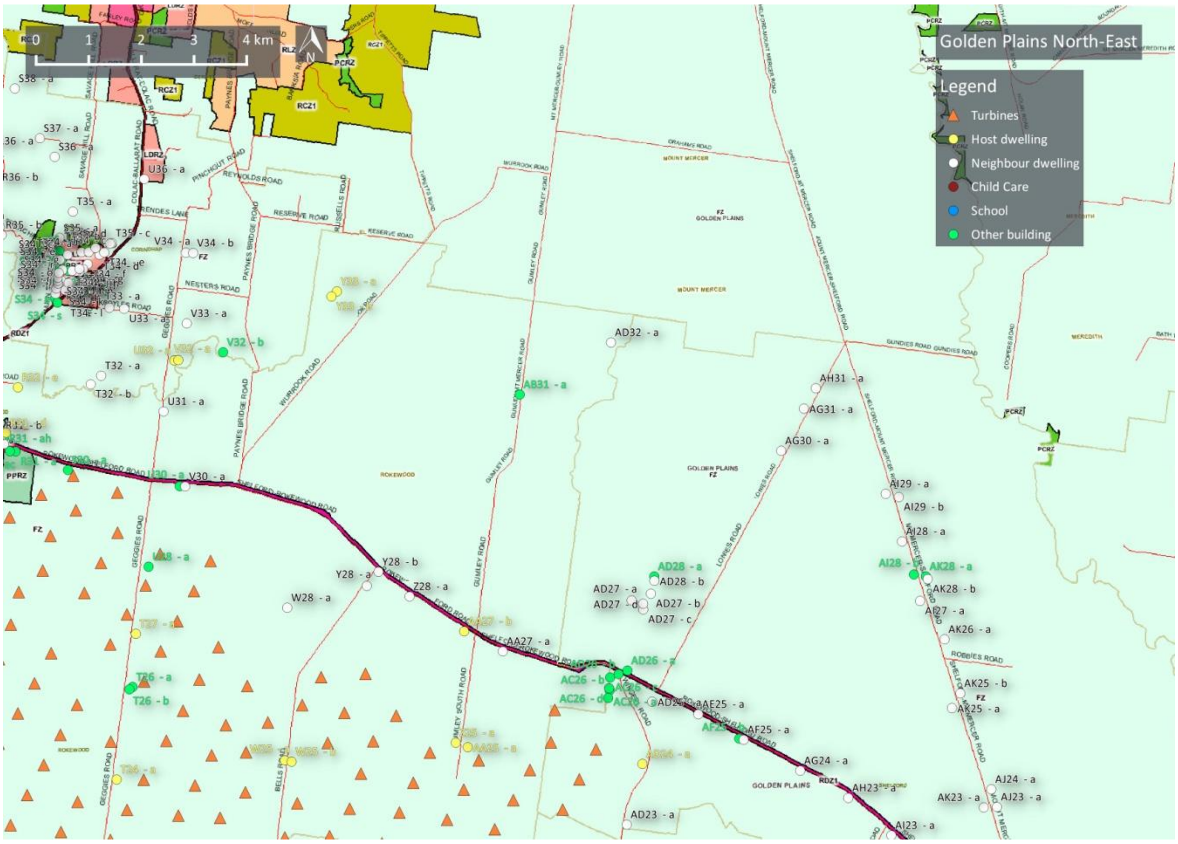


Figure 11: Zoning map – South West

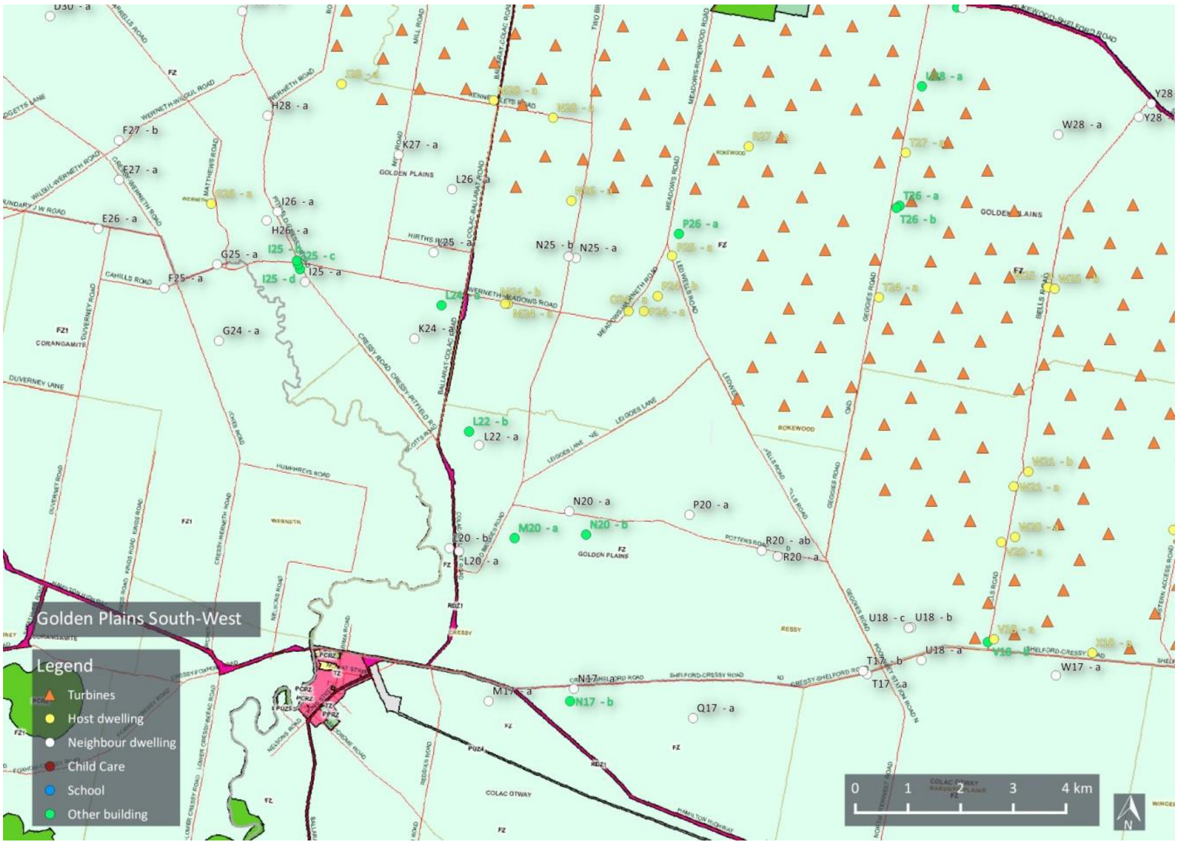


Figure 12: Zoning map – South East

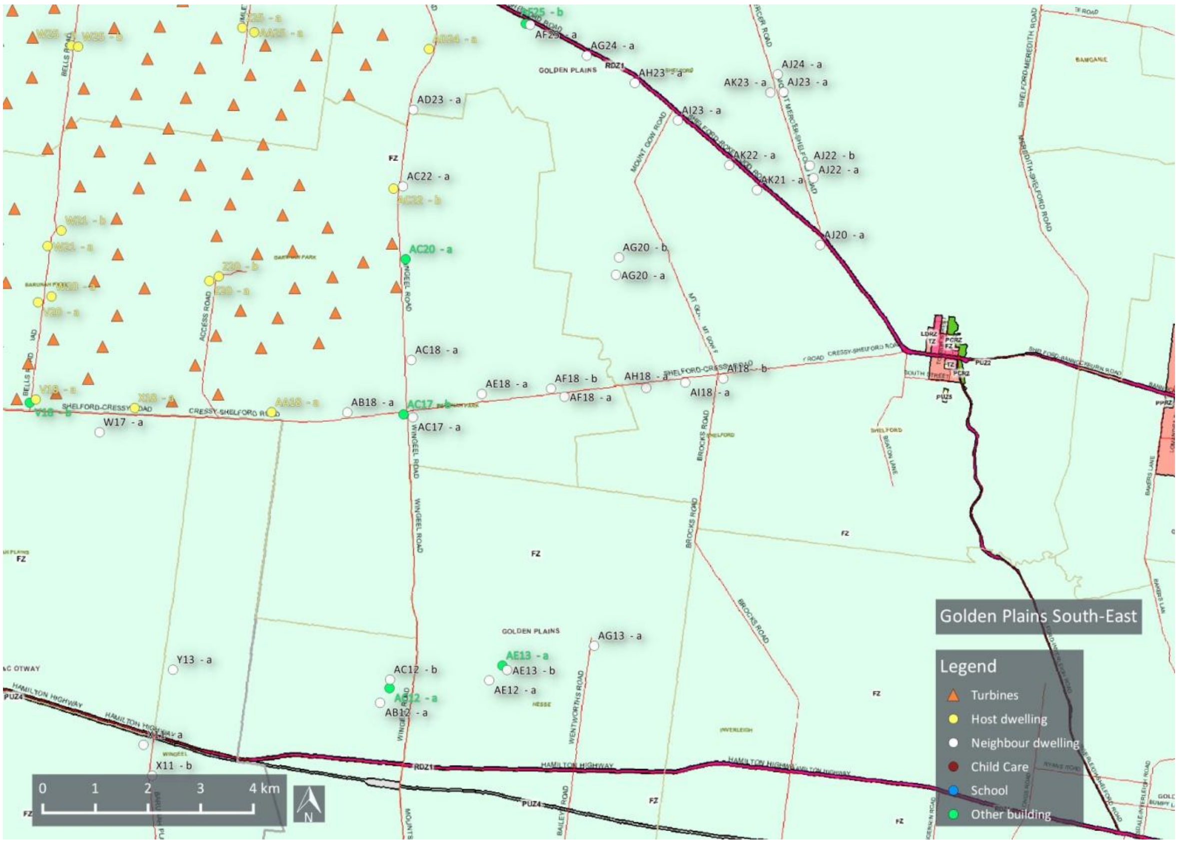


Figure 13: Zoning map – Rokewood Township

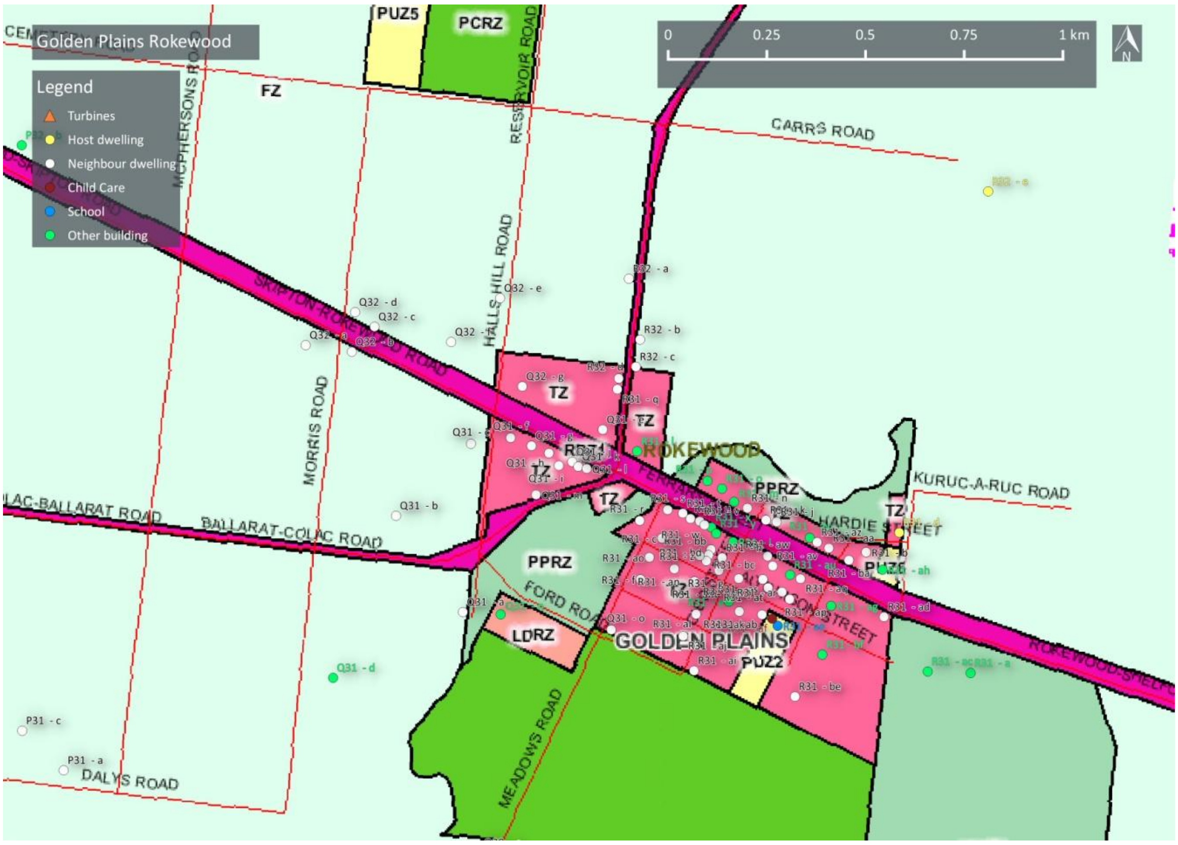
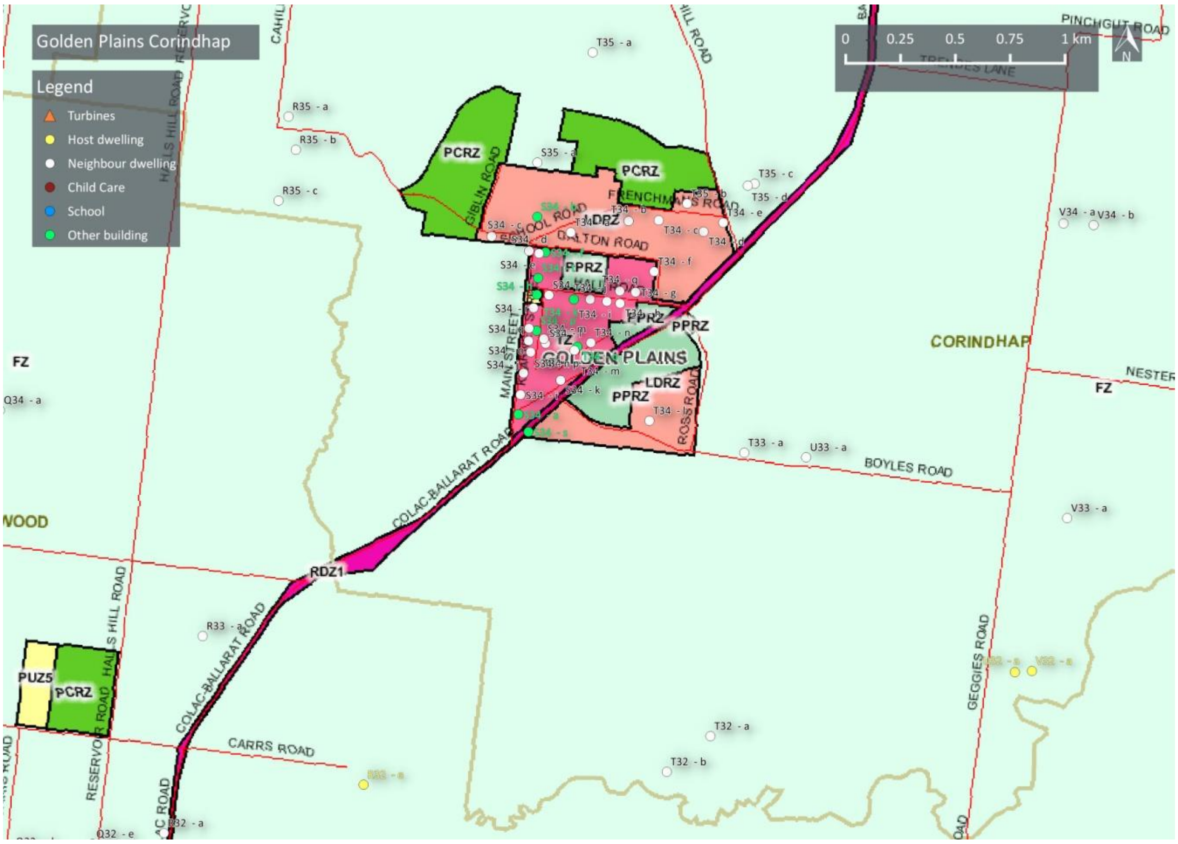


Figure 14: Zoning map – Corindhap Township



APPENDIX D NOISE PREDICTION MODEL

Operational wind farm noise levels are predicted at all residential dwellings considered within this assessment using a three-dimensional noise model generated in SoundPLAN® version 7.4 software. Specifically, predictions have been carried out using the SoundPLAN implementation of ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996) to calculate noise propagation from the wind farm to each receiver location.

The use of this method is supported by international research publications, measurement studies conducted by Marshall Day Acoustics and direct reference to the standard in NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010).

The standard specifies an engineering method for calculating noise at a known distance from a variety of sources under meteorological conditions favourable to sound propagation. The standard defines favourable conditions as downwind propagation where the source blows from the source to the receiver within an angle of +/-45 degrees from a line connecting the source to the receiver, at wind speeds between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground. Equivalently, the method accounts for average propagation under a well-developed moderate ground based thermal inversion. In this respect, it is noted that at the wind speeds relevant to noise levels from wind turbines, atmospheric conditions do not favour the development of thermal inversions throughout the propagation path from the source to the receiver.

To calculate far-field noise levels according to the ISO 9613-2:1996, the noise levels of each wind turbine are firstly characterised in the form of octave band frequency levels. A series of octave band attenuation factors are then calculated for a range of effects including:

- Geometric divergence
- Air absorption
- Reflecting obstacles
- Screening
- Vegetation
- Ground reflections

The octave band attenuation factors are then applied to the sound power level data to determine the corresponding octave band and total calculated noise level at relevant receiver locations.

Calculating the attenuation factors for each effect requires a relevant description of the environment into which the sound propagation such as the physical dimensions of the environment, atmospheric conditions and the characteristics of the ground between the source and the receiver.

Wind farm noise propagation has been the subject of considerable research in recent years. These studies have provided support for the reliability of engineering methods such as ISO 9613-2:1996 when a certain set of input parameters are chosen in combination.

A number of Australian and international studies support the assignment of a ground factor of G=0.5 for the source, middle and receiver ground regions between a wind farm and a calculation point. This ground factor of G=0.5 is adopted in combination with several cautious assumptions; specifically all wind turbines operating at identical wind speeds, emitting sound levels equal to the test measured levels plus a margin for uncertainty (or guaranteed values), at a temperature of 10 degrees and relative humidity of 70 % (conditions which give rise to low atmospheric absorption). The studies demonstrate that applying the ISO 9613-2:1996 prediction methodology in this way provides a reliable representation of the upper noise levels expected in practice.

The following specific adjustments have been made:

- In instances where the ground terrain provides marginal or partial acoustic screening, the barrier effect should be limited to not more than 2 dB
- Screening attenuation calculated based on the screening expected for the source located at the tip height of the wind turbine (in contrast to hub height in non-adjusted ISO 9613 predictions)
- In instances where the ground falls away significantly between the source and receiver, such as valleys, an adjustment of 3 dB should be added to the calculated sound pressure level. A terrain profile in which the ground falls away significantly is defined as one where the mean sound propagation height is at least 50 % greater than would occur over flat ground

In support of the use of ISO 9613-2:1996 and the choice of G=0.5 as an appropriate ground characterisation, the following references are noted:

- A factor of G=0.5 is frequently applied in Australia for general environmental noise modelling purposes as a way of accounting for the potential mix of ground porosity which may occur in regions of dry/compacted soils or in regions where persistent damp conditions may be relevant
- NZS 6808:2010 refers to ISO 9613-2:1996 as an appropriate prediction methodology for wind farm noise, and notes that soft ground conditions should be characterised by a ground factor of G=0.5
- In 1998, a comprehensive study, part funded by the European Commission, Development of a Wind Farm Noise Propagation Prediction Model[3] found that the ISO 9613-2:1996 model provided a robust representation of upper noise levels which may occur in practice, and provided a closer agreement between predicted and measured noise levels than alternative standards such as CONCAWE and ENM. Specifically, the report indicated the ISO 9613-2:1996 method generally tends to marginally over predict noise levels expected in practice
- The UK Institute of Acoustics journal dated March/April 2009 published a joint agreement between practitioners in the field of wind farm noise assessment, including consultants routinely employed on behalf of both developers and community opposition groups, and indicated the ISO 9613-2:1996 method as the appropriate standard and specifically designated G=0.5 as the appropriate ground characterisation. It is noted that this publication specifically refers to predictions made to receiver heights of 4 m in the interest of representing 2-storey dwellings which are more common in the UK. Predictions in Australia are generally based on a lower prediction height of 1.5 m which tends to result in higher ground attenuation factors, however conversely, predictions in Australia do not generally incorporate a -2 dB factor (as applied in the UK) to represent the relationship between L_{Aeq} and L_{A90} noise levels. The result is that these differences tend to balance out to a comparable approach and thus supports the use of G=0.5 in the context of Australian prediction methodologies.
- A range of comparative measurement and prediction studies[4, 5, 6] for wind farms in which Marshall Day Acoustics' staff have been involved in have provided further support for the use of ISO 9613-2:1996 and G=0.5 as an appropriate representation of typical upper noise levels expected to occur in practice.

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3 Bass, Bullmore and Sloth - *Development of a wind farm noise propagation prediction model*; Contract JOR3-CT95-0051, Final Report, January 1996 to May 1998.

4 Bullmore, Adcock, Jiggins & Cand – *Wind Farm Noise Predictions: The Risks of Conservatism*; Presented at the Second International Meeting on Wind Turbine Noise in Lyon, France September 2007.

5 Bullmore, Adcock, Jiggins & Cand – *Wind Farm Noise Predictions and Comparisons with Measurements*; Presented at the Third International Meeting on Wind Turbine Noise in Aalborg, Denmark June 2009.

6 Delaire, Griffin, & Walsh – *Comparison of predicted wind farm noise emission and measured post-construction noise levels at the Portland Wind Energy Project in Victoria, Australia*; Presented at the Fourth International Meeting on Wind Turbine Noise in Rome, April 2011.

The key findings of these studies demonstrated the suitability of the ISO 9613-2:1996 method to predict the propagation of wind turbine noise for:

- the types of noise source heights associated with a modern wind farm, extending the scope of application of the method beyond the 30 m maximum source heights considered in the original ISO 9613
- the types of environments in which wind farms are typically developed, and the range of atmospheric conditions and wind speeds typically observed around wind farm sites. Importantly, this supports the extended scope of application to wind speeds in excess of 5 m/s.

ISO 9613-2:1996 is primarily intended for the prediction of total A-weighted noise levels.

APPENDIX E NOISE CONTOUR MAPS – VESTAS V136-3.6

Figure 15: Noise contour map – North West

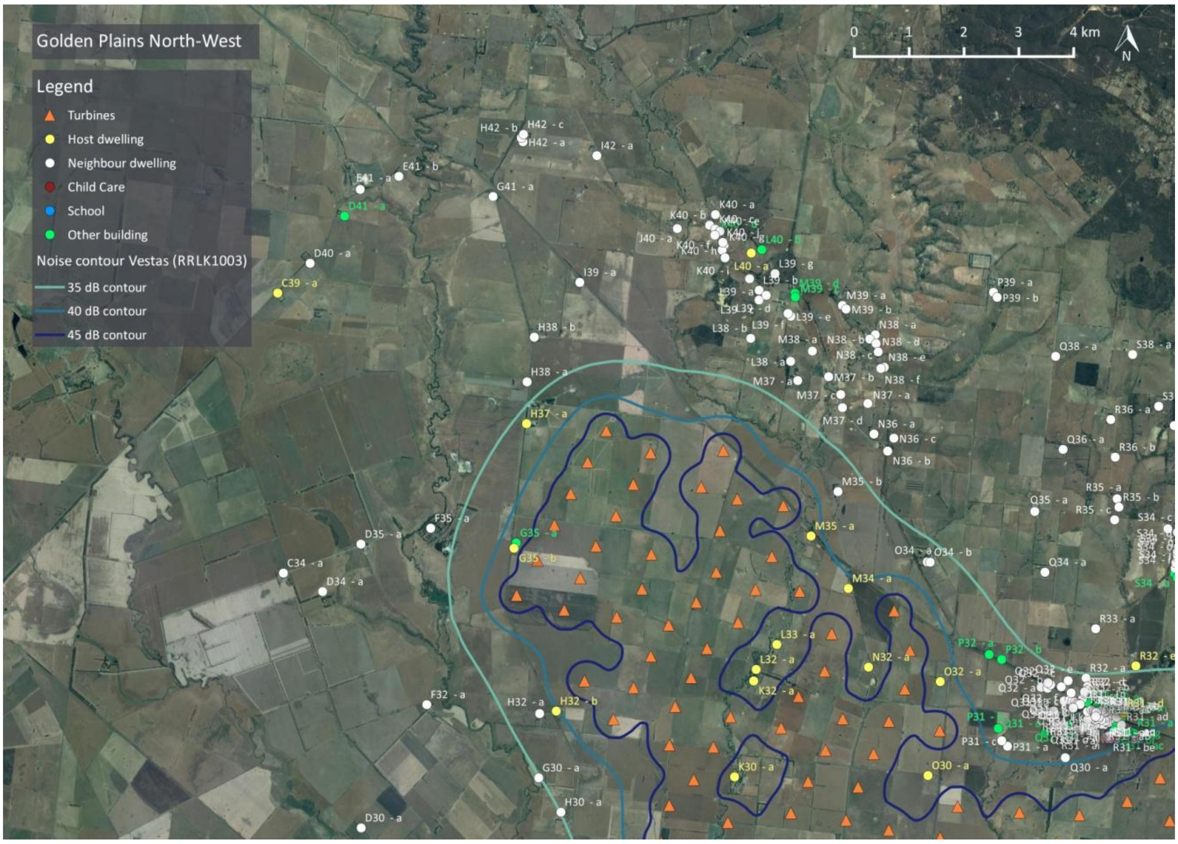

Figure 16: Noise contour map – North East

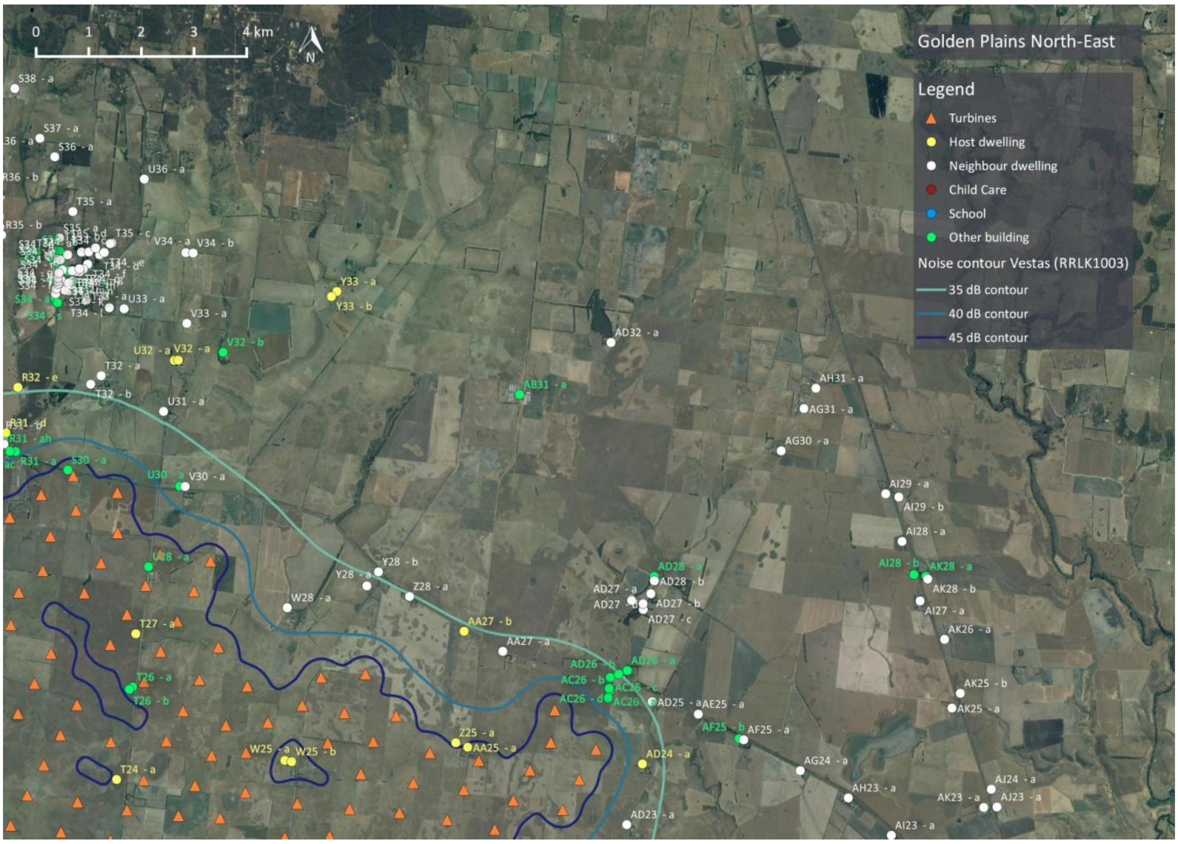

Figure 17: Noise contour map – South West

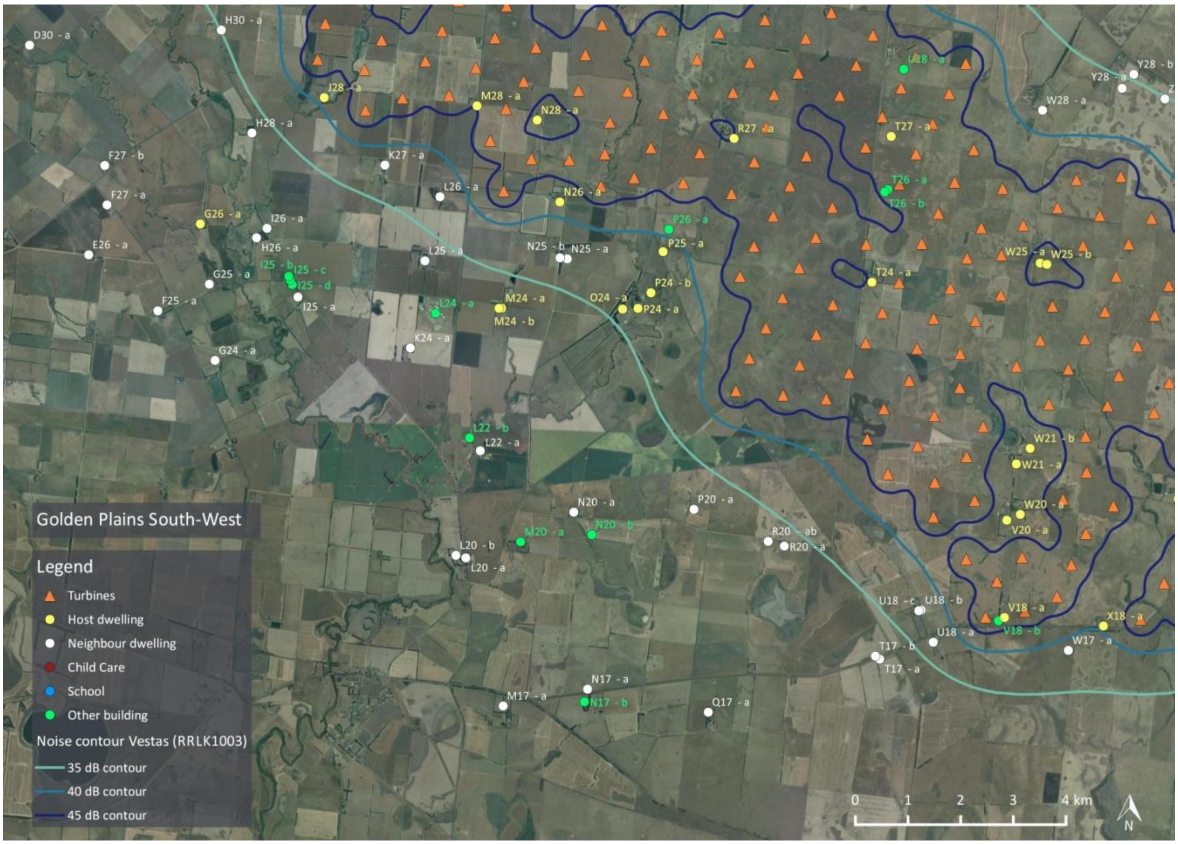

Figure 18: Noise contour map – South East

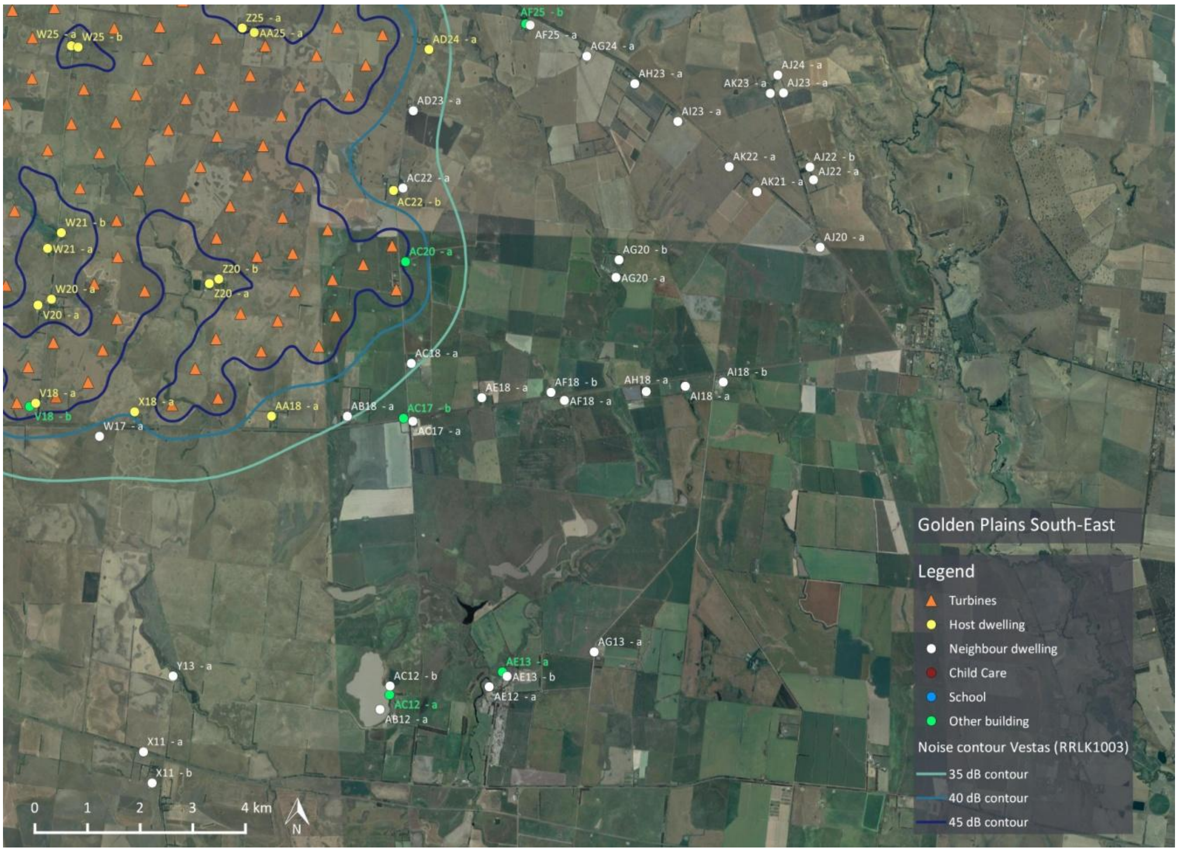

Figure 19: Noise contour map – Rokewood Township

Figure 20: Noise contour map – Corindhap Township

APPENDIX F DOCUMENTATION

F1 Predictions

(a) Map of the site showing topography, turbines and residential properties: See Section B1 of Appendix B

(b) Noise sensitive locations: See Section 2.3 and Appendix B

(c) Wind turbine sound power levels, L_{WA} dB (also refer to Section 2.2.2)

Sound power levels (Guaranteed levels + 1dB margin for uncertainty)

	Hub height wind speed (m/s)										
Turbine model	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Senvion 3.6M140	-	96.0	98.2	100.8	103.7	105.0	105.0	105.0	104.7	104.5	104.5
Vestas V136-3.6	93.2	93.5	95.5	98.4	101.5	104.4	106.4	106.5	106.5	106.5	106.5

Octave band spectrum adjusted, L_{WA}

	Octave Band Centre Frequency (Hz)									
Turbine model	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Overall**
Senvion 3.6M140*	75.8	85.8	93.0	97.8	99.9	99.5	95.5	89.7	78.9	105
Vestas V136-3.6	79.7	89.3	94.8	99.4	99.6	100.6	99.7	92.6	75.1	106.5

* Based on octave band spectral information for the Senvion 3.0M122 turbine

(d) Wind turbine model: See Table 1 of Section 2.2.1

(e) Turbine hub height: See Table 1 of Section 2.2.1

(f) Distance of noise sensitive locations from the wind turbines: See Tables B3, 0 and B5of Appendix B

(g) Calculation procedure used: ISO 9613-2:1996 prediction algorithm as implemented in SoundPLAN v7.4 (See Section 7.1 and Appendix D)

(h) Meteorological conditions assumed:

Temperature: 10 °C   Relative humidity: 70 %   Atmospheric pressure: 101.325 kPa

(i) Air absorption parameters:

	Octave band mid frequency (Hz)							
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Atmospheric attenuation (dB/km)	0.12	0.41	1.04	1.93	3.66	9.66	32.8	116.9

(j) Topography/screening: 10 m elevation contours provided by WestWind

(k) Predicted far-field wind farm sound levels: See Table 3 of Section 7.2 and Appendix E.