GoldenPlains
WIND FARM MANAGEMENT PTY LTD

Golden Plains Wind Farm

Appendix C.6: Environmental Noise Assessment

MARSHALL DAY Acoustics

GOLDEN PLAINS WIND FARM
ENVIRONMENTAL NOISE ASSESSMENT

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Project: **Golden Plains Wind Farm**
Environmental Noise Assessment

Prepared for: **Golden Plains Wind Farm Management Pty Ltd**
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EXECUTIVE SUMMARY

The Golden Plains Wind Farm is an approved wind farm that is proposed to be developed by Golden Plains Wind Farm Management Pty Ltd. The proponent is now seeking an amendment to the planning permit to accommodate a revised turbine layout and a larger turbine rotor diameter of up to 165 m.

This report presents an assessment of operational turbine noise levels associated with the Golden Plains Wind Farm based on a revised wind farm layout comprising two hundred and fifteen (215) multi-megawatt turbines and revised candidate turbines.

The actual turbine which would be used at the site would be determined at a later stage in the project. The final selection would be based on a range of design requirements including achieving compliance with the planning permit noise limits at surrounding noise sensitive locations (receivers). In advance of a final selection, the assessment considers two (2) candidate turbine models that are representative of the size and type of turbine which could be used at the site. For this purpose, the following candidate turbines have been nominated by the proponent for this assessment, all with a nominal hub height between 148-149 m:

- Vestas V162-6.0MW with a rotor diameter of 162 m; and
- GE Renewable Energy Cypress 6.0-164 with a rotor diameter of 164 m.

Operational noise from the proposed wind turbines has been assessed in accordance with the New Zealand Standard 6808:2010[1], as required by the Victorian Government's *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019. The assessment considers operational wind farm noise limits determined in accordance with NZS 6808:2010, accounting for the land zoning of the area and the results of the background noise monitoring survey undertaken at selected receivers surrounding the project.

Manufacturer specification data provided by the proponent for the candidate turbine models has been used as the basis for the assessment, using unconstrained generation modes (i.e. no noise reduced operating modes) and with blade serrations. The specifications provide noise emission data in accordance with the international standard[2] referenced in NZS 6808:2010.

The results of the noise modelling for the Golden Plains Wind Farm demonstrate that the predicted noise levels for the proposed turbine layout achieve the applicable base noise limits determined in accordance with NZS 6808:2010 at all neighbouring receivers.

The noise limits determined in accordance with NZS 6808:2010 apply to the total combined operational wind farm noise level, including the contribution of any neighbouring wind farm developments. The assessment has therefore also considered the nearby Berrybank Wind Farm, currently under construction.

An assessment of the predicted noise levels for each wind farm has demonstrated that cumulative wind farms noise levels do not affect the compliance outcomes for either of the assessed projects.

The noise assessment therefore demonstrates that the proposed Golden Plains Wind Farm, incorporating the revised layout and rotor diameter of up to 165 m, is able to be designed and developed to achieve Victorian policy requirements for operational noise, and that appropriate control mechanisms are available to ensure compliance is maintained over the life of the project.

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1 NZS 6808:2010 *Acoustics – Wind farm noise*

2 IEC 61400-11:2012 *Wind turbines - Part 11: Acoustic noise measurement techniques*

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1.0 INTRODUCTION

Golden Plains Wind Farm Management Pty Ltd (the proponent) is proposing to develop a wind farm known as the Golden Plains Wind Farm (the wind farm) within the Victorian Local Government area of Golden Plains.

The wind farm received planning approval[3] in December 2018 for a layout comprising up to two hundred and twenty-eight (228) turbines with a tip height of up to 230 m and a rotor diameter of up to 150 m. The permit was subsequently corrected three times with the current version issued on 29 April 2019.

The proponent is now seeking an amendment to the planning permit to accommodate a revised two hundred and fifteen (215) turbine layout, together with a larger turbine rotor diameter of up to 165 m.

This report presents the results of a revised assessment of operational turbine noise for the proposed wind farm. Operational noise from the associated ancillary infrastructure, and the noise and vibration from construction activities, were addressed previously in the noise assessment[4] accompanying the original planning application. As the proposed amendments to the planning permit primarily relate to the turbine rotor diameter and layout, no further assessments of ancillary infrastructure or construction noise and vibration have been undertaken as part of this revised assessment.

The noise assessment methodology for the proposed turbine revisions is identical to that of the original application. Specifically, the assessment of operational noise associated with the turbines was undertaken in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010). This is consistent with the requirements of clause 52.32-4 of the Planning Scheme and the Victorian Government's *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019 (the Victorian Wind Energy Guidelines).

The noise assessment presented in this report is based on:

- Background noise data from surveys undertaken at a range of noise sensitive locations around the site;
- Operational noise limits determined in accordance with NZS 6808:2010, accounting for local land zoning and background noise levels;
- Predicted noise levels for the proposed Golden Plains Wind Farm turbines, based on the proposed site layout and candidate turbine models that are representative of the size and type of turbine that the amendment application seeks consent for;
- A comparison of the predicted noise levels for the proposed Golden Plains Wind Farm with the criteria derived in accordance with NZS 6808:2010; and
- Cumulative noise modelling and assessment in accordance with NZS 6808:2010 to account for the neighbouring Berrybank Wind Farm that is currently under construction.

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

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[3] Permit No.: PA1700266, dated 21 December 2018

[4] Assessment of operational noise from ancillary infrastructure and noise and vibration from construction activities is detailed in the MDA Report Rp 003 R01 20170122 *Golden Plains Wind Farm - Environmental Noise & Vibration Assessment*, dated 23 February 2018 which was included as Appendix Q of the Environment Effects Statement (EES).

2.0 PROJECT DESCRIPTION

The Golden Plains Wind Farm is proposed to comprise two hundred and fifteen (215) wind turbines to the west, south and southeast of the Rokewood township, within the Shire of Golden Plains. The project site is situated approximately 60 km northwest of Geelong, 40 km south of Ballarat and 110 km west of Melbourne.

The coordinates of the proposed wind turbines are tabulated in Appendix B.

The proponent is seeking a revised consent for the wind farm to enable the development of a reduced layout comprising wind turbines extending to a tip height of up to 230 m with a rotor diameter of up to 165 m.

Two candidate turbine models have been selected by the proponent for this assessment with a power output of 6 MW and rotor diameters of 162 and 164 m. The candidate turbine models provide an appropriate representation of typical turbine models with rotor diameters of up to 165 m. Further details on the candidate turbine models are presented in Section 7.1.

A total of two hundred and sixteen (216) buildings have been identified by the proponent within 3 km of the proposed turbines, comprising the following:

- One hundred and forty-five (145) non-stakeholder receivers, including:
  - One hundred and forty-three (143) residential dwellings on properties that are not associated with the wind farm (referred to as neighbour dwellings herein)
  - One (1) school and one (1) child care facility within the township of Rokewood
- Twenty-nine (29) residential dwellings on stakeholder properties that are associated with the wind farm (referred to as *host dwellings* or *stakeholder receivers* herein)
- Forty-two (42) buildings (sheds, community halls, businesses, etc.) that are not considered as noise sensitive locations in accordance with NZS 6808:2010.

The coordinates of the receivers are tabulated in Appendix C.

Site layout plans illustrating the turbine layout, related infrastructure and receivers are provided in Appendix D.

3.0 PLANNING PERMIT

The current version of Planning Permit No. PA1700266 was issued on 29 April 2019 for a layout comprising up to two hundred and twenty-eight (228) turbines with a tip height of up to 230 m and a rotor diameter of up to 150 m.

Conditions 13 to 32 of the planning permit establish requirements for the control of noise during construction and operation of the Golden Plains Wind Farm. The conditions are reproduced in full in Appendix F.

The key requirements relevant to this assessment are summarised in Table 1.

Table 1: Summary of operational turbine noise related requirements relevant to this assessment

Condition	Summary of key requirements
Wind farm noise performance requirements	
13	Specifies that operational wind farm noise must comply with NZS 6808:2010 at noise sensitive locations
14	Specifies that a penalty must be applied to the measured wind farm noise levels, in accordance with NZS 6808:2010, if the presence of special audible characteristics has been determined
15	Specifies that compliance with Condition 13 does not apply at dwellings where an agreement exists between a landowner and the project developer, providing that evidence of the agreement is provided to the responsible authority
Noise compliance assessment requirements	
18	Establishes a requirement for a pre-construction noise assessment of operational wind turbine noise for the final turbine layout and turbine selection before development of the wind farm starts
18.a	Specifies that the pre-construction noise assessment must demonstrate compliance with conditions 13 and 16
18.b	Establishes a requirement for background noise monitoring to be undertaken over a minimum period of six (6) weeks with the results analysed separately for all periods (24 hour), night periods only and each 45 degree wind rose direction for each of the time periods
18.c.i	Specifies that the areas in and around the township of Rokewood that are zoned Township Zone and Low Density Residential Zone are recognised as high amenity areas for the purposes of NZS 6808:2010
18.c.ii	Establishes a requirement for an assessment of the applicability of the high amenity noise limit for the areas defined in condition 18.c.i, in accordance with clause C5.3.1 of NZS 6808:2010
18.d	Establishes a requirement for the pre-construction noise assessment to be accompanied by an Environmental Audit Report

4.0 VICTORIAN POLICY & GUIDELINES

The following publications are relevant to the assessment of operational noise from proposed wind farm developments in Victoria:

- Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019 (the *Victorian Wind Energy Guidelines*)
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010).

Details of the guidance and noise criteria provided by these publications are provided below.

4.1 Victorian Wind Energy Guidelines

The Victorian Wind Energy Guidelines provide advice to responsible authorities, proponents and the community about suitable sites to locate wind energy facilities and to inform planning decisions about a wind energy facility proposal.

The stated purpose of the Victorian Wind Energy Guidelines is to set out:

- *a framework to provide a consistent and balanced approach to the assessment of wind energy projects across the state*
- *a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project*
- *guidance as to how planning permit application requirements might be met.*

Section 5 of the Victorian Wind Energy Guidelines outlines the key criteria for evaluating the planning merits of a wind energy facility. Section 5.1.2(a) details information relating to the amenity of areas surrounding a wind farm development, including information relating to noise levels. In particular, it provides the following guidance for the assessment of noise levels for proposed new wind farm developments:

> *The Standard specifies a general 40 decibel limit (40 dB LA90(10min)) for wind energy facility sound levels outdoors at noise sensitive locations, or that the sound level should not exceed the background sound level by more than five decibels (referred to as 'background sound level +5 dB'), whichever is the greater.*
>
> *[…]*
>
> *Under Section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels may be justified in special circumstances. All wind energy facility 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 5.3.1 of the Standard. Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm*

Based on the Victorian Wind Energy Guidelines, the environmental noise of proposed new wind farm developments must be assessed in accordance with NZS 6808:2010. Consideration must also be given to whether a high amenity noise limit is warranted to reflect special circumstances at specific locations.

This is consistent with clause 52.32-4 of the Planning Scheme which requires that planning applications must be accompanied by the following information:

> *A pre-construction (predictive) noise assessment report demonstrating that the proposal can comply with the New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise, including an assessment of whether a high amenity noise limit is applicable under Section 5.3 of the Standard.*

4.2 NZS 6808:2010

The New Zealand Standard NZS 6808:2010 provides methods for the prediction, measurement, and assessment of sound from wind turbines. The following sections provide an overview of the objectives of NZS 6808:2010 and the key elements of the standard's assessment procedures.

4.2.1 Objectives

The foreword of NZS 6808:2010 provides guidance about the objectives of the noise criteria outlined within the standard:

> *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.*

The *Outcome Statement* of NZS 6808:2010 then goes on to provide information about the objective of the standard in a planning context:

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

Section C1.1 of the standard provides further information about 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.*

Based on the objectives outlined above, NZS 6808:2010 addresses health and amenity considerations at noise sensitive locations by specifying noise criteria which are to be used to assess wind farm noise.

4.2.2 Noise sensitive locations

The provisions of NZS 6808:2010 are intended to protect noise sensitive locations (also generally referred to as *receivers* herein) that existed before the development of a wind farm. Noise sensitive locations are defined by the Standard as:

> *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 include:*
>
> *(a) Any part of land zoned predominantly for residential use in a district plan;*
>
> *(b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*
>
> *(c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities …*
>
> *(d) Teaching areas and sleeping rooms in educational institutions …*
>
> *(e) Teaching areas and sleeping rooms in buildings for licensed kindergartens, childcare, and day-care centres; and*
>
> *(f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.*
>
> *In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.*

For the purposes of an assessment according to the Standard, the notional boundary is defined as:

> *A line 20 metres from any side of a dwelling or other building used for a noise sensitive activity or the legal boundary where this is closer to such a building.*

NZS 6808:2010 was prepared to provide methods of assessment in the statutory context of New Zealand. Specifically, the NZS 6808:2010 notes that in the context of the New Zealand Resource Management Act, application of the Standard will provide reasonable protection of health and amenity at noise sensitive locations. This is an important point of context, as the New Zealand Resource Act states:

> *(3)(a)(ii): A consent authority must not, when considering an application, have regard to any effect on a person who has given written approval to the application.*

Based on the above definitions and statutory context, noise predictions are normally prepared for stakeholder receivers irrespective of whether they are inside or outside of the boundary. However, the noise limits specified in the Standard are not applied to these locations on account of their participation with the project. Separate consideration is given to alternative guidance values (e.g. the recommendations of the Victorian Wind Energy Guidelines) for these locations, having regard to participating land owners both within and outside the site boundary, and participating neighbours outside the site boundary. In addition to consistency with NSZ 6808:2010 and its statutory context, this approach is also consistent with policy and guidance applied in other Australian states.

4.2.3 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 5 dB, or a level of 40 dB $L_{A90(10\,min)}$, whichever is the greater.*

This arrangement of limits requires the noise associated with a wind farm to be restricted to a permissible margin 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 noise levels are below the range of 30-35 dB.

The criteria specified in NZS 6808:2010 apply to the combined noise level of all wind farms influencing the environment at a receiver. Specifically, section 5.6.1 states:

> *The noise limits … should apply to the cumulative sound level of all wind farms affecting any noise sensitive location.*

4.2.4 High amenity

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} detailed in Section 4.2.3 above is "*appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*.". It goes on to note that the application of a high amenity noise limit 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.*

The definition of the high amenity noise limit 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.

In accordance with Section 5.3 of NZS 6808:2010, if a high amenity noise limit is justified, wind farm noise levels (L_{A90}) during evening and nigh-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. The standard recommends that this reduced noise limit would typically apply for wind speeds below 6 m/s at hub height. A high amenity noise limit is not applicable during the daytime period.

The methodology for assessing the applicability of the high amenity noise limit, detailed in NZS 6808:2010, is a two-step approach as follows:

1. Determination of whether the planning guidance for the area warrants consideration of a high amenity noise limit

   First and foremost, for a high amenity noise limit to be considered, the land zoning of a receiver location must promote a higher degree of acoustic amenity.

2. Evaluation of whether a high amenity noise limit is justified

   Following the guidance presented in C5.3.1, if the planning guidance for the area warrants consideration of a high amenity noise limit, and the receiver location is located within the 35 dB L_{A90} noise contour, then a calculation should be undertaken to determine whether background noise levels are sufficiently low.

4.2.5 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.*

NZS 6808:2010 emphasises assessment of special audible characteristics during the post-construction measurement phase of a project. An indication of the potential for tonality to be a characteristic of the noise emission from the assessed turbine model is sometimes available from tonality audibility assessments conducted as part of manufacturer turbine noise emission testing. However, this data is frequently not available at the planning stage of an assessment.

5.0 ASSESSMENT METHODOLOGY

5.1 Overview

Based on the policies and guidelines outlined in Section 3.0, assessing the operational noise levels of a proposed wind farm involves:

- assessing background noise levels at receivers around the project;
- assessing the land zoning of the project site and surrounding areas;
- establishing suitable noise criteria accounting for background noise levels and land zoning;
- predicting the level of noise expected to occur as a result of the proposed turbines; and
- assessing whether the development can achieve the requirements of Victorian policy and guidelines by comparing the predicted noise levels to the noise criteria.

5.2 Background noise levels

Background noise level information is used to inform the limits which apply to operational wind turbine noise.

The procedures for determining background noise levels for the assessment of wind turbines are defined in NZS 6808:2010. The first step in assessing background noise levels involves determining whether background noise measurements are warranted. For this purpose, Section 7.1.4 of the standard provides the following guidance:

> *Background sound level measurements and subsequent analysis to define the relative noise limits should be carried out where wind farm sound levels of 35 dB $L_{A90(10\,min)}$ or higher are predicted for noise sensitive locations, when the wind turbines are at 95% rated power. 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.*

The initial stage of a background noise monitoring program in accordance with NZS 6808:2010 therefore comprises:

- Preliminary wind turbine noise predictions to identify all receivers where predicted noise levels are higher than 35 dB L_{A90}
- Identification of selected receivers where background noise monitoring should be undertaken prior to development of the wind farm, if required.

If required, the surveys involve measurements of background noise levels at receivers and simultaneous measurement of wind speeds at the site of the proposed wind farm. The survey typically extends over a period of several weeks to enable a range of wind speeds and directions to be measured.

The results of the survey are then analysed to determine the trend between the background noise levels and the site wind speeds at the proposed hub height of the turbines. This trend defines the value of the background noise for the different wind speeds in which the turbines will operate. At the wind speeds when the value of the background noise is above 35 dB L_{A90} (or 30 dB L_{A90} in special circumstances where high amenity limits apply), the background noise levels are used to set the noise limits for the wind farm.

5.3 Noise predictions

Operational wind farm noise levels are predicted using:

- noise emission data for the wind turbines;
- a 3D digital model of the site and the surrounding environment; and
- international standards for calculating environmental sound propagation.

The method selected to predict noise levels is International Standard ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2). The prediction method is consistent with the guidance provided by NZS 6808:2010 and has been shown to provide a reliable method of predicting the typical upper levels of the noise expected to occur in practice.

Key elements of the noise prediction method are summarised in Table 2. Further discussion of the method and the calculation choices is provided in Appendix H.

Table 2: Noise prediction elements

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 8.2
Method	International Standard ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (ISO 9613-2). Adjustments to the ISO 9613-2 method are applied on the basis of the guidance contained in the UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (the UK Institute of Acoustics guidance). The adjustments are applied within the SoundPLAN modelling software and relate to the influence of terrain screening and ground effects on sound propagation. Specific details of adjustments are noted below and are discussed in Appendix H.
Source characterisation	Each turbine is modelled as a point source of sound. The total sound of the wind farm's turbines is then calculated on the basis of simultaneous operation of all wind turbines and summing the contribution of each. The following specific procedures are noted: • Calculations of turbine to receiver distances and average sound propagation heights are made on the basis of the point source being located at the position of the hub of the turbine. • Calculations of terrain related screening are made on the basis of the point source being located at the maximum tip height of each turbine. Further discussion of terrain screening effects is provided below.
Terrain data	10 m resolution data provided by the proponent.

Detail	Description
Terrain effects	Adjustments for the effect of terrain are determined and applied on the basis of the UK Institute of Acoustics guidance and research outlined in Appendix H. • Valley effects: +3 dB is applied to the calculated noise level of a wind turbine when a significant valley exists between the wind turbine and calculation point. A significant valley is determined to exist when the actual mean sound propagation height between the turbine and calculation point is 50 % greater than would occur if the ground were flat. • Terrain screening effects: only calculated if the terrain blocks line of sight between the maximum tip height of the turbine and the calculation point. The value of the screening effect is limited to a maximum value of 2 dB. For reference purposes, the ground elevations at the turbine and receiver locations are tabled in Appendix B and Appendix C respectively. The topography of the site is depicted in the elevation map provided in Appendix E.
Ground conditions	Ground factor of G = 0.5 on the basis of the UK Institute of Acoustics guidance and research outlined in Appendix H. The ground around the site corresponds to acoustically soft conditions (G = 1) according to ISO 9613-2. The adopted value of G = 0.5 assumes that 50 % of the ground cover is acoustically hard (G = 0) to account for variations in ground porosity and provide a cautious representation of ground effects.
Atmospheric conditions	Temperature 10 °C and relative humidity 70 % These represent conditions which result in relatively low levels of atmospheric sound absorption. The calculations are based on sound speed profiles[5] which increase the propagation of sound from each turbine to each receiver location, whether as a result of thermal inversions or wind directed toward each calculation point.
Receiver heights	1.5 m above ground level It is noted that the UK Institute of Acoustics guidance refers to predictions made at receiver heights of 4 m. Predictions in Australia are generally based on a lower prediction height of 1.5 m which results in lower noise levels. However, importantly, predictions in Australia do not generally subtract a margin recommended by the UK Institute of Acoustics guidance to account for differences between L_{Aeq} and L_{A90} noise levels (this is consistent with NZS 6808:2010 which indicates that predicted L_{Aeq} levels should be taken as the predicted L_{A90} sound level of the wind farm). The magnitude of these differences is comparable and therefore balance each other out to provide similar predicted noise levels.

[5] The sound speed profile defines the rate of change in the speed of sound with increasing height above ground

6.0 EXISTING NOISE ENVIRONMENT

Background noise monitoring in accordance with NZS 6808:2010 was undertaken by MDA as part of the EES at fifteen (15) receiver locations in the vicinity of the wind farm. The survey comprised unattended noise monitoring between March and May 2017 for a period of typically three (3) weeks at each monitoring location.

Between April and August 2019, an updated campaign of noise monitoring was undertaken by Resonate consultants in accordance with condition 18.b of the planning permit. Background noise levels were measured at twenty-five (25) receivers, including fifteen (15) neighbour dwellings. The results are presented in Resonate's report M180934RP10 Revision A *Golden Plains Wind Farm—Planning Permit Amendment Application Noise and Vibration Assessment,* dated 7 October 2020.

7.0 WIND TURBINE ASSESSMENT

7.1 Noise limits

7.1.1 High amenity

As detailed in Section 4.2.4, the applicability of a high amenity noise limit is based on a two-step approach comprising:

1. A land zoning review to determine whether the planning guidance for the area warrants consideration of a high amenity noise limit. If it does, then the second step should be considered
2. If the receiver location is located within the 35 dB L_{A90} noise contour and after conducting the calculation set out in clause C5.3.1, a high amenity noise limit may be justified.

Land zoning

The planning panel report[6] for the Golden Plains Wind Farm confirmed that the high amenity provision was not applicable to the Farming Zone. However, in relation to the Township Zone and Low Density Residential Zone, the panel concluded that the high amenity provision warranted consideration, irrespective of the planning scheme not promoting a higher degree of protection of amenity related to the sound environment.

Condition 18c.i of the planning permit states that:

> […] *the areas in and around Rokewood that are zoned Township Zone and Low Density Residential Zone are a high amenity area for the purposes of the Standard*

A high amenity limit may therefore warrant consideration for the neighbour dwellings that are in the Township Zone and Low Density Residential Zone in and around the township of Rokewood, and where predicted noise levels are above 35 dB L_{A90}.

Clause C5.3.1

Consistent with the Victorian Wind Energy Guidelines and clause 52.32-4 of the Planning Scheme, Condition 18.c.ii of the planning permit requires the following:

> *an assessment as to whether the high amenity noise limit should apply to these areas and the appropriate threshold wind speed, based on the guidance in Clause C5.3.1 of the Standard*

The calculation presented in C5.3.1 is based on comparison of predicted noise levels and background noise levels for receivers located in an area which warrants consideration of a high amenity noise limit. This comparison involves the calculation of a parameter which is not explicitly referenced in NZS 6808:2010 (or other relevant standards and guidance documents) but is referred to herein as the Noise Perception Index (NPI).

In accordance with Clause C5.3.1, if the NPI is greater than 8 dB during either the evening or night period, a high amenity noise limit is *likely to be justified*.

Background noise levels were measured by Resonate at three (3) neighbour dwellings located in the Township Zone and the Low Density Residential Zone in and around the township of Rokewood.

[6] *EES Inquiry and Planning Permit Application Panel Report - Golden Plains Wind Farm* dated 26 September 2018

The calculated evening and night-time NPIs for the neighbour dwelling with the highest predicted noise levels[7] within each zone are presented in Table 3 and Table 4 for the V162-6.0MW and GE 6.0-164 turbine models, respectively.

Table 3: Noise Perception Index (NPI), dB - V162-6.0MW

Receiver	Representative background location	Land zoning	Predicted level, dB L_{A90}	Evening NPI	Night NPI
Q31 - p	Q31 - p	LDRZ	36.5	5.6	7.5
R31 - be	R31 - ad	TZ	37.9	3.5	3.7

Table 4: Noise Perception Index (NPI), dB - GE 6.0-164

Receiver	Representative background location	Land zoning	Predicted level, dB L_{A90}	Evening NPI	Night NPI
Q31 - p	Q31 - p	LDRZ	37.9	6.4	8.1
R31 - be	R31 - ad	TZ	39.4	4.2	4.2

The following can be seen from the above tables:

- The calculated NPIs are below the 8 dB threshold (by at least 0.5 dB) at both receivers for the V162-6.0 MW turbine model;
- The calculated NPIs are marginally above the 8 dB threshold (by up to 0.1 dB) at one receiver for the GE 6.0-164 turbine model.

In accordance with the guidance of NZS 6808:2010, a high amenity noise limit may therefore be justified for the Golden Plains Wind Farm, depending on which candidate turbine model is selected, based on the current layout and measured background noise levels, and based on the Township Zone and the Low Density Residential Zone being treated as a high amenity by the current planning permit.

As such, for neighbour dwellings within the Township Zone and Low Density Residential Zone in and around the township of Rokewood, the high amenity base noise limit of 35 dB L_{A90} has been applied at hub height wind speeds up to 6 m/s. At higher wind speeds, the NZS 6808:2010 base noise limit of 40 dB L_{A90} has been applied.

As specified in condition 18.c.ii, the applicability of the high amenity noise limit would need to be reassessed when preparing the pre-construction noise assessment using the final turbine layout and turbine model.

7.1.2 Stakeholder receivers

Condition 15 of the planning permit specified that compliance with NZS 6808:2010 is not required for receivers where a noise agreement exists between the occupants and the proponent of the development.

As such, compliance with NZS 6808:2010 has not been assessed, and tabulated wind farm noise levels are not presented, for stakeholder receivers. However, stakeholder receivers are presented for information in the noise contour maps detailed in Section 7.4.

[7] Further details of the predicted noise levels are presented subsequently in Section 7.4

7.1.3 Assessment noise limits

The findings of the high amenity assessment detailed in the previous section demonstrated that the high amenity noise limits may be justified, depending on the final turbine selected for the project. As such, the high amenity limits are presented for receivers within the Low Density Residential Zone and Township Zone. The noise limits adopted for the assessment of the Golden Plains Wind Farm are summarised in Table 5.

It is noted that the actual noise limits which apply to the receivers in the Low Density Residential Zone and Township Zone will need to be revaluated and confirmed as part of the pre-construction assessment required by the current planning permit, accounting for predicted noise levels associated with the final turbine selection for the site.

Table 5: Assessment noise criteria, dB L_{A90}

Land zoning	Noise criteria
Farming Zone	40 dB or background L_{A90} + 5dB, whichever is higher
Low Density Residential Zone & Township Zone	Hub height wind speeds up to 6 m/s: 35 dB or background L_{A90} + 5 dB, whichever is higher Hub height wind speeds above 6 m/s: 40 dB or background L_{A90} + 5 dB, whichever is higher

As a conservative approach, for this assessment, predicted wind farms levels are assessed against the base noise limits, independent of background noise levels.

7.2 Wind turbine model

The final turbine model for the site would be selected after a tender process to procure the supply of turbines. The final selection would be based on a range of design requirements including achieving compliance with the planning permit noise limits at surrounding receivers.

Accordingly, to assess the proposed wind farm at this stage in the project, it is necessary to consider a candidate turbine model that is representative of the size and type of turbines being considered. The purpose of the candidate turbine is to assess the viability of achieving compliance with the applicable noise limits.

For this assessment, the proponent has nominated the Vestas V162-6.0MW and GE Cypress 6.0-164 as the candidate turbine models. These models have been selected as being representative of the size and type of turbines which could be used at the site.

These models are variable speed wind turbines, with the speed of rotation and the amount of power generated by the turbines being regulated by control systems which vary the pitch of the turbine blades (the angular orientation of the blade relative to its axis).

This assessment has been based on the candidate turbine models in unconstrained generation mode (i.e. no noise reduced operating modes) and with blade serrations. Blade serrations are now routinely used to reduce wind turbine noise emissions, and the proponent has advised that their use is now the market standard for turbines being offered in the Australian market.

Details of the assessed candidate wind turbines are provided in Table 6.

Table 6: Selected candidate wind turbine model

Detail	V162-6.0MW	GE 6.0-164
Make	Vestas	GE Renewable Energy
Rotor diameter	162 m	164 m
Hub height	149 m	148 m
Operating mode	PO6000 [1]	107.0 dBA Mode
Rated power	6.0 MW	6.0 MW
Cut-in wind speed (hub height)	3 m/s	3 m/s
Rated power wind speed (hub height)	12.0 m/s	TBC
Cut-out wind speed (hub height)	24 m/s	25 m/s

1 It is our understanding that 'PO6000' is a manufacturer designation which indicates a Power Optimisation mode to achieve a power output of 6,000 kW
This is an unconstrained mode of operation (i.e. without noise curtailment)

The hub heights detailed above are suitable for noise assessment purposes. It is our understanding that the final hub height of the selected wind turbine model may differ slightly. However, the magnitude of the potential changes is expected to be minor and inconsequential with respect to predicted noise levels.

The final hub height will be used for the pre-construction noise assessment once the turbine layout has been finalised and the final turbine model selected.

7.3 Wind turbine noise emissions

7.3.1 Sound power levels

The noise emissions of the wind turbines are described in terms of the sound power level for different wind speeds. The sound *power* level is a measure of the total sound energy produced by each turbine and is distinct from the sound *pressure* level which depends on a range of factors such as the distance from the turbine.

Sound power level data for the candidate turbine models, including sound frequency characteristics, have been sourced from the following manufacturer specifications:

- Vestas document No. 0095-3732_00 - *Third octave noise emission EnVentus™ V162-6.0MW*, dated 10 June 2020 (Vestas specification)
- GE Renewable Energy document *Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164 - 50Hz - Product Acoustic Specifications According to IEC 61400-11 Incl. Octave and 1/3 rd Octave Band Spectra* Rev. 01 – EN, dated 26 August 2020 (GE specification).

Based on the data sourced from the manufacturer's specification, the noise modelling undertaken for this assessment involved conversion of third octave band level to octave band levels (where applicable), and addition of an adjustment at each wind speed to provide a margin for typical values of uncertainty.

The Vestas specification does not provide information relating to uncertainty levels. An adjustment of +1.0 dB is therefore applied to each wind speed to account for typical values of test uncertainty.

Section 5 of the GE specification states the sound power data provided are the mean values of a representative batch of turbines not including uncertainty, noting the following:

For GE wind turbines, a typical value of σ_P = 0.8 dB can be assumed.

An adjustment of +0.8 dB has therefore been applied to the GE specification sound power data.

The overall A-weighted sound power levels (including the adjustment for uncertainty) as a function of hub height wind speed are presented in Table 7 with the octave band values presented in Table 8. These represent the total noise emissions of the turbine for each sound mode, including the secondary contribution of ancillary plant associated with each turbine (e.g. cooling fans). The octave band values for each turbine are for a hub height wind speed of 10 m/s; this was found to be representative of the spectrum which results in the highest predicted noise levels for each candidate.

Table 7: Sound power levels versus hub height wind speed, dB L_{WA}

	Hub height wind speed m/s								
Turbine	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**≥12**
V162-6.0MW	95.1	95.3	97.2	100.2	103.0	105.1	105.3	105.3	105.3
GE 6.0-164	94.6	96.5	100.0	103.3	105.5	107.5	107.8	107.8	107.8

Table 8: Octave band sound power levels, dB L_{WA}

	Octave band centre frequency (Hz)									
Turbine	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Total**
V162-6.0MW [1]	76.2	86.6	94.1	98.7	100.4	99.3	95.2	88.3	78.5	105.3
GE 6.0-164 [2]	79.6	88.9	94.4	98.9	101.5	103.1	100.9	93.4	77.6	107.8

[1] Based on one-third octave band levels at 10 m/s
[2] Based on octave band levels at 10 m/s

These sound power levels are also illustrated in Appendix K.

Review of available sound power data for a range of turbine models has shown that there isn't a clear relationship between turbine size or power output and the noise emission characteristics of a given turbine model. In practice, the overall noise emissions of a turbine are dependent on a range of factors, including the turbine size and power output, and other important factors such as the blade design and rotational speed of the turbine. Therefore, while turbine sizes and power ratings of contemporary turbines have increased, the noise emissions of the turbines are comparable to, or lower than, previous generations of turbines as a result of design improvements (notably, measures to reduce the speed of rotation of the turbines, and enhanced blade design features such as serrations for noise control).

7.3.2 Special Audible Characteristics

Special audible characteristics relate to potential tonality, amplitude modulation and impulsiveness of a turbine.

Information concerning potential tonality is often limited at the planning stage of a project, and test data for tonality is presently unavailable for the selected candidate turbine models. However, the occurrence of tonality in the noise of contemporary multi-megawatt turbine designs is unusual. This is supported by evidence of operational wind farms in Australia which indicates that the occurrence of tonality at receivers is atypical.

Amplitude modulation and impulsiveness are not able to be predicted, however the evidence of operational wind farms in Australia indicates that their occurrence is limited and atypical.

Given the above, adjustments for special audible characteristics have not been applied to the predicted noise levels presented in this assessment. Notwithstanding this, the subject of special audible characteristics would be addressed in subsequent assessment stages for the project, as specified in conditions 20 and 21 of the planning permit, reproduced in Appendix F.

7.4 Predicted noise levels

This section of the report presents the predicted noise levels of the Golden Plains Wind Farm at surrounding receivers.

Sound levels in environmental assessment work are typically reported to the nearest integer to reflect the practical use of measurement and prediction data. However, in the case of wind farm layout design, significant layout modifications may only give rise to fractional changes in the predicted noise level. This is a result of the relatively large number of sources influencing the total predicted noise level, as well as the typical separating distances between the turbine locations and surrounding assessment positions. It is therefore necessary to consider the predicted noise levels at a finer resolution than can be perceived or measured in practice. It is for this reason that the levels presented in this section are reported to one decimal place.

Noise levels from the proposed Golden Plains Wind Farm have been predicted using the sound power level data detailed in Section 7.3.1 for the candidate turbine models. The predicted noise levels are summarised in Table 9 for the wind speeds which result in the highest predicted noise levels (hub height wind speed ≥10 m/s), and for hub height wind speeds of 6 m/s (only for receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood, where the noise level at 6 m/s is relevant to high amenity limit considerations).

The locations of the predicted 30, 35, 40 and 45 dB L_{A90} noise contours are illustrated in Figure 1 to Figure 6, for the wind speed which results in the highest predicted noise levels (hub height wind speed ≥10 m/s).

Predicted noise levels for each integer wind speed are tabulated in Appendix I for all considered receivers, including dwellings where the highest predicted noise level is below 35 dB L_{A90}.

Table 9: Highest predicted noise level at receivers with predicted levels over 35 dB L_{A90}

	V162-6.0MW		GE 6.0-164	
Receiver	**6 m/s**	**≥10 m/s**	**6 m/s**	**≥10 m/s**
G30 - a	-	35.3	-	36.7
H30 - a	-	35.3	-	36.7
H32 - a	-	38.2	-	39.9
H38 - a	-	34.6	-	36.1
K27 - a	-	37.9	-	39.5
L26 - a	-	37.5	-	39.1
M35 - b	-	37.8	-	39.4
M37 - a	-	34.0	-	35.3
N25 - a	-	36.3	-	37.8
N25 - b	-	36.4	-	37.8
O24 - a	-	34.7	-	35.9
O34 - a	-	37.1	-	38.8

	V162-6.0MW		GE 6.0-164	
Receiver	**6 m/s**	**≥10 m/s**	**6 m/s**	**≥10 m/s**
O34 - b	-	37.0	-	38.6
P24 - a	-	35.2	-	36.5
P24 - b	-	36.3	-	37.8
P31 - a	-	38.3	-	39.8
P31 - c	-	38.3	-	39.8
P32 - a	-	37.3	-	38.9
Q30 - a	-	38.2	-	39.7
Q31 - a	-	36.5	-	37.8
Q31 - b	-	36.0	-	37.3
Q31 - c	-	35.5	-	36.8
Q31 - e*	27.3	35.4	28.9	36.7
Q31 - f*	27.3	35.4	28.9	36.7
Q31 - g*	27.4	35.5	29.0	36.8
Q31 - h*	27.4	35.5	29.0	36.8
Q31 - i*	27.5	35.6	29.1	36.9
Q31 - j*	27.5	35.6	29.1	36.9
Q31 - k*	27.5	35.6	29.1	36.9
Q31 - l*	27.5	35.6	29.1	36.9
Q31 - m*	27.7	35.8	29.3	37.1
Q31 - o*	28.6	36.7	30.3	38.1
Q31 - p*	28.4	36.5	30.1	37.9
Q32 - a	-	35.4	-	36.7
Q32 - b	-	35.3	-	36.6
Q32 - c	-	35.1	-	36.4
Q32 - d	-	35.1	-	36.4
Q32 - e	-	34.7	-	36.0
Q32 - f	-	35.0	-	36.3
Q32 - g*	27.1	35.2	28.6	36.4
R31 - aa*	28.5	36.6	30.3	38.1
R31 - ab*	28.9	37.0	30.6	38.4
R31 - ad*	29.4	37.5	31.3	39.1
R31 - ae	-	37.1	-	38.6

	V162-6.0MW		GE 6.0-164	
Receiver	**6 m/s**	**≥10 m/s**	**6 m/s**	**≥10 m/s**
R31 - af	-	37.0	-	38.5
R31 - ai*	29.1	37.2	30.9	38.7
R31 - aj*	28.8	36.9	30.5	38.3
R31 - ak*	28.8	36.9	30.5	38.3
R31 - al*	28.7	36.8	30.4	38.2
R31 - am*	28.4	36.5	30.1	37.9
R31 - an*	28.3	36.4	30.0	37.8
R31 - ao*	28.1	36.2	29.8	37.6
R31 - ap*	28.8	36.9	30.6	38.4
R31 - aq*	28.7	36.8	30.4	38.2
R31 - ar*	28.7	36.8	30.5	38.3
R31 - as*	28.6	36.7	30.3	38.1
R31 - at*	28.7	36.8	30.4	38.2
R31 - av*	28.5	36.6	30.2	38.0
R31 - aw*	28.4	36.5	30.1	37.9
R31 - ax*	28.5	36.6	30.2	38.0
R31 - az*	28.4	36.5	30.2	38.0
R31 - b*	28.7	36.8	30.5	38.3
R31 - ba*	28.7	36.8	30.5	38.3
R31 - bb*	28.2	36.3	29.9	37.7
R31 - bc*	28.2	36.3	29.9	37.7
R31 - bd*	28.3	36.4	30.0	37.8
R31 - be*	29.8	37.9	31.6	39.4
R31 - bf*	27.3	35.4	28.9	36.7
R31 - c*	28.0	36.1	29.7	37.5
R31 - d*	28.7	36.8	30.4	38.2
R31 - f*	28.3	36.4	30.0	37.8
R31 - g*	28.4	36.5	30.1	37.9
R31 - h*	28.3	36.4	30.0	37.8
R31 - j*	28.2	36.3	29.9	37.7
R31 - k*	28.1	36.2	29.8	37.6
R31 - n*	28.0	36.1	29.7	37.5

	V162-6.0MW		GE 6.0-164	
Receiver	**6 m/s**	**≥10 m/s**	**6 m/s**	**≥10 m/s**
R31 - q*	27.1	35.2	28.6	36.4
R31 - r*	27.9	36.0	29.5	37.3
R31 - s*	27.9	36.0	29.5	37.3
R31 - t*	27.9	36.0	29.6	37.4
R31 - u*	27.9	36.0	29.6	37.4
R31 - v*	28.0	36.1	29.7	37.5
R31 - w*	28.0	36.1	29.7	37.5
R31 - z*	28.2	36.3	29.9	37.7
R32 - a	-	34.5	-	35.8
R32 - b	-	34.9	-	36.2
R32 - c	-	35.0	-	36.3
R32 - d*	27.0	35.1	28.6	36.4
R32 - e	-	34.2	-	35.5
T32 - b	-	34.2	-	35.6
U18 - a	-	35.5	-	37.2
U18 - b	-	35.6	-	37.3
U18 - c	-	35.3	-	37.0
U31 - a	-	34.2	-	35.6
V30 - a	-	37.1	-	38.6
W17 - a	-	36.6	-	38.4
W27 - i	-	38.4	-	40.0
W28 - a	-	38.0	-	39.5
X18 - a	-	36.8	-	38.6
Y28 - a	-	35.0	-	36.4
Y28 - a	-	35.0	-	36.4
Y28 - b	-	33.9	-	35.2
Y28 - b	-	33.9	-	35.2
Z28 - a	-	34.5	-	35.8
AA27 - a	-	34.9	-	36.3
AA27 - b	-	34.8	-	36.1
AC22 - a	-	34.9	-	36.6

* Receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood
(S) School
(C) Childcare

From Table 9, the following conclusions can be made in relation to the predicted noise levels from the proposed Golden Plains Wind Farm, for both candidate turbine models:

- Compliance with the base noise limit of 40 dB L_{A90} is achieved at all receivers;
- Compliance with the base high amenity noise limit of 35 dB L_{A90} is achieved at hub height wind speeds less than or equal to 6 m/s, at all receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood.

The results therefore demonstrate that the Golden Plains Wind Farm is predicted to comply with the operational noise requirements of NZS 6808:2010, as required by the Victorian Wind Energy Guidelines.

As detailed in Section 5.3, and discussed in further detail in Appendix H, the ISO 9613-2 methodology yields a predicted noise level for a scenario in which a receiver is simultaneously downwind of every turbine. This situation is not possible for receivers where the turbines are proposed to be located in areas which span a wide range of directions from the receiver. In addition, winds that are outside of the downwind direction for each receiver will result in lower wind farm noise levels than predicted using the ISO 9613-2 methodology. The predictions presented in Table 9 are also based on the assumption that each turbine is simultaneously generating their maximum noise emissions, whereas variations in winds speeds across the site will frequently result in turbines producing lower noise levels than assumed in the modelling. These factors mean that there are inherent conservative factors assumed in the modelling and, as a result, actual wind farm noise levels in practice would be lower than predicted in many cases.

In light of these factors, and given that the highest predicted noise levels for the GE 6.0-164 candidate turbine are approaching, or equivalent to, the base noise limit at eleven (11) receivers (i.e. the predicted margin of compliance is less than 1 dB), a directional sensitivity analysis has been carried out to provide further information about the likely margins of compliance for these receivers. The directional sensitivity analysis comprises the application of adjustments to the downwind predicted noise levels to account for the reduction in wind turbine noise levels for wind directions that are outside of the downwind range.

The results of the directionality sensitivity analysis are also presented for hub height wind speeds between 6 and 10 m/s at the two neighbour dwellings with the highest predicted noise levels within the Township Zone and the Low Density Residential Zone, as listed in Table 3 and Table 4 of Section 7.1.1.

Further information is provided in Appendix J.

Figure 1: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - Overview

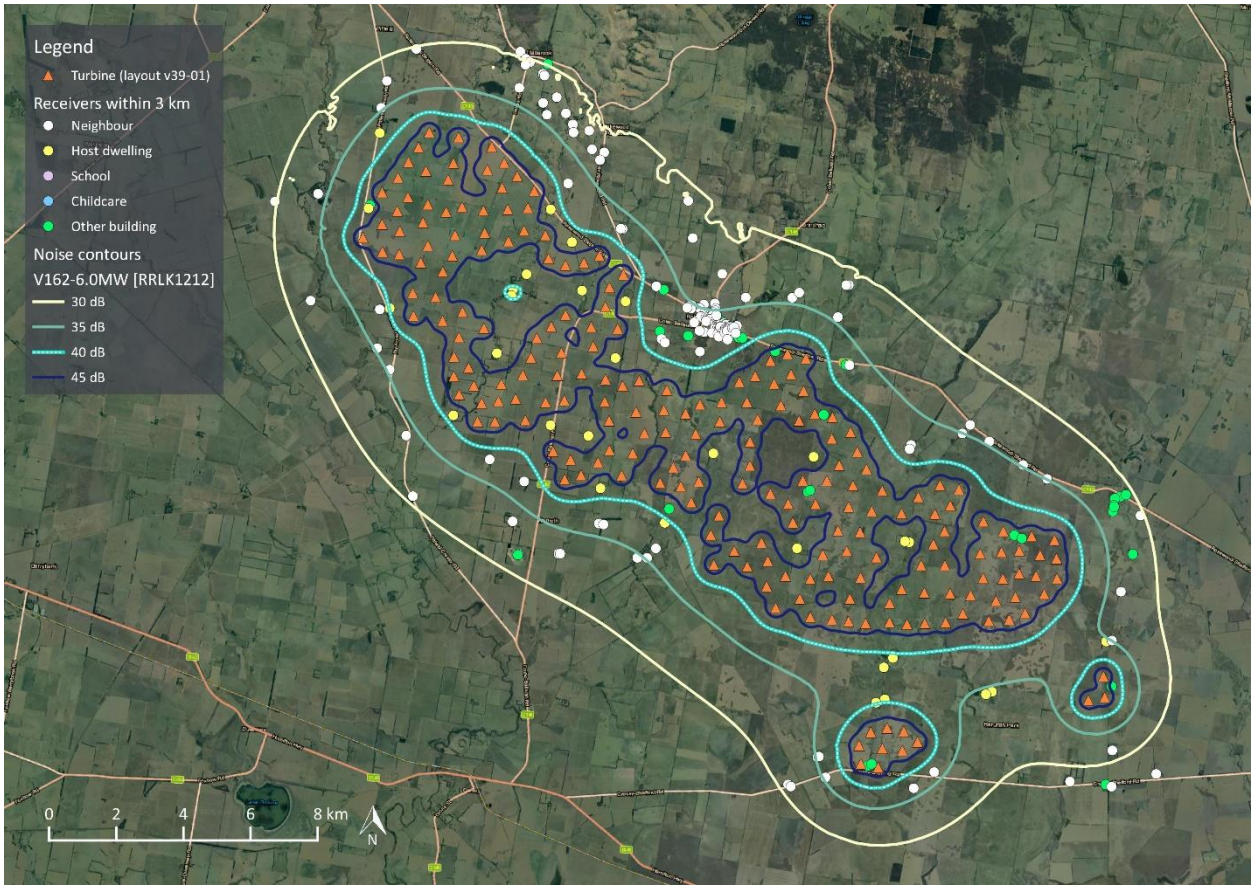


Figure 2: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - North west

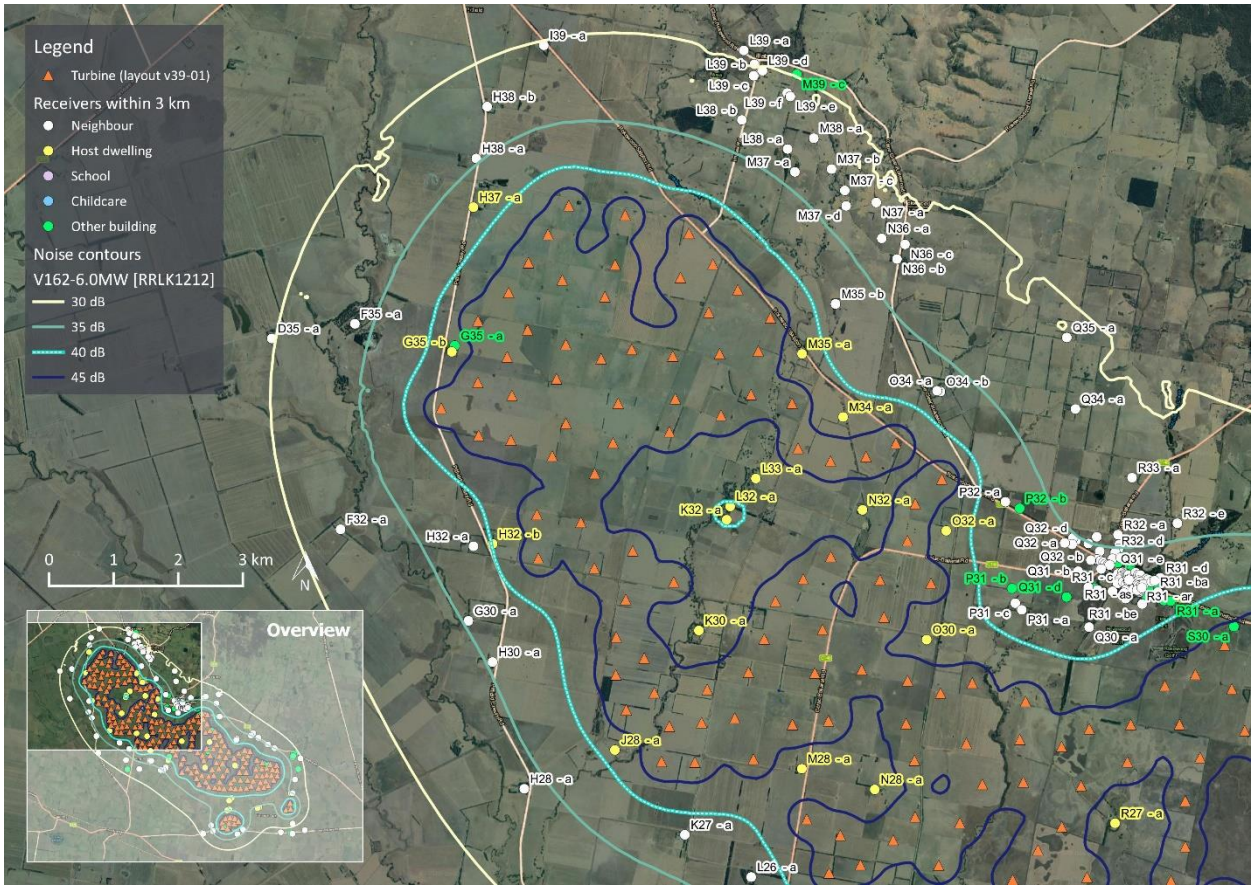


Figure 3: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - North east

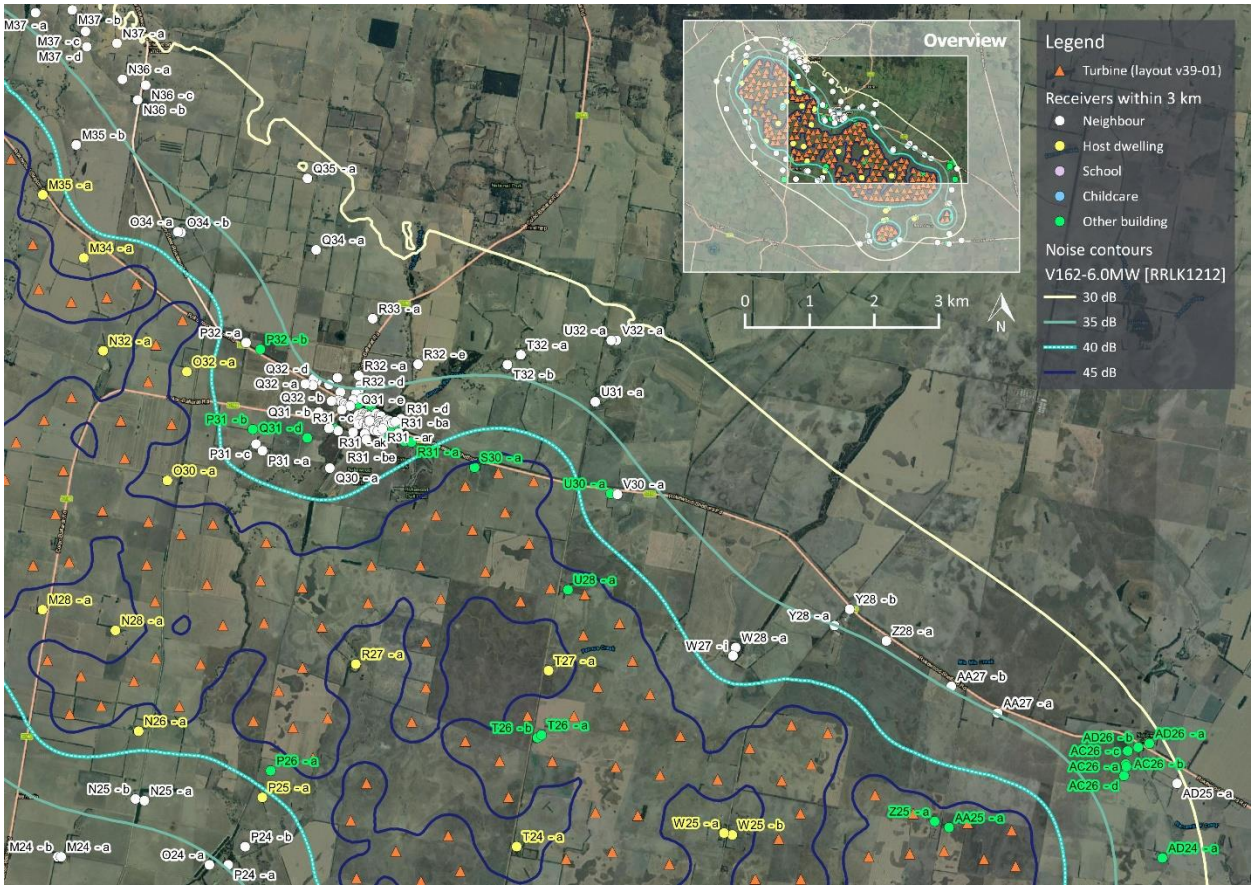


Figure 4: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - South west

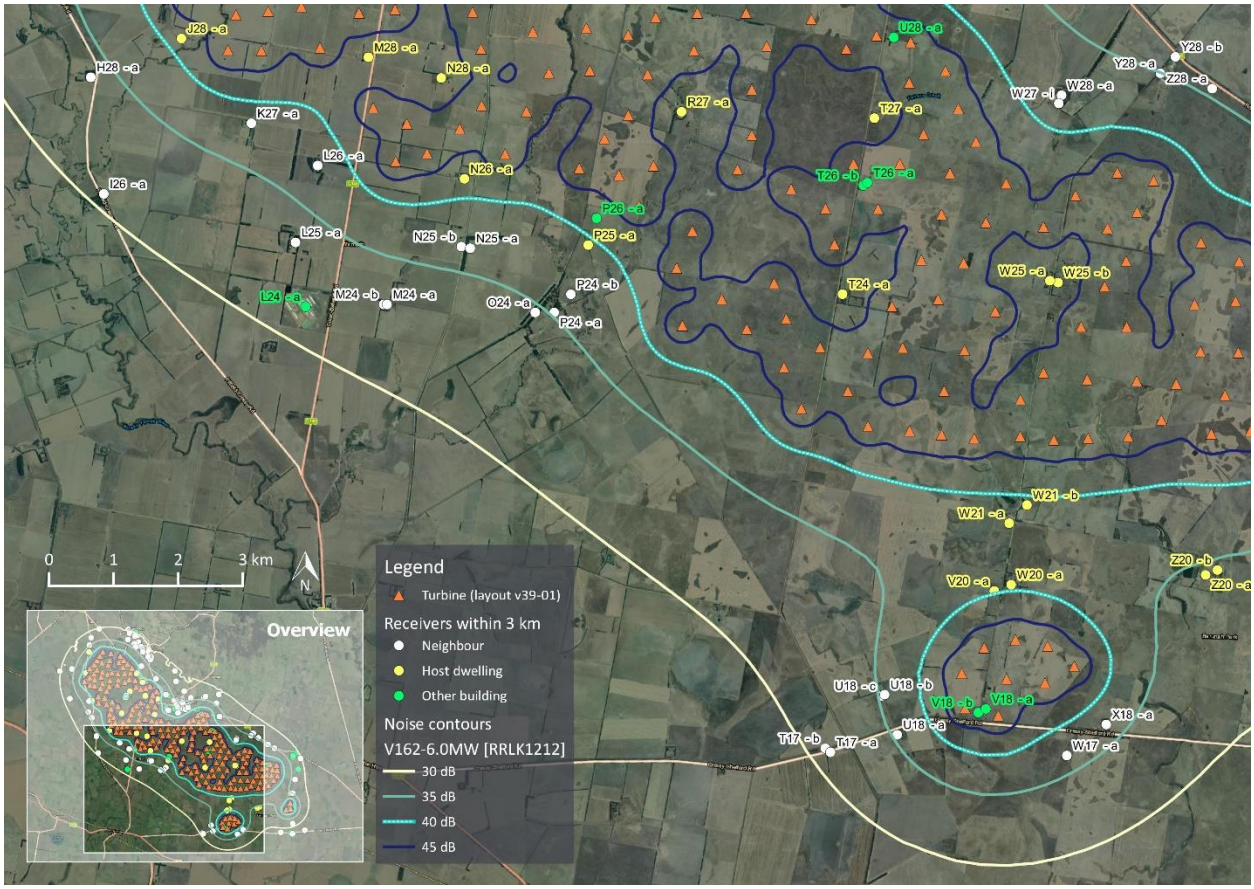


Figure 5: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - South east

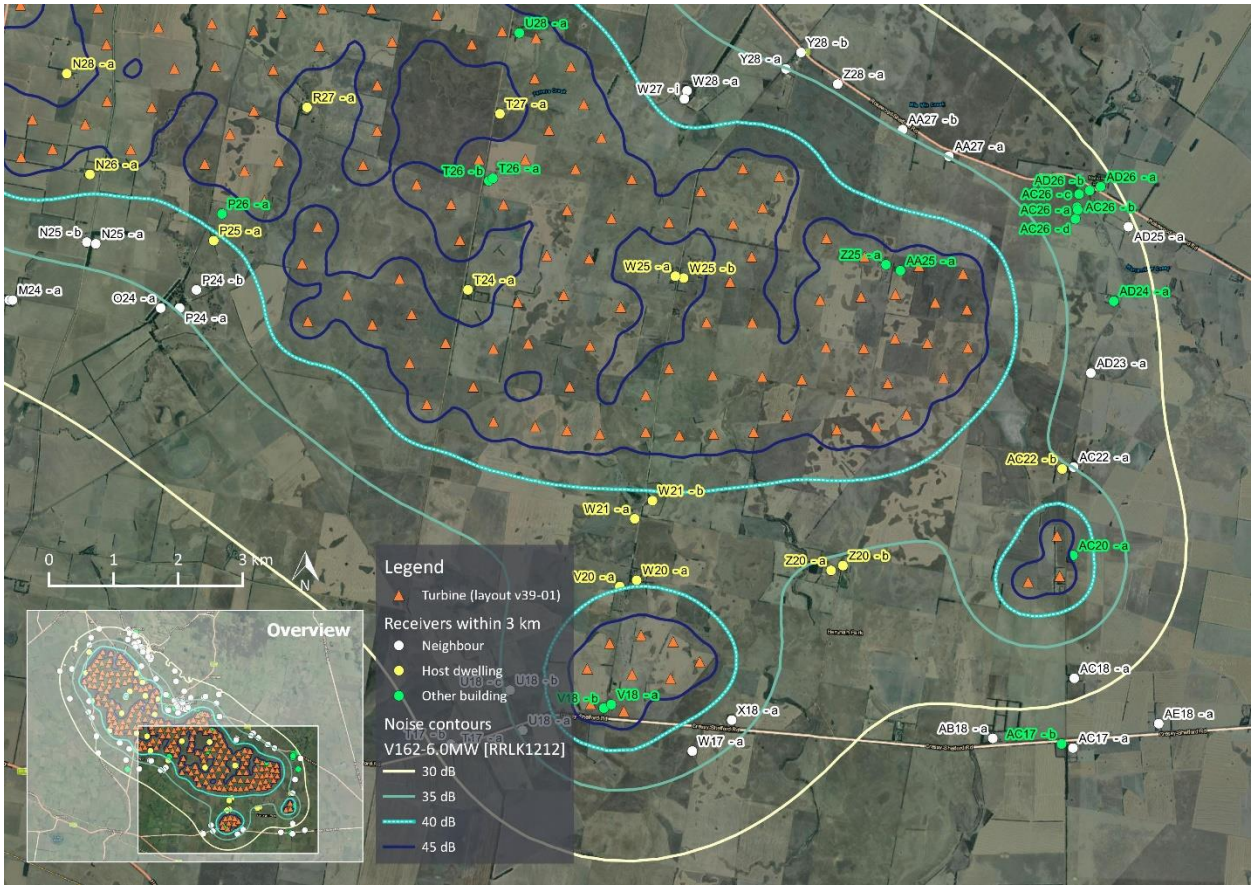


Figure 6: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - Rokewood township

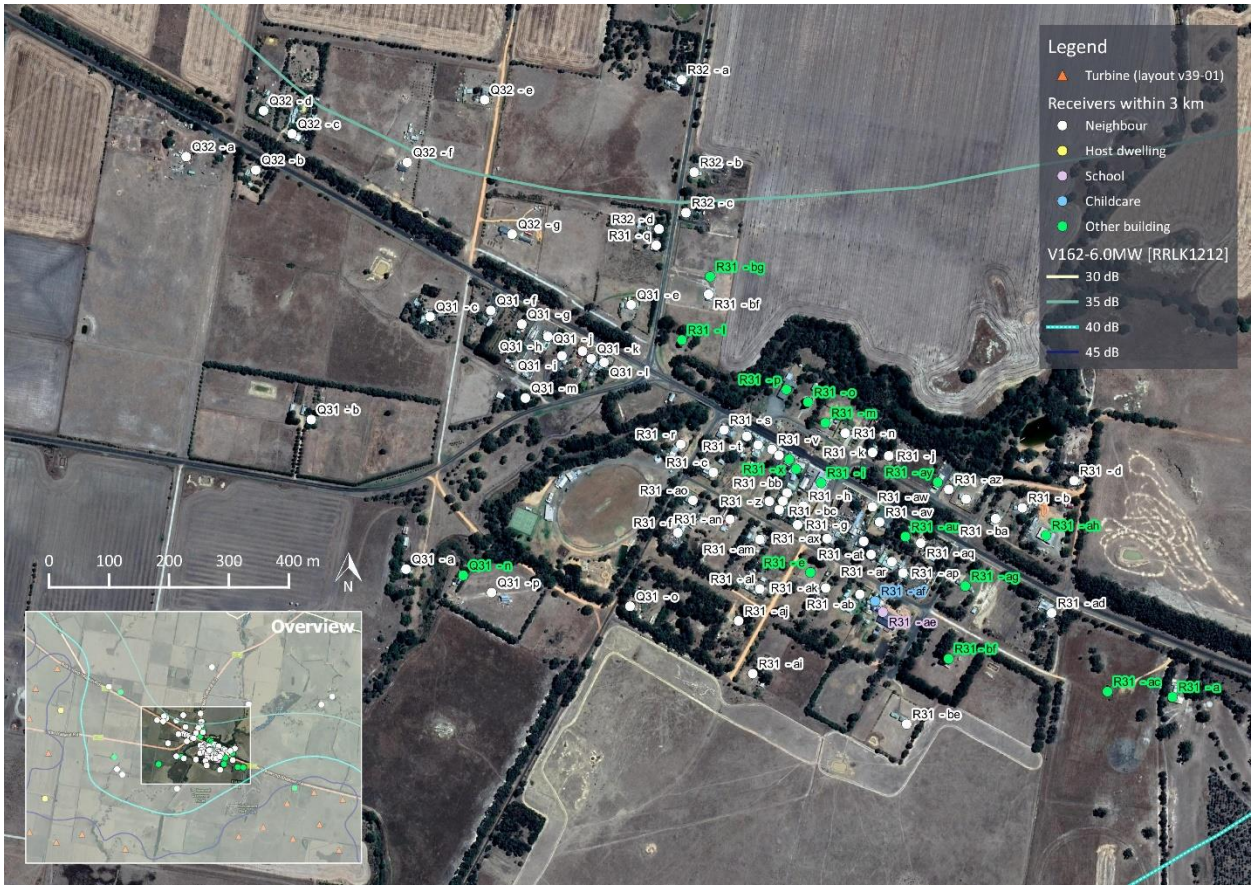


Figure 7: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - Overview

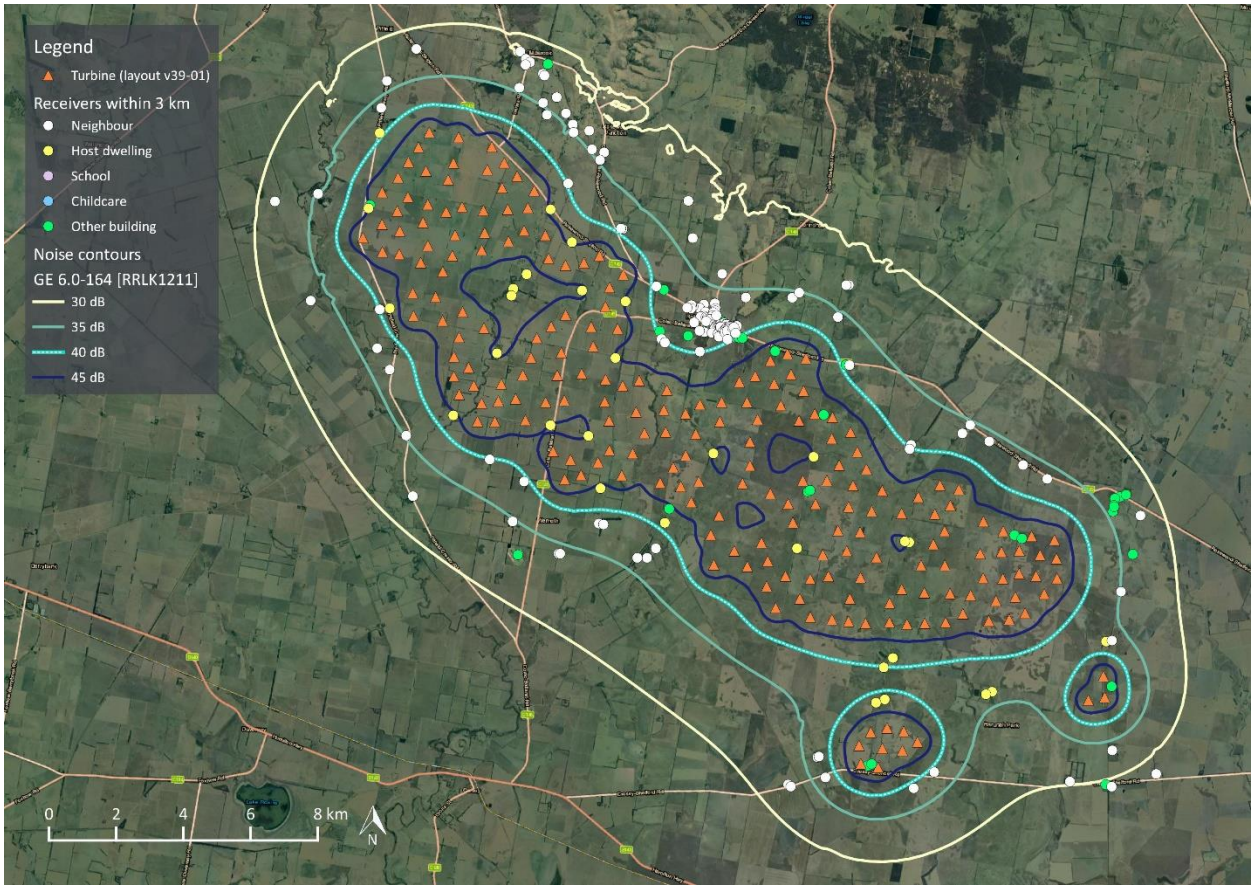


Figure 8: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - North west

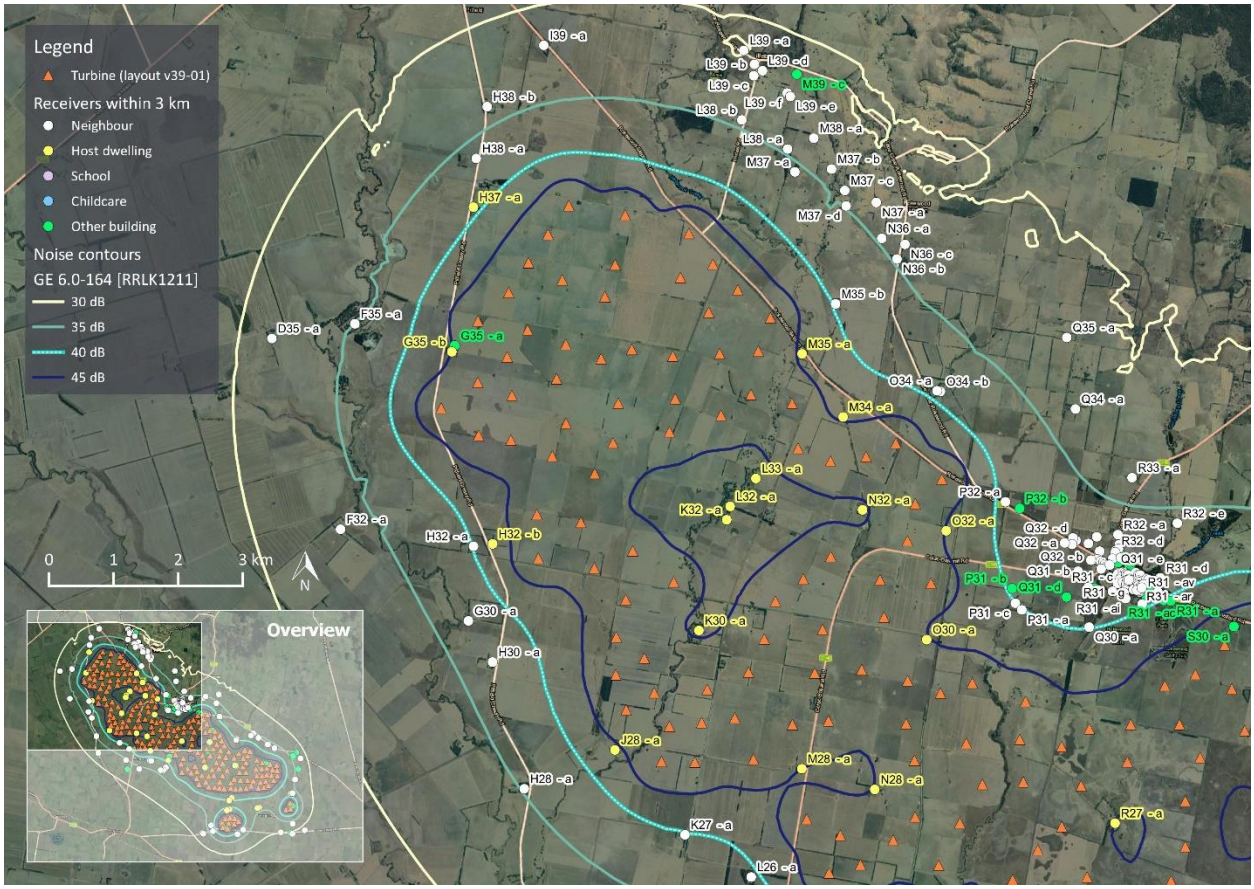


Figure 9: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - North east

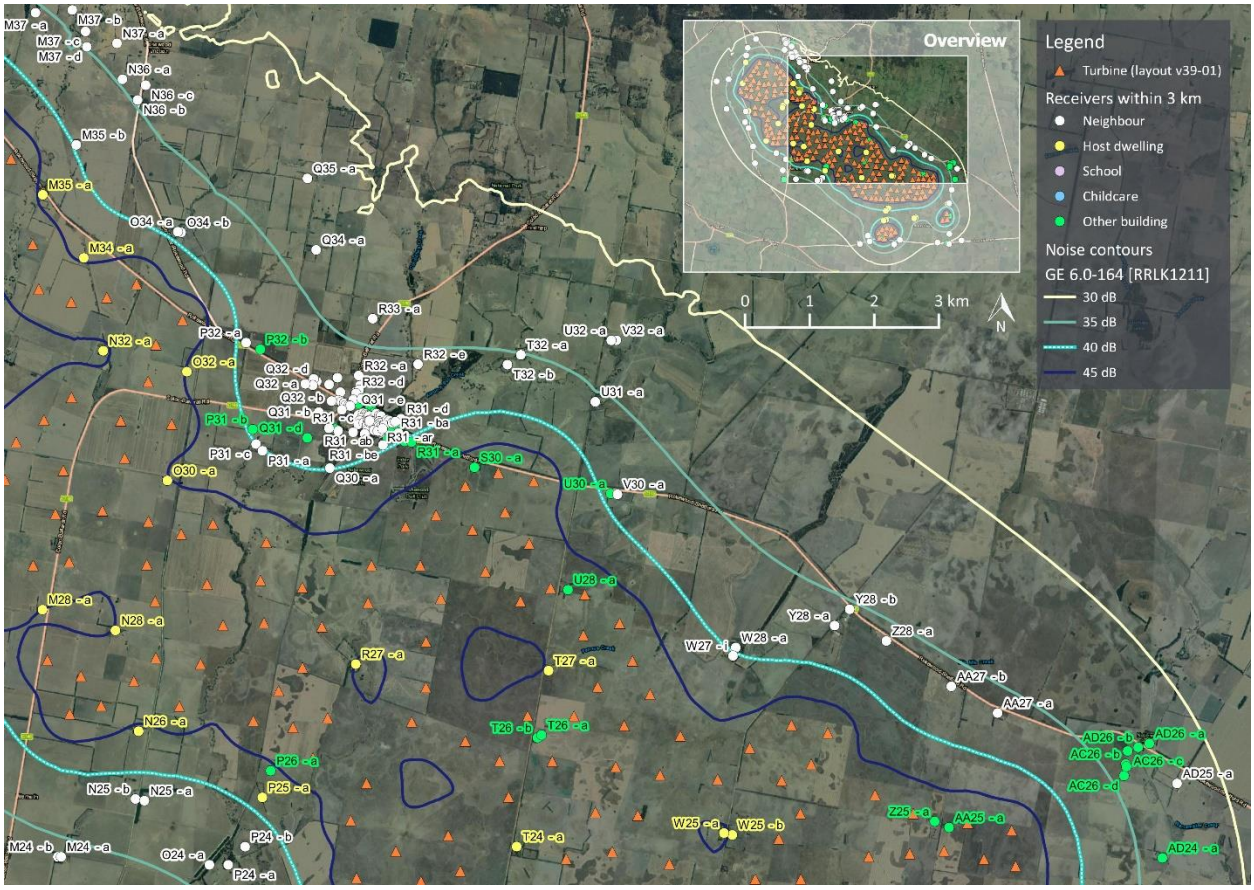


Figure 10: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - South west

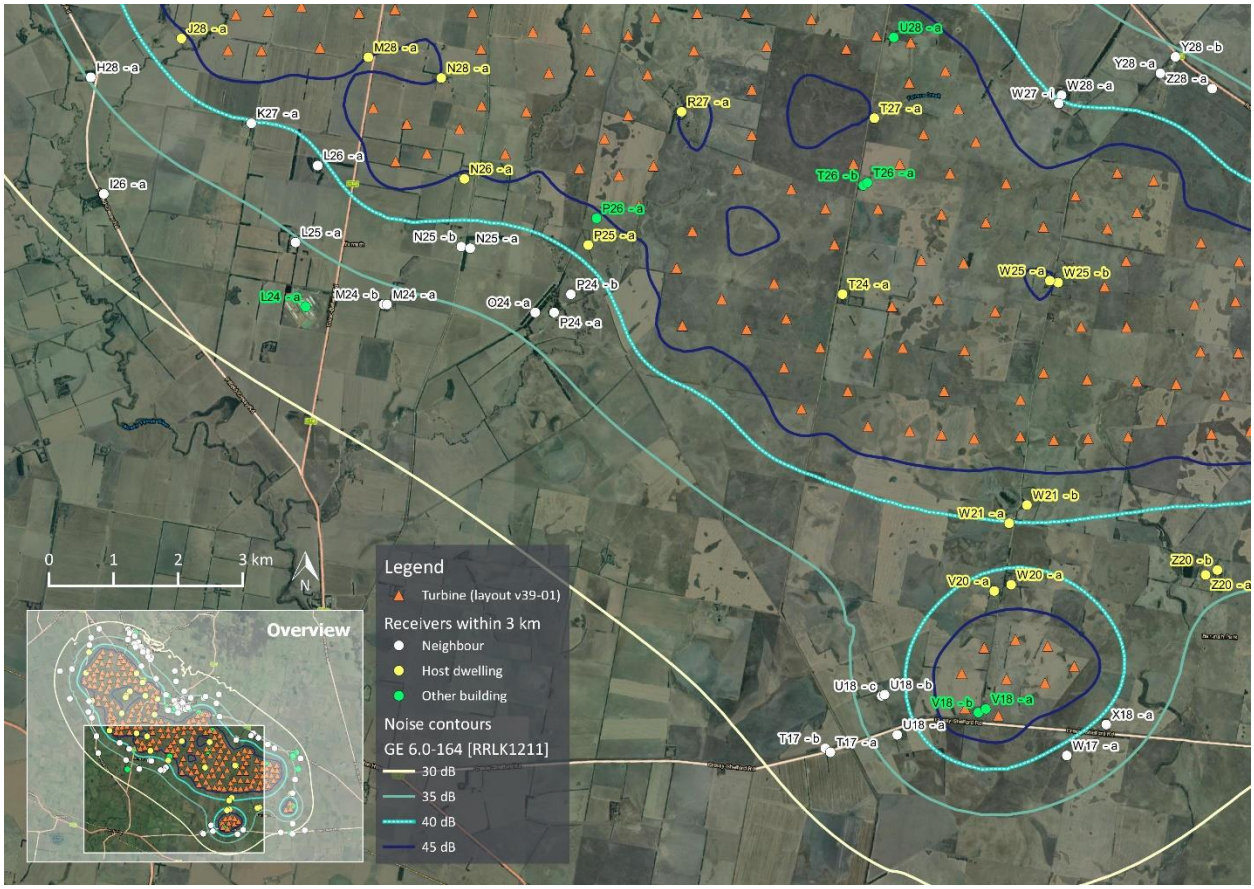


Figure 11: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - South east

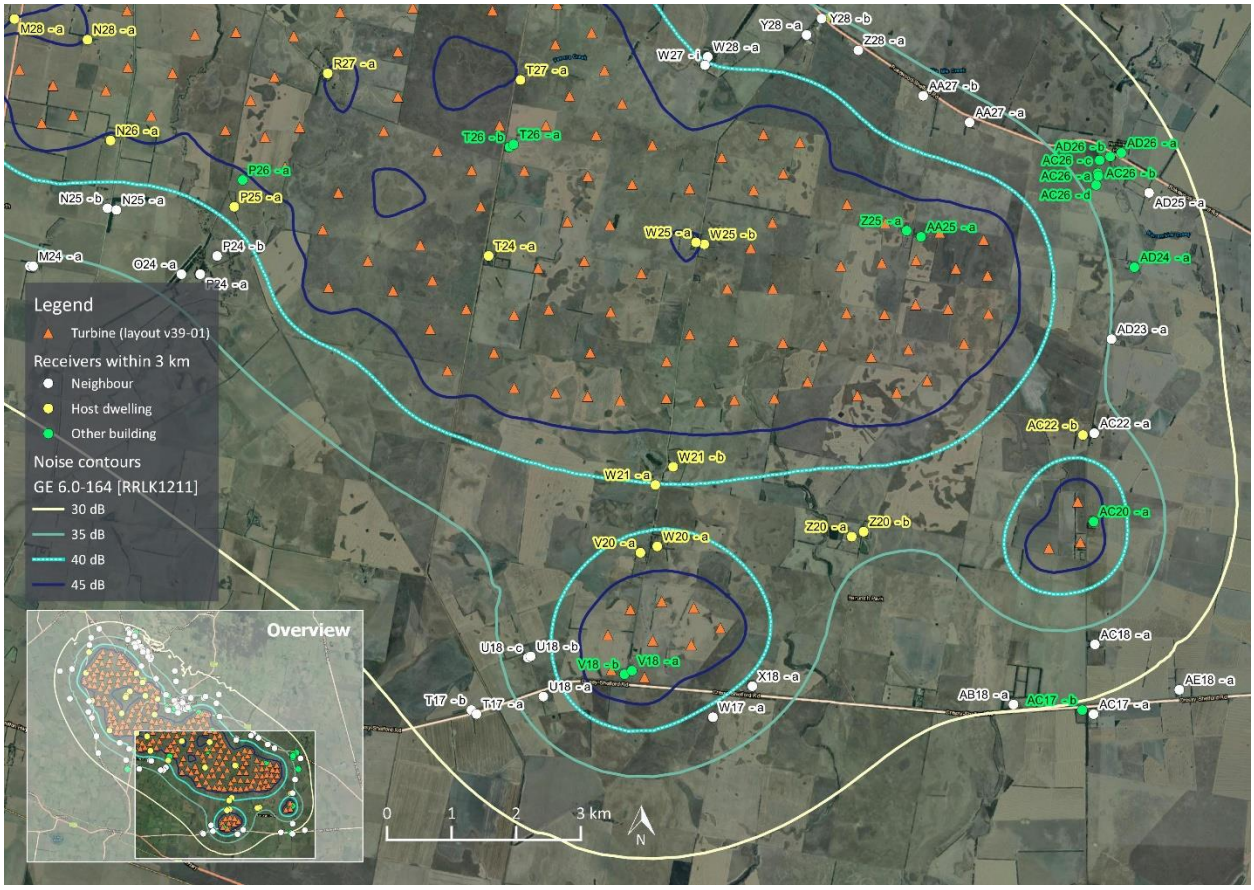


Figure 12: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - Rokewood township

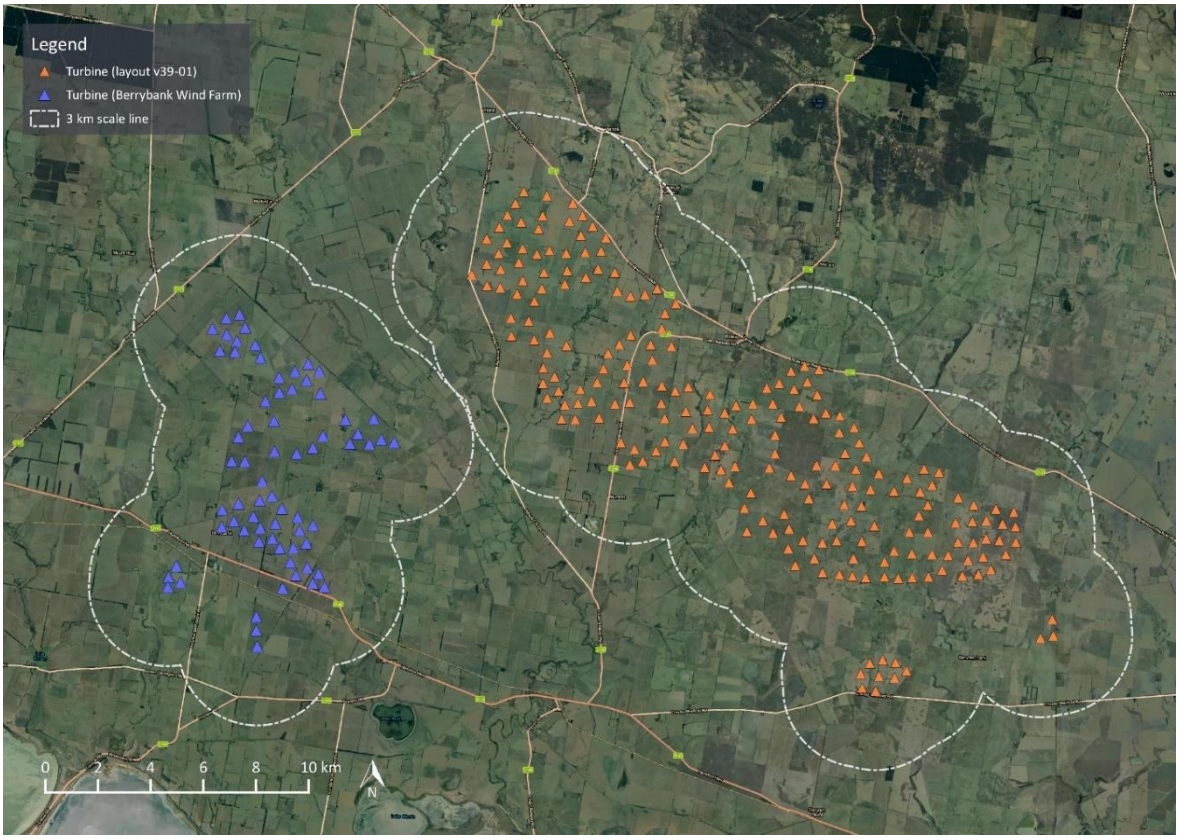
8.0 CUMULATIVE ASSESSMENT

The noise limits determined in accordance with NZS 6808:2010 apply to the total combined operational wind farm noise level, including the contribution of any neighbouring wind farm developments. The assessment has therefore considered other approved and operational wind farm projects in the surrounding area.

Based on the findings of the cumulative assessment presented as part of the EES[8], the potential cumulative noise from the Berrybank Wind Farm, now under construction, has been revised for this assessment. It is our understanding that no other wind farms have been approved within 10 km of the Golden Plains Farm since the EES.

A site plan showing the location of the Berrybank Wind Farm in relation to the Golden Plains Wind Farm is provided in Figure 13.

Figure 13: Berrybank Wind Farm and Golden Plains Wind Farm



The Berrybank Wind Farm received planning approval for the construction of up to seventy-nine (79) turbines. The coordinates of the turbines were provided by the proponent.

[8] Annexure E of Ev 001 20170122 *Expert Witness Statement of Christophe Frederic Delaire in the matter of the Golden Plains Wind Farm EES*, dated 19 July 2018

It is our understanding that construction of Stage 1 of the Berrybank Wind Farm, comprising forty-three (43) turbines, is under way at the time of writing this report. The following information about the Berrybank Wind Farm was sourced:

- Stage 1 turbine model: Vestas V136-4.2MW with a hub height of 112 m
- Sound power levels: Vestas document No. 0067-4732_04 - *V136-4.0/4.2 MW - Third octave noise emission*, dated 1 July 2020, provided by the proponent
- Applicable base noise limit for non-stakeholder receivers: 40 dB L_{A90}.

The turbine model for Stage 2, comprising twenty-seven (27) turbines was not available for this assessment. Accordingly, for the purpose of this cumulative assessment, the Stage 2 turbines are assumed to be the same as for Stage 1.

To inform the assessment of potential cumulative noise considerations, reference is made to Clause 5.6.4 of NZS 6808:2010 which states:

> *For the purposes of 5.6.1, if the 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.*

Additional contextual information is provided in the commentary to Clause 5.6.4 which notes:

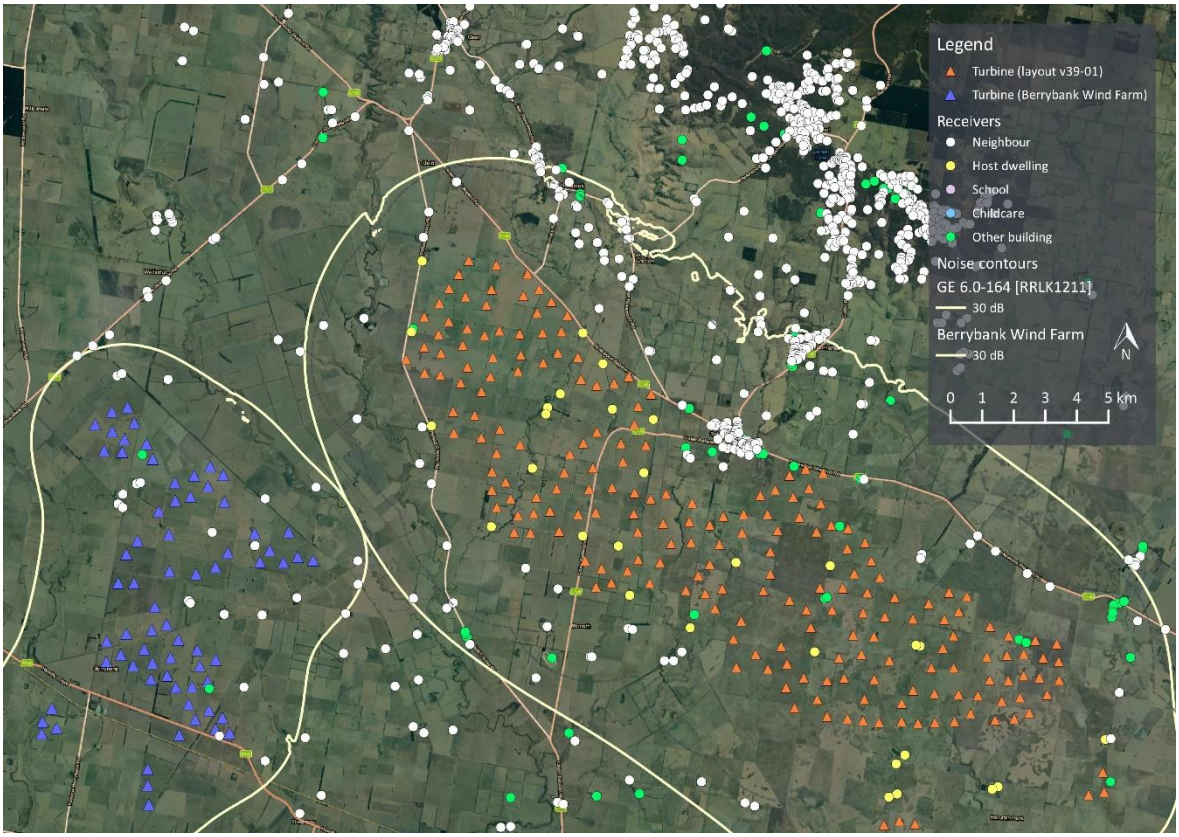
> *If an existing wind farm sound level is say 40 dB and the predicted wind farm sound level for a new wind farm is say 30 dB then the combined level would be 40.4 dB. This increase of less than 0.5 dB cannot be reliably measured and would be undetectable to people, and will therefore not give rise to any adverse cumulative effect.*

Based on the above guidance and considering the relatively large separating distances between the Golden Plains Wind Farm and the Berrybank Wind Farm, a simplified assessment of potential cumulative noise considerations can be made by comparing the predicted 30 dB L_{A90} contours from each project.

The predicted 30 dB L_{A90} contours associated with each wind farm operating in isolation are presented in Figure 14. The predicted 30 dB L_{A90} contour is presented for the wind speeds which give rise to the highest noise emissions from each site respectively. It is also noted that the noise level contours are predicted on the basis of downwind propagation from each turbine; in most instances where cumulative noise is considered, a noise sensitive receiver cannot be simultaneously downwind of all wind turbines of adjoining projects. The predictions are therefore conservative for the purpose of considering cumulative noise levels.

Noise contours for the Golden Plains Wind Farm are based on the GE candidate turbine model as it provides the highest predicted noise levels.

Figure 14: Predicted 30 dB L_{A90} contours for the Golden Plains Wind Farm and Berrybank Wind Farm



The results demonstrate that the predicted 30 dB L_{A90} contours for each project are generally separated. At the location where there is a marginal overlap, there are no receivers. Based on this finding, the following can be concluded:

- At any receiver location where the predicted noise level of one of the wind farms is between 30 and 40 dB, the predicted noise level from an adjoining wind farm will be less than 30 dB, and significantly lower in most cases
- At any receiver location in the area between the wind farms (i.e. where cumulative noise level assessments are most relevant) where the predicted noise level from one of the wind farms approaches the 40 dB base noise limit applicable to both sites, the predicted noise level associated with an adjoining wind farm will be more than 10 dB lower. Based on the guidance of NZS 6808:2010, the cumulative effect does not need to be taken in account for the nearest receivers to each wind farm development.

The predicted noise levels therefore demonstrate that cumulative wind farm noise considerations between the Golden Plains Wind Farm and the Berrybank Wind Farm are not applicable. Specifically, the noise contribution of the Berrybank Wind Farm is sufficiently low to be inconsequential to the noise assessment for the Golden Plains Wind Farm. Conversely, the predicted noise contribution of the Golden Plains Wind Farm at the receiver locations in the vicinity of the Berrybank Wind Farm would not affect the compliance outcome for this project.

9.0 SUMMARY

A revised assessment of operational turbine noise associated with the proposed Golden Plains Wind Farm has been carried out. The assessment is based on the proposed wind farm layout comprising a reduced layout of two hundred and fifteen (215) turbines with an increased rotor diameter of up to 165 m.

Operational noise associated with the proposed wind turbines has been assessed in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010) as required by the Victorian Government's *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019 and clause 52.32-4 of the Planning Scheme.

Noise modelling was carried out based on two candidate turbine models which have been selected as being representative of the size and type of turbines which could be used at the site.

The results of the modelling demonstrate that the proposed Golden Plains Wind Farm turbines are predicted to achieve compliance with the applicable noise limits determined in accordance with NZS 6808:2010, for both candidate turbine models, including the locations where high amenity limit considerations are relevant.

This assessment has also considered potential cumulative noise from the nearby Berrybank Wind Farm, currently under construction. Based on an assessment of predicted noise levels for each wind farm, it has been demonstrated that cumulative wind farm noise considerations are not applicable.

The noise assessment therefore demonstrates that the proposed Golden Plains Wind Farm can be designed and developed to achieve Victorian policy requirements for operational wind turbine noise.

APPENDIX A GLOSSARY OF TERMINOLOGY

Term	Definition	Abbreviation
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion below this table.
A-weighted 90th centile	The A-weighted pressure level that is exceeded for 90 % of a defined measurement period. It is used to describe the underlying background sound level in the absence of a source of sound that is being investigated, as well as the sound level of steady, or semi steady, sound sources.	L_{A90}
Decibel	The unit of sound level.	dB
Hertz	The unit for describing the frequency of a sound in terms of the number of cycles per second.	Hz
Octave Band	A range of frequencies. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.	-
Sound power level	A measure of the total sound energy emitted by a source, expressed in decibels.	L_W
Sound pressure level	A measure of the level of sound expressed in decibels.	L_p
Special Audible Characterises	A term used to define a set group of Sound characteristics that increase the likelihood of adverse reaction to the sound. The characteristics comprise tonality, impulsiveness and amplitude modulation.	SAC
Tonality	A characteristic to describe sounds which are composed of distinct and narrow groups of audible sound frequencies (e.g. whistling or humming sounds).	-

The basic quantities used within this document to describe noise adopt the conventions outlined in ISO 1996-1:2016 *Acoustics - Description measurement and assessment of environmental noise – Basic quantities and assessment procedures*. Accordingly, all frequency weighted sound pressure levels are expressed as decibels (dB) in this report. For example, sound pressure levels measured using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

APPENDIX B TURBINE COORDINATES

The following table sets out the coordinates of the proposed turbine layout of the Golden Plains Wind Farm (Layout reference v39-01 supplied by the proponent on 12 November 2020).

Table 10: Turbine coordinates – MGA 94 zone 54

Turbine	Easting, m	Northing, m	Terrain elevation, m	Turbine	Easting, m	Northing, m	Terrain elevation, m
WTG001	728,573	5,804,228	187	WTG111	739,173	5,795,948	160
WTG002	729,140	5,804,624	188	WTG112	739,197	5,798,745	168
WTG003	729,152	5,803,805	183	WTG113	739,628	5,794,893	160
WTG004	729,142	5,805,578	193	WTG114	739,777	5,799,925	170
WTG005	729,594	5,805,022	186	WTG115	739,873	5,796,901	161
WTG006	729,668	5,804,423	184	WTG116	740,004	5,799,325	170
WTG007	729,652	5,803,732	182	WTG117	740,015	5,794,428	160
WTG008	729,618	5,806,018	194	WTG118	740,094	5,798,140	169
WTG009	729,911	5,805,438	187	WTG119	740,093	5,797,433	167
WTG010	730,055	5,802,579	177	WTG120	740,250	5,800,102	177
WTG011	729,925	5,806,482	201	WTG121	740,323	5,798,812	170
WTG012	730,448	5,806,215	198	WTG122	740,703	5,800,557	180
WTG013	730,506	5,803,989	180	WTG123	740,592	5,793,835	160
WTG014	730,077	5,801,901	170	WTG124	740,625	5,794,588	160
WTG015	730,359	5,804,681	180	WTG125	740,438	5,795,137	160
WTG016	730,503	5,805,215	186	WTG126	740,703	5,796,599	165
WTG017	730,548	5,807,366	206	WTG127	740,814	5,799,874	178
WTG018	730,227	5,806,921	204	WTG128	740,860	5,793,194	159
WTG019	730,950	5,803,214	176	WTG129	741,214	5,800,761	181
WTG020	731,233	5,803,689	177	WTG130	741,014	5,799,230	175
WTG021	730,944	5,801,750	170	WTG131	741,151	5,794,143	160
WTG022	730,735	5,802,458	172	WTG132	741,234	5,796,295	167
WTG023	731,107	5,805,954	192	WTG133	741,318	5,800,150	180
WTG024	731,049	5,804,994	181	WTG134	741,373	5,795,737	164
WTG025	731,284	5,800,681	163	WTG135	741,556	5,798,769	177
WTG026	731,276	5,800,095	161	WTG136	741,668	5,796,990	172
WTG027	731,265	5,806,450	197	WTG137	741,692	5,799,663	180
WTG028	730,292	5,803,485	180	WTG138	741,763	5,800,628	183
WTG029	731,431	5,801,260	166	WTG139	741,890	5,794,055	162
WTG030	731,421	5,807,220	210	WTG140	741,892	5,792,921	160
WTG031	731,437	5,799,551	160	WTG141	741,580	5,793,465	160
WTG032	731,538	5,802,015	170	WTG142	742,024	5,798,974	180
WTG033	731,523	5,805,139	184	WTG143	742,048	5,796,289	170
WTG034	731,717	5,800,352	165	WTG144	742,263	5,794,778	165

Turbine	Easting, m	Northing, m	Terrain elevation, m
WTG035	731,872	5,799,816	160
WTG036	731,314	5,804,302	180
WTG037	731,984	5,798,751	160
WTG038	732,105	5,799,295	160
WTG039	732,107	5,803,861	178
WTG040	732,173	5,801,533	170
WTG041	732,409	5,806,935	201
WTG042	732,159	5,805,035	184
WTG043	732,277	5,806,250	196
WTG044	732,197	5,804,374	180
WTG045	732,500	5,798,741	160
WTG046	732,605	5,799,354	160
WTG047	733,749	5,801,235	170
WTG048	732,691	5,799,867	160
WTG049	732,715	5,805,712	190
WTG050	732,780	5,806,458	199
WTG051	732,884	5,805,071	189
WTG052	732,905	5,804,118	183
WTG053	733,119	5,799,424	160
WTG054	733,165	5,806,059	195
WTG056	733,331	5,800,134	163
WTG057	733,369	5,804,438	186
WTG058	733,407	5,798,787	160
WTG059	733,574	5,800,651	168
WTG060	733,482	5,805,112	190
WTG061	733,670	5,805,626	190
WTG062	734,178	5,801,578	171
WTG064	734,005	5,804,301	183
WTG065	734,011	5,799,324	160
WTG066	734,098	5,803,605	180
WTG067	734,232	5,797,856	157
WTG068	734,605	5,801,928	172
WTG069	734,357	5,800,123	163
WTG070	736,324	5,803,127	177
WTG071	734,478	5,800,796	166
WTG072	734,569	5,799,380	160
WTG073	734,579	5,797,024	154
WTG074	734,601	5,803,406	181

Turbine	Easting, m	Northing, m	Terrain elevation, m
WTG145	742,384	5,796,988	176
WTG146	742,430	5,794,137	164
WTG147	742,531	5,798,242	180
WTG148	742,537	5,792,850	160
WTG149	742,553	5,798,872	180
WTG150	742,752	5,797,445	180
WTG151	742,717	5,795,499	169
WTG152	742,978	5,794,887	169
WTG153	743,030	5,792,791	160
WTG154	743,032	5,796,204	173
WTG155	743,070	5,793,467	162
WTG156	743,162	5,796,841	180
WTG157	743,091	5,798,428	180
WTG158	743,343	5,789,093	150
WTG159	743,374	5,795,450	170
WTG160	743,386	5,794,099	164
WTG161	743,290	5,797,844	180
WTG162	743,397	5,788,550	150
WTG163	743,538	5,792,731	159
WTG164	743,563	5,797,329	180
WTG165	743,691	5,789,488	150
WTG166	743,718	5,796,079	173
WTG167	743,863	5,794,699	166
WTG168	744,038	5,789,006	150
WTG169	743,910	5,788,436	149
WTG170	744,031	5,796,684	180
WTG171	744,177	5,789,614	150
WTG172	744,249	5,792,765	156
WTG173	744,252	5,793,336	159
WTG174	744,634	5,788,942	150
WTG175	744,673	5,789,513	149
WTG176	744,609	5,796,010	175
WTG177	744,611	5,793,750	158
WTG178	744,769	5,792,707	154
WTG179	745,084	5,789,201	147
WTG180	745,191	5,794,463	162
WTG181	745,106	5,796,496	179
WTG182	745,286	5,793,646	154

Turbine	Easting, m	Northing, m	Terrain elevation, m
WTG075	734,752	5,797,609	156
WTG076	735,064	5,797,151	154
WTG077	735,083	5,800,173	163
WTG078	735,151	5,803,475	180
WTG079	735,367	5,801,566	170
WTG080	735,428	5,800,989	168
WTG081	735,571	5,797,531	155
WTG082	735,612	5,803,684	180
WTG083	735,771	5,799,337	160
WTG084	735,792	5,802,171	172
WTG085	735,795	5,800,004	160
WTG086	735,900	5,798,769	160
WTG087	735,911	5,797,893	157
WTG088	735,913	5,802,745	174
WTG089	736,156	5,801,512	168
WTG090	736,275	5,797,142	154
WTG091	736,303	5,799,811	160
WTG092	736,952	5,798,397	160
WTG093	736,703	5,799,033	160
WTG094	736,796	5,799,967	160
WTG095	736,603	5,797,799	159
WTG096	737,421	5,796,918	160
WTG097	737,531	5,799,092	165
WTG098	737,585	5,798,434	161
WTG099	737,621	5,799,682	166
WTG100	737,812	5,797,380	160
WTG101	738,035	5,796,813	160
WTG102	738,181	5,797,741	167
WTG103	738,179	5,798,983	170
WTG104	738,345	5,796,341	160
WTG105	738,480	5,798,374	170
WTG106	738,571	5,796,958	160
WTG107	738,607	5,799,257	170
WTG108	738,928	5,795,373	160
WTG109	739,018	5,794,481	153
WTG110	739,250	5,799,325	170

Turbine	Easting, m	Northing, m	Terrain elevation, m
WTG183	745,299	5,792,734	150
WTG184	745,556	5,795,088	166
WTG185	745,601	5,795,990	173
WTG186	745,752	5,796,849	182
WTG187	745,890	5,795,480	167
WTG188	745,897	5,794,461	160
WTG189	745,921	5,792,760	152
WTG190	746,052	5,793,622	154
WTG191	746,059	5,796,243	174
WTG192	746,315	5,796,726	179
WTG193	746,435	5,793,018	156
WTG194	746,949	5,794,811	161
WTG195	746,665	5,793,576	158
WTG196	747,046	5,795,768	167
WTG197	747,208	5,792,803	160
WTG198	747,038	5,794,081	160
WTG199	747,584	5,794,858	167
WTG200	747,420	5,793,402	161
WTG201	747,626	5,794,063	168
WTG202	747,814	5,792,850	160
WTG203	747,638	5,795,478	170
WTG204	748,114	5,794,900	170
WTG205	748,108	5,794,213	170
WTG206	747,996	5,793,519	165
WTG207	748,288	5,793,036	161
WTG208	748,481	5,795,331	174
WTG209	748,611	5,794,145	170
WTG210	748,732	5,794,771	172
WTG211	748,857	5,793,608	165
WTG212	749,161	5,795,217	175
WTG213	749,222	5,794,664	171
WTG214	749,238	5,794,071	167
WTG215	750,170	5,790,441	151
WTG216	750,659	5,790,531	152
WTG217	750,618	5,791,156	152

APPENDIX C RECEIVER LOCATIONS

The following table sets out the one hundred and forty-five (145) assessed receivers located within 3 km of the proposed turbines considered in the environmental noise assessment together with their respective distance to the nearest turbine and land zoning.

These include one (1) school and one (1) childcare located within the Rokewood township.

(Data supplied by the proponent on 27 November 2020).

Table 11: Receivers within 3 km of the proposed turbines – MGA 94 zone 54

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
D35 - a	725,951	5,805,306	190	2,838	WTG001	FZ
F32 - a	727,015	5,802,349	170	2,445	WTG001	FZ
F35 - a	727,236	5,805,534	187	1,874	WTG001	FZ
G30 - a	728,994	5,800,930	160	1,462	WTG014	FZ
H28 - a	729,859	5,798,327	153	2,002	WTG031	FZ
H30 - a	729,369	5,800,291	160	1,765	WTG014	FZ
H32 - a	729,073	5,802,087	170	1,032	WTG014	FZ
H38 - a	729,116	5,808,096	214	1,614	WTG017	FZ
H38 - b	729,285	5,808,898	223	1,991	WTG017	FZ
I26 - a	730,060	5,796,521	150	2,949	WTG037	FZ
I39 - a	730,161	5,809,849	229	2,518	WTG017	FZ
K27 - a	732,346	5,797,615	156	1,146	WTG045	FZ
L25 - a	733,029	5,795,769	148	2,000	WTG073	FZ
L26 - a	733,373	5,796,960	154	1,216	WTG073	FZ
L38 - a	733,936	5,808,242	240	2,015	WTG041	FZ
L38 - b	733,229	5,808,692	230	1,944	WTG041	FZ
L39 - a	733,258	5,809,770	224	2,963	WTG041	RLZ
L39 - b	733,422	5,809,554	232	2,812	WTG041	RLZ
L39 - c	733,411	5,809,378	239	2,644	WTG041	RLZ
L39 - d	733,548	5,809,456	235	2,770	WTG041	FZ
L39 - e	733,978	5,809,056	248	2,643	WTG041	FZ
L39 - f	733,930	5,809,110	249	2,658	WTG041	FZ
M24 - a	734,445	5,794,808	144	2,225	WTG073	FZ
M24 - b	734,394	5,794,808	144	2,229	WTG073	FZ
M35 - b	734,679	5,805,841	200	1,041	WTG061	FZ
M37 - a	734,049	5,807,888	240	1,902	WTG041	FZ
M37 - b	734,617	5,807,932	218	2,360	WTG050	FZ

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
M37 - c	734,822	5,807,599	200	2,267	WTG054	FZ
M37 - d	734,842	5,807,361	201	2,099	WTG061	FZ
M38 - a	734,342	5,808,410	239	2,435	WTG041	FZ
N25 - a	735,734	5,795,678	150	1,568	WTG090	FZ
N25 - b	735,596	5,795,705	150	1,548	WTG076	FZ
N36 - a	735,394	5,806,857	231	2,123	WTG061	FZ
N36 - b	735,629	5,806,537	229	2,165	WTG061	FZ
N36 - c	735,753	5,806,766	240	2,379	WTG061	FZ
N37 - a	735,309	5,807,414	240	2,430	WTG061	FZ
O24 - a	736,740	5,794,684	145	2,292	WTG109	FZ
O34 - a	736,250	5,804,496	190	1,043	WTG082	FZ
O34 - b	736,302	5,804,484	191	1,067	WTG082	FZ
P24 - a	737,032	5,794,683	145	2,002	WTG109	FZ
P24 - b	737,293	5,794,965	148	1,692	WTG108	FZ
P31 - a	737,563	5,801,100	162	1,376	WTG094	FZ
P31 - c	737,462	5,801,204	162	1,350	WTG089	FZ
P32 - a	737,308	5,802,776	175	1,055	WTG070	FZ
Q30 - a	738,605	5,800,832	170	1,489	WTG114	FZ
Q31 - a	738,592	5,801,449	170	1,936	WTG114	FZ
Q31 - b	738,434	5,801,699	170	2,179	WTG099	FZ
Q31 - c	738,632	5,801,871	171	2,262	WTG114	FZ
Q31 - e*	738,967	5,801,890	174	2,131	WTG114	TZ
Q31 - f*	738,733	5,801,881	172	2,222	WTG114	TZ
Q31 - g*	738,785	5,801,858	172	2,178	WTG114	TZ
Q31 - h*	738,828	5,801,838	172	2,140	WTG114	TZ
Q31 - i*	738,852	5,801,805	172	2,101	WTG114	TZ
Q31 - j*	738,886	5,801,813	173	2,093	WTG114	TZ
Q31 - k*	738,901	5,801,800	173	2,075	WTG114	TZ
Q31 - l*	738,922	5,801,794	173	2,061	WTG114	TZ
Q31 - m*	738,791	5,801,735	171	2,066	WTG114	TZ
Q31 - o*	738,965	5,801,387	171	1,679	WTG114	TZ
Q31 - p*	738,734	5,801,410	170	1,820	WTG114	LDRZ
Q32 - a	738,225	5,802,138	171	2,148	WTG070	FZ

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
Q32 - b	738,341	5,802,115	171	2,262	WTG070	FZ
Q32 - c	738,402	5,802,176	172	2,290	WTG070	FZ
Q32 - d	738,354	5,802,214	173	2,231	WTG070	FZ
Q32 - e	738,723	5,802,232	173	2,541	WTG114	FZ
Q32 - f	738,594	5,802,128	171	2,484	WTG070	FZ
Q32 - g*	738,769	5,802,008	173	2,319	WTG114	TZ
Q34 - a	738,393	5,804,213	227	2,341	WTG070	FZ
Q35 - a	738,259	5,805,321	250	2,928	WTG070	FZ
R31 - aa*	739,526	5,801,566	177	1,558	WTG122	TZ
R31 - ab*	739,349	5,801,407	174	1,550	WTG114	TZ
R31 - ad*	739,668	5,801,376	177	1,328	WTG122	TZ
R31 - ae (S)	739,387	5,801,377	175	1,511	WTG114	PUZ2
R31 - af (C)	739,374	5,801,396	174	1,532	WTG114	PUZ2
R31 - ai*	739,170	5,801,275	173	1,487	WTG114	TZ
R31 - aj*	739,146	5,801,363	173	1,577	WTG114	TZ
R31 - ak*	739,292	5,801,418	174	1,576	WTG114	TZ
R31 - al*	739,182	5,801,416	173	1,612	WTG114	TZ
R31 - am*	739,182	5,801,499	173	1,689	WTG114	TZ
R31 - an*	739,132	5,801,532	173	1,738	WTG114	TZ
R31 - ao*	739,070	5,801,564	173	1,791	WTG114	TZ
R31 - ap*	739,420	5,801,443	175	1,566	WTG114	TZ
R31 - aq*	739,450	5,801,493	176	1,571	WTG122	TZ
R31 - ar*	739,402	5,801,462	175	1,588	WTG114	TZ
R31 - as*	739,355	5,801,496	175	1,633	WTG114	TZ
R31 - at*	739,367	5,801,474	175	1,609	WTG114	TZ
R31 - av*	739,381	5,801,528	175	1,647	WTG122	TZ
R31 - aw*	739,370	5,801,553	175	1,671	WTG122	TZ
R31 - ax*	739,294	5,801,500	174	1,654	WTG114	TZ
R31 - az*	739,497	5,801,582	177	1,590	WTG122	TZ
R31 - b*	739,619	5,801,552	177	1,479	WTG122	TZ
R31 - ba*	739,575	5,801,533	177	1,500	WTG122	TZ
R31 - bb*	739,227	5,801,576	174	1,747	WTG114	TZ
R31 - bc*	739,220	5,801,563	174	1,736	WTG114	TZ

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
R31 - bd*	739,214	5,801,548	174	1,724	WTG114	TZ
R31 - be*	739,427	5,801,190	175	1,321	WTG114	TZ
R31 - bf*	739,096	5,801,908	175	2,101	WTG114	TZ
R31 - c*	739,104	5,801,611	173	1,821	WTG114	TZ
R31 - d*	739,706	5,801,597	178	1,449	WTG122	TZ
R31 - f*	739,045	5,801,510	172	1,752	WTG114	TZ
R31 - g*	739,245	5,801,523	174	1,691	WTG114	TZ
R31 - h*	739,254	5,801,555	174	1,718	WTG114	TZ
R31 - j*	739,397	5,801,638	176	1,703	WTG122	TZ
R31 - k*	739,370	5,801,644	176	1,727	WTG122	TZ
R31 - n*	739,324	5,801,676	176	1,782	WTG122	TZ
R31 - q*	739,009	5,801,990	175	2,208	WTG114	TZ
R31 - r*	739,050	5,801,658	173	1,885	WTG114	TZ
R31 - s*	739,122	5,801,682	174	1,880	WTG114	TZ
R31 - t*	739,160	5,801,671	174	1,857	WTG114	TZ
R31 - u*	739,179	5,801,657	174	1,838	WTG114	TZ
R31 - v*	739,202	5,801,649	174	1,823	WTG114	TZ
R31 - w*	739,214	5,801,639	174	1,810	WTG114	TZ
R31 - z*	739,198	5,801,563	174	1,743	WTG114	TZ
R32 - a	739,051	5,802,266	177	2,382	WTG122	FZ
R32 - b	739,072	5,802,112	176	2,258	WTG122	FZ
R32 - c	739,059	5,802,044	176	2,222	WTG122	FZ
R32 - d*	739,014	5,802,017	175	2,231	WTG114	TZ
R32 - e	739,971	5,802,442	183	2,028	WTG122	FZ
R33 - a	739,269	5,803,149	195	2,949	WTG070	FZ
T17 - a	741,311	5,787,868	140	2,200	WTG162	FZ
T17 - b	741,231	5,787,929	140	2,258	WTG162	FZ
T32 - a	741,562	5,802,587	190	1,865	WTG129	FZ
T32 - b	741,355	5,802,435	190	1,687	WTG129	FZ
U18 - a	742,345	5,788,139	143	1,139	WTG162	FZ
U18 - b	742,149	5,788,761	150	1,248	WTG158	FZ
U18 - c	742,105	5,788,742	150	1,296	WTG158	FZ
U31 - a	742,715	5,801,859	199	1,563	WTG138	FZ

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
U32 - a	742,962	5,802,812	201	2,496	WTG138	FZ
V30 - a	743,058	5,800,426	185	1,319	WTG138	FZ
V32 - a	743,040	5,802,814	202	2,536	WTG138	FZ
W17 - a	744,971	5,787,817	141	1,184	WTG174	FZ
W27 - i	744,847	5,797,923	185	1,412	WTG186	FZ
W28 - a	744,889	5,798,050	185	1,486	WTG186	FZ
X18 - a	745,581	5,788,298	143	1,041	WTG179	FZ
Y28 - a	746,420	5,798,391	192	1,675	WTG192	FZ
Y28 - b	746,653	5,798,644	194	1,954	WTG192	FZ
Z28 - a	747,222	5,798,153	190	1,697	WTG192	FZ
AA27 - a	748,944	5,797,036	187	1,773	WTG208	FZ
AA27 - b	748,226	5,797,449	184	2,049	WTG192	FZ
AB18 - a	749,623	5,788,015	148	2,492	WTG215	FZ
AC17 - a	750,863	5,787,865	152	2,672	WTG215	FZ
AC18 - a	750,884	5,788,946	159	1,608	WTG216	FZ
AC22 - a	750,874	5,792,218	160	1,102	WTG217	FZ
AD23 - a	751,141	5,793,676	170	1,949	WTG214	FZ
AD25 - a	751,723	5,795,944	175	2,667	WTG212	FZ
AE18 - a	752,191	5,788,243	155	2,758	WTG216	FZ

* Receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood
(S) School
(C) Childcare

APPENDIX D SITE LAYOUT PLAN

Figure 15: Proposed turbine layout and receivers - Overview

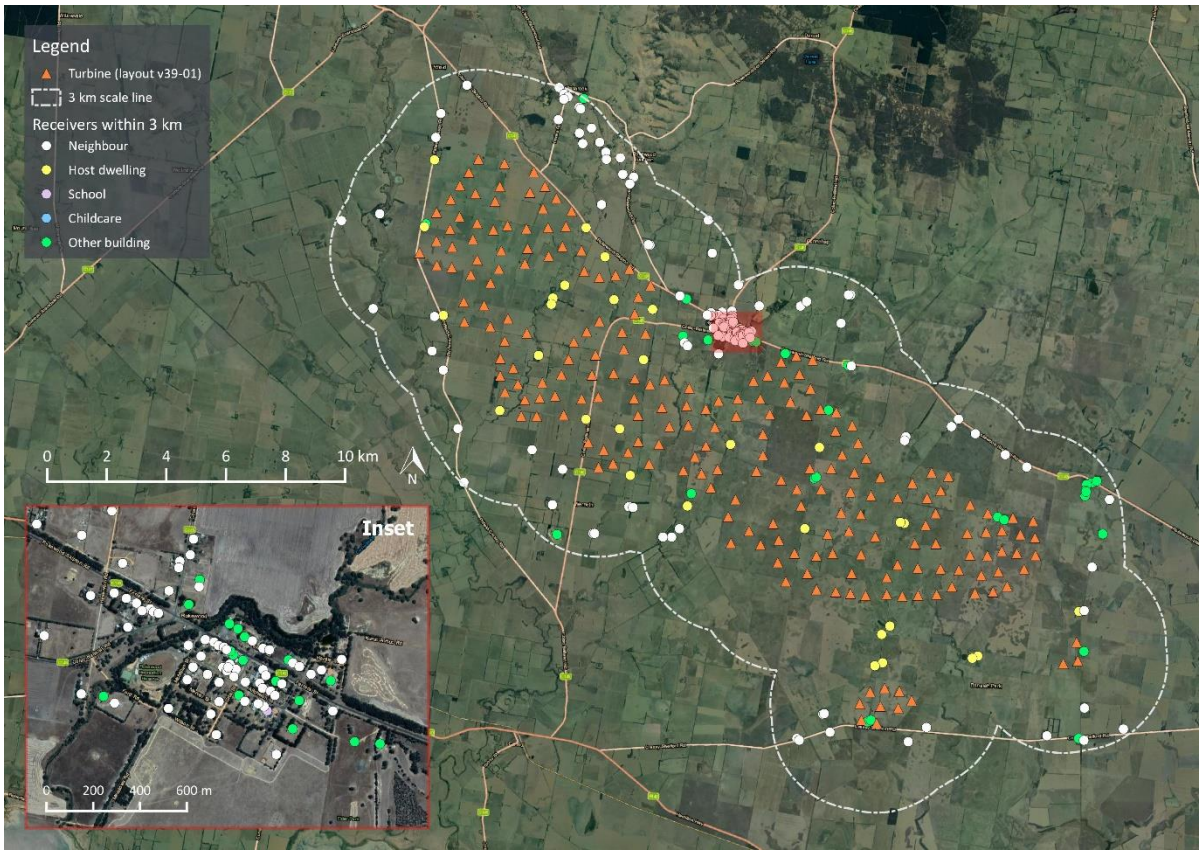


Figure 16: Proposed turbine layout and receivers – North west

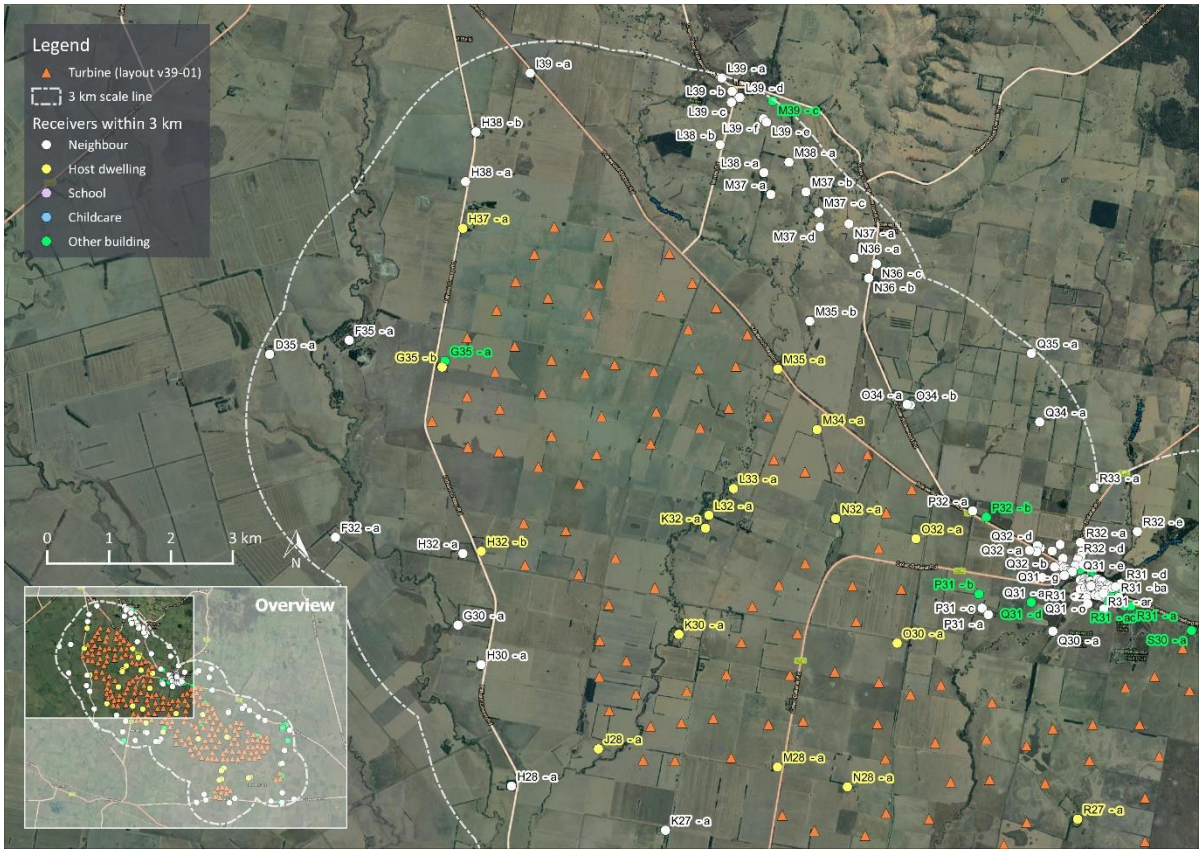


Figure 17: Proposed turbine layout and receivers – North east

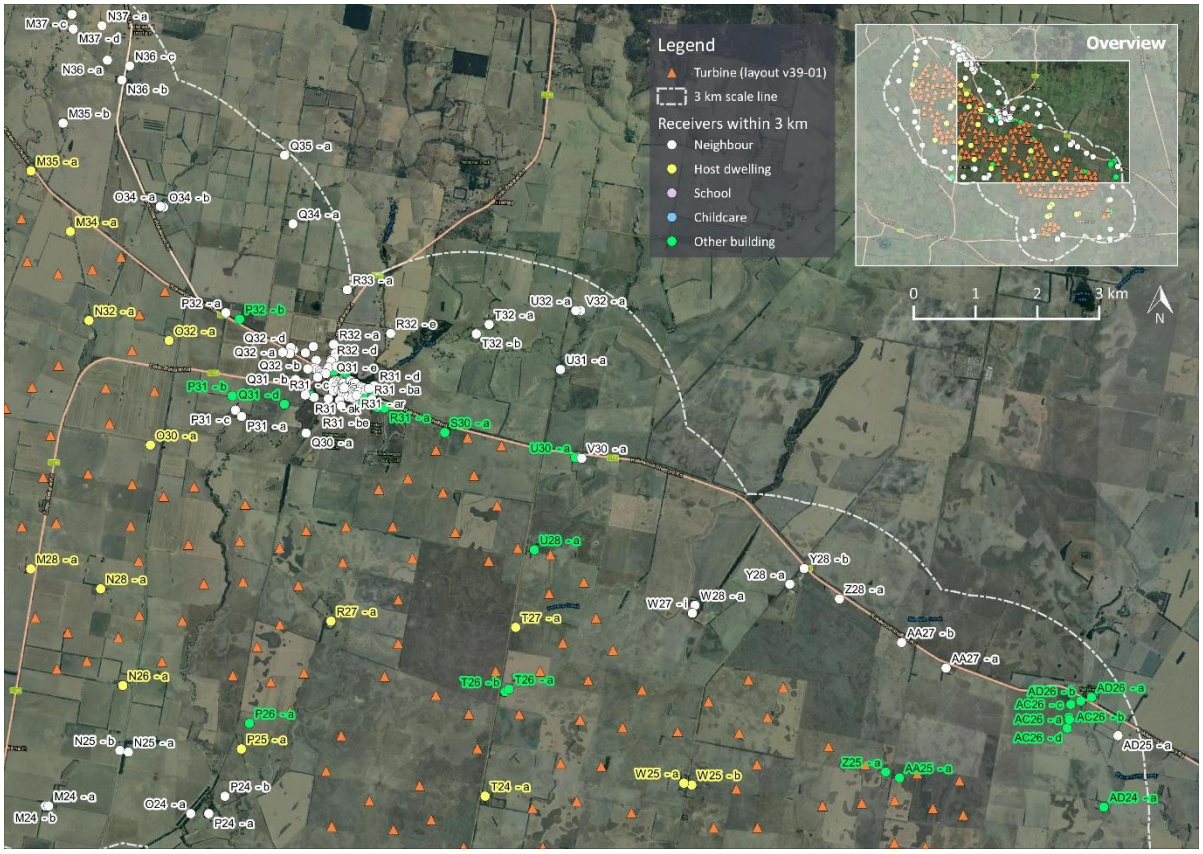


Figure 18: Proposed turbine layout and receivers – South west

Figure 19: Proposed turbine layout and receivers – South east

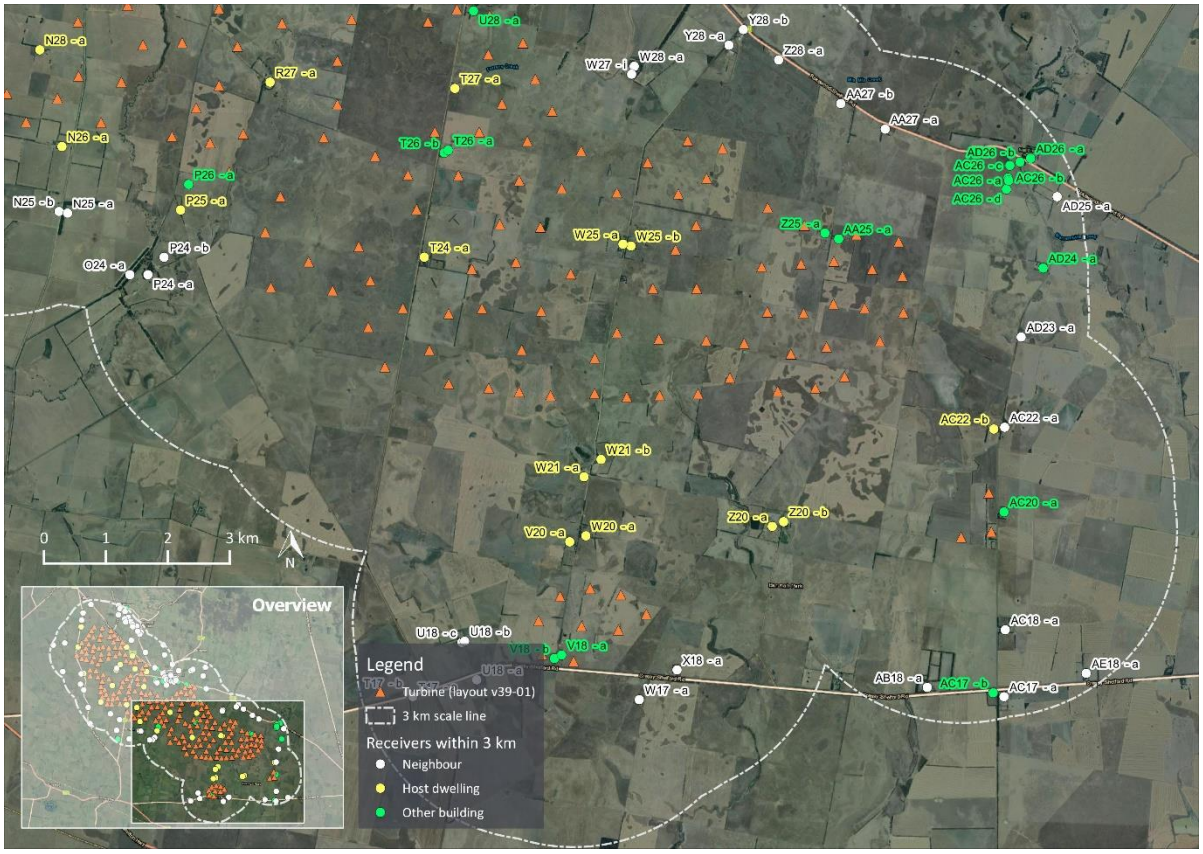
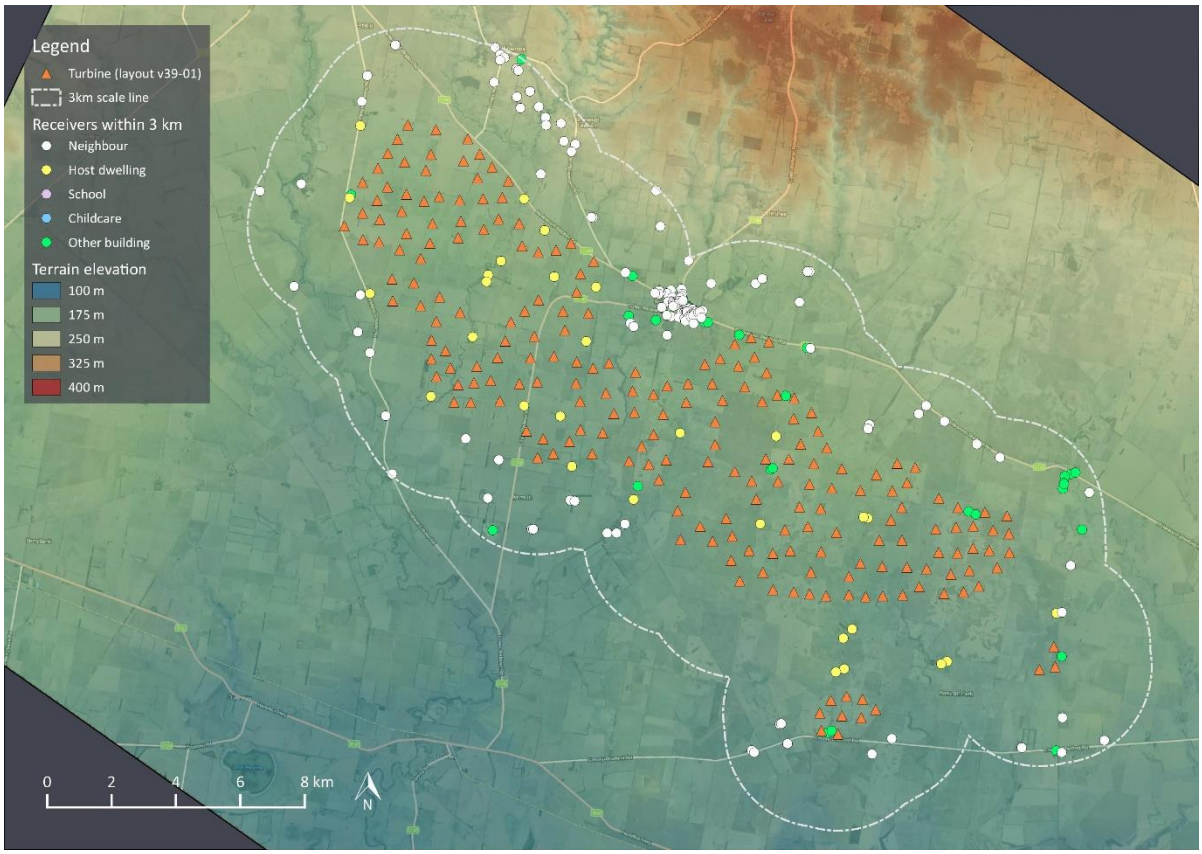


Figure 20: Proposed turbine layout and receivers – Rokewood township

APPENDIX E SITE TOPOGRAPHY

Figure 21: Terrain elevation map for the Golden Plains Wind Farm and surrounding area



APPENDIX F PLANNING PERMIT CONDITIONS

NOISE

In conditions 13-32:

- *'ancillary infrastructure' means the terminal station and collector stations.*
- *'the Standard' means New Zealand Standard 6808:2010, Acoustics – Wind Farm Noise.*
- *'noise sensitive locations' are locations defined as such in the Standard which existed as at 17 August 2017.*
- *'NIRV' means EPA Publication 1411: Noise from Industry in Regional Victoria.*
- *'noise sensitive areas' are locations defined as such in the Glossary in NIRV.*
- *'the first turbine operating' means the time from which a turbine first commences generating electricity.*
- *'the last turbine operating' means the time from which the last turbine to be constructed first commences generating electricity.*

Wind Farm Performance Requirement

13. *Subject to condition 14 and condition 18(c)(i), at any wind speed, noise from the operation of the wind turbines, when measured at noise sensitive locations, must comply with the appropriate limits in the Standard at all times.*
14. *If it is determined that sound from the wind energy facility has a special audible characteristic at any noise sensitive locations, the measured sound level shall have a penalty applied in accordance with the Standard.*
15. *The limits specified in condition 13 do not apply if an agreement has been entered into with the owner of the noise sensitive location that waives compliance with condition 13. Evidence of the agreement must be provided to the satisfaction of the responsible authority upon request, and be in a form that applies to the land upon which the noise sensitive location is located for the life of the wind energy facility.*

Ancillary Infrastructure Performance Requirements

16. *Subject to condition 17, noise from ancillary infrastructure associated with the wind energy facility must comply with the noise levels for noise sensitive areas in accordance with NIRV at all times.*
17. *The limits specified in condition 16 do not apply if an agreement has been entered into with the owner of a noise sensitive area which waives compliance with condition 16. Evidence of the agreement must be provided to the satisfaction of the responsible authority upon request, and be in a form that applies to the land upon which the noise sensitive area is located for the life of the wind energy facility.*

Compliance assessment

Pre-construction Noise Assessment

18. *Before development starts, a Pre-construction Noise Assessment based on the final turbine layout and turbine model to be installed and the detailed design of the ancillary infrastructure must be submitted to, approved and endorsed by the responsible authority. The endorsed Pre-Construction Noise Assessment must be placed on the project website as soon as practicable.*

    The Pre-construction Noise Assessment must:

    a. *be prepared in accordance with the Standard and NIRV, and must demonstrate to the satisfaction of the responsible authority that the facility will comply with the performance requirements specified in conditions 13 and 16*

    b. *include the collection of background noise monitoring data points over a 6-week period, or at least 4,032 valid data points (whichever is lesser) for each representative site, analysis by 24 hour and night (10 pm to 7 am) only period, and for each time sector analysis for each 45 degree wind rose direction*

    c. *include:*

        i. *a specific acknowledgement that the areas in and around Rokewood that are zoned Township Zone and Low Density Residential Zone are a high amenity area for the purposes of the Standard*

        ii. *an assessment as to whether the high amenity noise limit should apply to these areas and the appropriate threshold wind speed, based on the guidance in Clause C5.3.1 of the Standard*

    d. *be accompanied by an Environmental Audit Report prepared under Part IXD, Section 53V of the Environment Protection Act 1970 from an environmental auditor appointed under Part IXD of the Environment Protection Act 1970. The report must verify that the Pre- construction Noise assessment has been conducted in accordance with the Standard and meets the requirements of this permit.*

19. *The following data collected during the Pre-construction Noise Assessment must be retained in their original form and made available on request to the responsible authority, any person conducting a noise investigation report under the Noise Management Plan, or for independent review under conditions 28 to 31:*

    a. *background noise monitoring survey data, in their original form as recorded by each individual field sound level meter at each noise sensitive location at which monitoring was undertaken*

    b. *wind speed and direction monitoring survey data, in their original form as recorded for assessment at each noise sensitive location at which monitoring was undertaken.*

Near-field Compliance Testing Report

20. *Prior to the last turbine operating, a Near-field Compliance Testing Report must be prepared which describes and assesses the results of the sound power level testing of a representative sample of turbines, including the presence or absence of special audible characteristics and tonal audibility levels, by either:*

    a. *verifying that the measured sound power levels (including any penalties), accounting for test uncertainty, are equivalent to or less than the values adopted as the basis of the Pre- construction Noise Assessment carried out under condition 18; or*

    b. *verifying that predicted noise levels (including any penalties) determined on the basis of the measured sound power level test results are below the noise limits in condition 13 for noise sensitive locations, using the same prediction methodology used for the Pre- construction Noise Assessment carried out under condition 18.*

21. *If the measured sound power levels or tonal audibility levels are significantly different from the data referenced in the Pre-construction Noise Assessment, the Near Field Compliance Testing Report must address these differences and outline whether additional sound power level testing is warranted to verify and assess the noise emissions of other wind turbines at the site.*

Operating acoustic compliance assessment

22. *A post-construction noise assessment report prepared in accordance with the New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise demonstrating whether the wind energy facility complies with the Standard, must be submitted to the responsible authority. If the wind energy facility is constructed in stages, additional post-construction noise assessment reports for each stage must be submitted to the responsible authority.*

23. *The post-construction noise assessment report, prepared in accordance with the Standard and NIRV which demonstrates whether the facility complies with the performance requirements specified in conditions 13 and 16 (including any penalty for special audible characteristics), must be submitted to the responsible authority within:*

    a. *6 months of the first turbine operating (in respect of demonstrating compliance with condition 13); and*

    b. *6 months of the ancillary infrastructure commencing operations (in respect of demonstrating compliance with condition 16).*

    Further post-construction noise assessment reports prepared in accordance with this condition must be submitted to the responsible authority annually from the date of the first report being submitted until the final turbine is operating.

24. *Each post-construction noise assessment report must be accompanied by an environmental audit report prepared under Part IXD, Section 53V of the Environment Protection Act 1970 by an environmental auditor appointed under Part IXD of the Environment Protection Act 1970. The environmental audit report must verify that the acoustic assessment undertaken for the purpose of the post-construction noise assessment report has been conducted in accordance with the New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise.*

Noise Management Plan

25. *Before development starts, a Noise Management Plan must be submitted to, approved and endorsed by the responsible authority. The plan must be prepared in consultation with the general public within the vicinity of the project, to the satisfaction of the responsible authority. When endorsed the Noise Management Plan will form part of this permit. The endorsed Noise Management Plan must be placed on the project website for the life of the project.*

    The Noise Management Plan must specify details of:

    a. *Near-field Compliance Testing Report, detailing how this testing and report will be prepared in accordance with IEC 61400-11:2012 Wind turbines – Acoustic noise measurement techniques, and which presents the measured turbine sound power level and tonal audibility, including details of the representative sample of turbines to be tested.*

    b. *Post-construction Acoustic Compliance Reports: detailing how these will be prepared in accordance with the Standard and NIRV, to demonstrate whether or not the facility complies with the performance requirements in conditions 13 and 16.*

    c. *Noise Investigation Reports: detailing procedures for when complaints are received in accordance with the endorsed Complaints Investigation and Response Plan (condition 94) or when potential non-compliance with the performance requirements in conditions 13 and 16 is otherwise detected.*

d. *Noise Remediation Plans: detailing procedures for prompt actions to achieve compliance when non-compliance with the performance requirements in conditions 13 and 16 is found to have occurred.*

e. *The requirements for each of the documents referred to in condition 25(b), (c) and (d), including what matters they must address, and when they must be submitted.*

26. *The endorsed Noise Management Plan must be implemented to the satisfaction of the responsible authority. The endorsed Noise Management Plan must not be altered or modified without the written consent of the responsible authority.*

27. *The endorsed Noise Management Plan, any of the reports referred to in condition 25 and any peer review or peer review report under conditions 29 and 30 must promptly be placed on the Proponent's website.*

Peer review of noise reports and plans

28. *The Pre-Construction Noise Assessment required under condition 18, the Noise Management Plan required under condition 25, and each report and remediation plan required under condition 25, must be prepared by a suitably qualified and experienced acoustician.*

29. *The Noise Management Plan required under condition 25, and the noise remediation plan required under condition 25, must be accompanied by a peer review from an environmental auditor appointed under Part IXD of the Environment Protection Act 1970 verifying that the report or plan is suitable, and meets the requirements of this permit.*

30. *If requested by the responsible authority, the noise investigation reports required under condition 25(c) must be accompanied by a report from an environmental auditor appointed under Part IXD of the Environment Protection Act 1970 verifying that the report or plan is suitable, and meets the requirements of this permit.*

31. *If an auditor appointed under Part IXD of the Environment Protection Act 1970 cannot be retained for any of the requirements under conditions 29 and 30, written consent of the responsible authority may be sought to provide a peer review from a suitably qualified and experienced independent acoustic engineer instead.*

32. *The environmental auditor or peer reviewer must be a different author to the author of the report being reviewed and must make an appropriate conflict of interest declaration.*

APPENDIX G ZONING MAP

Figure 22: Zoning map for the Golden Plains Wind Farm and surrounding area - Overview

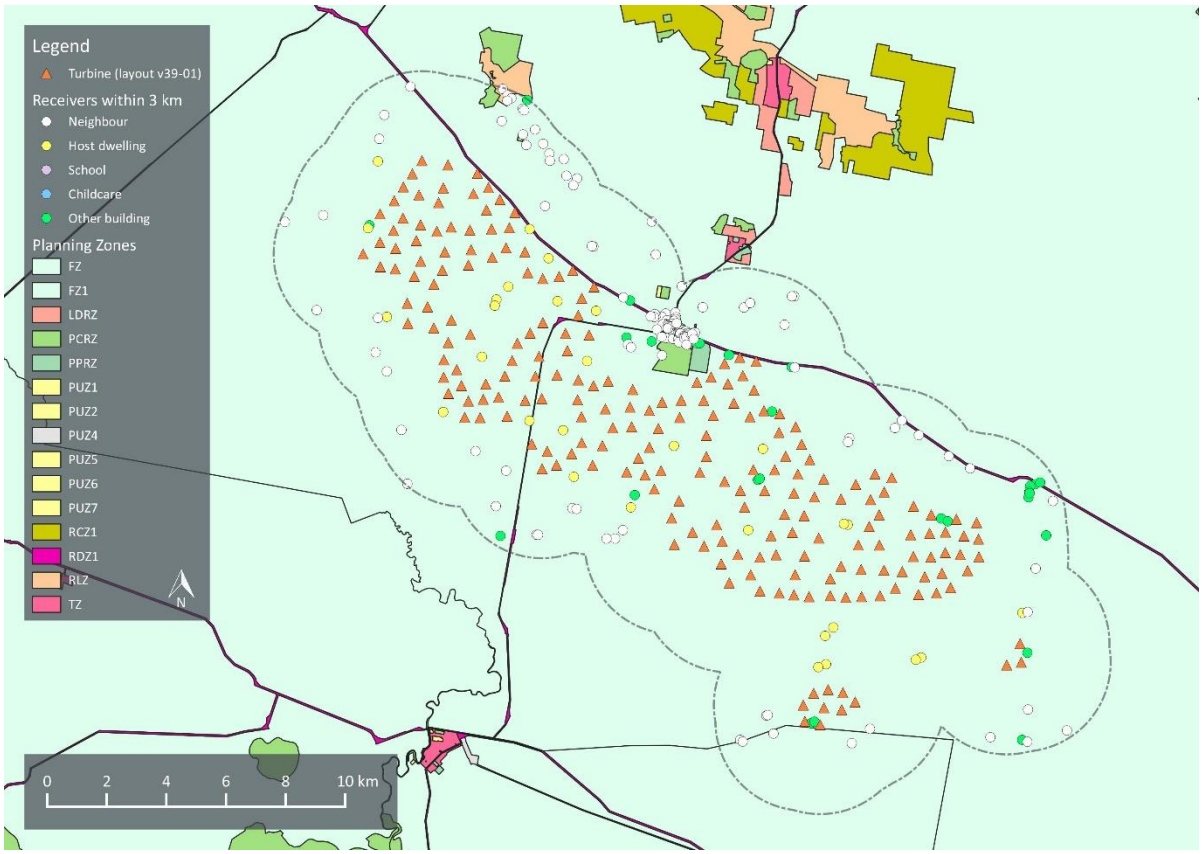


Figure 23: Zoning map for the Golden Plains Wind Farm and surrounding area – North west

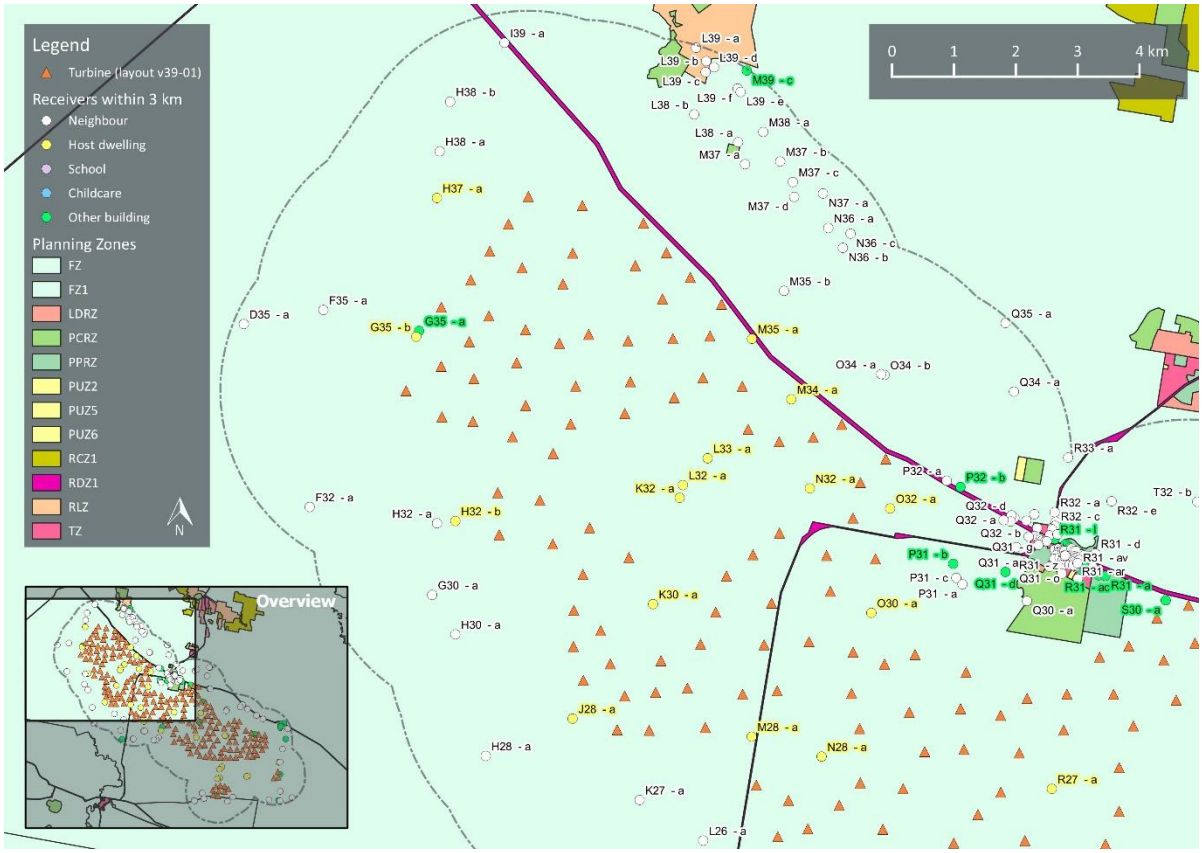


Figure 24: Zoning map for the Golden Plains Wind Farm and surrounding area – North east

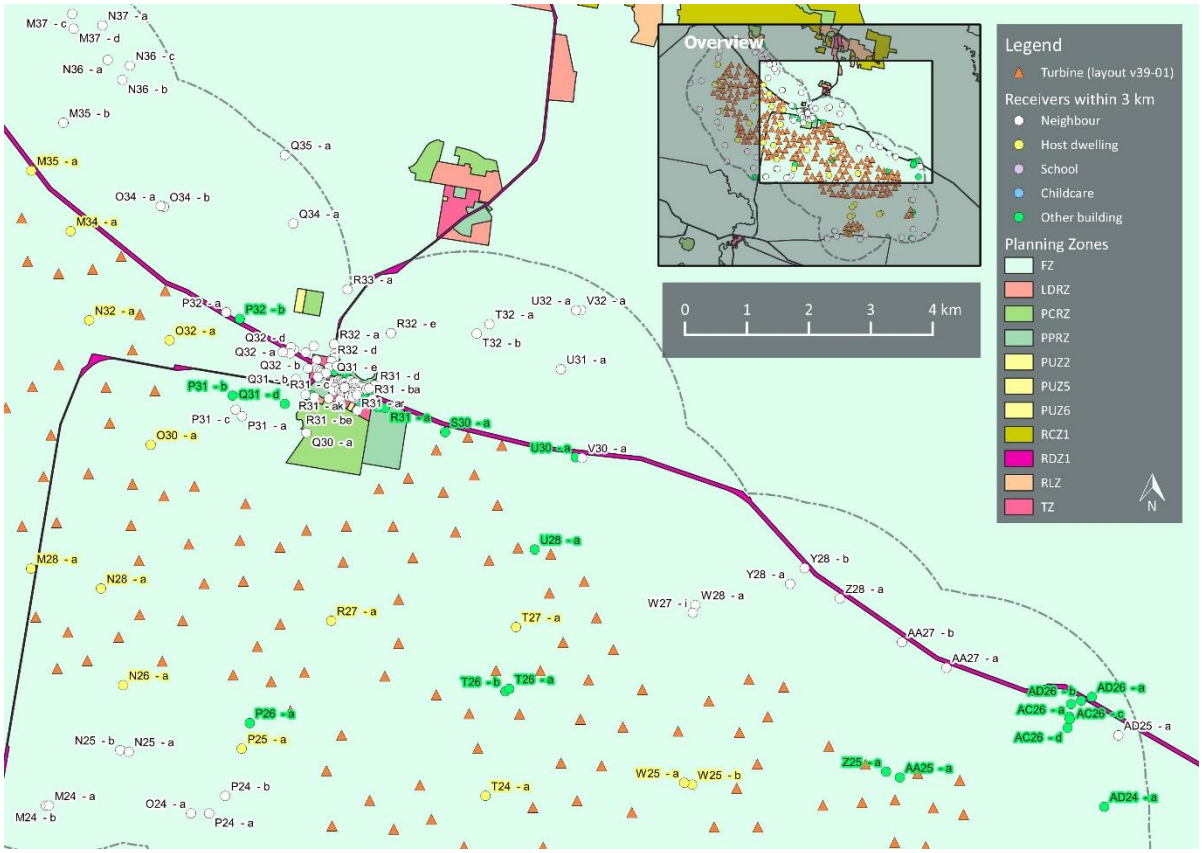


Figure 25: Zoning map for the Golden Plains Wind Farm and surrounding area – South west

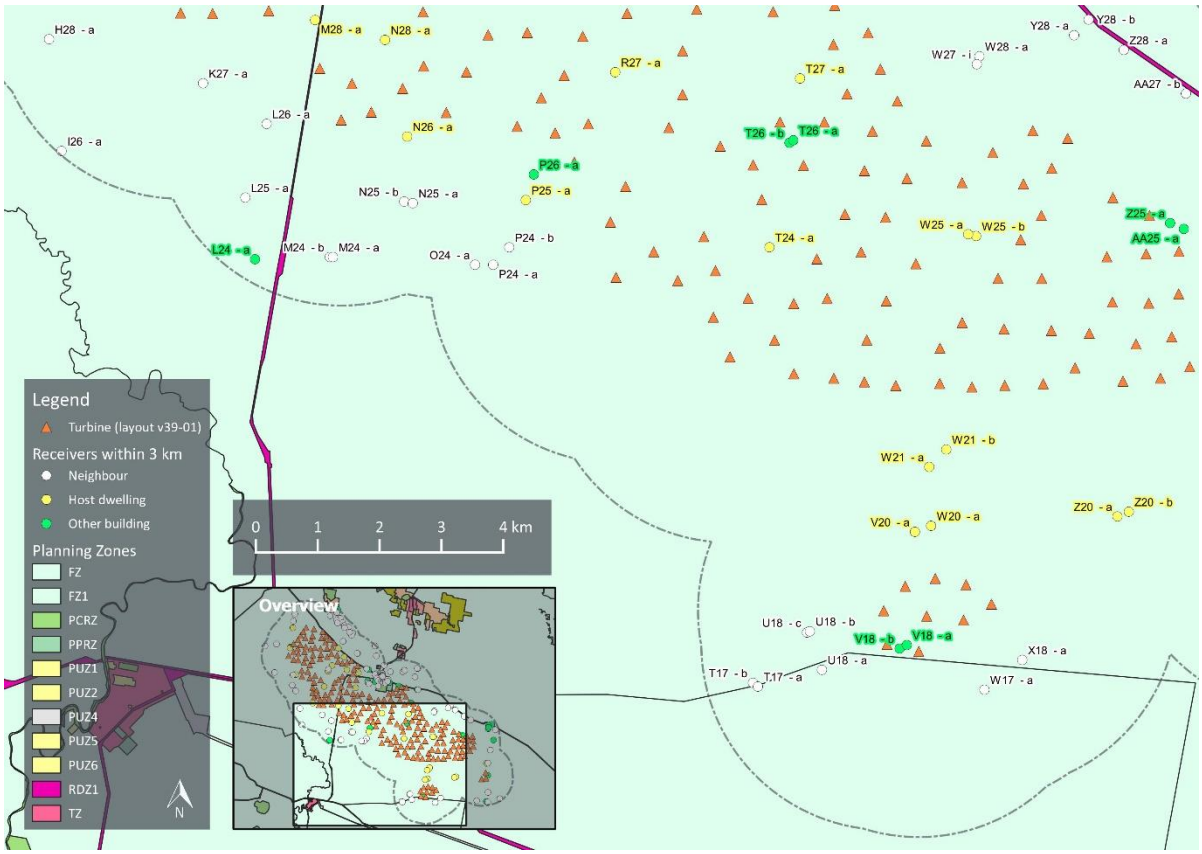


Figure 26: Zoning map for the Golden Plains Wind Farm and surrounding area – South east

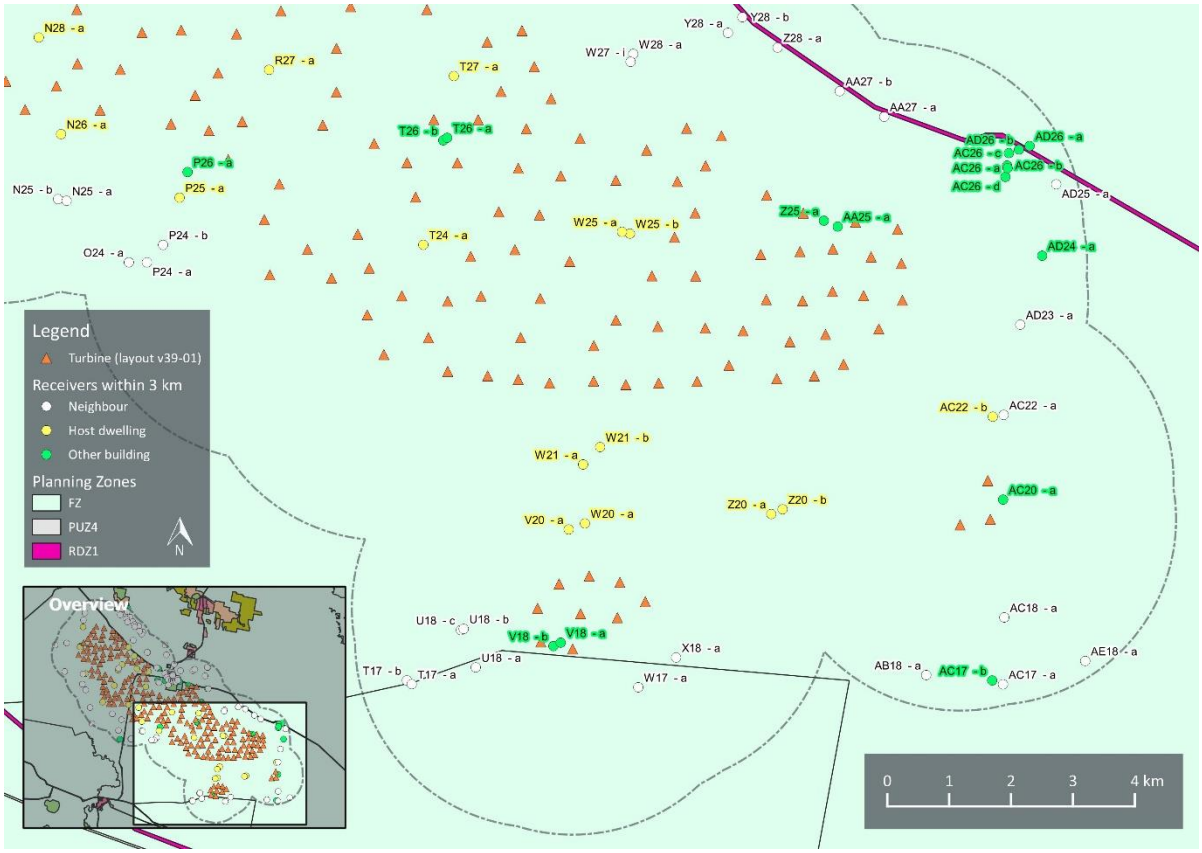


Figure 27: Zoning map for the Golden Plains Wind Farm and surrounding area – Rokewood township

APPENDIX H NOISE PREDICTION MODEL

H1 Downwind conditions

Environmental noise levels associated with wind farms are predicted using engineering methods. The international standard ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors* has been chosen as the most appropriate method to calculate the level of broadband A-weighted wind farm noise expected to occur at surrounding receivers. This method is considered the most robust and widely used international method for the prediction of wind farm noise.

The use of this standard 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*, AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators* and the South Australian EPA 2009 wind farm noise guidelines.

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 emissions 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, the noise emissions of each 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 noise emission data to determine the corresponding octave band and total calculated noise level at receivers.

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 when a certain set of input parameters are chosen in combination. Specifically, the studies to date tend to support that the assignment of a ground absorption factor of G = 0.5 for the source, middle and receiver ground regions between a wind farm and a calculation point tends to provide a reliable representation of the upper noise levels expected in practice, when modelled in combination with other key assumptions; specifically all 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 ^{o}C and relative humidity of 70 % to 80 %, with specific adjustments for screening and ground effects as a result of the ground terrain profile.

In support of the use of ISO 9613 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 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 (commonly cited as the Joule Report), part funded by the European Commission found that the ISO 9613 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 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 (the UK IOA 2009 joint agreement), including consultants routinely employed on behalf of both developers and community opposition groups, and indicated the ISO 9613 method as the appropriate standard and specifically designated G = 0.5 as the appropriate ground characterisation. This agreement was subsequently reflected in the recommendations detailed in the UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (UK Institute of Acoustics guidance). It is noted that these publications refer to predictions made at receiver heights of 4 m. Predictions in Australia are generally based on a lower prediction height of 1.5 m which tends to result in higher ground attenuation for a given ground factor, 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 measurement and prediction studies[9, 10, 11] for wind farms in which Marshall Day Acoustics' staff have been involved in have provided further support for the use of ISO 9613 and G = 0.5 as an appropriate representation of typical upper noise levels expected to occur in practice.

The findings of these studies demonstrate the suitability of the ISO 9613 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.

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[9] 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.

[10] 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.

[11] 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.

In addition to the choice of ground factor referred to above, adjustments to the ISO 9613 standard for screening and valleys effects are applied based on recommendations of the Joule Report, UK IOA 2009 joint agreement and the UK Institute of Acoustics guidance. The following adjustments are applied to the calculations:

- Screening effects as a result of terrain are limited to 2 dB
- Screening effects are assessed based on each turbine being represented by a single noise source located at the maximum tip height of the turbine rotor
- An adjustment of 3 dB is added to the predicted noise contribution of a turbine if the terrain between the turbine and receiver in question is characterised by a significant valley. A significant valley is defined as a situation where the mean sound propagation height is at least 50 % greater than it would be otherwise over flat ground.

The adjustments detailed above are implemented in the wind turbine calculation procedure of the SoundPLAN 8.2 software used to conduct the noise modelling. The software uses these definitions in conjunction with the digital terrain model of the site to evaluate the path between each turbine and receiver pairing, and then subsequently applies the adjustments to each turbine's predicted noise contribution where appropriate.

The prediction method inherently accounts for uncertainty through a combination of an uncertainty margin added to the input sound power level, and the use of conservative input parameters to the model, as described in this appendix, which have been shown to enable a reliable prediction of upper wind farm noise levels.

As an example of this, the ISO 9613-2 indicates an uncertainty margin of the order of +/-3 dB in relation to calculated noise levels at distances between 100 m and 1000 m for situations with an average propagation height between 5 m and 30 m (noting the information provided earlier in this appendix regarding the validation work undertaken to support the application of ISO 9613-2 to greater propagation heights). However, the uncertainty margins are noted for a prediction conducted in accordance with the inputs described in ISO 9613-2. A strict application of ISO 9613-2 would involve designating a ground factor of G = 1 (instead of the more conservative G = 0.5 ground factor used in the calculations) to represent the porous ground conditions around the site which ISO 9613-2 defines as follows:

> ***Porous ground**, 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. For porous ground G = 1.*

A prediction based on a ground factor of G = 1 instead of G = 0.5 used in the modelling would typically result in predicted noise levels approximately 3 dB lower, thus effectively offsetting the quoted uncertainty margin. This also does not account for the other conservative aspects of the model, such as the assumption that all turbines are operating simultaneously at their maximum noise emissions and that each receiver is simultaneously downwind of every turbine at all times (in contrast to NZS 6808:2010 compliance procedures which are based on assessing noise levels for a range of wind directions, consistent with broader Victorian noise assessment policies which do not evaluate compliance based solely on downwind noise levels).

Given the above, it is not necessary to apply uncertainty margins to the prediction results, as the results represent the upper predicted noise levels associated with the operation of the wind farm when measured and assessed in accordance with NZS 6808:2010. This finding is supported by extensive post-construction noise compliance monitoring undertaken at wind farm sites across Australia.

H2 Directional noise modelling

The noise prediction methods commonly used in Australia do not enable the change in noise level with wind direction to be reliably predicted:

- ISO 9613-2 is one of the most common methods for calculating noise propagation from wind farms, but primarily relates to noise levels under atmospheric conditions which enhance sound propagation
- CONCAWE is another engineering method which is used in Australia for general noise predictions. It enables predictions for varied weather conditions and directions but is generally regarded as unsuitable for wind turbine noise prediction. Specifically, it is an empirical method which was developed for ground based sources associated with petroleum refineries, and the method tends to overestimate both downwind noise levels and the difference between downwind and neutral propagation conditions (e.g. cross-wind directions)
- Nord 2000 and IMAGINE are alternative European methods which combine empirical and theoretical methods for predicting environmental noise propagation. They are among the most advanced and recent engineering prediction methods and enable noise predictions for varied weather conditions and directions. Industry adoption of these methods for wind farm noise prediction is limited and, to our knowledge, they have not been trialled in Australia.

In the absence of a ratified method for predicting wind direction effects on received noise levels, a cautious assessment has been made on the basis of a simplified set of definitions for downwind, crosswind and upwind conditions as described in the following subsections. The basis of the method is to apply adjustments to calculated downwind noise levels determined in accordance with ISO 9613-2, with the adjustments being determined according to the wind direction category (i.e. downwind, crosswind or upwind) and the distance between each receiver and turbine pairing.

The definitions and wind direction effects applied in this assessment are consistent with the recommendations of the UK Institute of Acoustics guidance. The general guidance on wind direction contained in the UK Institute of Acoustics guidance was reviewed as part of a research paper[12] which considered more advanced analytical methods of modelling the effects of atmospheric conditions. This research generally demonstrated that, with the exception of positions located at distances less than the typical separating distance of sensitive receiver locations, the more advanced prediction methods suggest higher levels of attenuation than the UK Institute of Acoustics guidance (i.e. providing further confidence in the UK Institute of Acoustics guidance values representing a cautious account of the effect of wind direction).

[12] Bullmore, Sims, van Renterghem, Horoshenkov – *Wind Turbine Noise Propagation – Results of Numerical Modelling Techniques to Investigate Specific Scenarios*, International Meeting on Wind Turbine Noise in Glasgow, Scotland 2015

H2.1 Definition of downwind propagation conditions

Wind speeds and directions which increase sound propagation from the turbines to the houses are termed downwind conditions. Under downwind conditions, the expected noise level from each turbine at each receiver is equal to the value predicted value according to ISO 9613-2 (with input parameters as described in the preceding section, including corrections for terrain features).

To provide a cautious account of changes in noise levels with wind direction, downwind conditions have been assumed to occur over a wide range of angles. Specifically, the range of these angles has been defined by assuming that downwind conditions occur for combinations of wind speeds and directions which equate to a vector wind speed of approximately 2 m/s in the direction from a turbine to receiver location.

While downwind propagation is frequently described in terms of wind speed and direction, the actual physical mechanism of downwind propagation relates to changes in wind speed with increasing height. A change in wind speed with height leads to a change in sound speed, in turn causing refraction of the sound wave (downwards refraction the case of sound travelling downwind). The relationship between wind direction and the sound speed profile in practice will be complex and vary considerably. It is for this reason that downwind conditions are described in simplified terms for noise propagation calculations and, similarly, why downwind conditions are assumed to occur even at relatively low downwind vector wind speeds.

Based on the above, a downwind propagation condition is considered to exist if the wind direction lies within a range of ±80 degrees from a wind blowing directly from a turbine to a receiver location. That is, until the wind reaches a direction 10 degrees forward of a cross wind, the noise is assumed to equal that of the downwind level predicted according to ISO 9613-2.

H2.2 Downwind vs crosswind propagation conditions

The calculation of noise levels under crosswind conditions is based on a maximum difference of 2 dB between noise levels occurring under downwind conditions and a cross-wind directly perpendicular to the line between a turbine and a receiver location. This value is consistent with expectations for an unscreened broad-band noise source propagating over relatively flat terrain.

In practice, this difference can be larger. In 1998, a comprehensive study, part funded by the European Commission *Development of a Wind Farm Noise Propagation Prediction Model* (the EC study) provided conclusions which stated:

> *At distances of 700m to 900m from the source, positive components of vector wind speed were found to increase the received noise level by up to 5dB(A) compared with the level measured under neutral propagation conditions.*

This maximum difference noted above relates to short term variations. The average difference is of the order of 2-3 dB.

Larger differences can also occur, particularly in complex environments or where the noise in question is dominated by distinct narrow bands of frequencies. These types of factors are not applicable to the broad-band noise characteristics of a wind turbine, nor are they applicable to the proposed development site.

The adoption of a relatively small difference between noise levels under direct downwind and cross-wind conditions represents a cautious assumption.

H2.3 Downwind vs upwind propagation conditions

The difference between noise levels occurring under downwind conditions and upwind conditions has been defined according to the values for complex landscapes defined in Table 12, as per the UK Institute of Acoustics guidance.

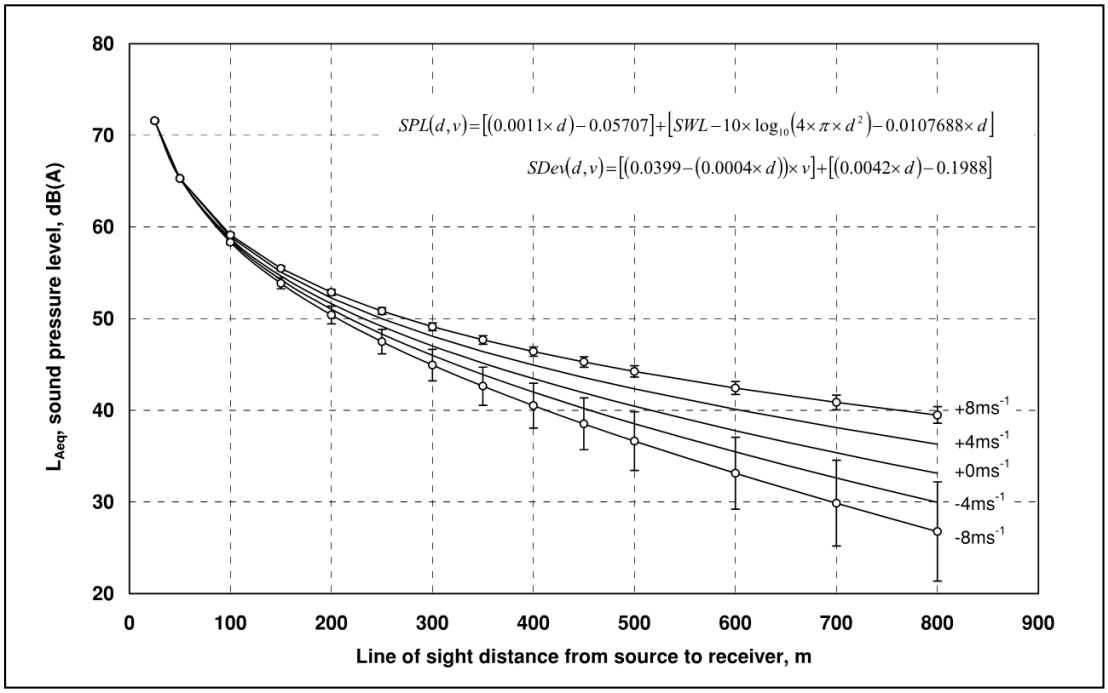
Table 12: Maximum upwind attenuation values, dB (difference between downwind and upwind attenuation)

Distance between turbine and receiver	Flat landscapes	Complex landscapes
≤ 5.25 x maximum turbine tip height	0	0
7.5 x maximum turbine tip height	4.2	2.2
11 x maximum turbine tip height	9	5
18 x maximum turbine tip height	13	7.9

The level of turbine noise reaching a receiver under upwind conditions will be much more variable as a result of propagation being highly dependent on atmospheric turbulence and associated refraction and scattering effects. However, as an indication of the suitability of the values referred to in Table 12, reference is made to Figure 9-13 from the EC Study referenced in the UK Institute of Acoustics guidance. This data is reproduced in Figure 28 below and demonstrates the results of noise measurements made under varying wind speeds and directions ranging from vector wind speeds of +8 m/s (i.e. downwind conditions) to -8 m/s (i.e. from test location to sound source). Referring to the measurement data noted for the 700 m and 800 m distances, this chart demonstrates:

- Relatively little measurement variability under downwind directions compared to the high level of variability exhibited for upwind conditions;
- A difference of 5 dB or more between average noise levels measured under wind speeds of +4 m/s and -4 m/s;
- Differences ranging from 5 dB to more than 15 dB between noise levels measured under wind speeds of +8 m/s and -8m/s.

Figure 28: Figure 9-13 from the EC Study



Similar trends were demonstrated in the measurement data exhibited in the other studies referenced in this assessment. Specifically, measured differences between upwind and downwind noise levels from operational wind farms were typically greater than 10 dB, with reduced differences only occurring at locations where background noise was believed to have been the factor which limited the observed difference.

The values outlined in Table 12, in conjunction with minimum upwind attenuation values of 0-2 dB at the direction when upwind condition commence, have been used as the basis for interpolating the values of attenuation that apply to:

- The actual separating distance associated with each turbine-receiver pairing
- Upwind conditions other than a direct upwind direction (i.e. upwind directions other than a wind blowing directly from the receiver to the turbine location in question).

H2.4 Propagation directivity

Based on the definitions provided in the preceding sections, and defining a relative wind direction[13] of 180 degrees as a wind blowing directly from a turbine to a receiver location (downwind), the proposed directivity relationship between noise levels and wind speed is summarised as follows:

- Wind directions between 100 degrees and 260 degrees: no reduction in noise levels assumed
- Wind directions 80 degrees and 100 degrees, and between 260 degrees and 280 degrees: 2 dB subtracted from the downwind predicted noise level
- Wind direction equal to 180 degrees: a value of between 0 dB and approximately 8 dB (based on the complex landscape attenuation rates) is subtracted from the downwind predicted noise, depending on the distance between the turbine and the receiver location in question.

Applying these attenuating factors at the defined wind directions, and interpolating over the intervening range for directions greater than 280 degrees and less than 80 degrees, a directional noise profile is produced, consistent the UK Institute of Acoustics guidance. For comparison purposes, the directional noise profiles for both flat and complex landscapes are presented in Figure 29 and Figure 30 respectively.

[13] The relative wind direction being the angle between the actual wind direction and a line directed from a turbine to a receiver location.

Figure 29: Propagation directivity profile – flat landscape

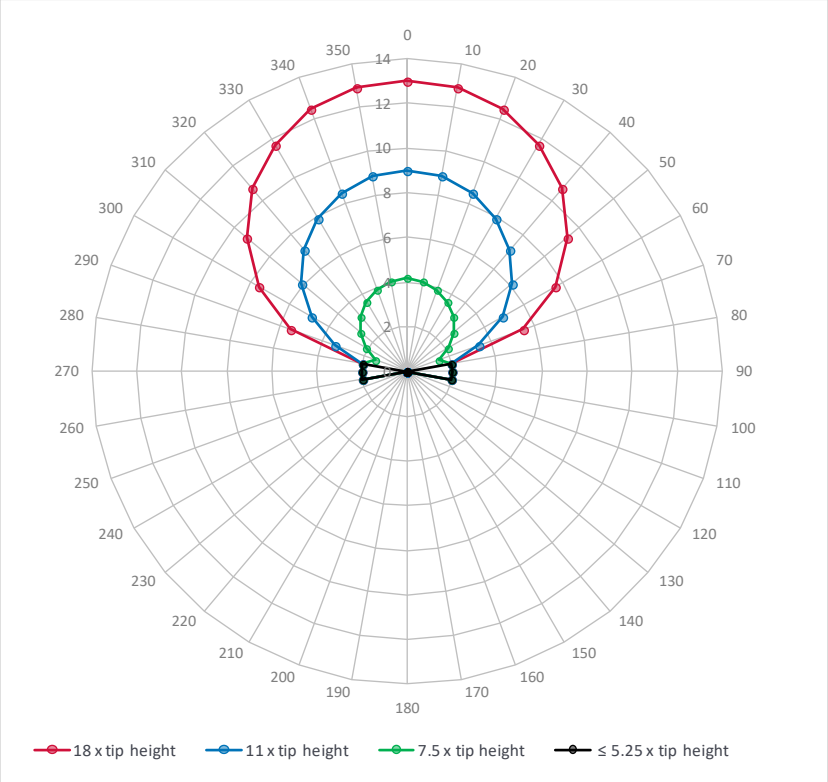
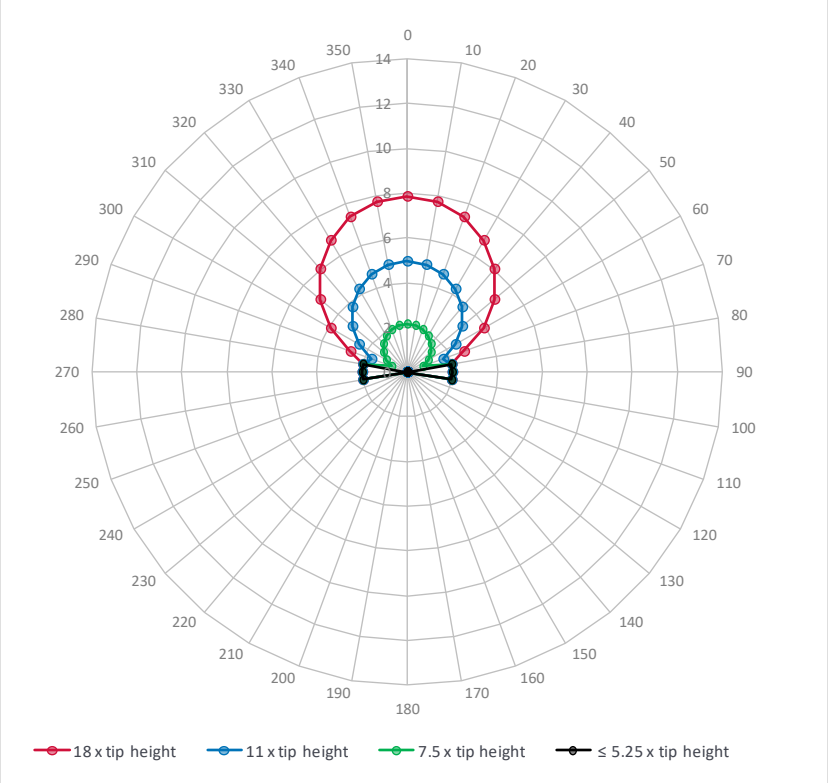


Figure 30: Propagation directivity profile – complex landscape



APPENDIX I TABULATED PREDICTED NOISE LEVEL DATA

Table 13: Predicted noise levels, dB L_{A90} - V162-6.0MW

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
D35 - a	19.6	19.8	21.7	24.7	27.5	29.6	29.8
F32 - a	21.6	21.8	23.7	26.7	29.5	31.6	31.8
F35 - a	23.4	23.6	25.5	28.5	31.3	33.4	33.6
G30 - a	25.1	25.3	27.2	30.2	33.0	35.1	35.3
H28 - a	23.4	23.6	25.5	28.5	31.3	33.4	33.6
H30 - a	25.1	25.3	27.2	30.2	33.0	35.1	35.3
H32 - a	28.0	28.2	30.1	33.1	35.9	38.0	38.2
H38 - a	24.4	24.6	26.5	29.5	32.3	34.4	34.6
H38 - b	22.0	22.2	24.1	27.1	29.9	32.0	32.2
I26 - a	20.3	20.5	22.4	25.4	28.2	30.3	30.5
I39 - a	20.0	20.2	22.1	25.1	27.9	30.0	30.2
K27 - a	27.7	27.9	29.8	32.8	35.6	37.7	37.9
L25 - a	23.0	23.2	25.1	28.1	30.9	33.0	33.2
L26 - a	27.3	27.5	29.4	32.4	35.2	37.3	37.5
L38 - a	22.9	23.1	25.0	28.0	30.8	32.9	33.1
L38 - b	22.7	22.9	24.8	27.8	30.6	32.7	32.9
L39 - a	18.0	18.2	20.1	23.1	25.9	28.0	28.2
L39 - b	19.5	19.7	21.6	24.6	27.4	29.5	29.7
L39 - c	20.5	20.7	22.6	25.6	28.4	30.5	30.7
L39 - d	19.8	20.0	21.9	24.9	27.7	29.8	30.0
L39 - e	20.6	20.8	22.7	25.7	28.5	30.6	30.8
L39 - f	20.6	20.8	22.7	25.7	28.5	30.6	30.8
M24 - a	22.4	22.6	24.5	27.5	30.3	32.4	32.6
M24 - b	22.4	22.6	24.5	27.5	30.3	32.4	32.6
M35 - b	27.6	27.8	29.7	32.7	35.5	37.6	37.8
M37 - a	23.8	24.0	25.9	28.9	31.7	33.8	34.0
M37 - b	21.7	21.9	23.8	26.8	29.6	31.7	31.9
M37 - c	22.6	22.8	24.7	27.7	30.5	32.6	32.8
M37 - d	22.9	23.1	25.0	28.0	30.8	32.9	33.1
M38 - a	21.7	21.9	23.8	26.8	29.6	31.7	31.9

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
N25 - a	26.1	26.3	28.2	31.2	34.0	36.1	36.3
N25 - b	26.2	26.4	28.3	31.3	34.1	36.2	36.4
N36 - a	23.0	23.2	25.1	28.1	30.9	33.0	33.2
N36 - b	23.0	23.2	25.1	28.1	30.9	33.0	33.2
N36 - c	22.4	22.6	24.5	27.5	30.3	32.4	32.6
N37 - a	22.1	22.3	24.2	27.2	30.0	32.1	32.3
O24 - a	24.5	24.7	26.6	29.6	32.4	34.5	34.7
O34 - a	26.9	27.1	29.0	32.0	34.8	36.9	37.1
O34 - b	26.8	27.0	28.9	31.9	34.7	36.8	37.0
P24 - a	25.0	25.2	27.1	30.1	32.9	35.0	35.2
P24 - b	26.1	26.3	28.2	31.2	34.0	36.1	36.3
P31 - a	28.1	28.3	30.2	33.2	36.0	38.1	38.3
P31 - c	28.1	28.3	30.2	33.2	36.0	38.1	38.3
P32 - a	27.1	27.3	29.2	32.2	35.0	37.1	37.3
Q30 - a	28.0	28.2	30.1	33.1	35.9	38.0	38.2
Q31 - a	26.3	26.5	28.4	31.4	34.2	36.3	36.5
Q31 - b	25.8	26.0	27.9	30.9	33.7	35.8	36.0
Q31 - c	25.3	25.5	27.4	30.4	33.2	35.3	35.5
Q31 - e*	25.2	25.4	27.3	30.3	33.1	35.2	35.4
Q31 - f*	25.2	25.4	27.3	30.3	33.1	35.2	35.4
Q31 - g*	25.3	25.5	27.4	30.4	33.2	35.3	35.5
Q31 - h*	25.3	25.5	27.4	30.4	33.2	35.3	35.5
Q31 - i*	25.4	25.6	27.5	30.5	33.3	35.4	35.6
Q31 - j*	25.4	25.6	27.5	30.5	33.3	35.4	35.6
Q31 - k*	25.4	25.6	27.5	30.5	33.3	35.4	35.6
Q31 - l*	25.4	25.6	27.5	30.5	33.3	35.4	35.6
Q31 - m*	25.6	25.8	27.7	30.7	33.5	35.6	35.8
Q31 - o*	26.5	26.7	28.6	31.6	34.4	36.5	36.7
Q31 - p*	26.3	26.5	28.4	31.4	34.2	36.3	36.5
Q32 - a	25.2	25.4	27.3	30.3	33.1	35.2	35.4
Q32 - b	25.1	25.3	27.2	30.2	33.0	35.1	35.3
Q32 - c	24.9	25.1	27.0	30.0	32.8	34.9	35.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
Q32 - d	24.9	25.1	27.0	30.0	32.8	34.9	35.1
Q32 - e	24.5	24.7	26.6	29.6	32.4	34.5	34.7
Q32 - f	24.8	25.0	26.9	29.9	32.7	34.8	35.0
Q32 - g*	25.0	25.2	27.1	30.1	32.9	35.0	35.2
Q34 - a	22.0	22.2	24.1	27.1	29.9	32.0	32.2
Q35 - a	20.6	20.8	22.7	25.7	28.5	30.6	30.8
R31 - aa*	26.4	26.6	28.5	31.5	34.3	36.4	36.6
R31 - ab*	26.8	27.0	28.9	31.9	34.7	36.8	37.0
R31 - ad*	27.3	27.5	29.4	32.4	35.2	37.3	37.5
R31 - ae	26.9	27.1	29.0	32.0	34.8	36.9	37.1
R31 - af	26.8	27.0	28.9	31.9	34.7	36.8	37.0
R31 - ai*	27.0	27.2	29.1	32.1	34.9	37.0	37.2
R31 - aj*	26.7	26.9	28.8	31.8	34.6	36.7	36.9
R31 - ak*	26.7	26.9	28.8	31.8	34.6	36.7	36.9
R31 - al*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - am*	26.3	26.5	28.4	31.4	34.2	36.3	36.5
R31 - an*	26.2	26.4	28.3	31.3	34.1	36.2	36.4
R31 - ao*	26.0	26.2	28.1	31.1	33.9	36.0	36.2
R31 - ap*	26.7	26.9	28.8	31.8	34.6	36.7	36.9
R31 - aq*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - ar*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - as*	26.5	26.7	28.6	31.6	34.4	36.5	36.7
R31 - at*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - av*	26.4	26.6	28.5	31.5	34.3	36.4	36.6
R31 - aw*	26.3	26.5	28.4	31.4	34.2	36.3	36.5
R31 - ax*	26.4	26.6	28.5	31.5	34.3	36.4	36.6
R31 - az*	26.3	26.5	28.4	31.4	34.2	36.3	36.5
R31 - b*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - ba*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - bb*	26.1	26.3	28.2	31.2	34.0	36.1	36.3
R31 - bc*	26.1	26.3	28.2	31.2	34.0	36.1	36.3
R31 - bd*	26.2	26.4	28.3	31.3	34.1	36.2	36.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
R31 - be*	27.7	27.9	29.8	32.8	35.6	37.7	37.9
R31 - bf*	25.2	25.4	27.3	30.3	33.1	35.2	35.4
R31 - c*	25.9	26.1	28.0	31.0	33.8	35.9	36.1
R31 - d*	26.6	26.8	28.7	31.7	34.5	36.6	36.8
R31 - f*	26.2	26.4	28.3	31.3	34.1	36.2	36.4
R31 - g*	26.3	26.5	28.4	31.4	34.2	36.3	36.5
R31 - h*	26.2	26.4	28.3	31.3	34.1	36.2	36.4
R31 - j*	26.1	26.3	28.2	31.2	34.0	36.1	36.3
R31 - k*	26.0	26.2	28.1	31.1	33.9	36.0	36.2
R31 - n*	25.9	26.1	28.0	31.0	33.8	35.9	36.1
R31 - q*	25.0	25.2	27.1	30.1	32.9	35.0	35.2
R31 - r*	25.8	26.0	27.9	30.9	33.7	35.8	36.0
R31 - s*	25.8	26.0	27.9	30.9	33.7	35.8	36.0
R31 - t*	25.8	26.0	27.9	30.9	33.7	35.8	36.0
R31 - u*	25.8	26.0	27.9	30.9	33.7	35.8	36.0
R31 - v*	25.9	26.1	28.0	31.0	33.8	35.9	36.1
R31 - w*	25.9	26.1	28.0	31.0	33.8	35.9	36.1
R31 - z*	26.1	26.3	28.2	31.2	34.0	36.1	36.3
R32 - a	24.3	24.5	26.4	29.4	32.2	34.3	34.5
R32 - b	24.7	24.9	26.8	29.8	32.6	34.7	34.9
R32 - c	24.8	25.0	26.9	29.9	32.7	34.8	35.0
R32 - d*	24.9	25.1	27.0	30.0	32.8	34.9	35.1
R32 - e	24.0	24.2	26.1	29.1	31.9	34.0	34.2
R33 - a	22.6	22.8	24.7	27.7	30.5	32.6	32.8
T17 - a	20.7	20.9	22.8	25.8	28.6	30.7	30.9
T17 - b	20.5	20.7	22.6	25.6	28.4	30.5	30.7
T32 - a	23.3	23.5	25.4	28.4	31.2	33.3	33.5
T32 - b	24.0	24.2	26.1	29.1	31.9	34.0	34.2
U18 - a	25.3	25.5	27.4	30.4	33.2	35.3	35.5
U18 - b	25.4	25.6	27.5	30.5	33.3	35.4	35.6
U18 - c	25.1	25.3	27.2	30.2	33.0	35.1	35.3
U31 - a	24.0	24.2	26.1	29.1	31.9	34.0	34.2

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
U32 - a	21.0	21.2	23.1	26.1	28.9	31.0	31.2
V30 - a	26.9	27.1	29.0	32.0	34.8	36.9	37.1
V32 - a	20.9	21.1	23.0	26.0	28.8	30.9	31.1
W17 - a	26.4	26.6	28.5	31.5	34.3	36.4	36.6
W27 - i	28.2	28.4	30.3	33.3	36.1	38.2	38.4
W28 - a	27.8	28.0	29.9	32.9	35.7	37.8	38.0
X18 - a	26.6	26.8	28.7	31.7	34.5	36.6	36.8
Y28 - a	24.8	25.0	26.9	29.9	32.7	34.8	35.0
Y28 - b	23.7	23.9	25.8	28.8	31.6	33.7	33.9
Z28 - a	24.3	24.5	26.4	29.4	32.2	34.3	34.5
AA27 - a	24.7	24.9	26.8	29.8	32.6	34.7	34.9
AA27 - b	24.6	24.8	26.7	29.7	32.5	34.6	34.8
AB18 - a	18.5	18.7	20.6	23.6	26.4	28.5	28.7
AC17 - a	17.6	17.8	19.7	22.7	25.5	27.6	27.8
AC18 - a	21.2	21.4	23.3	26.3	29.1	31.2	31.4
AC22 - a	24.7	24.9	26.8	29.8	32.6	34.7	34.9
AD23 - a	23.1	23.3	25.2	28.2	31.0	33.1	33.3
AD25 - a	20.1	20.3	22.2	25.2	28.0	30.1	30.3
AE18 - a	16.7	16.9	18.8	21.8	24.6	26.7	26.9

* Receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood
(S) School
(C) Childcare

Table 14: Predicted noise levels, dB L_{A90} – GE 6.0-164

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
D35 - a	17.8	19.8	23.3	26.6	28.8	30.8	31.1
F32 - a	19.8	21.7	25.2	28.5	30.7	32.7	33.0
F35 - a	21.7	23.7	27.2	30.5	32.7	34.7	35.0
G30 - a	23.5	25.4	28.9	32.2	34.4	36.4	36.7
H28 - a	21.7	23.7	27.2	30.5	32.7	34.7	35.0
H30 - a	23.5	25.4	28.9	32.2	34.4	36.4	36.7
H32 - a	26.6	28.6	32.1	35.4	37.6	39.6	39.9
H38 - a	22.9	24.8	28.3	31.6	33.8	35.8	36.1
H38 - b	20.3	22.2	25.7	29.0	31.2	33.2	33.5
I26 - a	18.5	20.4	23.9	27.2	29.4	31.4	31.7
I39 - a	18.2	20.2	23.7	27.0	29.2	31.2	31.5
K27 - a	26.3	28.2	31.7	35.0	37.2	39.2	39.5
L25 - a	21.3	23.2	26.7	30.0	32.2	34.2	34.5
L26 - a	25.8	27.8	31.3	34.6	36.8	38.8	39.1
L38 - a	21.2	23.2	26.7	30.0	32.2	34.2	34.5
L38 - b	21.0	22.9	26.4	29.7	31.9	33.9	34.2
L39 - a	16.2	18.2	21.7	25.0	27.2	29.2	29.5
L39 - b	17.6	19.6	23.1	26.4	28.6	30.6	30.9
L39 - c	18.7	20.6	24.1	27.4	29.6	31.6	31.9
L39 - d	17.9	19.9	23.4	26.7	28.9	30.9	31.2
L39 - e	18.8	20.8	24.3	27.6	29.8	31.8	32.1
L39 - f	18.8	20.7	24.2	27.5	29.7	31.7	32.0
M24 - a	20.6	22.6	26.1	29.4	31.6	33.6	33.9
M24 - b	20.6	22.5	26.0	29.3	31.5	33.5	33.8
M35 - b	26.2	28.1	31.6	34.9	37.1	39.1	39.4
M37 - a	22.1	24.0	27.5	30.8	33.0	35.0	35.3
M37 - b	20.0	21.9	25.4	28.7	30.9	32.9	33.2
M37 - c	20.9	22.8	26.3	29.6	31.8	33.8	34.1
M37 - d	21.2	23.2	26.7	30.0	32.2	34.2	34.5
M38 - a	19.9	21.9	25.4	28.7	30.9	32.9	33.2
N25 - a	24.6	26.5	30.0	33.3	35.5	37.5	37.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
N25 - b	24.6	26.5	30.0	33.3	35.5	37.5	37.8
N36 - a	21.2	23.2	26.7	30.0	32.2	34.2	34.5
N36 - b	21.3	23.2	26.7	30.0	32.2	34.2	34.5
N36 - c	20.6	22.5	26.0	29.3	31.5	33.5	33.8
N37 - a	20.3	22.2	25.7	29.0	31.2	33.2	33.5
O24 - a	22.7	24.6	28.1	31.4	33.6	35.6	35.9
O34 - a	25.5	27.5	31.0	34.3	36.5	38.5	38.8
O34 - b	25.4	27.3	30.8	34.1	36.3	38.3	38.6
P24 - a	23.2	25.2	28.7	32.0	34.2	36.2	36.5
P24 - b	24.5	26.5	30.0	33.3	35.5	37.5	37.8
P31 - a	26.6	28.5	32.0	35.3	37.5	39.5	39.8
P31 - c	26.6	28.5	32.0	35.3	37.5	39.5	39.8
P32 - a	25.7	27.6	31.1	34.4	36.6	38.6	38.9
Q30 - a	26.4	28.4	31.9	35.2	37.4	39.4	39.7
Q31 - a	24.6	26.5	30.0	33.3	35.5	37.5	37.8
Q31 - b	24.0	26.0	29.5	32.8	35.0	37.0	37.3
Q31 - c	23.6	25.5	29.0	32.3	34.5	36.5	36.8
Q31 - e*	23.4	25.4	28.9	32.2	34.4	36.4	36.7
Q31 - f*	23.5	25.4	28.9	32.2	34.4	36.4	36.7
Q31 - g*	23.5	25.5	29.0	32.3	34.5	36.5	36.8
Q31 - h*	23.6	25.5	29.0	32.3	34.5	36.5	36.8
Q31 - i*	23.7	25.6	29.1	32.4	34.6	36.6	36.9
Q31 - j*	23.6	25.6	29.1	32.4	34.6	36.6	36.9
Q31 - k*	23.7	25.6	29.1	32.4	34.6	36.6	36.9
Q31 - l*	23.7	25.6	29.1	32.4	34.6	36.6	36.9
Q31 - m*	23.8	25.8	29.3	32.6	34.8	36.8	37.1
Q31 - o*	24.8	26.8	30.3	33.6	35.8	37.8	38.1
Q31 - p*	24.7	26.6	30.1	33.4	35.6	37.6	37.9
Q32 - a	23.4	25.4	28.9	32.2	34.4	36.4	36.7
Q32 - b	23.3	25.3	28.8	32.1	34.3	36.3	36.6
Q32 - c	23.1	25.1	28.6	31.9	34.1	36.1	36.4
Q32 - d	23.1	25.1	28.6	31.9	34.1	36.1	36.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
Q32 - e	22.8	24.7	28.2	31.5	33.7	35.7	36.0
Q32 - f	23.1	25.0	28.5	31.8	34.0	36.0	36.3
Q32 - g*	23.2	25.1	28.6	31.9	34.1	36.1	36.4
Q34 - a	20.2	22.1	25.6	28.9	31.1	33.1	33.4
Q35 - a	18.8	20.7	24.2	27.5	29.7	31.7	32.0
R31 - aa*	24.8	26.8	30.3	33.6	35.8	37.8	38.1
R31 - ab*	25.2	27.1	30.6	33.9	36.1	38.1	38.4
R31 - ad*	25.8	27.8	31.3	34.6	36.8	38.8	39.1
R31 - ae	25.3	27.3	30.8	34.1	36.3	38.3	38.6
R31 - af	25.3	27.2	30.7	34.0	36.2	38.2	38.5
R31 - ai*	25.4	27.4	30.9	34.2	36.4	38.4	38.7
R31 - aj*	25.1	27.0	30.5	33.8	36.0	38.0	38.3
R31 - ak*	25.1	27.0	30.5	33.8	36.0	38.0	38.3
R31 - al*	24.9	26.9	30.4	33.7	35.9	37.9	38.2
R31 - am*	24.7	26.6	30.1	33.4	35.6	37.6	37.9
R31 - an*	24.5	26.5	30.0	33.3	35.5	37.5	37.8
R31 - ao*	24.4	26.3	29.8	33.1	35.3	37.3	37.6
R31 - ap*	25.2	27.1	30.6	33.9	36.1	38.1	38.4
R31 - aq*	25.0	26.9	30.4	33.7	35.9	37.9	38.2
R31 - ar*	25.1	27.0	30.5	33.8	36.0	38.0	38.3
R31 - as*	24.9	26.8	30.3	33.6	35.8	37.8	38.1
R31 - at*	25.0	26.9	30.4	33.7	35.9	37.9	38.2
R31 - av*	24.8	26.7	30.2	33.5	35.7	37.7	38.0
R31 - aw*	24.7	26.6	30.1	33.4	35.6	37.6	37.9
R31 - ax*	24.8	26.7	30.2	33.5	35.7	37.7	38.0
R31 - az*	24.7	26.7	30.2	33.5	35.7	37.7	38.0
R31 - b*	25.0	27.0	30.5	33.8	36.0	38.0	38.3
R31 - ba*	25.0	27.0	30.5	33.8	36.0	38.0	38.3
R31 - bb*	24.5	26.4	29.9	33.2	35.4	37.4	37.7
R31 - bc*	24.5	26.4	29.9	33.2	35.4	37.4	37.7
R31 - bd*	24.5	26.5	30.0	33.3	35.5	37.5	37.8
R31 - be*	26.2	28.1	31.6	34.9	37.1	39.1	39.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
R31 - bf*	23.4	25.4	28.9	32.2	34.4	36.4	36.7
R31 - c*	24.3	26.2	29.7	33.0	35.2	37.2	37.5
R31 - d*	25.0	26.9	30.4	33.7	35.9	37.9	38.2
R31 - f*	24.5	26.5	30.0	33.3	35.5	37.5	37.8
R31 - g*	24.7	26.6	30.1	33.4	35.6	37.6	37.9
R31 - h*	24.6	26.5	30.0	33.3	35.5	37.5	37.8
R31 - j*	24.4	26.4	29.9	33.2	35.4	37.4	37.7
R31 - k*	24.4	26.3	29.8	33.1	35.3	37.3	37.6
R31 - n*	24.2	26.2	29.7	33.0	35.2	37.2	37.5
R31 - q*	23.2	25.1	28.6	31.9	34.1	36.1	36.4
R31 - r*	24.1	26.0	29.5	32.8	35.0	37.0	37.3
R31 - s*	24.1	26.0	29.5	32.8	35.0	37.0	37.3
R31 - t*	24.1	26.1	29.6	32.9	35.1	37.1	37.4
R31 - u*	24.2	26.1	29.6	32.9	35.1	37.1	37.4
R31 - v*	24.2	26.2	29.7	33.0	35.2	37.2	37.5
R31 - w*	24.3	26.2	29.7	33.0	35.2	37.2	37.5
R31 - z*	24.5	26.4	29.9	33.2	35.4	37.4	37.7
R32 - a	22.6	24.5	28.0	31.3	33.5	35.5	35.8
R32 - b	22.9	24.9	28.4	31.7	33.9	35.9	36.2
R32 - c	23.1	25.0	28.5	31.8	34.0	36.0	36.3
R32 - d*	23.1	25.1	28.6	31.9	34.1	36.1	36.4
R32 - e	22.2	24.2	27.7	31.0	33.2	35.2	35.5
R33 - a	20.7	22.7	26.2	29.5	31.7	33.7	34.0
T17 - a	18.9	20.9	24.4	27.7	29.9	31.9	32.2
T17 - b	18.8	20.8	24.3	27.6	29.8	31.8	32.1
T32 - a	21.6	23.6	27.1	30.4	32.6	34.6	34.9
T32 - b	22.4	24.3	27.8	31.1	33.3	35.3	35.6
U18 - a	23.9	25.9	29.4	32.7	34.9	36.9	37.2
U18 - b	24.0	26.0	29.5	32.8	35.0	37.0	37.3
U18 - c	23.7	25.7	29.2	32.5	34.7	36.7	37.0
U31 - a	22.4	24.3	27.8	31.1	33.3	35.3	35.6
U32 - a	19.2	21.2	24.7	28.0	30.2	32.2	32.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
V30 - a	25.4	27.3	30.8	34.1	36.3	38.3	38.6
V32 - a	19.1	21.1	24.6	27.9	30.1	32.1	32.4
W17 - a	25.2	27.1	30.6	33.9	36.1	38.1	38.4
W27 - i	26.8	28.7	32.2	35.5	37.7	39.7	40.0
W28 - a	26.3	28.2	31.7	35.0	37.2	39.2	39.5
X18 - a	25.3	27.3	30.8	34.1	36.3	38.3	38.6
Y28 - a	23.1	25.1	28.6	31.9	34.1	36.1	36.4
Y28 - b	22.0	23.9	27.4	30.7	32.9	34.9	35.2
Z28 - a	22.6	24.5	28.0	31.3	33.5	35.5	35.8
AA27 - a	23.1	25.0	28.5	31.8	34.0	36.0	36.3
AA27 - b	22.9	24.8	28.3	31.6	33.8	35.8	36.1
AB18 - a	16.8	18.7	22.2	25.5	27.7	29.7	30.0
AC17 - a	15.8	17.8	21.3	24.6	26.8	28.8	29.1
AC18 - a	19.8	21.7	25.2	28.5	30.7	32.7	33.0
AC22 - a	23.3	25.3	28.8	32.1	34.3	36.3	36.6
AD23 - a	21.4	23.3	26.8	30.1	32.3	34.3	34.6
AD25 - a	18.3	20.2	23.7	27.0	29.2	31.2	31.5
AE18 - a	15.0	16.9	20.4	23.7	25.9	27.9	28.2

* Receivers located within the Township Zone and Low Density Residential Zone in and around the township of Rokewood
(S) School
(C) Childcare

APPENDIX J DIRECTIONAL SENSITIVITY ANALYSIS

The noise prediction method outlined in Section 5.3 for modelling downwind conditions is based on the assumption that sound from the wind farm propagates equally in all directions. In practice, sound propagation will vary with wind direction.

In order to provide some context to the downwind predicted noise levels presented in Section 7.4, directional modelling has been carried out using the UK Institute of Acoustics guidance on the change in sound propagation with wind direction, as described in further detail in Appendix H. The resulting predicted directional noise levels were reviewed, together with the prevalence of different wind speeds and directions based on historical wind data provided by the proponent from the two (2) met masts closest to the assessed receivers.

J1 Historical wind data

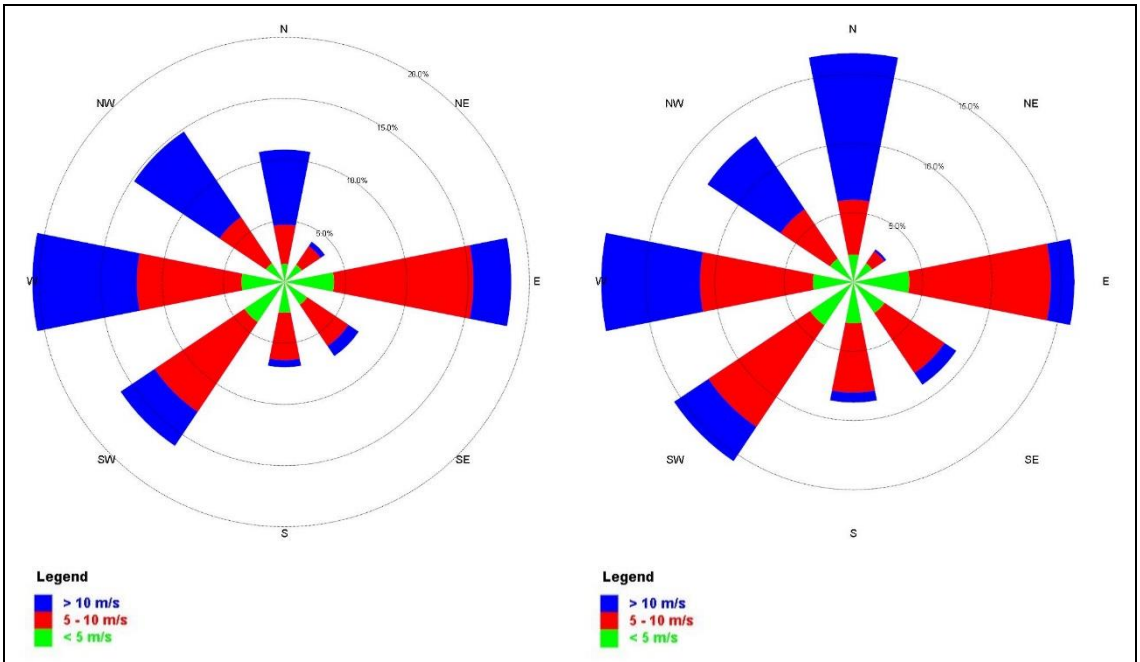
The proponent provided historical wind data from two (2) met masts located within the site as detailed in Table 15.

Table 15: Met mast locations

Met mast	Easting	Northing
RWS	740,758	5,795,604
RWW	730,722	5,803,576

The wind data measured between mid-2017 and February 2021 was extrapolated by the proponent to the highest modelled hub height of 149 m. For each met mast, a wind rose is presented in Figure 31 and the prevalence of hub height wind speeds above and below 10 m/s is presented in Table 16 for each wind direction octant.

Figure 31: Historical data wind roses



RWS met mast RWW met mast

Table 16: Prevalence of hub height wind speeds above and below 10 m/s

Wind direction	RWS		RWW	
	< 10 m/s	≥ 10 m/s	< 10 m/s	≥ 10 m/s
N	4.9%	6.5%	6.2%	11.1%
NE	3.7%	0.5%	2.8%	0.2%
E	12.5%	3.0%	11.7%	1.4%
SE	6.6%	1.1%	8.3%	1.1%
S	6.7%	0.6%	8.3%	0.8%
SW	13.3%	3.5%	13.1%	3.1%
W	12.6%	9.0%	11.5%	7.5%
NW	6.7%	8.8%	6.6%	6.6%
Total	67.0%	33.0%	68.3%	31.7%

The prevalence of wind conditions derived from the provided historical wind data was used to give an indication of the frequency of occurrence of the range of predicted noise levels for each of the assessed receivers. This information is illustrated in the form of histograms in in Appendix J3.

J2 Directional modelling

The UK Institute of Acoustics guidance includes methods for sites characterised by flat or complex landscapes. In recognition of the terrain profile around the Golden Plains Wind Farm, the method for *flat landscapes* has been factored into the modelling.

The method is based on downwind propagation conditions occurring over a very broad range of wind directions. Specifically, a wind direction within a range of ±80 degrees of a wind blowing directly from a wind turbine to a receiver location is considered to result in downwind sound propagation conditions. During cross wind conditions, marginal reductions in sound level are then factored into the calculation. For wind directions ranging from cross wind to upwind, the further reductions are progressively factored into the calculation until a minimum level is reached when the wind is blowing directly from a receiver to a turbine.

Full details of the UK Institute of Acoustics guidance on propagation directivity and its implementation for the Golden Plains Wind Farm are provided in Appendix H2.

The UK Institute of Acoustics guidance on directional analysis has not yet been incorporated into standard proprietary noise modelling software tools. Accordingly, implementing the method involves extensive processing of the downwind noise predictions generated from the modelling described in Section 5.3.

This process is used to calculate the noise level in 5 degree wind direction increments. For each 5 degree wind direction increment, the angle between the wind direction and a line drawn from a turbine to a receiver is determined for each turbine and receiver pairing. For each assessed receiver, the angle is calculated for each of the turbines, for each 5 degree wind sectors. The angle is then used to determine the directional adjustment according to the UK institute of Acoustics guidance, for each turbine and assessed receiver. The adjusted turbine contributions are then summed to determine the total wind farm noise level for each 5 degree wide sector.

The analysis was carried out for receivers where the compliance margin using the GE 6.0-164 candidate turbine model was predicted to be less than 1 dB. For each receiver detailed in Table 17, the analysis is presented for the hub height wind speed corresponding to the highest predicted noise levels (10 m/s).

Table 17: Highest downwind and directional predicted noise levels at receivers with predicted levels over 39 dB L_{A90}

		Highest predicted noise level, dB L_{A90} – GE 6.0-164	
Receiver	**Nearest met mast**	**Downwind**	**Directional**
H32 - a	RWW	39.9	39.9
K27 - a	RWW	39.5	39.5
L26 - a	RWW	39.1	39.1
M35 - b	RWW	39.4	39.4
P31 - a	RWW	39.8	39.4
P31 - c	RWS	39.8	39.3
Q30 - a	RWS	39.7	39.3
R31 - ad	RWS	39.1	38.9
R31 - be	RWS	39.4	39.2
W27 - i	RWS	40.0	39.8
W28 - a	RWS	39.5	39.4

The directional results, for the GE 6.0-164 candidate turbine, are plotted in Appendix J3 to illustrate the variation in noise level with wind direction.

Table 18: Highest downwind and directional predicted noise levels at receivers with the highest predicted levels within the Township Zone and Low Density Residential Zone

		Highest predicted noise level, dB L_{A90} – GE 6.0-164	
Receiver	**Nearest met mast**	**Downwind**	**Directional**
Q31 - p	RWS	37.9	37.5
R31 - be	RWS	39.4	39.2

The directional results, for the GE 6.0-164 candidate turbine, are plotted in Appendix J4 to illustrate the variation in noise level with wind direction.

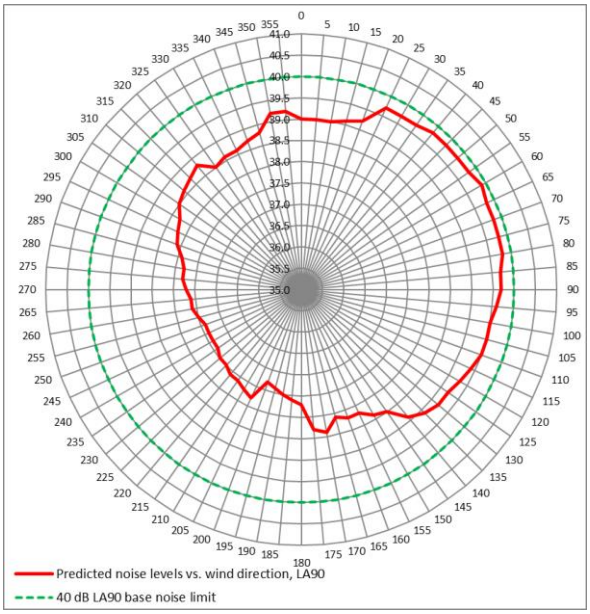
J3 Predicted noise levels – directional plots and prevalence histograms

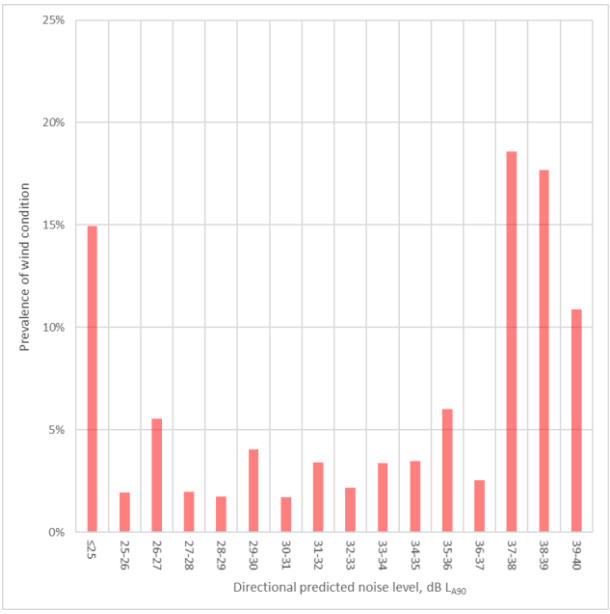
This section presents predicted noise level information for each of the eleven (11) receivers as follows:

- **Directional plots:** A directional noise prediction plot which demonstrates the change in the highest predicted wind farm noise levels (i.e. at hub height winds speeds equal to or greater than 10 m/s) with changes in wind direction
- **Prevalence histograms:** A chart to illustrate the predicted frequency of occurrence of the range of predicted wind farm noise levels for each receiver, accounting for changes in both wind speed and direction, and the frequency of occurrence of different wind speeds and directions from the historical data provided by the proponent.

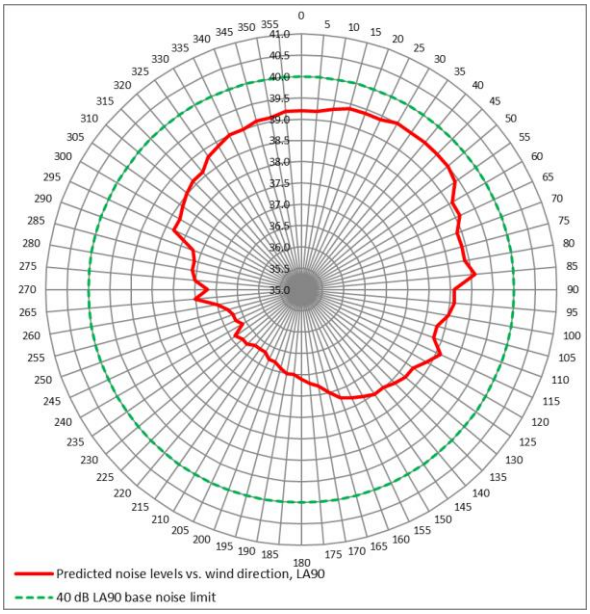
Note that that prevalence histograms indicate a wider range of noise levels than illustrated by the directional plots, on account of the directional plots being restricted to wind speeds equal to or greater than 10 m/s at hub height (i.e. direction is the only variable accounted for in the directional plots), whereas the prevalence histograms account for variations in wind speeds and directions.

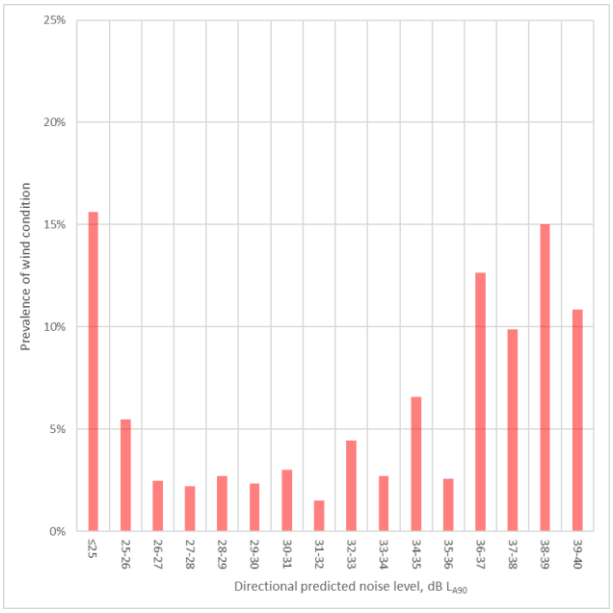
H32 - a



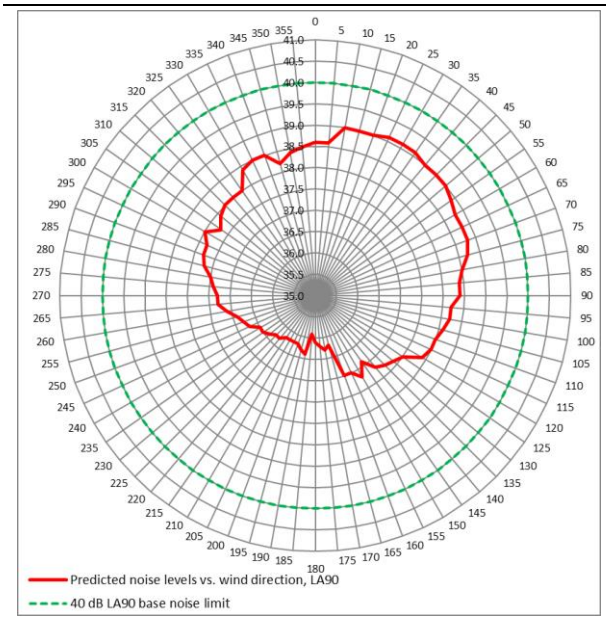


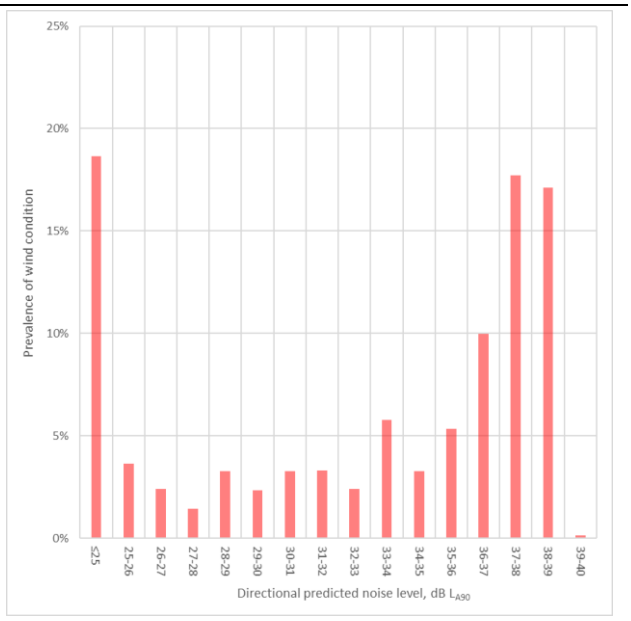
K27 - a


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

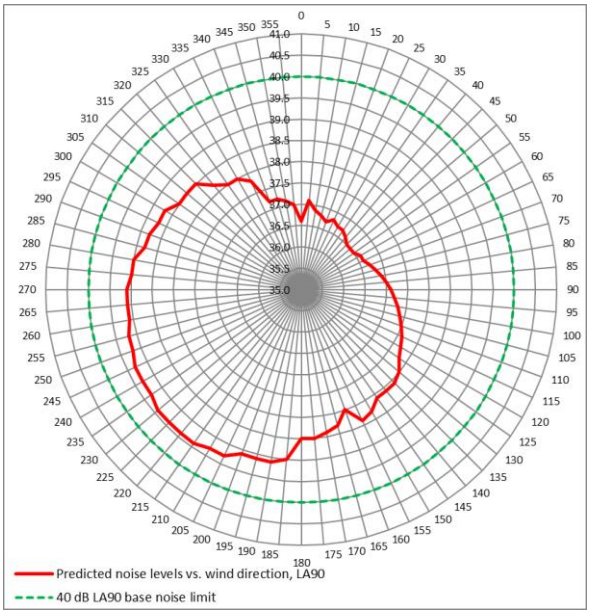

Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

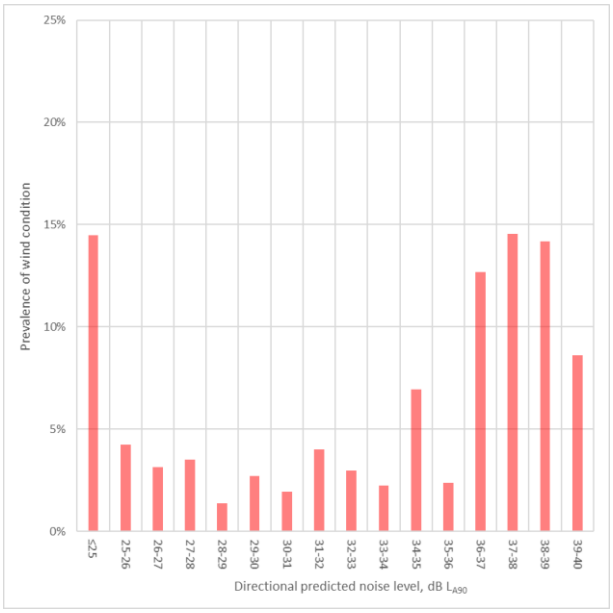
L26 - a


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

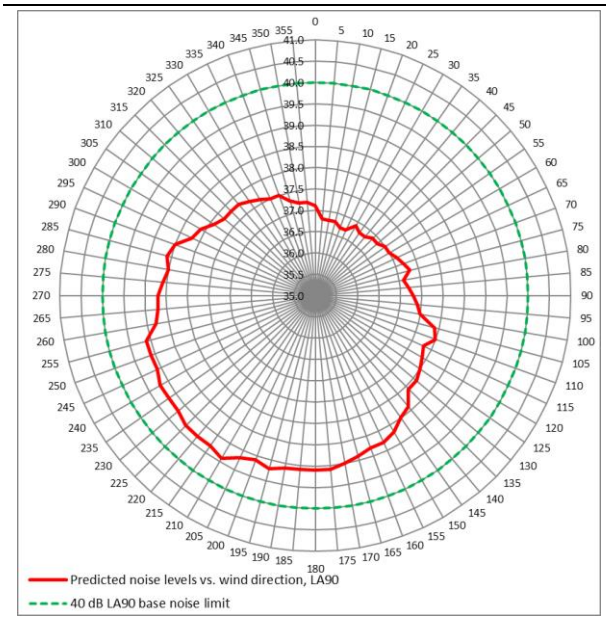

Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

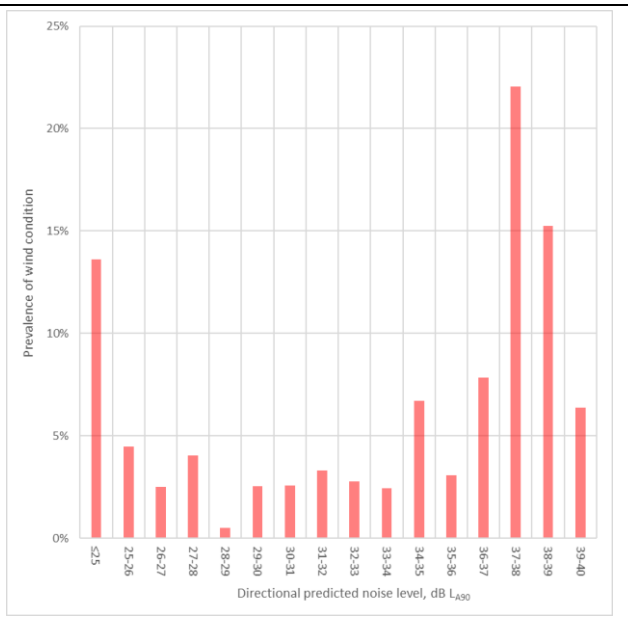
M35 - b


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

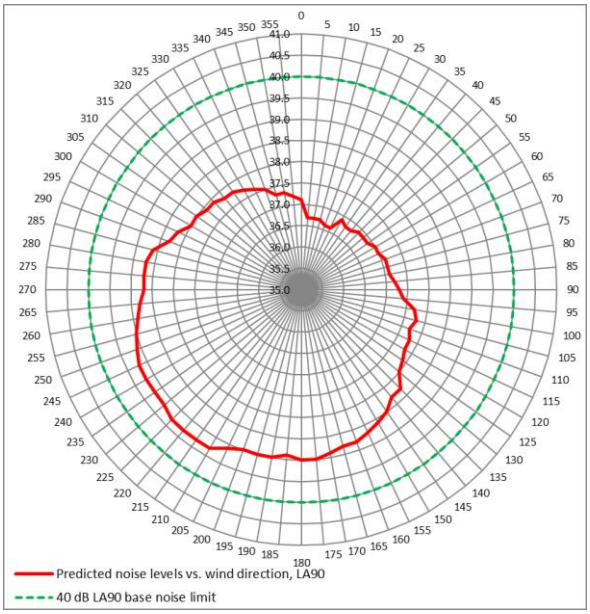

Prevalence of wind condition
25%
20%
15%
10%
5%
0%
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40
Directional predicted noise level, dB LA90

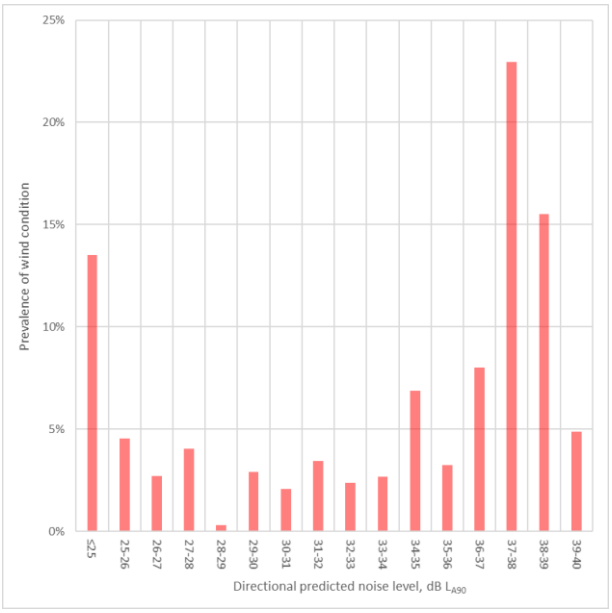
P31 - a


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

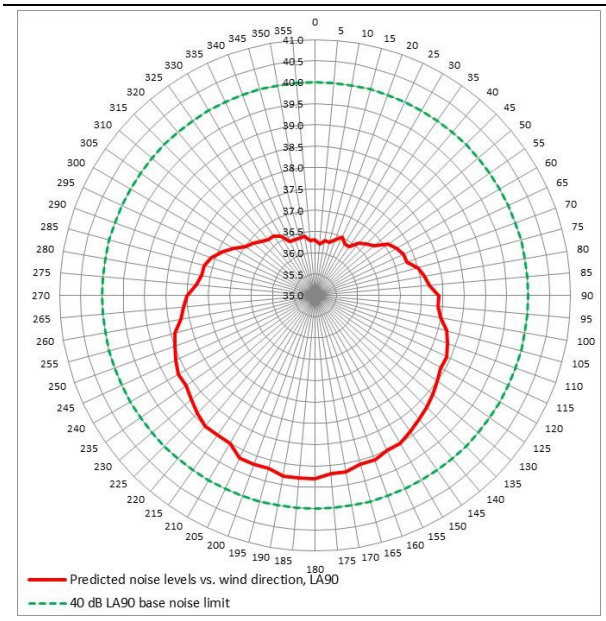

Prevalence of wind condition
25%
20%
15%
10%
5%
0%
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40
Directional predicted noise level, dB LA90

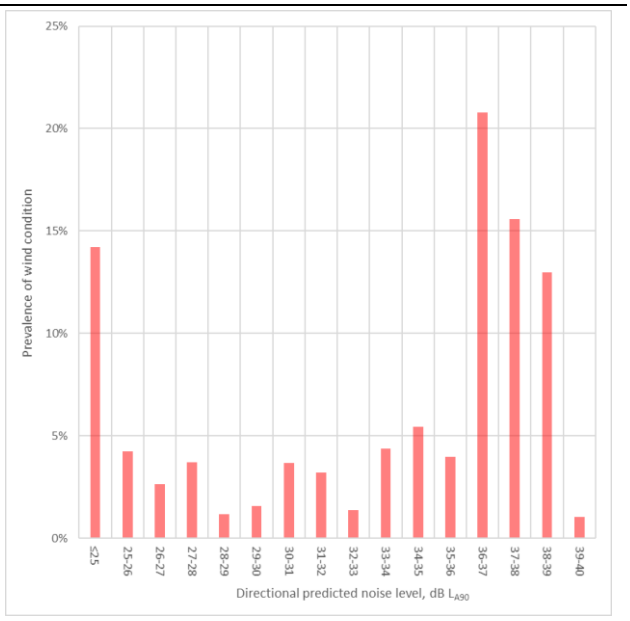
P31 - c


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit


Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

Q30 - a


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit


Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
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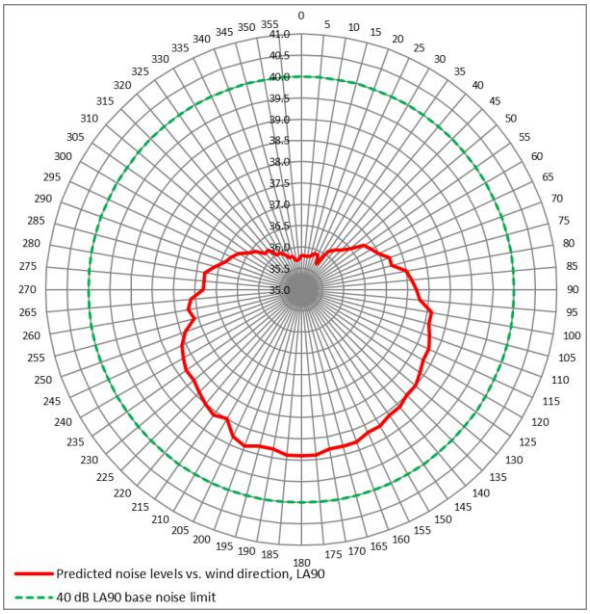
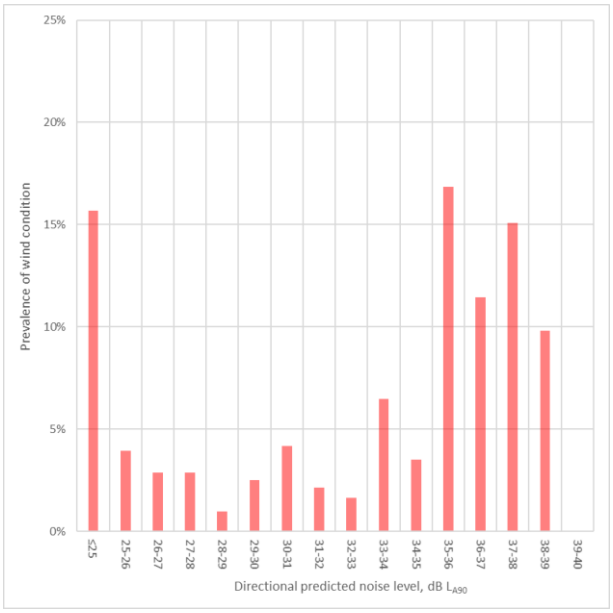
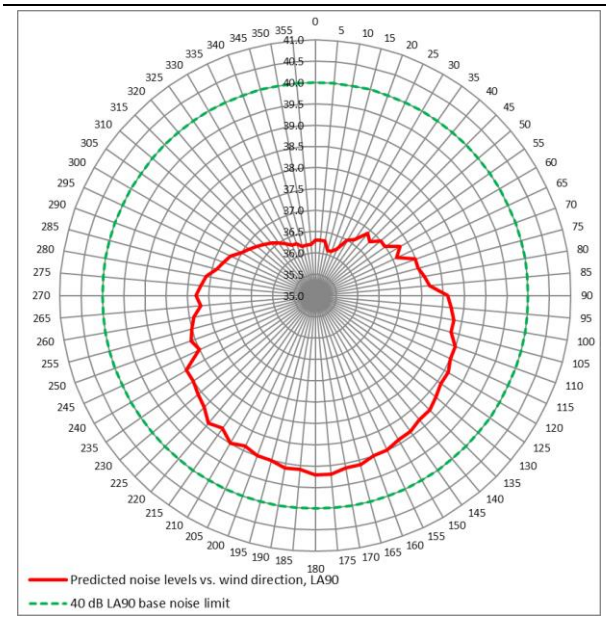
35-36
36-37
37-38
38-39
39-40

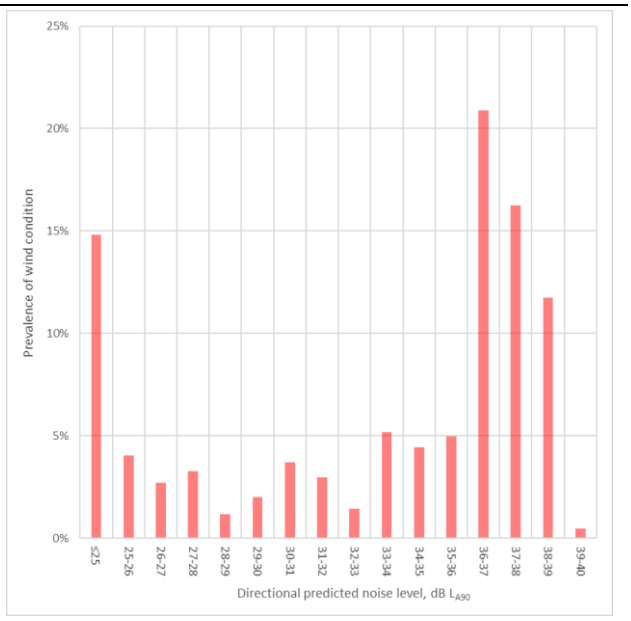
R21 - ad


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

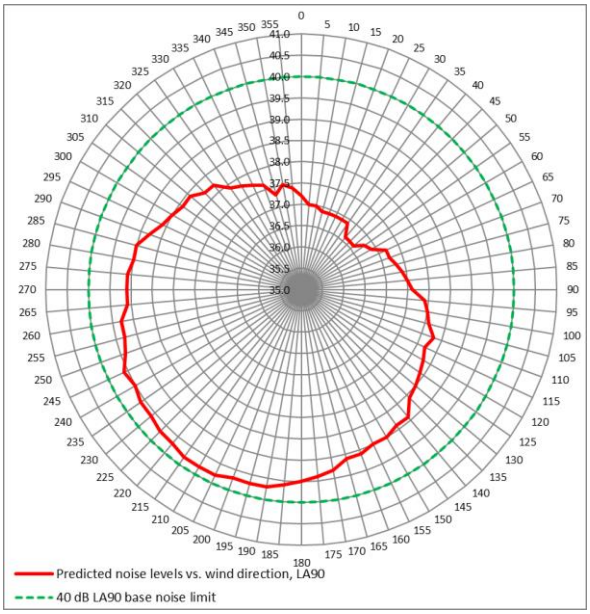

Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

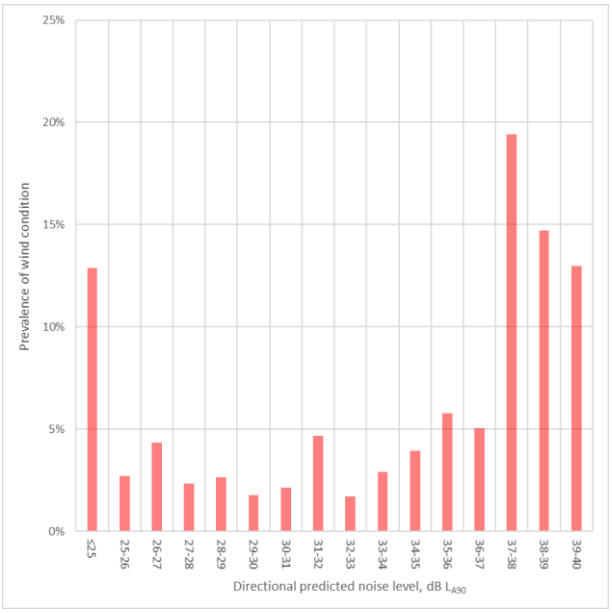
R31 - be


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit

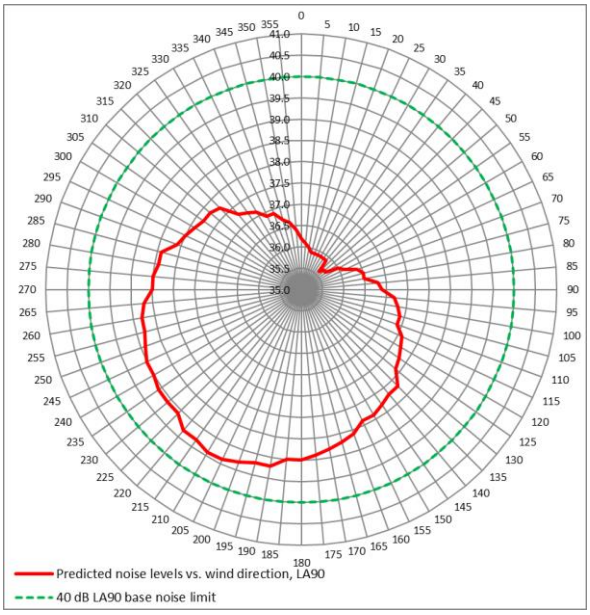

Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

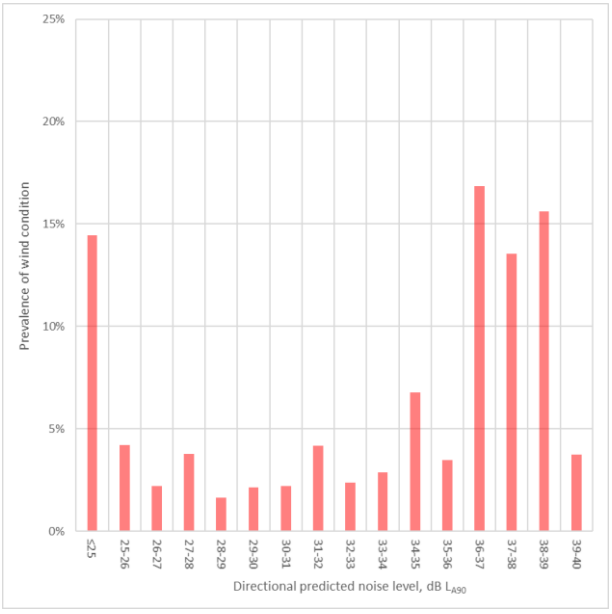
W27 - i


Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit


Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

W28 - a

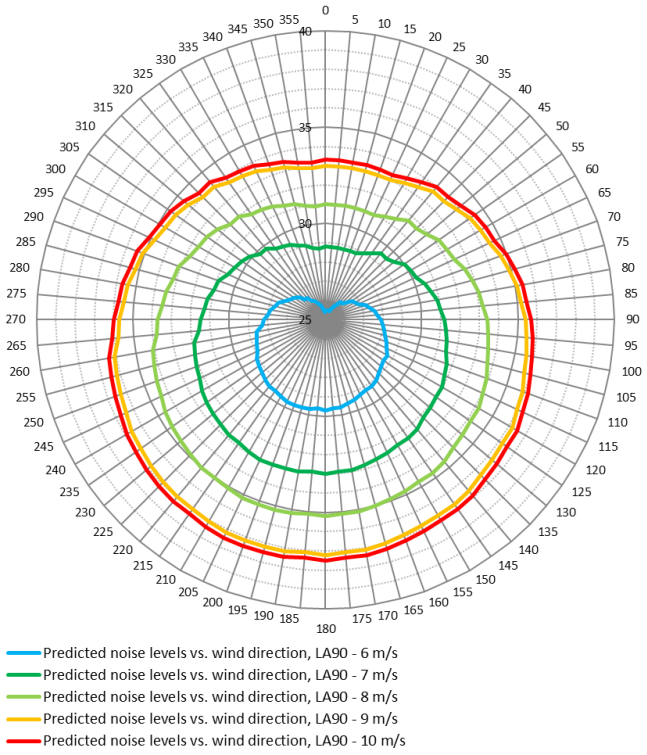

Predicted noise levels vs. wind direction, LA90
40 dB LA90 base noise limit


Prevalence of wind condition
Directional predicted noise level, dB LA90
≤25
25-26
26-27
27-28
28-29
29-30
30-31
31-32
32-33
33-34
34-35
35-36
36-37
37-38
38-39
39-40

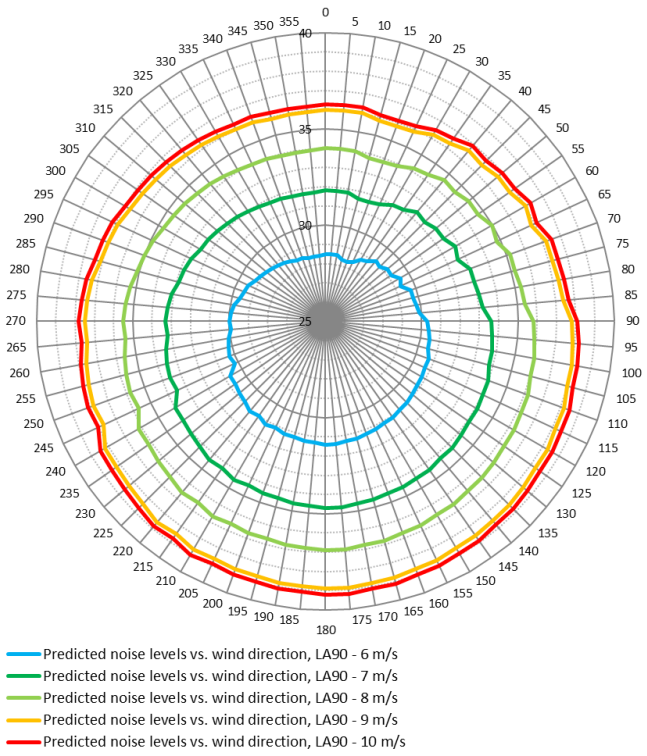
J4 Predicted noise levels – directional plots for TZ and LDRZ receivers

This section presents directional noise prediction plots for the two neighbour dwellings with the highest predicted noise levels within the Township Zone and the Low Density Residential Zone. These plots demonstrate the change in predicted wind farm noise levels with wind direction for hub height winds speeds between 6 and 10 m/s.

Q31 - p



R31 - be



APPENDIX K NZS 6808:2010 DOCUMENTATION

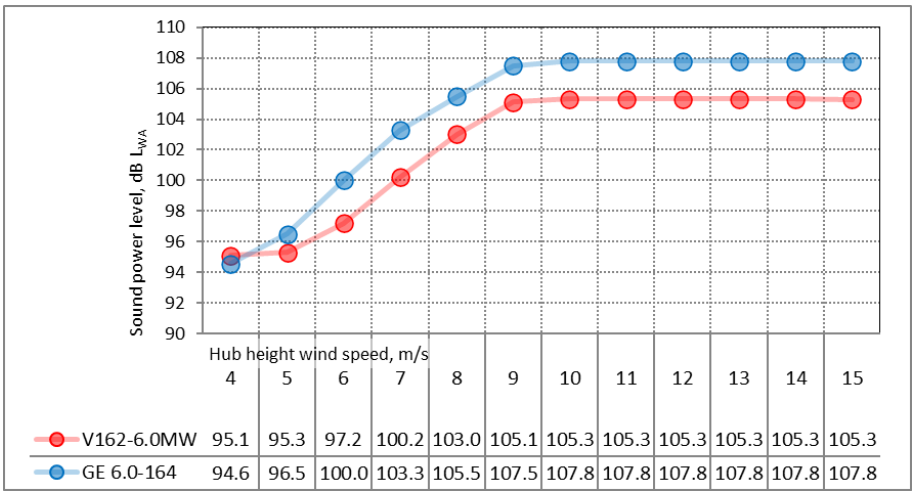
(a) Map of the site showing topography, turbines and residential properties:

See Appendix D and Appendix E

(b) Noise sensitive locations: See Section 2.0 and Appendix C

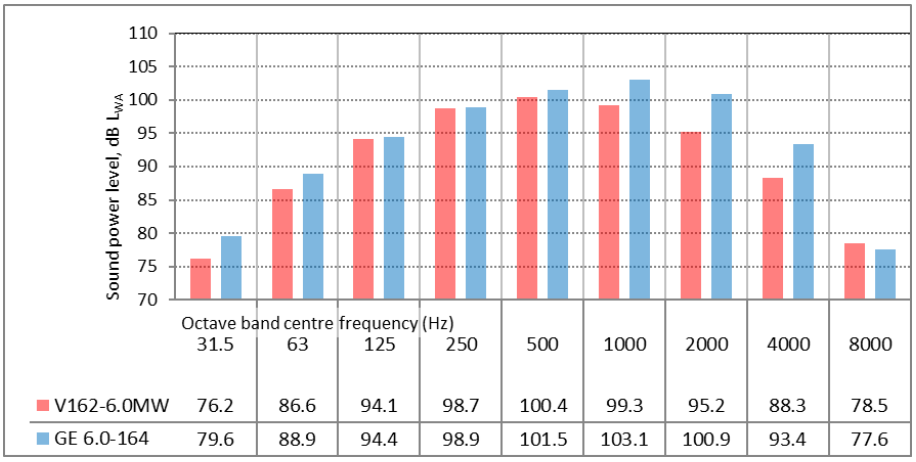
(c) Wind turbine sound power levels, L_{WA} dB (refer to Section 7.3.1)

Sound power levels (manufacturer specification including margin for uncertainty), dB L_{WA}



Hub height wind speed, m/s	4	5	6	7	8	9	10	11	12	13	14	15
V162-6.0MW	95.1	95.3	97.2	100.2	103.0	105.1	105.3	105.3	105.3	105.3	105.3	105.3
GE 6.0-164	94.6	96.5	100.0	103.3	105.5	107.5	107.8	107.8	107.8	107.8	107.8	107.8

Reference octave band spectra adjusted to the highest sound power level detailed above dB L_{WA}



Octave band centre frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
V162-6.0MW	76.2	86.6	94.1	98.7	100.4	99.3	95.2	88.3	78.5
GE 6.0-164	79.6	88.9	94.4	98.9	101.5	103.1	100.9	93.4	77.6

(d) Wind turbine model: See Table 6 of Section 7.2

(e) Turbine hub height: See Table 6 of Section 7.2

(f) Distance of noise sensitive locations from the wind turbines: See Appendix C

(g) Calculation procedure used:

ISO 9613-2:1996 prediction algorithm as implemented in SoundPLAN v8.2
(See Section 5.0 and Appendix H)

(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 resolution elevation contours provided by the proponent– See Appendix E

(k) Predicted far-field wind farm sound levels: See Section 7.4 and Appendix I.

Golden Plains Wind Farm

Planning Permit Amendment Application

Noise and Vibration Assessment

M180934RP10 Revision E

Monday, 15 March 2021

Document Information

Project	Golden Plains Wind Farm
Client	Golden Plains Wind Farm Management Pty Ltd
Report title	Planning Permit Amendment Application—Noise and Vibration Assessment
Project Number	M180934

Revision Table

Report revision	Date	Description	Author	Reviewer
0	17 September 2020	For Issue	Tom Evans	Damien van Raaphorst
A	7 October 2020	Updated Issue	Tom Evans	Damien van Raaphorst
B	18 November 2020	Updated Layout	Tom Evans	Damien van Raaphorst
C	25 November 2020	Updated Issue	Tom Evans	Damien van Raaphorst
D	22 February 2021	Updated Issue including response to auditor (Appendix F)	Tom Evans	Damien van Raaphorst
E	15 March 2021	Updated Issue	Tom Evans	Damien van Raaphorst

Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second.
L_{A90}	The A-weighted noise level exceeded for 90% of the measurement time. The L_{90} level is used to assess both background noise and wind turbine noise under NZS 6808:2010.
L_{Aeq}	Equivalent Noise Level—Energy averaged A-weighted noise level over the measurement time.
L_W	Sound Power Level – a measure of the acoustic output of a source, independent of distance and referenced to 10^{-12} W.
NZS 6808:2010	New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise*.
Special audible characteristics	Special Audible Characteristics are unusual characteristics of wind farm sound that make it more likely to cause adverse community response at lower sound levels. Special audible characteristics are defined by NZS 6808:2010 to include tonality, impulsiveness and amplitude modulation.

Table of Contents

Executive summary

Golden Plains Wind Farm Management Pty Ltd (GPWFM) are developing the Golden Plains Wind Farm (the Project), which involves the establishment of a wind energy facility (WEF) including wind turbines and associated electrical infrastructure on 16,723 ha to the West, South and South East of Rokewood, a small rural town in the Shire of Golden Plains; approximately 60 km North West of Geelong. The Project's Planning Permit (PA1700266) (the Permit) currently allows for up to 228 Wind Turbine Generators (WTGs) with a rotor diameter of up to 150 m and a maximum blade tip height of up to 230 m above ground level (AGL).

GPWFM has developed the final layout and design plans to meet the requirements of the Permit, with the number of WTGs reduced to 215. This 215 WTG layout will be presented to the Minister for Planning as part of an application to amend the Permit. At the same time, GPWFM are seeking to amend Condition 1b iii of the Planning Permit, which currently limits the rotor diameter of the WTGs to 150 m, to allow rotor diameters of up to 165 m. No change is proposed to the maximum allowed tip height of the WTGs, such that the maximum overall height above ground will not exceed 230 m.

GPWFM has identified two potential candidate WTGs with rotor diameters larger than 150 m that could operate within the 215 WTG layout. This report presents a noise and vibration assessment of the Project with the 215 WTG layout and the two candidate WTGs, assessing whether:

- the 215 WTG layout is capable of achieving compliance with the noise and vibration requirements documented in the Planning Permit
- the amended WTG specification is capable of achieving compliance with the noise and vibration requirements documented in the Planning Permit with the 215 WTG layout
- the amendment to the layout and the new WTG specification has resulted in any increased level of impact or detriment when compared with the impacts assessed as part of the Environmental Effects Statement (EES).

For the purposes of the comparative assessment with the EES, this noise and vibration assessment has been conducted with reference to the Marshall Day Acoustics (MDA) Environmental Noise & Vibration Assessment for the Project, included as Appendix Q to the EES and dated 23 February 2018.

Wind turbine noise

A noise model of the 215 WTG layout has been developed and used to predict wind turbine noise levels for both candidate WTGs for comparison with the noise levels outlined in the EES. The two candidate WTGs are a GE 6.0-164 WTG with a rotor diameter of 164 m and a maximum sound power level of 107.8 dB L_{WA} and a Vestas V162-6.0MW WTG with a rotor diameter of 162 m and a maximum sound power level of 105.3 dB L_{WA}.

Although GPWFM is seeking approval for a 165 m rotor diameter, sound power level data is not currently available for a suitable candidate WTG with a 165 m rotor. Manufacturer sound power levels for WTGs are affected by a number of factors, as shown by the 2.5 dB difference between the two candidate WTGs, but do not typically increase proportional to blade length. Given this, and the very marginal difference in rotor diameter between the candidate WTGs and the maximum considered rotor diameter, the candidate WTGs are considered an appropriate representation of WTGs with rotor diameters of up to 165 m.

Wind farm noise levels for the 215 WTG layout with both candidate WTGs are predicted to be compliant with the minimum applicable noise limit of 40 dB under the Permit and New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010). The highest predicted noise level at any noise-sensitive location was 40.0 dB L_{A90} for the GE 6.0-164 WTG and 38.4 dB L_{A90} for the V162-6.0MW WTG. The predicted noise levels remain compliant with the 40 dB criterion allowing for the potential contribution of noise from the approved neighbouring Berrybank Wind Farm.

Under the Permit, areas within the Rokewood Township Zone and Low-Density Residential Zone (LDRZ) are considered to be high amenity. While an analysis of predicted and background noise levels indicated that the high amenity limit is only justified for the LDRZ, an assessment against the high amenity limit of 35 dB L_{A90} has been conducted for both the Township Zone and LDRZ for the wind turbines operating at a wind speed of 6 m/s, which is the maximum wind speed at which it would apply to in accordance with NZS 6808:2010. At a wind speed of 6 m/s, the highest predicted noise level at any noise sensitive location within the high amenity areas is 32.4 dB L_{A90} for the GE 6.0-164 WTG and 29.7 dB L_{A90} for the V162-6.0MW WTG, both compliant with the minimum applicable limit of 35 dB.

The predictions above are based on an assumption that each noise-sensitive location is simultaneously downwind of all WTGs at the site, a situation that is not able to occur in reality. To assess the potential change in noise levels with wind direction, predictions were also conducted with consideration of directivity effects on WTGs where the noise-sensitive location is not downwind of each WTG. Taking into account these directivity effects, it was predicted that, for the louder GE 6.0-164 WTG, the maximum wind turbine noise level at any noise-sensitive location for any wind speed would be 39.8 dB L_{A90}, a marginal reduction on the 40.0 dB L_{A90} predicted assuming no directivity effects. A typical difference in noise level of 3 to 4 dB was predicted between the wind direction sectors with the highest and lowest predicted noise levels at each of the various noise-sensitive locations.

The change in WTG selection has resulted in marginal predicted changes in noise levels at noise sensitive locations. For the majority of locations, these changes are not expected to result in a perceptible increase in noise level from the site. A small number of locations may experience a just perceptible increase in wind turbine noise levels with the candidate GE 6.0-164 WTG, but the predicted levels remain compliant with the applicable Planning Permit requirements.

Wind turbine noise levels have also been predicted at stakeholder dwellings and found to be generally below the adopted noise target of 45 dB L_{A90}. There is one stakeholder dwelling with a marginal predicted exceedance of the target but, as this exceedance is 0.1 dB, there is not expected to be any perceptible difference at this location between the predicted level and a compliant level of 45.0 dB. For all stakeholder dwellings, GPWFM holds an appropriate agreement with the landowner in accordance with the requirements of Condition 13 of the Planning Permit.

Ancillary infrastructure noise

Noise levels from the ancillary infrastructure sites, consisting of one terminal station and three collector stations, were predicted and found to be 29 dB $L_{eq,30min}$ or lower at noise sensitive land uses. In comparison to the EES, predicted noise levels from ancillary infrastructure were no higher than, and were marginally lower than, those levels predicted in the EES.

Construction noise and vibration

The 215 WTG layout and proposed amendment associated with this application, namely an increase of the rotor size of the WTGs, is not expected to noticeably alter noise or vibration associated with construction works. Works will be carried out at similar setback distances to noise-sensitive land uses and a similar methodology, including similar plant and equipment, to that envisaged and assessed as part of the EES will be required to construct the Project.

Noise and vibration from the construction of the Project can be appropriately managed through the development and implementation of a Construction Noise and Vibration Management Plan (CNVMP) as per the Permit requirements. A CNVMP would usually include provisions that:

- schedule work to normal working hours where feasible
- manage out of hours works such that the impact of any unavoidable works is managed to be minimise impact, where feasible; and
- implement appropriate community consultation measures.

With application of the above, in accordance with the Permit, it is anticipated that construction noise and vibration associated with the Project will be able to be acceptably managed.

Conclusion

Based on the 215 WTG layout with two candidate WTGs with larger rotor diameters, it is concluded that:

- Operational wind turbine noise from the 215 WTG layout with an increased rotor diameter of 165 m is expected to achieve compliance with the applicable noise limits under the Permit, including the high amenity limit when applied to the Rokewood Township Zone and LDRZ.
- Ancillary infrastructure noise is expected to achieve compliance with the applicable NIRV limits.
- Construction noise and vibration is expected to be able to be managed to an acceptable level through adherence to the relevant Planning Permit condition for development of a Construction Noise and Vibration Management Plan.

When compared to the EES assessment, the predicted noise levels are not generally expected to result in any noticeable increase in operational wind turbine noise or ancillary infrastructure noise. A small number of locations may experience a just perceptible increase in wind turbine noise levels with the candidate GE 6.0-164 WTG, but the predicted levels remain compliant with the applicable Planning Permit requirements.

1 Introduction

Golden Plains Wind Farm Management Pty Ltd (GPWFM) is developing the Golden Plains Wind Farm (the Project), which involves the establishment of a wind energy facility (WEF) including wind turbines and associated electrical infrastructure on 16,723 ha to the West, South and South East of Rokewood, a small rural town in the Shire of Golden Plains; approximately 60 km North West of Geelong.

The site is located on land that is primarily used for agricultural purposes and has been substantially modified over time due to agricultural operations such as broad acre cropping and livestock grazing. The Project's Planning Permit (PA1700266) currently allows for up to 228 Wind Turbine Generators (WTGs) with a rotor diameter of up to 150 m and a maximum blade tip height of up to 230 m above ground level (AGL).

GPWFM has developed the final project layout and design plans to meet the requirements of the Permit, with the number of WTGs reduced to 215. This 215 WTG layout will be presented to the Minister for Planning as part of an application to amend the Permit.

At the same time, GPWFM is seeking to amend Condition 1b iii of the Planning Permit, which currently limits the rotor diameter of the WTGs to 150 m, to instead allow rotor diameters of up to 165 m. No change is proposed to the maximum allowed tip height of the WTGs, such that the maximum overall height above ground will not exceed 230 m. GPWFM has identified two potential candidate WTGs with rotor diameters larger than 150 m that are being considered.

This report presents a noise and vibration assessment of the Project with the Condition 1 plans and the two candidate WTGs with larger rotors, assessing whether:

- the 215 WTG layout is capable of achieving compliance with the noise and vibration requirements documented in the Planning Permit
- the amended WTG specification is capable of achieving compliance with the noise and vibration requirements documented in the Planning Permit with the 215 WTG layout
- the amendment to the layout and the new WTG specification has resulted in any increased level of impact or detriment when compared with the impacts assessed as part of the Environmental Effects Statement (EES).

For the purposes of the comparative assessment with the EES, this noise and vibration assessment has been conducted with reference to the Marshall Day Acoustics (MDA) Environmental Noise & Vibration Assessment for the Project, included as Appendix Q to the EES and dated 23 February 2018.

2 Site description

2.1 The Project

GPWFM has developed a 215 WTG layout for the Project that complies with the Planning Permit requirements. The WEF consists of 215 WTGs together with ancillary infrastructure, namely an internal terminal station located on Geggies Road, and three internal collector stations. The location of the WTGs and ancillary infrastructure are shown on Figure 1a to 1c and detailed in Appendix A. The original 228 EES WTG locations are also shown on Figure 1a to 1c for reference and detailed in Appendix B.

2.2 WTG specification

GPWFM has identified the following candidate WTGs for the Project:

- GE 6.0MW WTG with a hub height of 148 m AGL and rotor diameter of 164 m
- Vestas V162-6.0MW WTG with a hub height of 149 m AGL and a rotor diameter of 162 m.

Sound power levels been provided by GPWFM for both the candidate GE[1] and Vestas[2] models and are summarised in Table 1. The sound power levels for the Vestas V150-4.2MW WTG, the loudest WTG of the three WTGs considered in the EES, are also presented in Table 1 for comparison.

Table 1 WTG sound power levels with wind speed

WTG	Sound power level in dB L_{WA} for hub height wind speed in m/s							
	3	4	5	6	7	8	9	≥ 10
GE 6.0-164 WTG	94.6[1]	94.6	96.5	100	103.3	105.5	107.5	107.8
V162-6.0MW	94.9	95.1	95.3	97.2	100.2	103.0	105.1	105.3
V150-4.2MW (EES)	92.1	92.3	94.2	97.4	100.9	104.3	105.9	105.9

(1) The GE specification is for wind speeds of 4 m/s and up, with no data available at 3 m/s. It has been assumed that the sound power level at 3 m/s is equivalent to that at 4 m/s.

Uncertainty factors have been adopted for each WTG as follows:

- For the GE 6.0-164 WTG, a 0.8 dB uncertainty factor has been applied in accordance with the GE Specification.
- For the Vestas WTGs, a 1 dB uncertainty factor has been applied for consistency with the EES.

The octave band spectrums used for the assessment are presented for each WTG in Table 2 to Table 4. For the EES, a single spectrum was used for the V150-4.2MW, with the spectrum adjusted to fit the overall sound power level as per Table 1 for lower wind speeds.

Although GPWFM is seeking approval for a 165 m rotor diameter, sound power level data is not currently available for a suitable candidate WTG with a 165 m rotor. Manufacturer sound power levels for WTGs do not typically increase proportional to blade length as shown by the two Vestas WTGs Table 1. Given this, and the very marginal difference in rotor diameter between the candidate WTGs and the maximum considered rotor diameter, the candidate WTGs are considered an appropriate representation of WTGs with rotor diameters of up to 165 m.

[1] *Technical Documentation Wind Turbine Generator Systems Cypress GE 6.0-164-50Hz – Product Acoustic Specifications According to IEC 61400-11* issued by GE and dated 26 August 2020.

[2] *EnVentus V162-6.0 MW 50/60 Hz* issued by Vestas, reference 0094-4372 V01 and dated 6 May 2020.

North-west

GOLDEN PLAINS WIND FARM
Rokewood, Victoria
Figure 1a: Site Layout - North-West

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary

WTG
- Project layout
- EES layout
- Collector Station
- Terminal Station
- BG monitoring site

Receivers
- Stakeholder
- House
- School
- Child Care

High amenity zones
- LDRZ
- Township Zone

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

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Centre

Rokewood Township

GOLDEN PLAINS WIND FARM
Rokewood, Victoria
Figure 1b: Site Layout - Central

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary

WTG
- Project layout
- EES layout
- Collector Station
- Terminal Station
- BG monitoring site

Receivers
- Stakeholder
- House
- School
- Child Care

High amenity zones
- LDRZ
- Township Zone

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

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South-east

GOLDEN PLAINS WIND FARM
Rokewood, Victoria
Figure 1c: Site Layout - South-East

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary

WTG
- Project layout
- EES layout
- Collector Station
- Terminal Station
- BG monitoring site

Receivers
- Stakeholder
- House
- School
- Child Care

High amenity zones
- LDRZ
- Township Zone

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

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Table 2 GE 6.0-164 WTG sound power level spectrum

Wind	Sound power level in dB L_{WA} at octave band centre frequency in Hz									Overall
m/s	31.5	63	125	250	500	1000	2000	4000	8000	dB L_{WA}
4	68.2	77.1	83.8	87.6	88.0	88.4	87.2	81.7	65.9	94.6
5	69.1	78.8	86.7	90.7	90.1	89.3	88.1	83.7	69.0	96.5
6	71.9	81.3	88.8	93.7	94.3	93.5	91.2	86.1	71.7	100.0
7	75.0	84.1	90.8	95.9	97.7	97.7	95.0	88.7	74.3	103.3
8	77.3	86.5	92.4	97.3	99.6	100.6	98.0	91.0	76.0	105.5
9	79.3	88.6	94.0	98.6	101.1	102.7	100.5	93.1	77.3	107.5
10	79.6	88.9	94.4	98.9	101.5	103.1	100.9	93.4	77.6	107.8

Table 3 Vestas V162-6.0MW WTG sound power level spectrum

Wind	Sound power level in dB L_{WA} at octave band centre frequency in Hz									Overall
m/s	31.5	63	125	250	500	1000	2000	4000	8000	dB L_{WA}
3	64.6	75.2	82.9	87.8	89.9	89.2	85.6	79.3	70.1	94.9
4	65.9	76.3	83.7	88.4	90.2	89.1	85.2	78.5	68.9	95.1
5	66.1	76.6	84.1	88.7	90.4	89.3	85.1	78.2	68.1	95.3
6	67.8	78.3	86.0	90.6	92.3	91.2	87.0	80.0	69.9	97.2
7	70.8	81.4	89.0	93.6	95.3	94.2	90.0	83.0	73.0	100.2
8	73.7	84.2	91.8	96.4	98.1	97.0	92.8	85.9	75.9	103.0
9	75.9	86.4	93.9	98.5	100.2	99.1	95.0	88.1	78.2	105.1
10	76.2	86.6	94.1	98.7	100.4	99.3	95.2	88.3	78.5	105.3

Table 4 Vestas V150-4.2MW WTG sound power level spectrum

Hub height wind speed	Sound power level in dB L_{WA} at octave band centre frequency in Hz									Overall
m/s	31.5	63	125	250	500	1000	2000	4000	8000	dB L_{WA}
≥ 9	78.2	87.8	94.8	99.1	100.8	99.9	96.3	90.1	81.2	105.9

2.3 Noise-sensitive locations

Noise-sensitive locations surrounding the Project consist of:

- dwellings
- Rokewood Primary School
- a childcare facility adjacent to Rokewood Primary School.

These locations are shown on Figure 1a to 1c and detailed in Appendix C.

In addition to the noise-sensitive locations, a number of stakeholder dwellings are located around the site that have an agreement with GPWFM that meets the requirements of Condition 13 of the Permit. These stakeholder locations are shown on Figure 1 and are summarised in Appendix D but are not defined as noise-sensitive locations under the Permit.

2.4 Land zoning

The areas surrounding the Project are generally zoned as Farming Zones under the Golden Plains Planning Scheme. However, in the area around Rokewood township, dwellings are also located in areas that the Planning Scheme identifies as Low Density Residential Zones (LDRZ) or Township Zones (TZ). These areas are shown on Figure 1a to 1c.

Condition 18c of the Permit requires that more stringent assessment criteria apply to dwellings located in the LDRZ and TZ, as they are deemed to be in High Amenity areas under New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010).

2.5 Existing noise environment

An extensive background noise monitoring campaign was undertaken between April and August 2019, with background noise monitoring conducted at 15 noise-sensitive land uses, along with 10 stakeholder dwellings.

The results of this background noise monitoring are summarised for the noise-sensitive land uses in Appendix E, analysed in accordance with the Permit conditions for a hub height of 149 m. A hub height wind speed of 149 m (the nominated hub height for the V162-6.0MW WTG) has been selected as it is the marginally higher of the two hub height wind speeds, providing a more conservative assessment as background noise levels will typically be lower for a given hub height wind speed when the hub height increases.

From Appendix E, it is apparent that background noise levels vary across the site but, at each noise-sensitive location, are below 35 dB L_{A90} for some wind direction sectors and time periods up to a wind speed of at least 10 m/s.

3 Planning requirements

The following requirements apply to noise and vibration emissions from the Project relevant to this assessment:

- Planning Permit PA1700266
- NZS 6808:2010 as referenced by the Planning Permit for the assessment of wind farm noise.
- Environment Protection Authority (EPA) Victoria Publication 1411 *Noise from Industry in Regional Victoria* (NIRV), October 2011 as referenced by the Permit for the assessment of noise from ancillary infrastructure
- EPA Victoria Publication 1254 *Noise Control Guidelines* (NCG).

The key requirements of each of the above documents relevant to this noise and vibration assessment are summarised below.

3.1 Planning Permit conditions

Conditions 13 to 32 of Planning Permit PA1700266 issued for the Project detail requirements for the measurement, assessment and management of background noise and operational noise. Condition 63 relates to the management of noise and vibration generated during construction works. This assessment does not take the place of any of the assessments required under the Permit, but instead provides a standalone assessment of the 215 WTG layout with the two candidate WTGs to inform the proposed Planning Permit amendment. The Permit condition that are relevant to this assessment are summarised in Table 5.

Table 5 Summary of Planning Permit conditions

Condition	Summary of requirement	Relevance to this assessment
13	Wind farm noise must comply with the appropriate noise limits from NZS 6808:2010.	The predicted wind farm noise levels have been assessed against the requirements of NZS 6808:2010.
15	The noise limits in Condition 13 do not apply where a suitable agreement is in place with a landowner.	Stakeholder dwellings are not addressed in this assessment as noise limits do not apply under the Permit.
16	Noise from ancillary infrastructure must comply with the recommended noise levels from NIRV.	Noise from ancillary infrastructure has been assessed against the recommended noise levels from NIRV.
17	The noise limits in Condition 16 do not apply where a suitable agreement is in place with a landowner.	Stakeholder dwellings are not addressed in this assessment as noise limits do not apply under the Permit.

For clarity, GPWFM's application to amend the Permit will not seek to vary any of the Permit conditions that relate to noise (i.e. condition 13 to 32 inclusive).

3.2 Standard for wind farm noise assessment

NZS 6808:2010 *Acoustics – Wind farm noise* details procedures as to how wind farm noise assessments should be undertaken and is the relevant Standard for wind farm noise assessments in Victoria. NZS 6808:2010 is referenced in the Permit issued for the site.

NZS 6808:2010 details noise limits for wind farms and specifies the methods which are used for measurement of the noise at the site and the analysis of that data. Some of the items which are specified in NZS 6808:2010 include:

- type of measurement equipment that is to be used

- location where the equipment should be setup on site, height of microphone and distance from other objects
- type of noise and weather data that should be gathered and quantity of that data
- methods that should be used for data analysis.

3.2.1 Wind farm noise limits

Under Condition 13, noise from the wind farm must comply with the noise limits detailed in NZS 6808:2010. Therefore, the following Noise Limits apply at all noise-sensitive locations around the Project:

- Base limit: 40 dB L_{A90} or
- Background-adjustment limit: background noise level (L_{A90}) plus 5 dB,

whichever is the greater with wind speed.

In addition to the above, noise-sensitive locations within the Rokewood LDRZ and TZ are deemed to be in a High Amenity area. Clause 5.3.1 of NZS 6808:2010 states that locations in High Amenity areas are subject to a more stringent base limit of 35 dB L_{A90} under certain conditions. These conditions are:

- the more stringent limit only applies at evening and night-time
- the more stringent limit only applies up to a defined wind speed threshold, the recommended wind speed threshold being 6 m/s
- the more stringent limit only applies when the background noise level is lower than 30 dB L_{A90}, otherwise it becomes the background noise level (L_{A90}) plus 5 dB.

While NZS 6808:2010 does require that consideration be given to marked differences in noise levels that may occur during periods of different wind directions and time of day, no specific requirements are stated. However, Condition 18 of the Permit makes clear that specific consideration is to be given to the night-time period (10 pm to 7 am) and to data collected under each 45-degree wide wind direction sector. The analysis of background noise levels summarised in Appendix E has been conducted in accordance with these requirements.

3.2.2 Special audible characteristics

NZS 6808:2010 states that, where special audible characteristics are detected at noise-sensitive locations as a result of wind farm noise, then a penalty shall be applied to the measured wind farm noise level for the purposes of assessing compliance with the Noise Limits. Wind farm special audible characteristics can only be assessed once the wind farm has commenced operation and is beyond the scope of this assessment.

3.3 Requirements for ancillary infrastructure noise

NIRV prescribes procedures for determining appropriate environmental noise criteria that should be applied at noise-sensitive locations, such as residential areas, with respect to noise due to commercial, industrial and trade operations. The NIRV recommended maximum noise levels are dependent on:

- The time of day: more stringent noise criteria apply at night-time than apply during the daytime and evening.
- The zoning of the land containing the noise source and the land containing the noise receiver: lower noise criteria apply in areas designated for residential, and similar, uses.

Generally, the NIRV criteria are recommended noise levels rather than mandatory limits. However, as the NIRV is referenced in the Planning Permit, the ancillary infrastructure associated with the Project must achieve compliance with the NIRV criteria such that they are termed as noise limits within this NMP.

3.3.1 Ancillary infrastructure noise limits

The ancillary infrastructure for the Project and the nearest noise-sensitive locations are located in Farming Zones. Where this occurs, the noise limits detailed in Table 6 are derived in accordance with NIRV procedures for utilities.

Unlike NZS 6808:2010, background noise measurements are not normally required to establish specific NIRV limits. Background noise levels should be measured to determine the NIRV criteria in 'background relevant areas', such as those areas where traffic noise contributes to the environment that may result in a higher background noise environment than typically expected in rural areas, but this is not considered to be the case for noise-sensitive locations surrounding the Project.

Table 6 Ancillary infrastructure noise limits

NIRV time period	Times	Noise Limit, dB $L_{Aeq,30min}$
Day	7 am to 6 pm Weekdays 7 am to 1 pm Saturdays	45
Evening	6 pm to 10 pm Weekdays 1 pm to 10 pm Saturdays 7 am to 10 pm Sundays and Public Holidays	39
Night	10 pm to 7 am All Days	34

3.3.2 Special audible characteristics

NIRV does not use the term special audible characteristics but adopts the measurement procedures in State Environmental Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1). SEPP N-1 details procedures for the assessment of potentially annoying characteristics such as tonality and impulsiveness. Where these characteristics occur at a noise-sensitive location as a result of noise from the ancillary infrastructure, then a penalty shall be applied to the measured ancillary infrastructure noise level in accordance with SEPP N-1 procedures.

3.4 Requirements for construction noise

The EPA NCG provide guidance on the management of construction noise that needs to be considered under Condition 63 of the Planning Permit. The NCG defines requirements for different working hours as Table 7.

Table 7 Working hours

Time period	Details	Construction noise targets
Normal Working Hours	7 am – 6 pm Monday to Friday 7 am – 1 pm Saturdays	No specific targets. Implement reasonable measures to control construction noise.
Weekend/Evening Work Hours	6 pm – 10 pm Monday to Friday 7 am – 8 am & 1 pm – 10 pm Saturdays 7 am – 10 pm Sundays and public holidays	Background + 10 dB for up to 18 months after project commencement. Background + 5 dB after 18 months.
Night Period	10 pm – 7 am any day	Noise inaudible within a habitable room of any residential premises.

Works do not need to comply with the targets in Table 7 if they are:

- Unavoidable works: works that must be conducted out of hours, such as concrete pours continuing beyond Normal Working Hours or works that pose an unacceptable risk if not conducted out of hours.
- Low-noise or managed-impact works: inherently quiet works or those works that are mitigated through actions specified in a noise management plan supported by an acoustic assessment.

4 Applicable noise limits

4.1 Wind farm noise limits

4.1.1 All noise-sensitive locations

Under Condition 13, noise from the wind farm must comply with the noise limits detailed in NZS 6808:2010. Therefore, the following Noise Limits apply at all noise-sensitive locations around the Project:

- Base limit: 40 dB L_{A90} or
- Background-adjustment limit: background noise level (L_{A90}) plus 5 dB,

whichever is the greater with wind speed.

From Appendix E, it is apparent that background noise levels vary across the site but, at each noise-sensitive location, below 35 dB L_{A90} for some wind direction sectors and time periods up to a wind speed of at least 10 m/s, which corresponds to the wind speed at which both candidate WTGs reach their maximum sound power level.

Therefore, this assessment has been carried out against the minimum applicable limit of 40 dB L_{A90} at all noise-sensitive locations.

4.1.2 High amenity condition

In addition to the above, noise-sensitive locations within the Rokewood LDRZ and TZ are deemed to be in a high amenity area in accordance with Condition 19c of the Planning Permit.

Condition 19c also requires that an assessment as to whether the high amenity limit applies in accordance with Clause C.5.3.1 of NZS 6808:2010. C5.3.1 states that a comparison should be made between predicted wind farm noise levels and measured background noise levels during the evening and night-time periods. For each 10-minute period, the final noise level is estimated by combining the predicted and background noise levels, and then the arithmetic difference between the final noise level and background noise level is calculated. These differences are arithmetically averaged across the whole dataset and if the difference exceeds 8 dB, then a high amenity noise limit is "likely to be justified".

To assess this for the Project, an assessment has been carried on the following four background noise monitoring locations that located within the Rokewood LDRZ or Rokewood TZ:

- Q31-o
- Q31-p
- R31-ad.

For each of these four locations, an assessment has been conducted by:

- Considering the measured $L_{A90,10min}$ background noise levels during the evening and night (6 pm to 7 am) periods only. The definition of evening as being from 6 pm to 10 pm is consistent with standard practice in both Victoria and New Zealand.
- Based on the wind speed for those periods, determining the downwind predicted wind farm noise level in accordance with the noise prediction model summarised in Section 5. It is noted that, as this noise prediction model predicts the downwind noise level, it will result in a conservative over-estimation of the difference between the wind farm and background noise level at times when Rokewood is not downwind of the Project. The predicted downwind wind farm noise levels for the three locations are presented in Table 8 for both candidate WTGs.

Table 8 Predicted wind farm noise levels at background noise monitoring locations in High Amenity area

WTG	Location	Predicted noise level in dB L_{A90} at hub height wind speed in m/s							
		3	4	5	6	7	8	9	≥10
GE 6.0-164 WTG	Q31-o	25.8	25.8	28.2	31.2	34.1	36.0	37.7	38.1
	Q31-p	25.7	25.7	28.0	31.1	33.9	35.9	37.6	37.9
	R31-ad	26.6	26.6	28.9	32.1	35.0	37.0	38.7	39.1
V162-6.0MW WTG	Q31-o	26.2	26.4	26.7	28.6	31.6	34.4	36.5	36.7
	Q31-p	26.1	26.3	26.6	28.4	31.4	34.2	36.4	36.6
	R31-ad	27.1	27.3	27.6	29.4	32.4	35.2	37.4	37.6

- Limiting the assessment between the cut-in wind speed of 3 m/s and the typical rated power wind speed of 14 m/s. This removes periods where the wind farm is not operating (at speeds below 3 m/s) and where the wind farm is operating but the background noise level is typically higher (at speeds above 14 m/s) resulting in a conservative assessment of the difference between background and operational noise levels.

The outcomes of the high amenity analysis, based on C5.3.1 of NZS 6808:2010, are summarised in Table 9.

Table 9 High amenity analysis based on background and predicted noise levels

WTG	Location	Zone	Number of data points analysed	Average difference	High amenity requirement	High amenity limit justified?
GE 6.0-164 WTG	Q31-o	Township	2701	8 dB	> 8 dB	No
	Q31-p	LDRZ	2702	9.4 dB	> 8 dB	Yes
	R31-ad	Township	2047	5.2 dB	> 8 dB	No
V162-6.0MW WTG	Q31-o	Township	2701	7 dB	> 8 dB	No
	Q31-p	LDRZ	2702	8.3 dB	> 8 dB	Yes
	R31-ad	Township	2047	4.7 dB	> 8 dB	No

From Table 9 it is apparent that the high amenity limit is not justified in either location within the Township Zone but is justified in the single location in the LDRZ in accordance with C5.3.1 of NZS 6808:2010. As a conservative approach, however, a high amenity limit has been adopted for both the Township Zone and LDRZ in this assessment.

Under NZS 6808:2010, it is recommended that the high amenity limit only apply up to a wind speed of 6 m/s. Alternative wind speed thresholds may be applied 'where justified on meteorological, topographical and acoustical grounds.' It is unclear what NZS 6808:2010 refers to with respect to these factors but it is noted that:

- The Project and its surrounds are relatively flat and there are no unusual topographical features that could lead to changes in wind farm noise levels, such as pronounced slopes or valleys.
- The background noise levels measured at dwellings around the Project are typical of background noise levels measured at other locations in regional Victoria. While one location within the LDRZ does trigger the high amenity limit in accordance with C5.3.1 of NZS 6808:2010, it is only triggered by approximately 1 dB even allowing for a conservative assessment and does not imply that a significant deviation from NZS 6808:2010 is required.

- The WTGs being considered for the Project have a standard hub height and sound power level emission for modern wind farms, such that it is not considered that there are any unusual acoustical features.

On the basis of the above, the recommended 6 m/s wind speed threshold has been adopted for the purposes of this assessment. At this wind speed, an assessment has been conducted for noise-sensitive locations in the Rokewood Township Zone and LDRZ against the minimum applicable high amenity limit of 35 dB L_{A90}.

It is understood that an audit undertaken by EnviroRisk[3] of a Marshall Day Acoustics noise assessment report[4] conducted for the Planning Permit Amendment Application was inconclusive with respect to the appropriate wind speed threshold for the high amenity limit for the Project. This was based on a review of the summary of background noise measurements in Appendix E of a previous revision of this report, specifically at the three locations in the high amenity area. The audit report noted that:

> With consideration to the gap in seasonal background noise data and the ambiguities of the Standard, the applicability of wind speeds above 6 m/sec may be necessary in setting a night period high amenity noise limit for post-construction compliance monitoring and is recommended to be evaluated by the Responsible Authority.

Appendix F provides additional detail on the background noise measurements within the high amenity area to respond to EnviroRisk's comment and to support the conclusion above that the recommended 6 m/s wind speed threshold is appropriate for the Project.

4.1.3 Stakeholder dwellings

Stakeholder dwellings are not defined as noise-sensitive locations under the Planning Permit, and no formal noise limits apply under the Permit conditions. However, for the purposes of this assessment, stakeholder dwellings have been assessed against a noise target of 45 dB L_{A90}, consistent with that used for the EES.

It is noted that GPWFM holds specific agreements with stakeholders, in accordance with the requirements of the Planning Permit, which allows the relevant noise limits to be exceeded at stakeholder dwellings.

4.2 Ancillary infrastructure noise limits

As the ancillary infrastructure may operate 24 hours per day, compliance will need to be achieved with the more stringent night-time NIRV limit of 34 dB $L_{Aeq,30min}$ at noise-sensitive locations. Table 10 summarises the noise limits for the nearest noise-sensitive locations to each ancillary infrastructure location.

Table 10 Ancillary infrastructure noise limits at nearest noise-sensitive locations

Ancillary infrastructure location	Nearest noise-sensitive location	Noise limit, dB $L_{Aeq,30min}$
Cressy Terminal Station (Geggies Road)	R20 – a	34
Golden Plains Central Collector (Gilletts Road)	P31 – a	34
Golden Plains Western Collector (Boyles Road)	H32 – a	34
Golden Plains Eastern Collector (Bells Road)	W28 – a	34

[3] EnviroRisk, 6 January 2021, *Environmental Audit of the Golden Plains Wind Energy Facility Pre-Construction Noise Assessment*, r_GoldenPlains_Rokewood_PreConstruction_201218_R0

[4] Marshall Day Acoustics, 4 January 2021, *Golden Plains Wind Farm Environmental Noise Assessment*, Rp 001 R02 20200919

5 Wind turbine noise

5.1 Noise model

To assess wind farm noise levels from the 215 WTG layout with the candidate WTGs, an environmental noise model of the Project has been developed in SoundPlan version 8.2 environmental noise prediction software. The noise model has been used to assess predicted noise levels for:

- the EES layout with the V150-4.2MW WTG at a hub height of 155 m
- the 215 WTG layout with each of the GE 6.0-164 WTG and the V162-6.0MW WTG at hub heights of 148 m and 149 m respectively.

The results of the modelling for the EES layout correspond with the results presented in the EES and provide a basis for comparison with the 215 WTG layout with the amended WTG specification.

In accordance with standard prediction procedures for wind farm noise, predictions have been undertaken on the basis of the following parameters:

- WTG and receiver locations as per the coordinates detailed in Appendices A to C.
- It has been assumed that each receiver is simultaneously downwind of all WTGs simultaneously.
- Topographical contours sourced from Vicmap.
- Ground absorption factor of 50% representing mixed reflective and absorptive ground. This corresponds to a value of G = 0.5 in accordance with ISO 9613-2:1996.
- WTG sound power levels as per Table 1.
- Receiver height of 1.5 m above ground.
- Temperature of 10˚C and relative humidity of 70%.
- ISO 9613-2:1996[5] prediction algorithm implemented for predictions.
- +3 dB applied to the predicted noise level from any WTG where concave topography observed as per the UK Institute of Acoustics Good Practice Guide definition
- Topographical shielding limited to 2 dB.

The air absorption values from ISO 9613-2:1996 have been adopted. Air absorption is dependent on the assumed temperature and humidity and therefore the relevant air absorption values for this assessment are shown in Table 11.

Table 11 Air absorption factors as per ISO 9613-2

Conditions	Atmospheric attenuation in dB/km for octave band centre frequency in Hz							
	63	125	250	500	1000	2000	4000	8000
Temperature 10˚C Rel humidity 70%	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117

This prediction methodology is consistent with that adopted in the EES and is also in accordance with that recommended by the UK Institute of Acoustics *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (Good Practice Guide) with the exceptions that:

- The Good Practice Guide recommends a receiver height of 4 m above ground rather than 1.5 m above ground. A receiver height of 4 m above ground would increase predicted noise levels by approximately 1.5 dB.

[5] International Standard ISO 9613-2, 1996, *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*

- The Good Practice Guide recommends that 2 dB be subtracted from predicted noise levels to adjust predicted L_{eq} noise levels to the assessed L_{90} noise levels. This has not been adopted for this assessment.

Given that the above two changes effectively negate each other, the predicted noise levels using the adopted methodology are considered to be consistent with the IoA Good Practice Guide. It is also noted that this methodology has been shown to accurately predicted downwind noise levels for Australian sites with sloping or relatively flat topography.[6]

5.2 Predicted wind turbine noise levels

5.2.1 Noise-sensitive locations

Based on the noise model for the 215 WTG layout with the two candidate WTGs, a total of:

- 107 noise-sensitive locations have been identified with the predicted 35 dB contour from the wind farm for the GE 6.0-164 WTG. This is an increase of 13 locations above the 94 locations predicted within this contour based on the EES layout.
- 91 noise-sensitive locations have been identified with the predicted 35 dB contour from the wind farm for the V162-6.0MW WTG. This decrease of 3 locations below the 94 locations predicted within this contour based on the EES layout.

Table 12 presents the highest predicted wind farm noise levels at each noise-sensitive location (non-stakeholder dwellings) within the 35 dB contour. It can be seen that the highest predicted noise level is 40.0 dB L_{A90} for the GE 6.0-164 WTG and 38.4 dB L_{A90} for the V162-6.0MW WTG, both compliant with the applicable noise limit of 40 dB. This demonstrates that the proposed change in rotor diameter does not alter the capacity of the Project to be planned and constructed with predicted noise levels achieving compliance with the applicable noise limits.

Predicted wind turbine noise contour maps for the Project are included in Appendix G.

5.2.2 High amenity area

To assess wind turbine noise levels against the minimum applicable high amenity limit of 35 dB L_{A90}, wind turbine noise levels have been predicted at all locations within the Rokewood Township Zone and LDRZ for a hub height wind speed of 6 m/s, corresponding to the highest wind speed at which the high amenity limit applies.

At this wind speed, the highest predicted noise level for any noise-sensitive location is:

- 32.4 dB L_{A90} for the GE 6.0-164 WTG
- 29.7 dB L_{A90} for the V162-6.0MW WTG

In both cases, the highest predicted noise level for the high amenity area occurs at noise-sensitive location R31 – be.

The predicted noise levels are 3 – 5 dB below the minimum applicable high amenity limit of 35 dB L_{A90} for the Rokewood Township Zone and LDRZ indicating that the candidate WTGs are capable of achieving compliance with the Planning Permit condition relating to high amenity.

Predicted wind turbine noise contour maps for the Project at a wind speed of 6 m/s are included in Appendix G, showing the Rokewood township area with predicted noise levels for each candidate WTG.

[6] Evans T & Cooper J, 2012, *Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms*, Acoustics Australia, vol. 40, no. 1, pp 28-36.

Table 12 Predicted noise levels at noise-sensitive locations within the 35 dB contour

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
F35 - a	House (neighbour)	32.5	35	2.5	✓	33.6	1.1	✓
G30 - a	House (neighbour)	34.7	36.7	2	✓	35.3	0.6	✓
H28 - a	House (neighbour)	33.4	35	1.6	✓	33.6	0.2	✓
H30 - a	House (neighbour)	34.9	36.7	1.8	✓	35.3	0.4	✓
H32 - a	House (neighbour)	37.4	39.9	2.5	✓	38.2	0.8	✓
H38 - a	House (neighbour)	33.4	36.1	2.7	✓	34.6	1.2	✓
K27 - a	House (neighbour)	37.5	39.5	2	✓	37.9	0.4	✓
L26 - a	House (neighbour)	37.2	39.1	1.9	✓	37.5	0.3	✓
M35 - b	House (neighbour)	37	39.4	2.4	✓	37.8	0.8	✓
M37 - a	House (neighbour)	32.9	35.3	2.4	✓	34	1.1	✓
N25 - a	House (neighbour)	36.4	37.8	1.4	✓	36.3	-0.1	✓
N25 - b	House (neighbour)	36.4	37.8	1.4	✓	36.4	0	✓
O24 - a	House (neighbour)	35.3	36	0.7	✓	34.7	-0.6	✓
O34 - a	House (neighbour)	36.4	38.8	2.4	✓	37.1	0.7	✓
O34 - b	House (neighbour)	36.3	38.6	2.3	✓	37	0.7	✓
P24 - a	House (neighbour)	35.8	36.5	0.7	✓	35.2	-0.6	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
P24 - b	House (neighbour)	36.8	37.8	1	✓	36.3	-0.5	✓
P31 - a	House (neighbour)	38.8	39.8	1	✓	38.3	-0.5	✓
P31 - c	House (neighbour)	38.7	39.8	1.1	✓	38.3	-0.4	✓
P32 - a	Other Noise Sensitive Location[1]	36.5	38.9	2.4	✓	37.3	0.8	✓
Q30 – a	House (neighbour)	39.2	39.7	0.5	✓	38.2	-1	✓
Q31 – a	House (neighbour)	37	37.8	0.8	✓	36.5	-0.5	✓
Q31 – b	House (neighbour)	36.4	37.3	0.9	✓	36	-0.4	✓
Q31 – c	House (neighbour)	35.9	36.8	0.9	✓	35.5	-0.4	✓
Q31 – e	House (neighbour)	35.8	36.7	0.9	✓	35.4	-0.4	✓
Q31 – f	House (neighbour)	35.8	36.7	0.9	✓	35.4	-0.4	✓
Q31 – g	House (neighbour)	35.9	36.8	0.9	✓	35.5	-0.4	✓
Q31 – h	House (neighbour)	35.9	36.8	0.9	✓	35.5	-0.4	✓
Q31 – i	House (neighbour)	36	36.9	0.9	✓	35.6	-0.4	✓
Q31 – j	House (neighbour)	36	36.9	0.9	✓	35.6	-0.4	✓
Q31 – k	House (neighbour)	36	36.9	0.9	✓	35.6	-0.4	✓
Q31 – l	House (neighbour)	36	36.9	0.9	✓	35.6	-0.4	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
Q31 – m	House (neighbour)	36.2	37.1	0.9	✓	35.8	-0.4	✓
Q31 – o	House (neighbour)	37.3	38.1	0.8	✓	36.7	-0.6	✓
Q31 – p	House (neighbour)	37.1	37.9	0.8	✓	36.5	-0.6	✓
Q32 – a	House (neighbour)	35.6	36.7	1.1	✓	35.4	-0.2	✓
Q32 – b	House (neighbour)	35.5	36.6	1.1	✓	35.3	-0.2	✓
Q32 – c	House (neighbour)	35.4	36.4	1	✓	35.1	-0.3	✓
Q32 – d	House (neighbour)	35.3	36.4	1.1	✓	35.1	-0.2	✓
Q32 – e	House (neighbour)	35	36	1	✓	34.7	-0.3	✓
Q32 – f	House (neighbour)	35.3	36.3	1	✓	35	-0.3	✓
Q32 – g	House (neighbour)	35.5	36.5	1	✓	35.2	-0.3	✓
R31 – aa	House (neighbour)	37	38.1	1.1	✓	36.6	-0.4	✓
R31 – ab	House (neighbour)	37.5	38.4	0.9	✓	37	-0.5	✓
R31 – ad	House (neighbour)	38	39.1	1.1	✓	37.5	-0.5	✓
R31 – ae	School	37.6	38.6	1	✓	37.1	-0.5	✓
R31 – af	Childcare	37.5	38.5	1	✓	37	-0.5	✓
R31 – ai	House (neighbour)	37.8	38.7	0.9	✓	37.2	-0.6	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
R31 – aj	House (neighbour)	37.4	38.3	0.9	✓	36.9	-0.5	✓
R31 – ak	House (neighbour)	37.4	38.3	0.9	✓	36.9	-0.5	✓
R31 – al	House (neighbour)	37.3	38.2	0.9	✓	36.8	-0.5	✓
R31 – am	House (neighbour)	37	37.9	0.9	✓	36.5	-0.5	✓
R31 – an	House (neighbour)	36.9	37.8	0.9	✓	36.4	-0.5	✓
R31 – ao	House (neighbour)	36.7	37.6	0.9	✓	36.2	-0.5	✓
R31 – ap	House (neighbour)	37.4	38.4	1	✓	36.9	-0.5	✓
R31 – aq	House (neighbour)	37.2	38.3	1.1	✓	36.8	-0.4	✓
R31 – ar	House (neighbour)	37.3	38.3	1	✓	36.8	-0.5	✓
R31 – as	House (neighbour)	37.1	38.1	1	✓	36.7	-0.4	✓
R31 – at	House (neighbour)	37.2	38.2	1	✓	36.8	-0.4	✓
R31 – av	House (neighbour)	37	38	1	✓	36.6	-0.4	✓
R31 – aw	House (neighbour)	36.9	37.9	1	✓	36.5	-0.4	✓
R31 – ax	House (neighbour)	37.1	38	0.9	✓	36.6	-0.5	✓
R31 – az	House (neighbour)	37	38	1	✓	36.5	-0.5	✓
R31 – b	House (neighbour)	37.2	38.3	1.1	✓	36.8	-0.4	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
R31 – ba	House (neighbour)	37.2	38.3	1.1	✓	36.8	-0.4	✓
R31 – bb	House (neighbour)	36.8	37.7	0.9	✓	36.3	-0.5	✓
R31 – bc	House (neighbour)	36.8	37.7	0.9	✓	36.3	-0.5	✓
R31 – bd	House (neighbour)	36.9	37.8	0.9	✓	36.4	-0.5	✓
R31 – be	House (neighbour)	38.4	39.4	1	✓	37.9	-0.5	✓
R31 - bf	Other Noise Sensitive Location[1]	35.8	36.7	0.9	✓	35.4	-0.4	✓
R31 - c	House (neighbour)	36.6	37.5	0.9	✓	36.1	-0.5	✓
R31 - d	House (neighbour)	37.1	38.2	1.1	✓	36.8	-0.3	✓
R31 - f	House (neighbour)	36.9	37.8	0.9	✓	36.4	-0.5	✓
R31 - g	House (neighbour)	37	37.9	0.9	✓	36.5	-0.5	✓
R31 - h	House (neighbour)	36.9	37.8	0.9	✓	36.4	-0.5	✓
R31 - j	House (neighbour)	36.7	37.7	1	✓	36.3	-0.4	✓
R31 - k	House (neighbour)	36.6	37.6	1	✓	36.2	-0.4	✓
R31 - n	House (neighbour)	36.5	37.5	1	✓	36.1	-0.4	✓
R31 - q	House (neighbour)	35.5	36.5	1	✓	35.2	-0.3	✓
R31 - r	House (neighbour)	36.4	37.3	0.9	✓	36	-0.4	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
R31 - s	House (neighbour)	36.4	37.3	0.9	✓	36	-0.4	✓
R31 - t	House (neighbour)	36.4	37.4	1	✓	36	-0.4	✓
R31 - u	House (neighbour)	36.5	37.4	0.9	✓	36	-0.5	✓
R31 - v	House (neighbour)	36.5	37.5	1	✓	36.1	-0.4	✓
R31 - w	House (neighbour)	36.6	37.5	0.9	✓	36.1	-0.5	✓
R31 – z	House (neighbour)	36.8	37.7	0.9	✓	36.3	-0.5	✓
R32 – a	House (neighbour)	34.8	35.8	1	✓	34.5	-0.3	✓
R32 – b	House (neighbour)	35.2	36.2	1	✓	34.9	-0.3	✓
R32 – c	House (neighbour)	35.4	36.3	0.9	✓	35	-0.4	✓
R32 – d	House (neighbour)	35.5	36.4	0.9	✓	35.1	-0.4	✓
R32 – e	House (neighbour)	34.4	35.5	1.1	✓	34.2	-0.2	✓
T32 – b	House (neighbour)	34.1	35.6	1.5	✓	34.2	0.1	✓
U18 – a	House (neighbour)	36.5	37.2	0.7	✓	35.5	-1	✓
U18 – b	House (neighbour)	37.4	37.3	-0.1	✓	35.6	-1.8	✓
U18 – c	House (neighbour)	37.1	37	-0.1	✓	35.3	-1.8	✓
U31 – a	House (neighbour)	34.2	35.6	1.4	✓	34.2	0	✓

Location ID	Type	EES 228 WTG layout	GE 215 WTG layout			V162-6.0MW 215 WTG layout		
		Predicted noise level, dB L_{A90}	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?	Predicted noise level, dB L_{A90}	Change relative to EES layout, dB L_{A90}	Compliance with 40 dB L_{A90}?
V30 – a	House (neighbour)	37.7	38.6	0.9	✓	37.1	-0.6	✓
W17 – a	House (neighbour)	39	38.4	-0.6	✓	36.6	-2.4	✓
W27 - i	Other Noise Sensitive Location[1]	38.7	40.0	1.3	✓	38.4	-0.3	✓
W28 – a	House (neighbour)	38.3	39.5	1.2	✓	38	-0.3	✓
X18 – a	House (neighbour)	43	38.6	-4.4	✓	36.8	-6.2	✓
Y28 – a	House (neighbour)	35.3	36.4	1.1	✓	35	-0.3	✓
Y28 – b	House (neighbour)	34.3	35.2	0.9	✓	33.9	-0.4	✓
Z28 – a	House (neighbour)	34.8	35.9	1.1	✓	34.5	-0.3	✓
AA27 – a	House (neighbour)	35.7	36.3	0.6	✓	34.9	-0.8	✓
AA27 – b	House (neighbour)	35.1	36.1	1	✓	34.8	-0.3	✓
AC22 – a	House (neighbour)	37.4	36.6	-0.8	✓	34.9	-2.5	✓

(1) This location was not assessed in the EES and, therefore, the EES did not present predicted noise levels to this accuracy in the report for this location. The presented level is a predicted level using a noise model with the same inputs as the EES noise model.

5.2.3 Change in predicted noise levels

Due to changes in WTG locations and specifications, there are differences in predicted noise levels between the EES layout and the 215 WTG layout with the two candidate WTGs. These are summarised in Table 13 for each candidate WTG for noise-sensitive locations with a predicted noise level of 35 dB L_{A90} or greater.

Table 13 Predicted change in noise levels relative to EES

Change in predicted noise level relative to EES, dB L_{A90}	Number of noise-sensitive locations for GE 6.0-164 WTG	Number of noise-sensitive locations for V162-6.0MW WTG
≤ -4.5	0	1
-4.4 to -3.5	1	0
-3.4 to -2.5	0	0
-2.4 to -1.5	0	3
-1.4 to -0.5	2	35
-0.4 to 0.4	2	46
0.5 to 1.4	88	6
1.5 to 2.4	11	0
≥ 2.5	3	0

The GE 6.0-164 WTG typically results in a small increase in predicted noise levels of 1 to 2 dB relative to the EES, with a maximum predicted increase at any noise-sensitive location of 2.7 dB. Increases of 1 to 2 dB are unlikely to be perceptible in field conditions. Although the maximum increase of 2.7 dB may be just perceptible in some conditions, any change in impact as a result of the increase will be minimal.

For the V162-6.0MW WTG, these is generally no change, or a marginal decrease, in predicted noise levels relative to the EES. The largest increase in predicted noise levels at any noise-sensitive location is 0.8 dB. For the majority of noise-sensitive locations there would be expected to be no perceptible change between the V162-6.0MW WTG noise levels and the original EES noise levels, and no location would be expected to experience a perceptible increase in wind turbine noise levels.

It should be noted that regardless of the minor changes noted above, both WTG models result in noise levels that are compliant with the permitted limits at all non-stakeholder dwellings.

5.2.4 Cumulative noise from Berrybank Wind Farm

The Berrybank Wind Farm is an approved wind farm site to the west of the Project, with Stage 1 currently under construction. GPWFM has provided a 70-WTG layout (Stage 1 and Stage 2) for the Berrybank Wind Farm, indicating that the nearest Berrybank WTG is at least 6 km from any proposed WTG site for the Project.

Predictions have been carried out for the Berrybank Wind Farm using the same noise modelling procedure as was used for the Project and incorporating:

- the 70 WTG layout for Berrybank Wind Farm supplied by GPWFM on 2 October 2020 and as documented in Appendix H
- a hub height of 112 m and rotor diameter of 136 m
- a maximum sound power level for the Vestas V136-4.2MW WTG of 104.9 dB L_{WA} as shown in Table 14, based on information provided by Vestas and incorporating a 1 dB uncertainty factor.

Table 14 Vestas V136-4.2MW WTG sound power level spectrum

Hub height wind speed	Sound power level in dB L_{WA} at octave band centre frequency in Hz									Overall
m/s	31.5	63	125	250	500	1000	2000	4000	8000	dB L_{WA}
≥ 9	75.2	85.8	93.5	98.2	100.0	98.9	94.8	87.9	77.8	104.9

The highest predicted noise level from Berrybank Wind Farm at any noise-sensitive location with a predicted Project noise level of 35 dB or greater is 24.1 dB L_{A90} at G30 - a. The cumulative noise level from both the Project, with the noisier GE 6.0-164 WTG, and Berrybank Wind Farm at this location is 36.9 dB L_{A90} or a 0.2 dB increase above the predicted noise level for the Project alone.

The predicted 0.2 dB increase at G30 - a corresponds to the equal highest predicted increase in noise level at any noise-sensitive location within the 35 dB contour from the Project. At the noise-sensitive location with the highest predicted Project noise level (W27 - i), the predicted noise level from Berrybank Wind Farm is 10.3 dB L_{A90} and the predicted cumulative noise level would remain at 40.0 dB L_{A90}, remaining compliant with the minimum applicable limit.

On this basis and considering cumulative predictions at all locations, wind farm noise levels from the Project are predicted to remain compliant with the minimum applicable limit of 40 dB L_{A90} at all noise-sensitive locations when cumulative noise from the Project and Berrybank Wind Farm is considered.

5.2.5 Stakeholder dwellings

The predicted noise levels at stakeholder dwellings are shown in Table 15 for each candidate WTG.

Table 15 Predicted noise levels at stakeholder dwellings

ID	Predicted noise level with GE 6.0-164 WTG	Compliance with 45 dB L_{A90} target?	Predicted noise level with V162-6.0MW WTG	Compliance with 45 dB L_{A90} target?
G35 - b	44.8	✓	42.8	✓
H32 - b	42	✓	40.1	✓
H37 - a	39	✓	37.3	✓
J28 - a	43.8	✓	41.8	✓
K30 - a	44.5	✓	42.6	✓
K32 - a	41.5	✓	39.9	✓
L32 - a	41.5	✓	39.9	✓
L33 - a	42.7	✓	41	✓
M28 - a	44.8	✓	42.8	✓
M34 - a	44.4	✓	42.3	✓
M35 - a	44.1	✓	42.1	✓
N26 - a	43.9	✓	41.9	✓
N28 - a	44.9	✓	43	✓
N32 - a	44.5	✓	42.6	✓

ID	Predicted noise level with GE 6.0-164 WTG	Compliance with 45 dB L_{A90} target?	Predicted noise level with V162-6.0MW WTG	Compliance with 45 dB L_{A90} target?
O30 - a	45	✓	43	✓
O32 - a	44.6	✓	42.5	✓
P25 - a	41	✓	39.3	✓
R27 - a	44.7	✓	42.8	✓
T24 - a	45	✓	43.1	✓
T27 - a	45.1	0.1 dB exceedance	43.2	✓
V20 - a	41.6	✓	39.7	✓
W20 - a	41.1	✓	39.3	✓
W21 - a	39.7	✓	38.2	✓
W21 - b	40.9	✓	39.2	✓
W25 - a	44.7	✓	42.8	✓
W25 - b	45	✓	43.1	✓
Z20 - a	35.8	✓	34.5	✓
Z20 - b	35.8	✓	34.5	✓
AC22 - b	37.1	✓	35.4	✓

For the GE 6.0-164 WTG, it can be seen that the predicted noise levels at stakeholder dwellings are generally below the adopted noise target of 45 dB L_{A90}. There is one stakeholder dwelling (T27 - a) with a marginal predicted exceedance of the target. As this exceedance is 0.1 dB, there is not expected to be any perceptible difference at this location between the predicted level and the target level of 45.0 dB. It is also noted that compliance with the stakeholder noise target is not a requirement under the Planning Permit.

For the V162-6.0MW WTG, the predicted noise levels at all stakeholder dwellings remain compliant with the 45 dB target, with a maximum predicted noise level at any stakeholder dwelling of 43.3 dB L_{A90}.

For all stakeholder dwellings, GPWFM holds an appropriate agreement with the landowner in accordance with the requirements of Condition 13 of the Planning Permit.

5.3 Predicted noise levels under different wind directions

The predicted noise levels presented in Section 5.2 and in the noise contour maps in Appendix G are based on the assumption that each noise sensitive land use will be simultaneously downwind of all WTGs. While this is a normal assumption made for planning stage assessments of wind farm noise and generally provides an accurate prediction of wind turbine noise levels under downwind conditions, it overstates predicted noise levels for wind directions where a noise sensitive land use is not downwind of the nearest WTGs. It can also overstate predicted noise levels for larger sites where noise levels at a noise sensitive land use may be contributed to by WTGs in markedly different directions, such as is the case for some sensitive land uses around the Project site.

A study conducted in Australia[7] found that, for a WTG with tip height of 135 m, noise levels under upwind conditions were 3 to 5 dB lower than under downwind conditions at a distance of 500 m from the WTG (3.7 times tip height), with this difference increasing to 6 to 7 dB at a distance of 1000 m (7.4 times tip height). Noise levels under crosswind conditions were considered likely to be relatively similar to those under upwind conditions.

Section 4.4 of the UK IoA Good Practice Guide also provides guidance on directivity corrections that can be applied to WTG sound power levels, with varying corrections applied depending on the distance of the prediction location (noise-sensitive location) from the WTG relative to tip height. The Good Practice Guide corrections, for flat landscapes such as that around the Project, are shown in Figure 4. Note that a direction of 180º corresponds to the prediction location being downwind of the WTG.

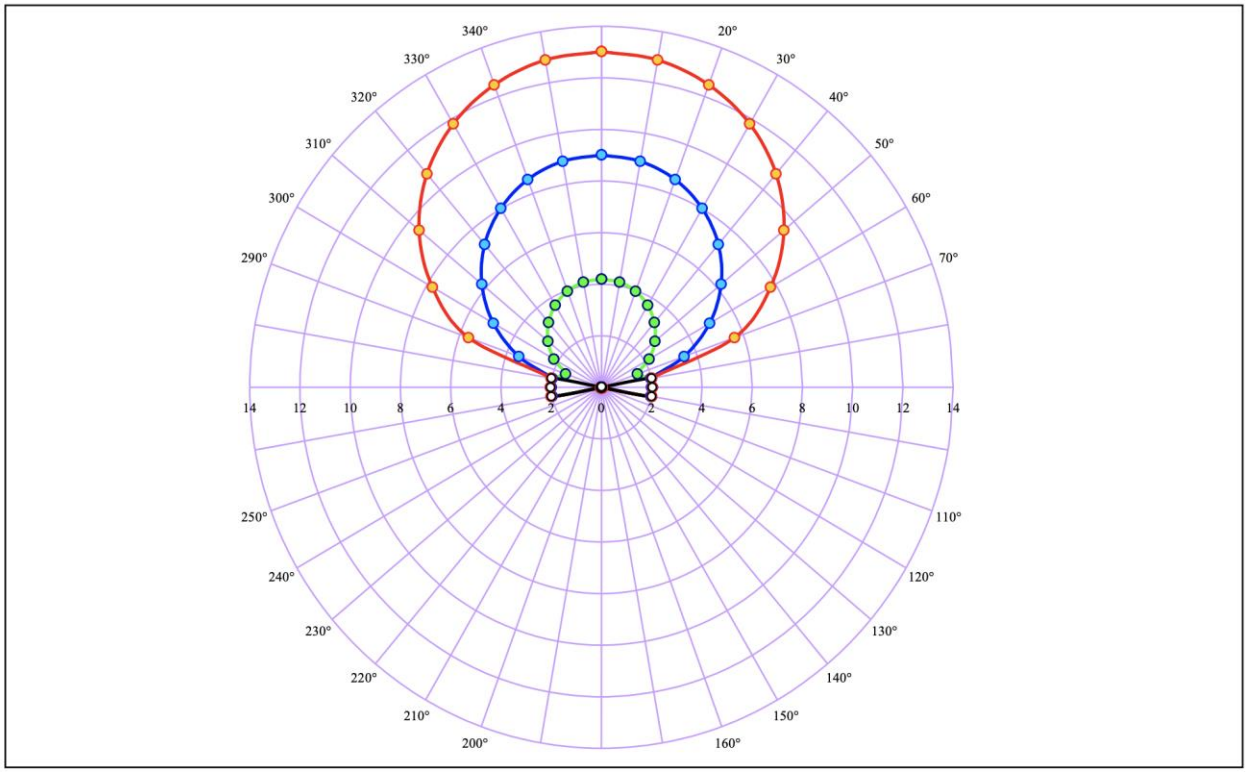


Figure 4 Assumed reduction in noise levels with wind direction from WTG on a flat site from Good Practice Guide. Black line is shown for distances of less than 5.25x tip height, Green line for 7.5x tip height, Blue line for 11x tip height and Red line for 18 x tip height

Compared to the Australian study results, the Good Practice Guide corrections appear relatively limited in close proximity to the WTG. The Good Practice Guide corrections indicate little or no attenuation under upwind conditions when within 5.25 tip heights of the nearest WTG, whereas the Australian study observed reductions of 3 to 5 dB at 3.7 tip heights. Therefore, adoption of the Good Practice Guide corrections is considered a conservative approach for assessing the change in noise level with wind direction.

Table 16 presents predicted noise levels at noise-sensitive locations within the 35 dB contour with consideration of direction and distance from each WTG and the Good Practice Guide corrections shown in Figure 4. Predictions are shown for each of eight wind direction sectors and for the louder GE 6.0-164 WTG model.

[7] Evans T & Cooper J, 2012, *Influence of wind direction on noise emission and propagation from wind turbines*, Proceedings of Acoustics 2012, 21-23 November 2012, Fremantle, Australia.

Table 16 Predicted noise levels at noise-sensitive locations within the 35 dB contour considering wind direction

ID	Predicted wind turbine noise level for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
F35 - a	34	35	35	34.7	32.7	29.6	28.7	31.3	35	28.7
G30 - a	36.5	36.7	36.1	34.8	32.3	31	33	35.2	36.7	31
H28 - a	34.9	35	34.5	32.4	28.6	28.2	31.5	34.1	35	28.2
H30 - a	36.5	36.7	36.1	34.8	32.3	31	33	35.2	36.7	31
H32 - a	39.7	39.8	39.5	38.3	37.8	37.6	38.4	38.8	39.8	37.6
H38 - a	32.8	35.4	36.1	36.1	35.6	33.5	30.6	30.4	36.1	30.4
K27 - a	39.5	39.1	38.6	37.8	36.9	36.8	38.4	39.1	39.5	36.8
L26 - a	39.1	38.8	38.1	36.8	35.6	36.3	37.6	38.5	39.1	35.6
M35 - b	36.7	36.6	37.5	38	39.3	39.2	38.8	37.3	39.3	36.6
M37 - a	29.3	30.5	33.2	34.9	35.3	35.1	34.1	31.6	35.3	29.3
N25 - a	37.7	37.2	35.8	34.1	33.2	34.6	36.3	37.3	37.7	33.2
N25 - b	37.8	37.2	35.9	34.2	33.3	34.7	36.4	37.4	37.8	33.3
O24 - a	35.9	35.5	34.3	32.5	30	31.4	33.6	35.1	35.9	30
O34 - a	36	36.2	37.2	38.1	38.7	38.6	38	37	38.7	36
O34 - b	35.9	36.1	37.2	38	38.6	38.5	37.8	36.9	38.6	35.9
P24 - a	36.4	36.1	35	33.4	31.5	32.3	34.3	35.7	36.4	31.5
P24 - b	37.6	37.4	36.5	35	33.4	34.1	35.6	36.8	37.6	33.4
P31 - a	36.5	36.9	37.8	38.7	39.2	39.2	38.2	37.3	39.2	36.5
P31 - c	36.7	36.9	37.6	38.7	39.3	39.1	38.3	37.5	39.3	36.7
P32 - a	35.7	36.2	36.9	37.9	38.2	38.6	38.3	37.5	38.6	35.7
Q30 – a	36.5	37.5	38.4	39.1	39.1	38.5	37.4	36.5	39.1	36.5
Q31 – a	34	35.1	36.2	37.1	37.3	36.6	35.2	34.1	37.3	34
Q31 – b	32.9	34.1	35.3	36.3	36.9	36.2	35	33.6	36.9	32.9
Q31 – c	32.3	33.7	34.9	35.9	36.4	35.6	34.4	33	36.4	32.3
Q31 – e	32.3	33.9	35.1	36	36.3	35.3	34	32.6	36.3	32.3
Q31 – f	32.2	33.6	34.9	35.9	36.3	35.5	34.2	32.8	36.3	32.2
Q31 – g	32.3	33.7	35	36	36.4	35.5	34.1	32.8	36.4	32.3
Q31 – h	32.3	33.9	35.2	36	36.4	35.5	34.1	32.7	36.4	32.3
Q31 – i	32.6	34	35.3	36.2	36.5	35.6	34.3	32.9	36.5	32.6
Q31 – j	32.5	34	35.3	36.2	36.5	35.5	34.2	32.8	36.5	32.5

ID	Predicted wind turbine noise level for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
Q31 – k	32.6	34.1	35.4	36.2	36.5	35.5	34.2	32.8	36.5	32.6
Q31 – l	32.6	34.1	35.4	36.2	36.5	35.5	34.2	32.8	36.5	32.6
Q31 – m	32.7	34.1	35.4	36.3	36.7	35.8	34.4	33.1	36.7	32.7
Q31 – o	34.2	35.5	36.8	37.5	37.7	36.7	35.4	34.2	37.7	34.2
Q31 – p	34.1	35.4	36.4	37.2	37.5	36.7	35.2	34.1	37.5	34.1
Q32 – a	32.3	32.9	34.1	35.4	36.3	35.9	34.9	33.6	36.3	32.3
Q32 – b	32.1	33	34.1	35.4	36.2	35.7	34.7	33.2	36.2	32.1
Q32 – c	31.9	32.7	34	35.2	36	35.5	34.5	33.1	36	31.9
Q32 – d	31.9	32.7	33.9	35.2	36	35.5	34.5	33.2	36	31.9
Q32 – e	31.4	32.7	34	35	35.7	35	33.7	32.3	35.7	31.4
Q32 – f	31.8	32.8	34.2	35.3	35.9	35.3	34.1	32.7	35.9	31.8
Q32 – g	31.9	33.3	34.6	35.6	36.1	35.3	33.9	32.5	36.1	31.9
R31 – aa	34.3	36	37.2	37.7	37.8	36.6	35.2	33.9	37.8	33.9
R31 – ab	34.7	36.4	37.4	38	38	37	35.6	34.5	38	34.5
R31 – ad	35.6	37.3	38.3	38.8	38.6	37.7	36.3	35.2	38.8	35.2
R31 – ae	34.9	36.6	37.6	38.2	38.1	37.1	35.7	34.6	38.2	34.6
R31 – af	34.8	36.5	37.5	38.1	38	37	35.7	34.5	38.1	34.5
R31 – ai	35.3	36.5	37.6	38.2	38.3	37.3	36	34.9	38.3	34.9
R31 – aj	34.5	36.1	37.2	37.8	37.9	36.9	35.6	34.3	37.9	34.3
R31 – ak	34.5	36.2	37.2	37.9	37.9	36.9	35.5	34.3	37.9	34.3
R31 – al	34.3	35.9	37	37.7	37.8	36.8	35.4	34.1	37.8	34.1
R31 – am	34	35.6	36.7	37.4	37.5	36.5	35	33.8	37.5	33.8
R31 – an	33.8	35.4	36.5	37.2	37.4	36.4	34.9	33.6	37.4	33.6
R31 – ao	33.6	35.1	36.3	37.1	37.2	36.3	34.9	33.6	37.2	33.6
R31 – ap	34.7	36.5	37.4	38	37.9	36.9	35.6	34.4	38	34.4
R31 – aq	34.4	36	37.3	37.8	37.8	36.8	35.4	34.1	37.8	34.1
R31 – ar	34.5	36.3	37.3	37.9	37.8	36.8	35.4	34.2	37.9	34.2
R31 – as	34.2	36	37.1	37.7	37.7	36.6	35.2	34	37.7	34
R31 – at	34.3	36.1	37.2	37.8	37.8	36.7	35.3	34	37.8	34
R31 – av	34.1	35.9	37	37.6	37.6	36.5	35.1	33.9	37.6	33.9

ID	Predicted wind turbine noise level for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
R31 – aw	34	35.8	36.9	37.5	37.5	36.5	35.1	33.8	37.5	33.8
R31 – ax	34.1	35.8	36.9	37.5	37.6	36.6	35.2	33.9	37.6	33.9
R31 – az	34.1	35.8	37	37.6	37.7	36.5	35.1	33.7	37.7	33.7
R31 – b	34.6	36.3	37.4	37.9	38	36.7	35.3	34.1	38	34.1
R31 – ba	34.6	36.2	37.4	37.9	38	36.8	35.3	34.1	38	34.1
R31 – bb	33.6	35.4	36.5	37.2	37.3	36.3	34.8	33.5	37.3	33.5
R31 – bc	33.7	35.4	36.5	37.2	37.3	36.3	34.9	33.6	37.3	33.6
R31 – bd	33.8	35.5	36.6	37.2	37.4	36.4	34.9	33.6	37.4	33.6
R31 – be	36.3	37.6	38.6	39.1	39	37.8	36.5	35.6	39.1	35.6
R31 - bf	32.3	34	35.2	36	36.4	35.4	33.9	32.5	36.4	32.3
R31 - c	33.4	35	36.2	36.9	37.1	36.2	34.7	33.4	37.1	33.4
R31 - d	34.5	36.3	37.3	37.9	38	36.8	35.3	34	38	34
R31 - f	33.8	35.3	36.4	37.2	37.4	36.4	35	33.7	37.4	33.7
R31 - g	33.9	35.6	36.7	37.4	37.5	36.5	35.1	33.8	37.5	33.8
R31 - h	33.8	35.5	36.6	37.3	37.4	36.4	35	33.7	37.4	33.7
R31 - j	33.6	35.3	36.6	37.2	37.2	36.2	34.8	33.5	37.2	33.5
R31 - k	33.5	35.2	36.5	37.1	37.2	36.2	34.8	33.5	37.2	33.5
R31 - n	33.4	35.2	36.3	36.9	37	36.1	34.7	33.4	37	33.4
R31 - q	31.8	33.6	34.9	35.7	36.2	35.1	33.6	32.2	36.2	31.8
R31 - r	33.2	34.7	35.9	36.7	36.9	36.1	34.7	33.3	36.9	33.2
R31 - s	33.2	34.8	35.9	36.7	36.9	36	34.6	33.2	36.9	33.2
R31 - t	33.2	34.9	36	36.8	36.9	36	34.6	33.2	36.9	33.2
R31 - u	33.3	35	36.1	36.9	37	36.1	34.6	33.2	37	33.2
R31 - v	33.4	35.1	36.2	36.9	37	36.1	34.6	33.3	37	33.3
R31 - w	33.4	35.1	36.3	36.9	37.1	36.1	34.6	33.3	37.1	33.3
R31 – z	33.7	35.4	36.5	37.2	37.3	36.3	34.9	33.6	37.3	33.6
R32 – a	31	32.7	34.1	35	35.5	34.7	33.2	31.6	35.5	31
R32 – b	31.4	33.3	34.6	35.4	35.9	34.9	33.3	31.8	35.9	31.4
R32 – c	31.6	33.5	34.8	35.6	36	35.1	33.5	32	36	31.6
R32 – d	31.7	33.6	34.8	35.7	36.1	35.1	33.6	32.1	36.1	31.7

ID	Predicted wind turbine noise level for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
R32 – e	30.6	32.8	34.3	35	35.4	34.4	32.6	30.9	35.4	30.6
T32 – b	30.1	32	34.4	35.3	35.6	35.1	33.4	31	35.6	30.1
U18 – a	37.2	37.1	36.9	34.8	34.5	34.7	35.8	36.2	37.2	34.5
U18 – b	37.3	37.2	36.9	35.8	34	32.9	34.2	35.7	37.3	32.9
U18 – c	37	36.9	36.6	35.5	33.7	32.6	34	35.5	37	32.6
U31 – a	30.1	32	34.4	35.3	35.6	35.1	33.4	31	35.6	30.1
V30 – a	34.5	34.4	35.8	37.5	38.6	38.4	37.8	36.5	38.6	34.4
W17 – a	38	36.9	36	35.5	36.3	37.4	38.3	38.4	38.4	35.5
W27 - i	36.6	37	38.1	39.1	39.8	39.3	38.5	37.4	39.8	36.6
W28 – a	35.8	36.4	37.6	38.5	39.4	38.8	37.9	36.9	39.4	35.8
X18 – a	37.8	36.8	36.8	36.9	37.2	37.8	38.5	38.5	38.5	36.8
Y28 – a	30.8	32.1	34.4	35.8	36.3	36.1	34.7	32.7	36.3	30.8
Y28 – b	29.4	30.6	33	34.6	35.2	34.9	33.7	31.6	35.2	29.4
Z28 – a	30	31.1	33.7	35.3	35.8	35.5	34.3	32.4	35.8	30
AA27 – a	30.6	31.3	34	35.7	36.3	36.1	35.1	33	36.3	30.6
AA27 – b	30.3	31.5	33.8	35.4	36.1	35.8	34.7	32.5	36.1	30.3
AC22 – a	35.5	34.5	33.3	34.8	35.8	36.6	35.6	36.1	36.6	33.3

From Table 16, the highest predicted noise level at any noise-sensitive location and for any wind direction sector is 39.8 dB L_{A90} at W27 - i for a SSW wind, a marginal decease on the 40.0 dB predicted when assuming the location is simultaneously downwind of all WTGs. Under other wind directions, the predicted noise levels at this location decrease by up to 3.2 dB.

The predictions also show a change in noise levels with wind direction for all locations. This change in noise levels with wind direction depends on the layout of the Project around each noise sensitive location but is typically in the range of 3 – 4 dB, increasing up to a maximum of 6.8 dB.

5.4 Special audible characteristics

Consistent with the EES, this assessment has been carried out on the assumption that wind turbine noise at noise-sensitive locations will not be subject to any penalties for special audible characteristics.

No specific information is available from the manufacturers regarding special audible characteristics for either candidate WTG at this time but, based on previous experience and consistent with the EES, it is considered appropriate to conduct this assessment on the basis that no penalty applies.

Special audible characteristics will be assessed at the operational stage of the wind farm. The Planning Permit includes a number of conditions relating to the assessment of special audible characteristics at the commencement of operation of the wind farm.

5.5 Summary

As detailed above, the 215 WTG layout with the two candidate WTGs with larger rotor diameters is capable of achieving compliance with the Permit conditions relating to wind turbine noise emissions from the site.

The change in layout and WTG selection has resulted in marginal predicted changes in noise levels at noise sensitive locations. For the majority of locations, these changes are not generally expected to result in a perceptible increase in noise level from the site. A small number of locations may experience a just perceptible increase in wind turbine noise levels with the candidate GE 6.0-164 WTG, but the predicted levels remain compliant with the applicable Planning Permit requirements and represent a minimal change in impact.

6 Ancillary infrastructure noise

The proposed amendment to the Planning Permit is related to the WTGs and not to noise-generating ancillary infrastructure. Therefore, it is not expected that the change to WTG rotor diameter will alter noise levels associated with ancillary infrastructure when compared to the previously permitted WTG specifications.

Ancillary infrastructure associated with the Project will involve:

- a terminal station at Geggies Road (Cressy Terminal Station)
- collector stations at Gilletts Road (Golden Plains Central Collector), Boyles Road (Golden Plains Western Collector) and Bells Road (Golden Plains Eastern Collector).

Designs for these stations are still being finalised with transformer ratings summarised in Table 17. For the purposes of this assessment, the sound power level per transformer has been based on Australian Standard / New Zealand Standard AS/NZS 60076.10:2009 *Power transformers: Determination of sound levels*.

Table 17 Assumed ancillary infrastructure sound power levels

Site	Transformer rating	Sound power level per transformer
Cressy Terminal Station (Geggies Road)	2 x 850 MVA	107
Golden Plains Central Collector (Gilletts Road)	2 x 220 MVA	99
Golden Plains Western Collector (Boyles Road)	2 x 220 MVA	99
Golden Plains Eastern Collector (Bells Road)	2 x 300 MVA	101

Noise levels for ancillary infrastructure have been predicted using the developed noise model and the ISO 9613-2 prediction algorithm, incorporating a potential +2 dB tonality penalty for transformer noise. The predicted noise levels for the nearest noise-sensitive location to each ancillary site is shown in Table 10.

Table 18 Predicted noise levels from ancillary infrastructure

Site	Nearest noise-sensitive location	Predicted noise level, dB $L_{Aeq,30min}$	Noise limit, dB $L_{Aeq,30min}$
Cressy Terminal Station (Geggies Road)	R20 – a	31	34
Golden Plains Central Collector (Gilletts Road)	P31 – a	19	34
Golden Plains Western Collector (Boyles Road)	H32 – a	19	34
Golden Plains Eastern Collector (Bells Road)	W28 – a	19	34

It can be seen that the predicted noise levels achieve compliance with the most stringent NIRV night-time noise limit of 34 dB $L_{Aeq,30min}$, indicating that the 215 WTG layout is considered capable of achieving compliance with the Permit requirements with respect to ancillary infrastructure noise.

With respect to the EES assessment, the EES predicted ancillary infrastructure noise levels at R20 – a and H32 – a as 32 dB and 22 dB respectively, indicating that the proposed amendment is not expected to result in any increase in ancillary infrastructure noise.

7 Construction noise and vibration

Noise and vibration from the construction of the Project will need to be managed through:

- the development and implementation of a Construction Noise and Vibration Management Plan as per the Planning Permit requirements
- scheduling work to normal working hours where feasible
- managing out of hours works such that the impact of any unavoidable works is managed to be low impact, where feasible
- implementing appropriate community consultation measures.

With application of the above, in accordance with the Permit, it is anticipated that construction noise and vibration associated with the Project will be able to be acceptably managed.

The proposed 215 WTG layout sits within the nominated site boundary of the Project and, while there have been changes associated with turbine positions, the typical setback distance from noise-sensitive land uses has remained consistent between the EES layout and the 215 WTG layout. The proposed amendment to alter the WTG rotor diameter is also not expected to noticeably alter noise or vibration associated with construction works. A similar methodology, including similar plant and equipment, to that envisaged and assessed as part of the EES will be required to construct the Project.

Therefore, it is not expected that the change in layout or WTG specification will result in marked changes in construction noise and vibration levels at noise-sensitive land uses relative to the EES.

8 Conclusion

An assessment has been undertaken of the potential noise and vibration arising from the 215 WTG layout developed for the Project including consideration of WTGs with larger rotor diameters. The assessment has considered operational wind turbine noise and ancillary infrastructure noise, as well as construction phase noise and vibration against the relevant noise-related conditions of the Planning Permit.

Based on the 215 WTG layout with two candidate WTGs with larger rotor diameters, it is concluded that:

- Operational wind turbine noise from the 215 WTG with an increase rotor diameter of 165m is expected to achieve compliance with the applicable noise limits under the Permit, including the high amenity limit when applied to the Rokewood Township Zone and LDRZ.
- Ancillary infrastructure noise is expected to achieve compliance with the applicable NIRV limits.
- Construction noise and vibration is expected to be able to be managed to an acceptable level through adherence to the relevant Planning Permit condition for development of a Construction Noise and Vibration Management Plan.

When compared to the EES assessment, the predicted noise levels are not generally expected to result in any noticeable increase in operational wind turbine noise or ancillary infrastructure noise. A small number of locations may experience a just perceptible increase in wind turbine noise levels with the candidate GE 6.0-164 WTG, but the predicted levels remain compliant with the applicable Planning Permit requirements.

Appendix A—215 WTG layout coordinates

Table A1 215 WTG layout coordinates as WGS UTM Zone 54S

WTG ID	Easting	Northing	WTG ID	Easting	Northing
WTG001	728573	5804228	WTG032	731538	5802015
WTG002	729140	5804624	WTG033	731523	5805139
WTG003	729152	5803805	WTG034	731717	5800352
WTG004	729142	5805578	WTG035	731872	5799816
WTG005	729594	5805022	WTG036	731314	5804302
WTG006	729668	5804423	WTG037	731984	5798751
WTG007	729652	5803732	WTG038	732105	5799295
WTG008	729618	5806018	WTG039	732107	5803861
WTG009	729911	5805438	WTG040	732173	5801533
WTG010	730055	5802579	WTG041	732409	5806935
WTG011	729925	5806482	WTG042	732159	5805035
WTG012	730448	5806215	WTG043	732277	5806250
WTG013	730506	5803989	WTG044	732197	5804374
WTG014	730077	5801901	WTG045	732500	5798741
WTG015	730359	5804681	WTG046	732605	5799354
WTG016	730502	5805215	WTG047	733749	5801235
WTG017	730548	5807366	WTG048	732691	5799867
WTG018	730227	5806921	WTG049	732715	5805712
WTG019	730950	5803214	WTG050	732780	5806458
WTG020	731233	5803689	WTG051	732884	5805071
WTG021	730944	5801750	WTG052	732905	5804118
WTG022	730735	5802458	WTG053	733119	5799424
WTG023	731107	5805954	WTG054	733165	5806059
WTG024	731049	5804994	WTG056	733331	5800134
WTG025	731284	5800681	WTG057	733369	5804438
WTG026	731276	5800095	WTG058	733407	5798787
WTG027	731265	5806450	WTG059	733574	5800651
WTG028	730292	5803485	WTG060	733482	5805112
WTG029	731431	5801260	WTG061	733670	5805626
WTG030	731421	5807220	WTG062	734178	5801578
WTG031	731437	5799551	WTG064	734005	5804301

WTG ID	Easting	Northing	WTG ID	Easting	Northing
WTG065	734011	5799324	WTG098	737585	5798434
WTG066	734098	5803605	WTG099	737621	5799682
WTG067	734232	5797856	WTG100	737812	5797380
WTG068	734605	5801928	WTG101	738035	5796813
WTG069	734357	5800123	WTG102	738181	5797741
WTG070	736324	5803127	WTG103	738179	5798983
WTG071	734478	5800796	WTG104	738345	5796341
WTG072	734569	5799380	WTG105	738480	5798374
WTG073	734579	5797024	WTG106	738571	5796958
WTG074	734601	5803406	WTG107	738607	5799257
WTG075	734752	5797609	WTG108	738928	5795373
WTG076	735064	5797151	WTG109	739018	5794481
WTG077	735083	5800173	WTG110	739250	5799325
WTG078	735151	5803475	WTG111	739173	5795948
WTG079	735367	5801566	WTG112	739197	5798745
WTG080	735428	5800989	WTG113	739628	5794893
WTG081	735571	5797531	WTG114	739777	5799925
WTG082	735612	5803684	WTG115	739873	5796901
WTG083	735771	5799337	WTG116	740004	5799325
WTG084	735792	5802171	WTG117	740015	5794428
WTG085	735795	5800004	WTG118	740094	5798140
WTG086	735900	5798769	WTG119	740093	5797433
WTG087	735911	5797893	WTG120	740250	5800102
WTG088	735913	5802745	WTG121	740323	5798812
WTG089	736156	5801512	WTG122	740703	5800557
WTG090	736275	5797142	WTG123	740592	5793835
WTG091	736303	5799811	WTG124	740625	5794588
WTG092	736952	5798397	WTG125	740438	5795137
WTG093	736703	5799033	WTG126	740703	5796599
WTG094	736796	5799967	WTG127	740814	5799874
WTG095	736603	5797799	WTG128	740860	5793194
WTG096	737421	5796918	WTG129	741214	5800761
WTG097	737531	5799092	WTG130	741014	5799230

WTG ID	Easting	Northing	WTG ID	Easting	Northing
WTG131	741151	5794143	WTG164	743563	5797329
WTG132	741234	5796295	WTG165	743691	5789488
WTG133	741318	5800150	WTG166	743718	5796079
WTG134	741373	5795737	WTG167	743863	5794699
WTG135	741556	5798769	WTG168	744038	5789006
WTG136	741668	5796990	WTG169	743910	5788436
WTG137	741692	5799663	WTG170	744031	5796684
WTG138	741763	5800628	WTG171	744177	5789614
WTG139	741890	5794055	WTG172	744249	5792765
WTG140	741892	5792921	WTG173	744252	5793336
WTG141	741580	5793465	WTG174	744634	5788942
WTG142	742024	5798974	WTG175	744673	5789513
WTG143	742048	5796289	WTG176	744609	5796010
WTG144	742263	5794778	WTG177	744611	5793750
WTG145	742384	5796988	WTG178	744769	5792707
WTG146	742430	5794137	WTG179	745084	5789201
WTG147	742531	5798242	WTG180	745191	5794463
WTG148	742537	5792850	WTG181	745106	5796496
WTG149	742553	5798872	WTG182	745286	5793646
WTG150	742752	5797444	WTG183	745299	5792734
WTG151	742717	5795499	WTG184	745556	5795088
WTG152	742978	5794887	WTG185	745601	5795990
WTG153	743030	5792791	WTG186	745752	5796849
WTG154	743032	5796204	WTG187	745890	5795480
WTG155	743070	5793467	WTG188	745897	5794461
WTG156	743162	5796841	WTG189	745921	5792760
WTG157	743091	5798428	WTG190	746052	5793622
WTG158	743343	5789093	WTG191	746059	5796243
WTG159	743374	5795450	WTG192	746315	5796726
WTG160	743386	5794099	WTG193	746435	5793018
WTG161	743290	5797844	WTG194	746949	5794811
WTG162	743397	5788550	WTG195	746665	5793576
WTG163	743538	5792731	WTG196	747046	5795768

WTG ID	Easting	Northing	WTG ID	Easting	Northing
WTG197	747208	5792803	WTG208	748481	5795331
WTG198	747038	5794081	WTG209	748611	5794145
WTG199	747584	5794858	WTG210	748732	5794771
WTG200	747420	5793402	WTG211	748857	5793608
WTG201	747626	5794063	WTG212	749161	5795217
WTG202	747814	5792850	WTG213	749222	5794664
WTG203	747638	5795478	WTG214	749238	5794071
WTG204	748114	5794900	WTG215	750170	5790441
WTG205	748108	5794213	WTG216	750659	5790531
WTG206	747996	5793519	WTG217	750618	5791156
WTG207	748288	5793036			

Appendix B—EES WTG coordinates

Table B1 EES WTG coordinates as WGS UTM Zone 54S

WTG ID	Easting	Northing	WTG ID	Easting	Northing
GP001	728745	5804263	GP032	732188	5801309
GP002	729152	5804867	GP033	732402	5799963
GP003	729492	5805489	GP034	732398	5804499
GP004	729599	5803943	GP035	732516	5805242
GP005	729817	5806040	GP036	732575	5801854
GP006	730020	5802627	GP037	732621	5806706
GP007	729919	5804507	GP038	732774	5798972
GP008	730152	5806596	GP039	732741	5803525
GP009	730232	5805071	GP040	732848	5805799
GP010	730405	5801929	GP041	733104	5804147
GP011	730518	5807148	GP042	733215	5799528
GP012	730551	5803771	GP043	733477	5804714
GP013	730624	5805602	GP044	733452	5801627
GP014	730797	5802482	GP045	733557	5800081
GP015	730966	5806155	GP046	733634	5798856
GP016	731034	5804255	GP047	733695	5805610
GP017	731035	5803054	GP048	733794	5802180
GP018	731171	5799657	GP049	733899	5800634
GP019	731235	5804877	GP050	733925	5804072
GP020	731308	5806708	GP051	734167	5799355
GP021	731349	5800323	GP052	734241	5801187
GP022	731402	5801412	GP053	734309	5802544
GP023	731456	5803566	GP054	734375	5797973
GP024	731540	5802103	GP055	734454	5803286
GP025	731816	5800764	GP056	734569	5799902
GP026	731854	5802614	GP057	734583	5801739
GP027	732013	5803970	GP058	734588	5797015
GP028	732033	5798656	GP059	734702	5798560
GP029	732069	5799418	GP060	734805	5800492
GP030	732175	5803152	GP061	735063	5799055
GP031	732217	5806046	GP062	735116	5801080

WTG ID	Easting	Northing	WTG ID	Easting	Northing
GP063	735141	5797594	GP098	739681	5796300
GP064	735327	5799686	GP099	739712	5799954
GP065	735423	5801653	GP100	739709	5792922
GP066	735611	5803646	GP101	739862	5794718
GP067	735740	5802224	GP102	739805	5798585
GP068	735861	5797542	GP103	740035	5796851
GP069	735911	5802907	GP104	740040	5793400
GP070	736112	5798840	GP105	740127	5795306
GP071	736258	5799505	GP106	740279	5798970
GP072	736191	5801467	GP107	740318	5800401
GP073	736218	5797111	GP108	740116	5797470
GP074	736538	5797621	GP109	740443	5794013
GP075	736603	5800053	GP110	740759	5799502
GP076	736662	5798211	GP111	740470	5795859
GP077	737026	5798778	GP112	740518	5792815
GP079	737438	5799339	GP113	740736	5794580
GP080	737583	5797617	GP114	740812	5796411
GP081	737685	5798324	GP115	740942	5800729
GP082	737747	5799907	GP116	740963	5800075
GP083	738008	5796986	GP117	740984	5793280
GP084	738262	5798675	GP119	741269	5792022
GP085	738343	5797555	GP120	741326	5793833
GP086	738392	5799331	GP121	741392	5799063
GP087	738815	5799798	GP122	741384	5795693
GP088	738868	5793063	GP123	741496	5797517
GP090	738940	5795207	GP124	741611	5792574
GP091	739028	5798660	GP125	741629	5791346
GP092	739101	5793648	GP126	741668	5794385
GP093	739239	5795766	GP127	741725	5799647
GP094	739369	5797339	GP128	741765	5800373
GP095	739434	5799148	GP129	741839	5798069
GP096	739471	5794196	GP130	742011	5794938
GP097	739643	5797986	GP131	742105	5796790

WTG ID	Easting	Northing	WTG ID	Easting	Northing
GP132	742170	5793018	GP165	744036	5788660
GP133	742219	5791848	GP166	744168	5793257
GP134	742221	5798598	GP167	744408	5795860
GP135	742272	5793749	GP168	744640	5793725
GP136	742447	5797343	GP169	744732	5788886
GP137	742456	5790495	GP170	744828	5792537
GP138	742476	5795651	GP171	744898	5794322
GP139	742514	5791145	GP172	744931	5790691
GP140	742563	5799069	GP173	745034	5789473
GP141	742652	5792345	GP174	745087	5796204
GP142	742611	5794238	GP175	745140	5793148
GP143	742794	5797821	GP176	745317	5790096
GP144	742819	5796203	GP177	745366	5791168
GP145	742980	5794784	GP178	745386	5791809
GP146	743054	5789651	GP179	745471	5796712
GP147	743070	5792906	GP180	745491	5793710
GP148	743109	5793529	GP181	745538	5795467
GP149	743132	5798448	GP182	745808	5792510
GP150	743114	5791598	GP183	745881	5796019
GP151	743157	5796776	GP184	745841	5790514
GP152	743254	5790767	GP185	745896	5794209
GP153	743330	5795389	GP186	746137	5792994
GP154	743359	5788564	GP187	746058	5794855
GP155	743428	5794152	GP188	746355	5788240
GP156	743474	5799000	GP189	746316	5796735
GP157	743483	5792152	GP190	746489	5795504
GP158	743547	5797371	GP191	746484	5793520
GP159	743606	5789228	GP192	746739	5792260
GP160	743647	5795972	GP193	746759	5788881
GP161	743931	5794610	GP194	746844	5794030
GP162	744025	5795365	GP195	746862	5795919
GP163	744061	5796612	GP196	746957	5792809
GP164	744105	5789657	GP197	747128	5794640

WTG ID	Easting	Northing	WTG ID	Easting	Northing
GP198	745453	5788777	GP214	748633	5793690
GP199	746877	5789470	GP215	748729	5791106
GP200	747259	5791481	GP216	748766	5790513
GP201	747394	5793361	GP217	748912	5792346
GP202	747509	5795164	GP218	748981	5794225
GP203	747617	5792088	GP219	746286	5789895
GP204	747470	5789486	GP220	749410	5794787
GP205	747711	5793893	GP221	749415	5791518
GP206	747936	5792606	GP222	749391	5790590
GP207	745964	5789142	GP223	738366	5796442
GP208	748052	5791084	GP224	749775	5795280
GP209	748079	5794466	GP225	749878	5795889
GP210	748261	5793145	GP226	749940	5794002
GP211	747366	5788903	GP227	750057	5790834
GP212	748391	5795006	GP228	750283	5794555
GP213	748569	5791793	GP229	750622	5791159

Appendix C—Noise-sensitive locations

Table C1 Noise-sensitive locations as WGS UTM Zone 54S

ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m	ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m
C34 - a	724514	5804849	WTG001	4106	R31 - b	739619	5801552	WTG122	1472
C39 - a	724648	5809914	WTG004	6245	R31 - ba	739575	5801533	WTG122	1492
D30 - a	725715	5800178	WTG014	4690	R31 - bb	739227	5801576	WTG114	1740
D34 - a	725213	5804482	WTG001	3369	R31 - bc	739220	5801563	WTG114	1730
D35 - a	725951	5805306	WTG001	2835	R31 - bd	739214	5801548	WTG114	1718
D40 - a	725263	5810425	WTG018	6076	R31 - be	739427	5801190	WTG114	1312
E26 - a	726653	5796182	WTG031	5851	R31 - c	739104	5801611	WTG114	1815
E41 - a	726239	5811717	WTG017	6124	R31 - d	739706	5801597	WTG122	1441
E41 - b	726953	5811919	WTG017	5801	R31 - f	739045	5801510	WTG114	1746
F25 - a	727915	5795066	WTG037	5489	R31 - g	739245	5801523	WTG114	1684
F27 - a	727045	5797104	WTG031	5028	R31 - h	739254	5801555	WTG114	1712
F27 - b	727035	5797848	WTG031	4720	R31 - j	739397	5801638	WTG122	1696
F32 - a	727015	5802349	WTG001	2441	R31 - k	739370	5801644	WTG122	1720
F35 - a	727236	5805534	WTG001	1869	R31 - n	739324	5801676	WTG122	1776
G24 - a	728958	5794082	WTG037	5563	R31 - q	739009	5801990	WTG114	2203
G25 - a	728917	5795521	WTG037	4454	R31 - r	739050	5801658	WTG114	1879
G26 - a	728798	5796662	WTG037	3809	R31 - s	739122	5801682	WTG114	1875
G30 - a	728994	5800930	WTG014	1455	R31 - t	739160	5801671	WTG114	1852
G41 - a	728654	5811474	WTG017	4524	R31 - u	739179	5801657	WTG114	1832
H26 - a	729853	5796352	WTG037	3208	R31 - v	739202	5801649	WTG114	1817
H28 - a	729859	5798327	WTG031	1997	R31 - w	739214	5801639	WTG114	1804
H30 - a	729369	5800291	WTG014	1759	R31 - z	739198	5801563	WTG114	1737
H32 - a	729073	5802087	WTG014	1021	R32 - a	739051	5802266	WTG122	2377
H38 - a	729116	5808096	WTG017	1608	R32 - b	739072	5802112	WTG122	2254
H38 - b	729285	5808898	WTG017	1986	R32 - c	739059	5802044	WTG122	2217
H42 - a	729246	5812439	WTG017	5237	R32 - d	739014	5802017	WTG114	2227
H42 - b	729216	5812512	WTG017	5316	R32 - e	739971	5802442	WTG122	2023
H42 - c	729261	5812572	WTG017	5363	R33 - a	739269	5803149	WTG070	2945
I25 - a	730587	5795201	WTG037	3815	R35 - a	739771	5805479	WTG070	4173

ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m	ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m
I26 - a	730060	5796521	WTG037	2945	R35 - b	739797	5805327	WTG070	4111
I39 - a	730161	5809849	WTG017	2513	R35 - c	739707	5805101	WTG070	3916
I42 - a	730581	5812125	WTG017	4759	R36 - a	739722	5806917	WTG070	5090
J40 - a	731984	5810738	WTG030	3563	R36 - b	739771	5806233	WTG070	4640
K24 - a	732676	5794142	WTG073	3454	S34 - c	740671	5804894	WTG129	4168
K27 - a	732346	5797615	WTG045	1137	S34 - d	740838	5804820	WTG129	4076
K40 - a	732690	5810959	WTG030	3949	S34 - e	740883	5804807	WTG129	4059
K40 - b	732574	5810772	WTG030	3735	S34 - g	740919	5804616	WTG129	3866
K40 - c	732676	5810695	WTG030	3695	S34 - i	740768	5804172	WTG129	3440
K40 - e	732759	5810654	WTG030	3686	S34 - j	740787	5804269	WTG129	3534
K40 - f	732661	5810587	WTG030	3588	S34 - k	740954	5804229	WTG129	3478
K40 - g	732821	5810395	WTG030	3470	S34 - l	740894	5804398	WTG129	3651
K40 - h	732782	5810310	WTG030	3377	S34 - m	740886	5804419	WTG129	3673
K40 - i	732828	5810170	WTG041	3262	S34 - n	740824	5804362	WTG129	3622
K40 - j	732802	5810450	WTG030	3513	S34 - o	740817	5804414	WTG129	3674
L20 - a	733543	5790142	WTG073	6960	S34 - q	740821	5804470	WTG129	3730
L20 - b	733358	5790199	WTG073	6933	S34 - r	740846	5804562	WTG129	3819
L22 - a	733912	5792144	WTG073	4926	S35 - a	740895	5805218	WTG129	4468
L25 - a	733029	5795769	WTG073	1994	S36 - a	740874	5806753	WTG070	5818
L26 - a	733373	5796960	WTG073	1207	S37 - a	740607	5807115	WTG070	5852
L38 - a	733936	5808242	WTG041	2010	S38 - a	740176	5808074	WTG070	6269
L38 - b	733229	5808692	WTG041	1939	T17 - a	741311	5787868	WTG162	2194
L39 - a	733258	5809770	WTG041	2959	T17 - b	741231	5787929	WTG162	2253
L39 - b	733422	5809554	WTG041	2808	T32 - a	741562	5802587	WTG129	1859
L39 - c	733411	5809378	WTG041	2640	T32 - b	741355	5802435	WTG129	1680
L39 - d	733548	5809456	WTG041	2766	T33 - a	741776	5803862	WTG129	3151
L39 - e	733978	5809056	WTG041	2638	T34 - a	741032	5804895	WTG129	4138
L39 - f	733930	5809110	WTG041	2654	T34 - b	741298	5804934	WTG129	4174
L39 - g	733726	5809840	WTG041	3189	T34 - c	741435	5804931	WTG129	4176
L40 - a	733311	5810232	WTG041	3418	T34 - d	741637	5804869	WTG129	4130
M17 - a	734120	5787323	WTG109	8674	T34 - e	741729	5804906	WTG129	4177

ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m	ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m
M24 - a	734445	5794808	WTG073	2220	T34 - f	741404	5804700	WTG129	3943
M24 - b	734394	5794808	WTG073	2224	T34 - g	741315	5804611	WTG129	3851
M35 - b	734679	5805841	WTG061	1031	T34 - h	741242	5804563	WTG129	3802
M37 - a	734049	5807888	WTG041	1897	T34 - i	741182	5804575	WTG129	3814
M37 - b	734617	5807932	WTG050	2355	T34 - j	741106	5804588	WTG129	3828
M37 - c	734822	5807599	WTG054	2262	T34 - l	741350	5804026	WTG129	3268
M37 - d	734842	5807361	WTG061	2093	T34 - m	741073	5804323	WTG129	3565
M38 - a	734342	5808410	WTG041	2431	T34 - n	741100	5804392	WTG129	3633
M39 - a	734929	5809208	WTG041	3393	T34 - p	741024	5804361	WTG129	3605
M39 - b	734991	5809140	WTG041	3395	T34 - q	741243	5804619	WTG129	3858
N17 - a	735738	5787563	WTG128	7612	T35 - a	741170	5805704	WTG129	4943
N20 - a	735634	5790906	WTG109	4923	T35 - b	741568	5805000	WTG129	4254
N25 - a	735734	5795678	WTG090	1561	T35 - c	741880	5805076	WTG129	4366
N25 - b	735596	5795705	WTG076	1540	T35 - d	741849	5805068	WTG129	4353
N36 - a	735394	5806857	WTG061	2118	U18 - a	742345	5788139	WTG162	1129
N36 - b	735629	5806537	WTG061	2160	U18 - b	742149	5788761	WTG158	1240
N36 - c	735753	5806766	WTG061	2374	U18 - c	742105	5788742	WTG158	1287
N37 - a	735309	5807414	WTG061	2425	U31 - a	742715	5801859	WTG138	1557
N38 - a	735501	5808650	WTG054	3488	U32 - a	742962	5802812	WTG138	2492
N38 - b	735395	5808578	WTG054	3364	U33 - a	742057	5803828	WTG129	3181
N38 - c	735511	5808490	WTG054	3378	U36 - a	742553	5806253	WTG129	5653
N38 - d	735540	5808339	WTG054	3292	V30 - a	743058	5800426	WTG138	1311
N38 - e	735638	5808055	WTG061	3126	V32 - a	743040	5802814	WTG138	2532
N38 - f	735574	5808036	WTG061	3071	V33 - a	743234	5803497	WTG138	3225
O24 - a	736740	5794684	WTG109	2288	V34 - a	743279	5804830	WTG138	4467
O34 - a	736250	5804496	WTG082	1032	V34 - b	743416	5804817	WTG138	4504
O34 - b	736302	5804484	WTG082	1056	W17 - a	744971	5787817	WTG174	1175
P20 - a	737916	5790852	WTG128	3762	W28 - a	744889	5798050	WTG186	1479
P24 - a	737032	5794683	WTG109	1997	X11 - a	745457	5781937	WTG169	6681
P24 - b	737293	5794965	WTG108	1685	X11 - b	745593	5781347	WTG169	7286
P31 - a	737563	5801100	WTG094	1369	X18 - a	745581	5788298	WTG179	1030

ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m	ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m
P31 - c	737462	5801204	WTG089	1342	Y13 - a	746084	5783324	WTG169	5555
P39 - a	737692	5809316	WTG061	5458	Y28 - a	746420	5798391	WTG192	1668
P39 - b	737755	5809223	WTG061	5442	Y28 - b	746653	5798644	WTG192	1947
Q12 - a	738643	5782652	WTG162	7575	Y33 - a	746112	5803965	WTG138	5482
Q12 - b	738684	5782617	WTG162	7577	Y33 - b	746004	5803874	WTG138	5341
Q12 - c	738234	5782821	WTG162	7712	Z28 - a	747222	5798153	WTG192	1691
Q12 - d	738323	5782776	WTG162	7686	AA18 - a	748183	5788086	WTG215	3082
Q17 - a	738008	5787022	WTG162	5601	AA27 - a	748944	5797036	WTG208	1767
Q30 - a	738605	5800832	WTG114	1482	AA27 - b	748226	5797449	WTG192	2043
Q31 - a	738592	5801449	WTG114	1930	AB12 - a	749986	5782516	WTG215	7927
Q31 - b	738434	5801699	WTG099	2174	AB18 - a	749623	5788015	WTG215	2487
Q31 - c	738632	5801871	WTG114	2258	AC12 - b	750195	5782943	WTG215	7498
Q31 - e	738967	5801890	WTG114	2125	AC17 - a	750863	5787865	WTG215	2668
Q31 - f	738733	5801881	WTG114	2217	AC18 - a	750884	5788946	WTG216	1601
Q31 - g	738785	5801858	WTG114	2173	AC22 - a	750874	5792218	WTG217	1092
Q31 - h	738828	5801838	WTG114	2135	AD23 - a	751141	5793676	WTG214	1944
Q31 - i	738852	5801805	WTG114	2095	AD25 - a	751723	5795944	WTG212	2663
Q31 - j	738886	5801813	WTG114	2088	AD27 - a	751435	5797880	WTG212	3502
Q31 - k	738901	5801800	WTG114	2069	AD27 - b	751807	5797990	WTG212	3833
Q31 - l	738922	5801794	WTG114	2055	AD27 - c	751647	5797700	WTG212	3514
Q31 - m	738791	5801735	WTG114	2061	AD27 - d	751648	5797808	WTG212	3591
Q31 - o	738965	5801387	WTG114	1672	AD32 - a	751272	5802759	WTG192	7808
Q31 - p	738734	5801410	WTG114	1815	AE12 - a	752078	5782840	WTG216	7821
Q32 - a	738225	5802138	WTG070	2143	AE13 - b	752427	5783020	WTG216	7716
Q32 - b	738341	5802115	WTG070	2257	AE18 - a	752191	5788243	WTG216	2754
Q32 - c	738402	5802176	WTG070	2285	AE25 - a	752600	5795678	WTG212	3469
Q32 - d	738354	5802214	WTG070	2226	AF18 - a	753758	5788117	WTG216	3928
Q32 - e	738723	5802232	WTG114	2536	AF18 - b	753511	5788281	WTG216	3633
Q32 - f	738594	5802128	WTG070	2480	AF25 - a	753427	5795150	WTG213	4233
Q32 - g	738769	5802008	WTG114	2314	AG13 - a	754103	5783398	WTG216	7921

ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m	ID	Easting	Northing	Nearest WTG	Hori. distance to WTG, m
Q34 - a	738393	5804213	WTG070	2336	AG20 - a	754846	5790368	WTG216	4191
Q35 - a	738259	5805321	WTG070	2925	AG20 - b	754919	5790692	WTG216	4264
Q36 - a	738827	5806418	WTG070	4134	AG24 - a	754486	5794523	WTG217	5128
Q38 - a	738771	5808106	WTG082	5434	AG30 - a	754407	5800566	WTG212	7492
R20 - ab	739297	5790184	WTG128	3392	AG31 - a	754876	5801342	WTG212	8377
R20 - a	739599	5790079	WTG128	3361	AH18 - a	755320	5788211	WTG216	5207
R31 - aa	739526	5801566	WTG122	1551	AH23 - a	755373	5793966	WTG217	5523
R31 - ab	739349	5801407	WTG114	1542	AH31 - a	755120	5801714	WTG212	8816
R31 - ad	739668	5801376	WTG122	1320	AI18 - a	756067	5788273	WTG216	5861
R31 - ae	739387	5801377	WTG114	1503	AI18 - b	756791	5788318	WTG216	6519
R31 - af	739374	5801396	WTG114	1525	AI23 - a	756158	5793222	WTG217	5913
R31 - ai	739170	5801275	WTG114	1480	AI27 - a	756911	5797613	WTG212	8112
R31 - aj	739146	5801363	WTG114	1570	AI28 - a	756622	5798751	WTG212	8255
R31 - ak	739292	5801418	WTG114	1570	AI29 - a	756353	5799663	WTG212	8455
R31 - al	739182	5801416	WTG114	1605	AI29 - b	756599	5799590	WTG212	8628
R31 - am	739182	5801499	WTG114	1683	AJ20 - a	758750	5790748	WTG216	8094
R31 - an	739132	5801532	WTG114	1731	AJ22 - a	758683	5792013	WTG217	8110
R31 - ao	739070	5801564	WTG114	1785	AJ22 - b	758625	5792254	WTG217	8082
R31 - ap	739420	5801443	WTG114	1559	AJ23 - a	758189	5793663	WTG217	7975
R31 - aq	739450	5801493	WTG122	1564	AJ24 - a	758097	5794001	WTG217	8002
R31 - ar	739402	5801462	WTG114	1582	AK21 - a	757599	5791840	WTG217	7014
R31 - as	739355	5801496	WTG114	1626	AK22 - a	757094	5792332	WTG217	6582
R31 - at	739367	5801474	WTG114	1602	AK23 - a	757938	5793666	WTG217	7738
R31 - av	739381	5801528	WTG122	1641	AK25 - a	757422	5795566	WTG217	8108
R31 - aw	739370	5801553	WTG122	1664	AK25 - b	757593	5795837	WTG217	8400
R31 - ax	739294	5801500	WTG114	1647	AK26 - a	757343	5796868	WTG212	8347
R31 - az	739497	5801582	WTG122	1583	AK28 - b	757076	5798019	WTG212	8396

Appendix D—Stakeholder dwellings

Table D1 Stakeholder dwelling locations as WGS UTM Zone 54S

ID	Easting	Northing	Nearest WTG	Horizontal distance to nearest WTG, m
G35 - b	728737	5805100	WTG002	623
H32 - b	729369	5802123	WTG014	742
H37 - a	729072	5807342	WTG011	1212
J28 - a	731263	5798929	WTG031	646
K30 - a	732563	5800781	WTG040	847
K32 - a	732993	5802497	WTG040	1265
L32 - a	733047	5802703	WTG066	1385
L33 - a	733445	5803136	WTG066	804
M28 - a	734156	5798638	WTG065	701
M34 - a	734796	5804089	WTG078	709
M35 - a	734161	5805068	WTG060	680
N26 - a	735644	5796755	WTG076	702
N28 - a	735286	5798317	WTG087	755
N32 - a	735097	5802650	WTG088	821
O30 - a	736089	5800639	WTG085	700
O32 - a	736392	5802326	WTG084	620
P25 - a	737560	5795728	WTG104	996
R27 - a	739006	5797794	WTG105	783
T24 - a	741497	5794967	WTG134	780
T27 - a	741991	5797694	WTG147	769
V20 - a	743487	5790367	WTG171	823
W20 - a	744108	5790465	WTG171	854
W21 - a	744079	5791417	WTG172	1359
W21 - b	744354	5791698	WTG172	1072
W25 - a	744707	5795176	WTG176	840
W25 - b	744836	5795147	WTG184	722
Z20 - a	747119	5790617	WTG197	2188
Z20 - b	747303	5790693	WTG197	2112
AC22 - b	750698	5792190	WTG217	1037

Appendix E—Background noise measurements

Summary

Background noise measurements were conducted at 15 noise-sensitive locations around the Project site between April and August 2019. The measurements were conducted and analysed in accordance with NZS 6808:2010 and the specific requirements of the Permit.

The monitoring locations are summarised in Table E1, including the monitoring dates, number of valid data points and the meteorological mast used for wind speed and direction data for each location.

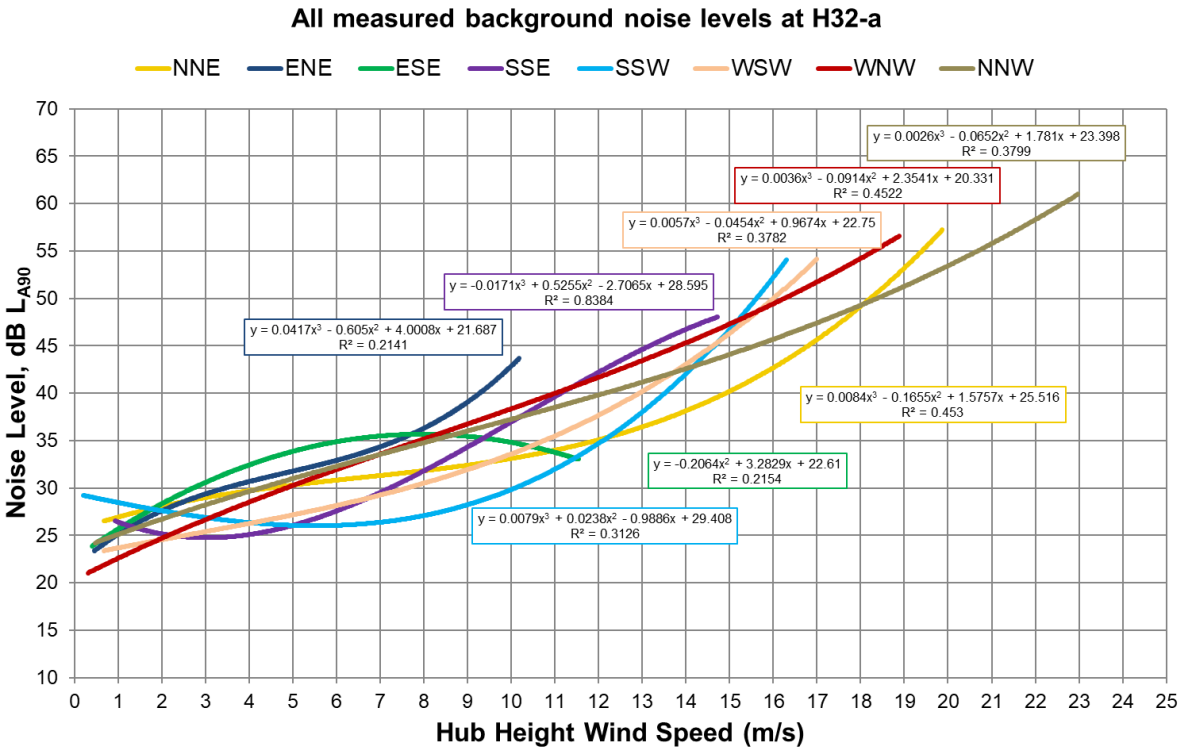
Table E1 Background noise monitoring summary

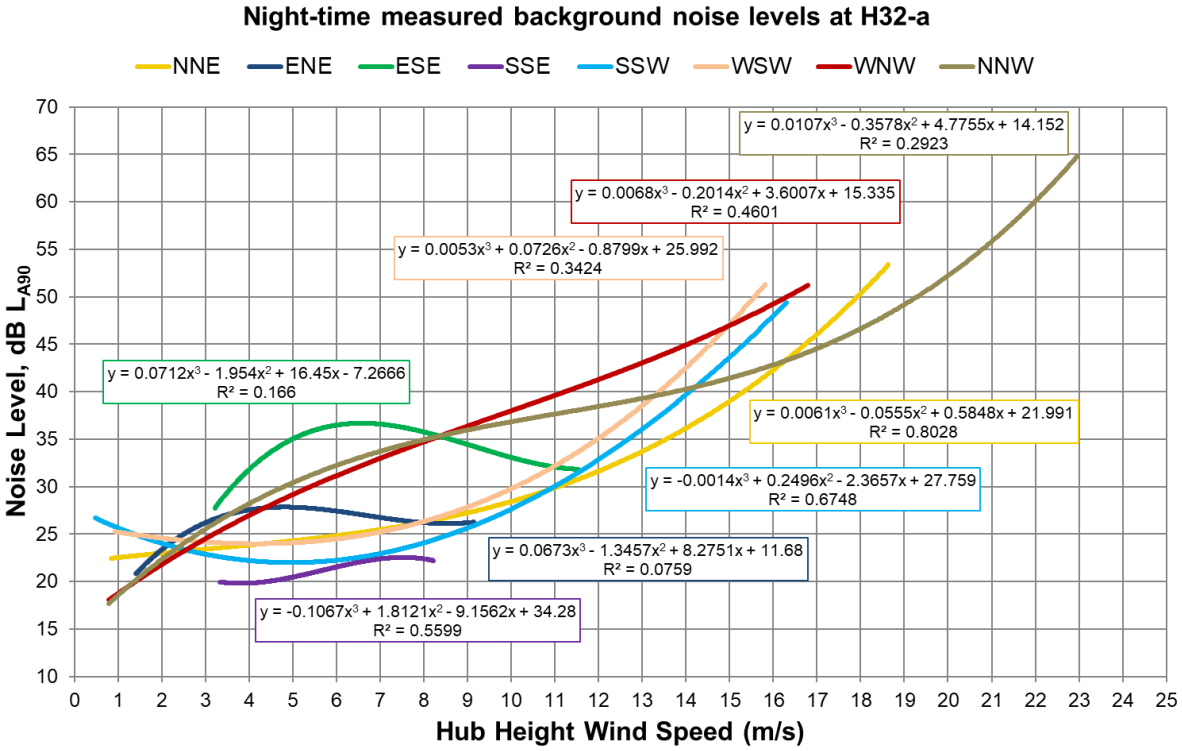
Noise-sensitive location	Monitoring dates	Valid data points	Meteorological mast
H32 - a	22/05/2019 – 10/07/2019	6266	RWW100
K27 - a	21/05/2019 – 10/07/2019	6406	RWW100
O34 - a	20/05/2019 – 10/07/2019	6548	RWW100
P24 - b	09/04/2019 – 18/06/2019	5760	RWS100
P31 - a	08/04/2019 – 20/05/2019	5781	RWS100
Q30 - a	10/07/2019 – 21/08/2019	5489	RWS100
Q31 - o	09/04/2019 – 21/05/2019	5761	RWS100
Q31 - p	09/04/2019 – 21/05/2019	5796	RWS100
R20 - a	09/04/2019 – 21/05/2019	5281	RWS100
R31 - ad	10/07/2019 – 21/08/2019	5487	RWS100
U18 - a	21/05/2019 – 10/07/2019	6089	BP100
W28 - a	21/05/2019 – 11/07/2019	6359	RWS100
AC18 - a	21/05/2019 – 10/07/2019	6239	BP100
AD23 - a	21/05/2019 – 10/07/2019	6231	BP60
AE25 - e	11/07/2019 – 22/08/2019	5270	BP60

The analysed background noise levels, against a hub height of 149 m AGL, are presented on the following pages for both all time and night-time (10 pm to 7 am) periods, and for each wind direction sector. Note that these background noise levels may be subject to change if the final design for the wind farm utilises a hub height that differs from 149 m.

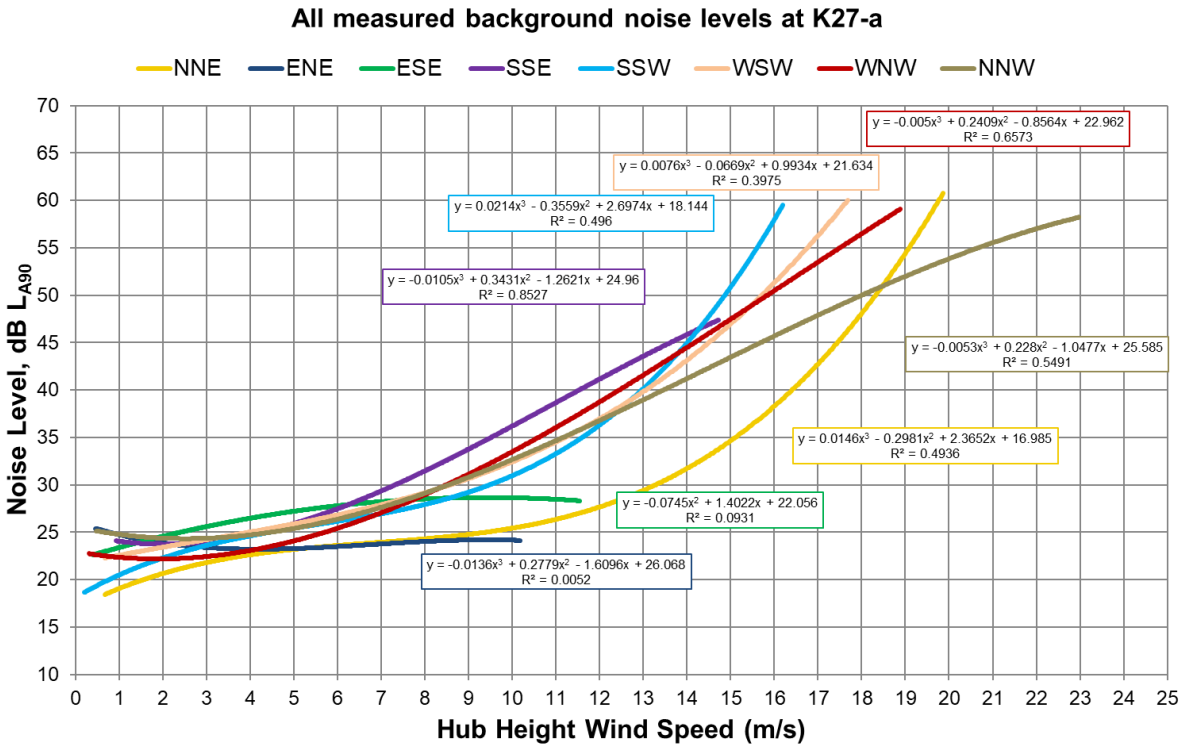
From the Figures on the following pages, it is apparent that background noise levels are generally below 35 dB L_{A90} for some wind direction sectors and time periods up to a wind speed of at least 10 m/s, which is the wind speed at which the candidate WTGs both reach their maximum sound power level. Therefore, this assessment has been carried out against the minimum applicable noise limit of 40 dB L_{A90} at this wind speed.

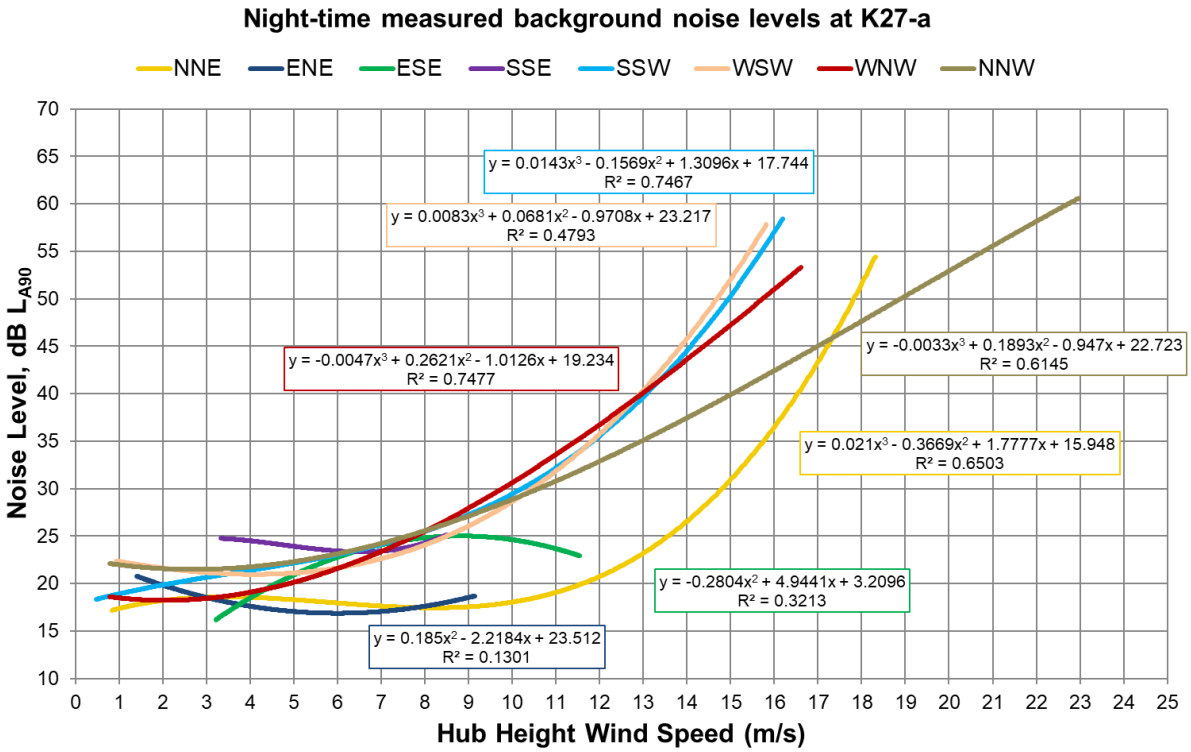
Background noise levels at H32-a



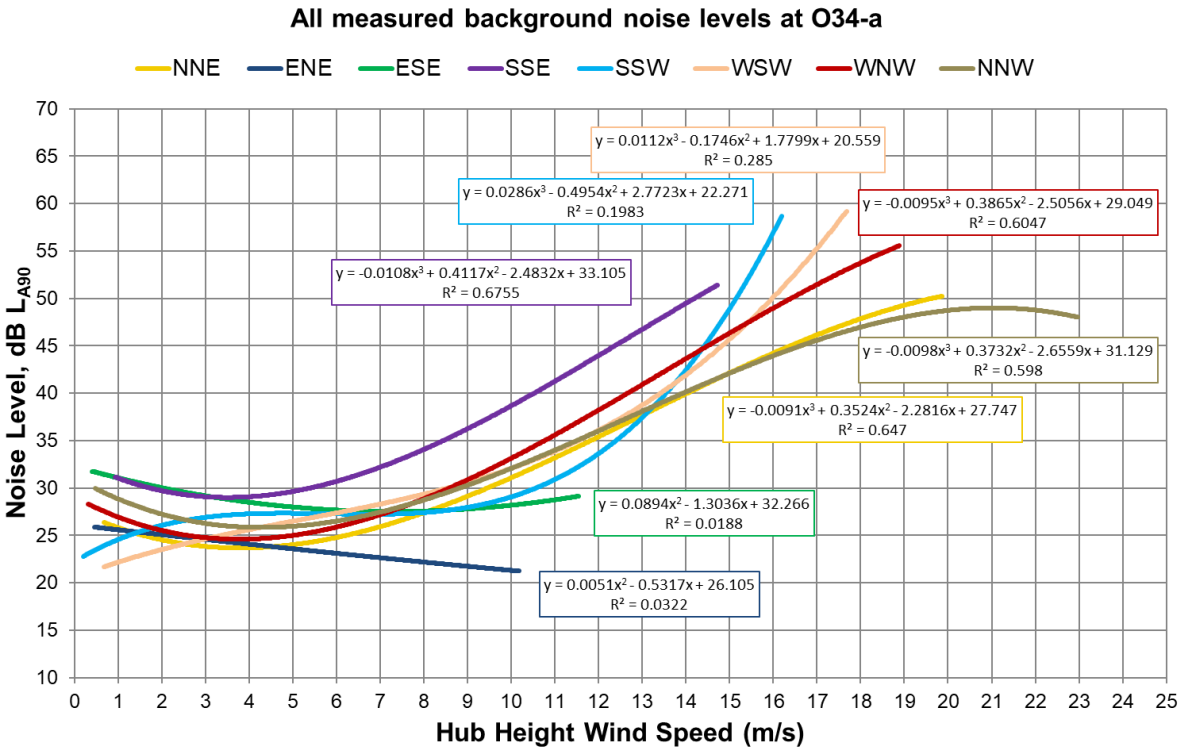


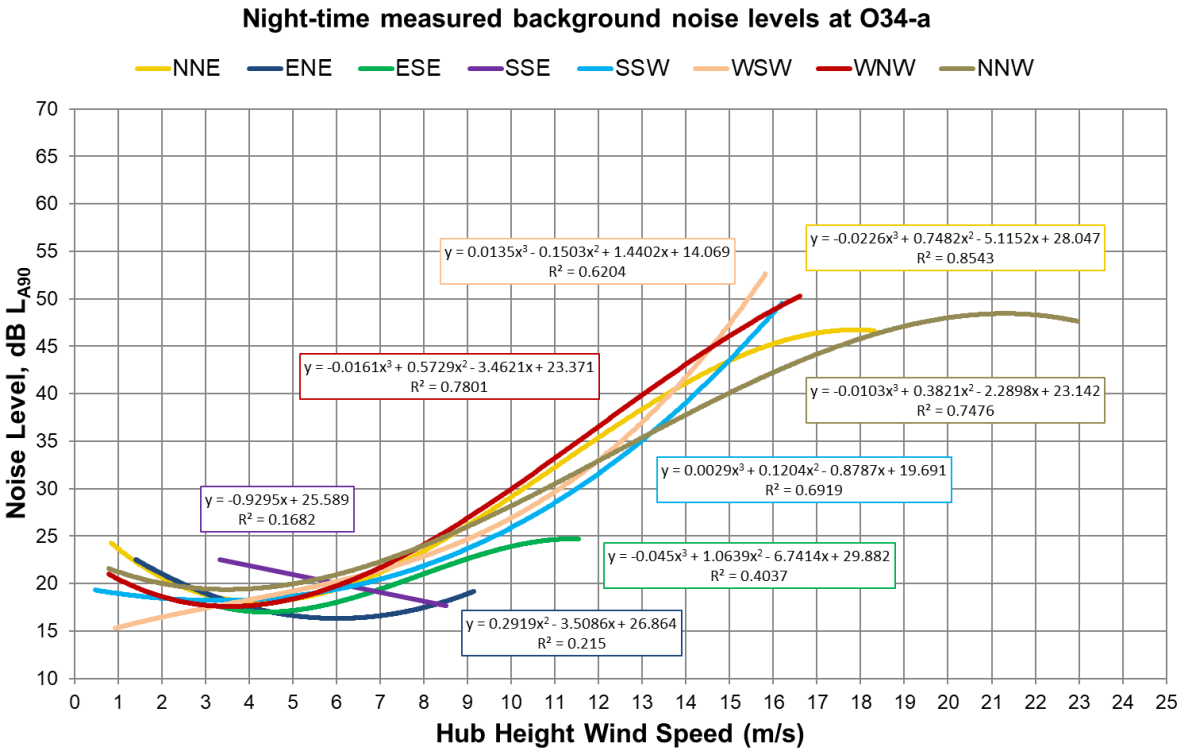
Background noise levels at K27-a



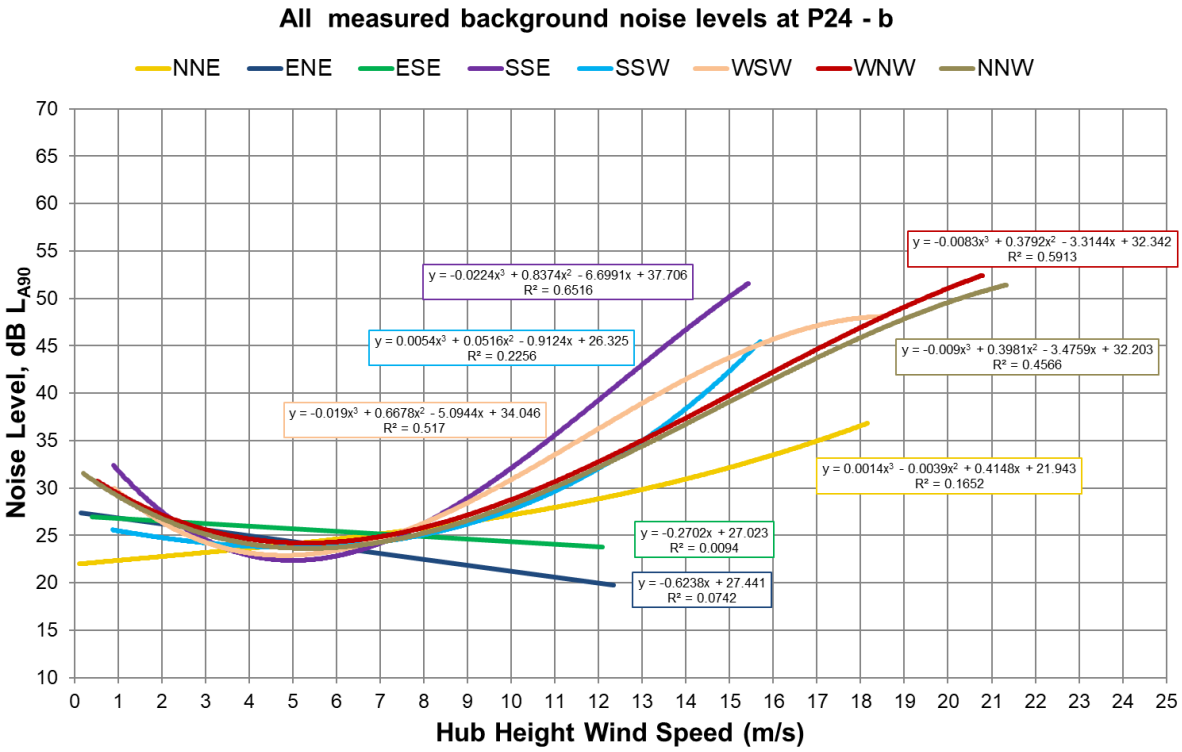


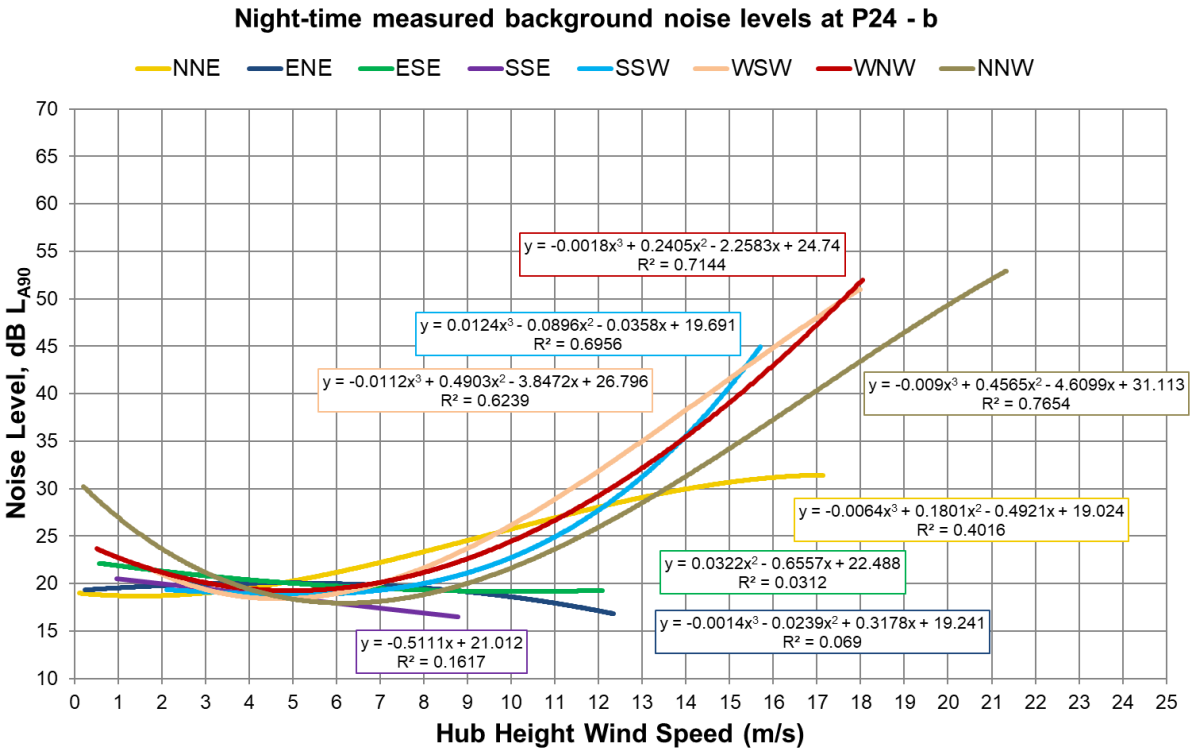
Background noise levels at O34-a



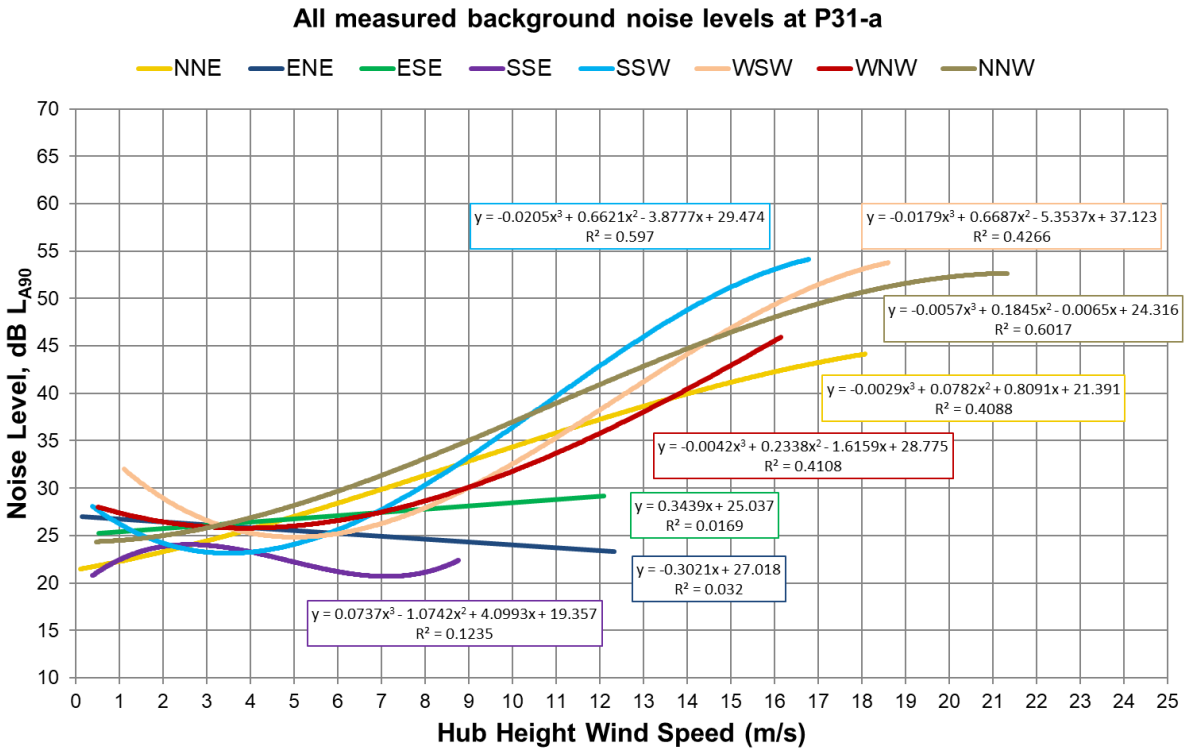


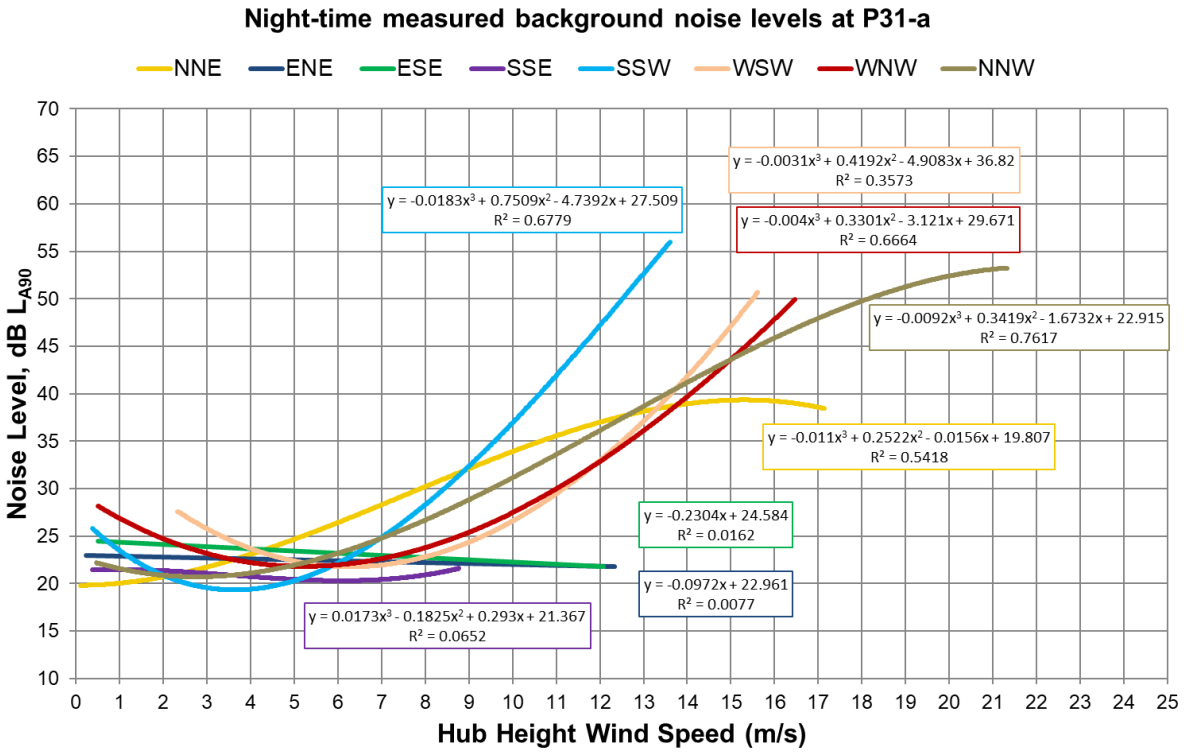
Background noise levels at P24-b



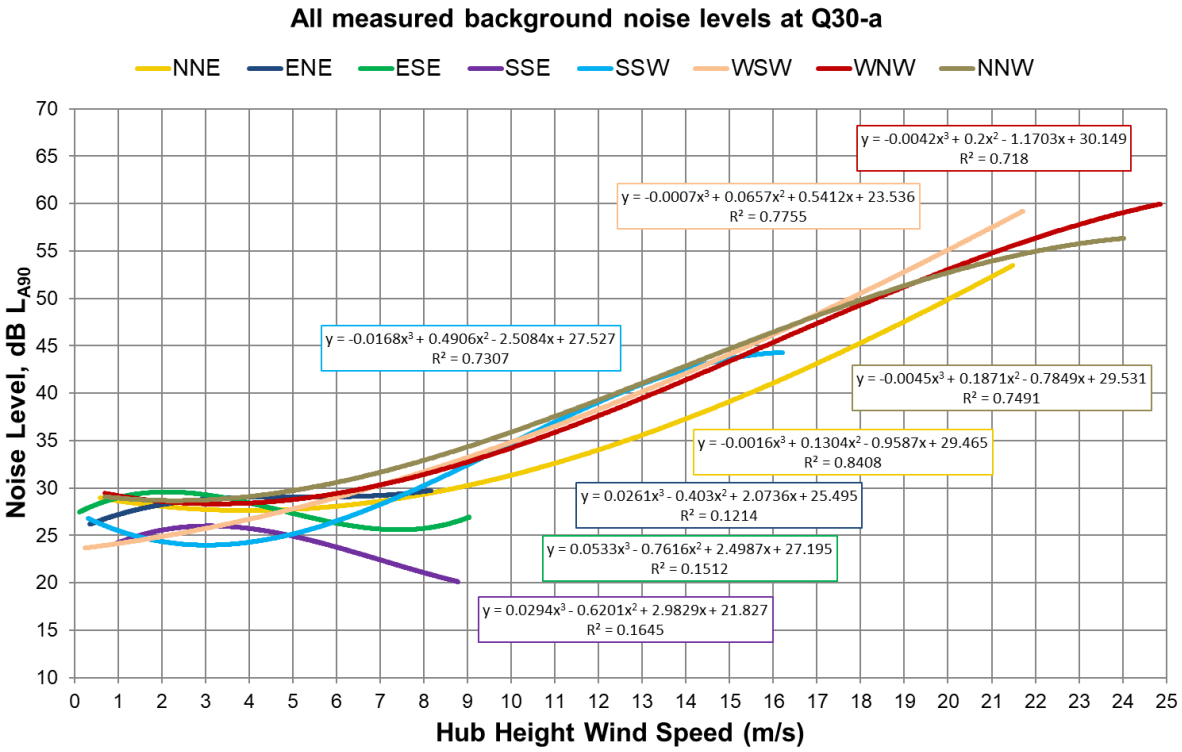


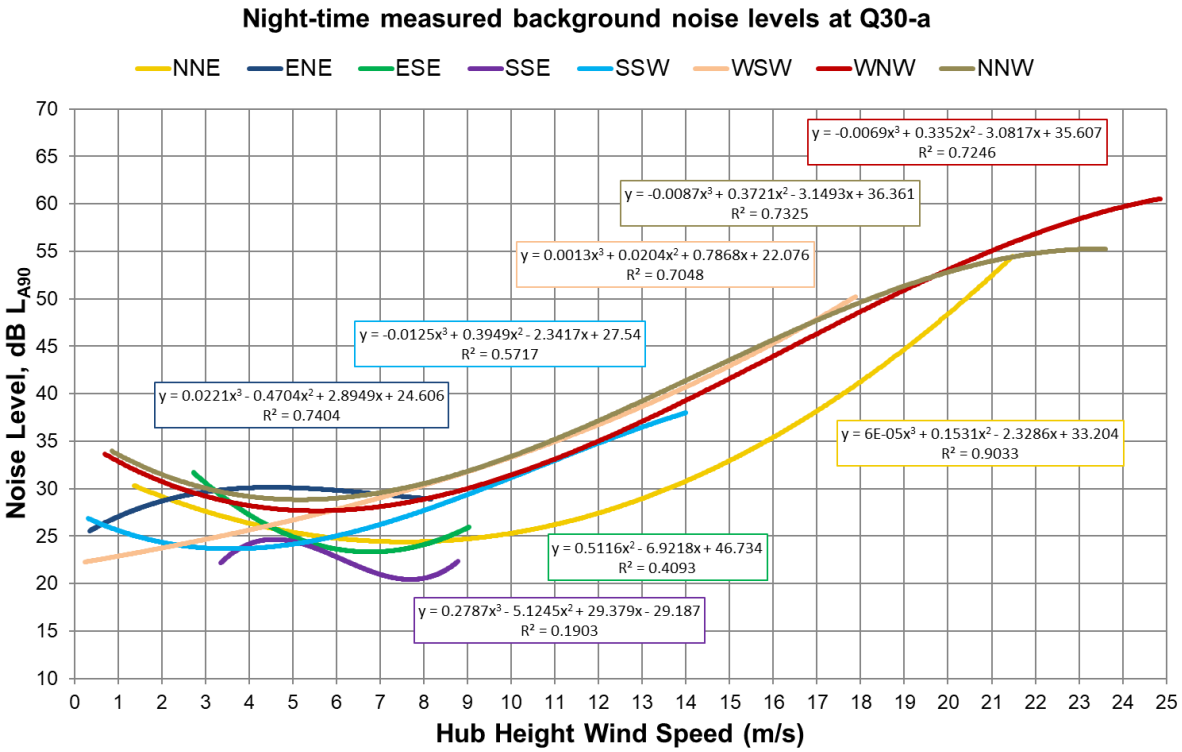
Background noise levels at P31-a



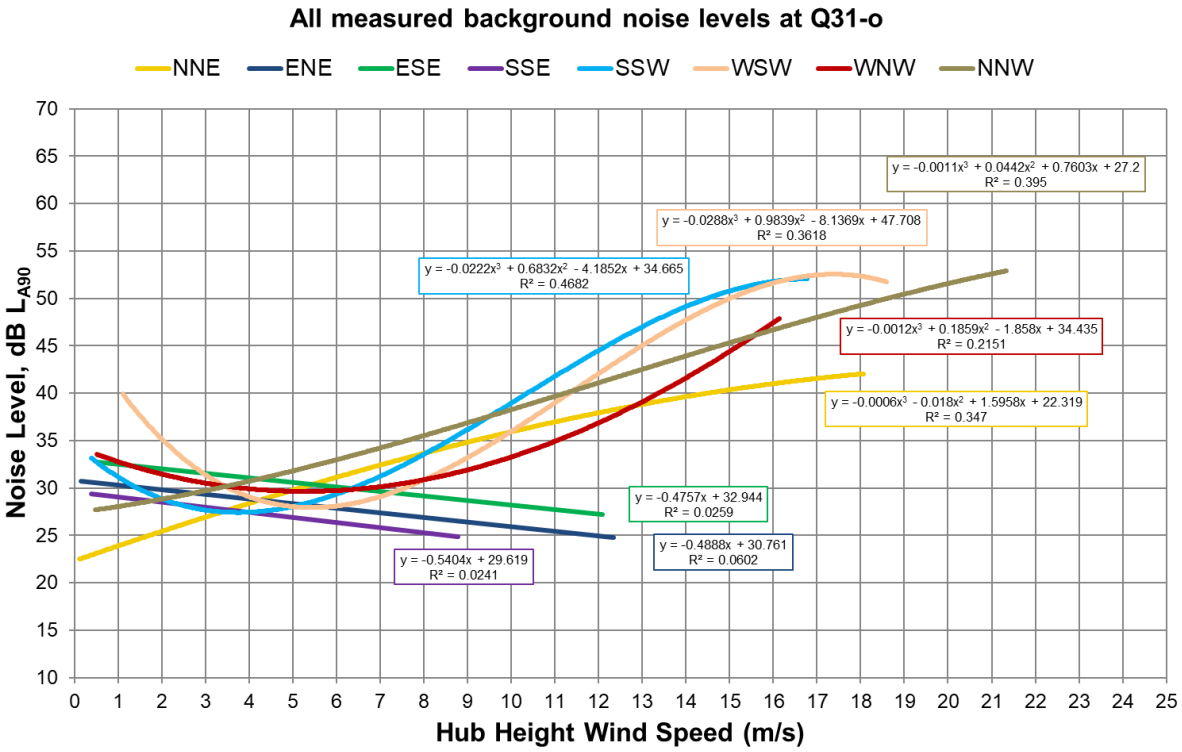


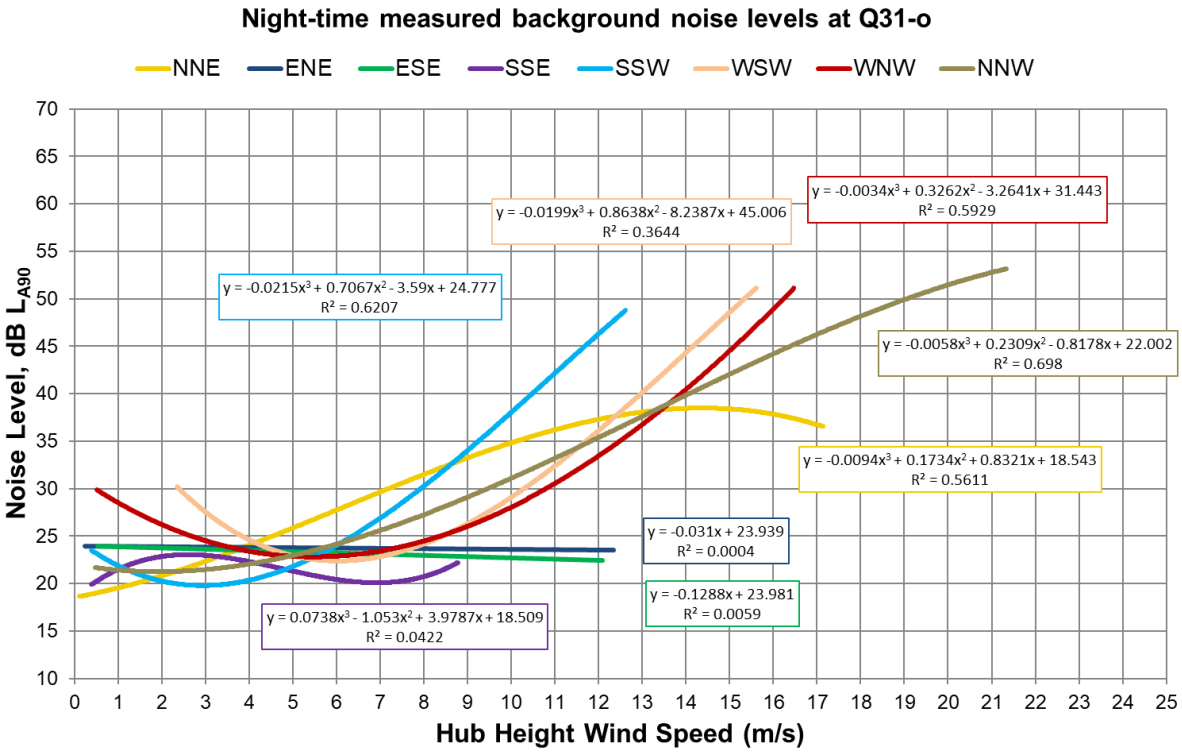
Background noise levels at Q30-a



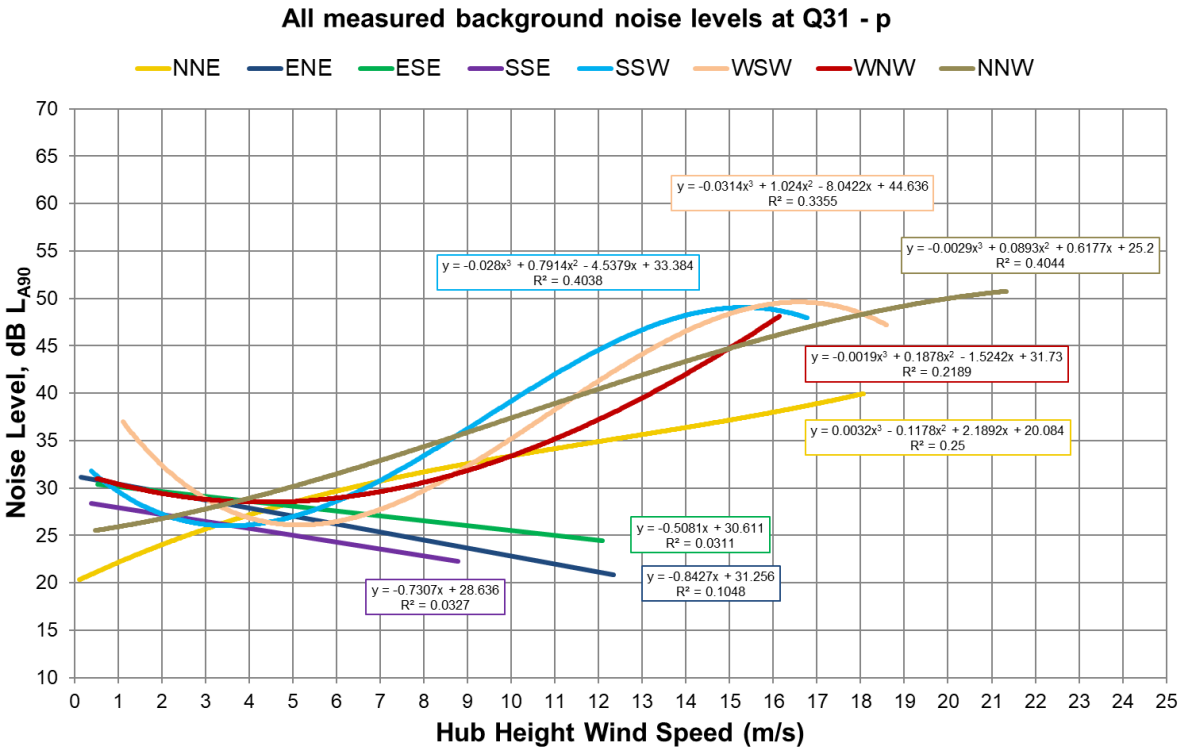


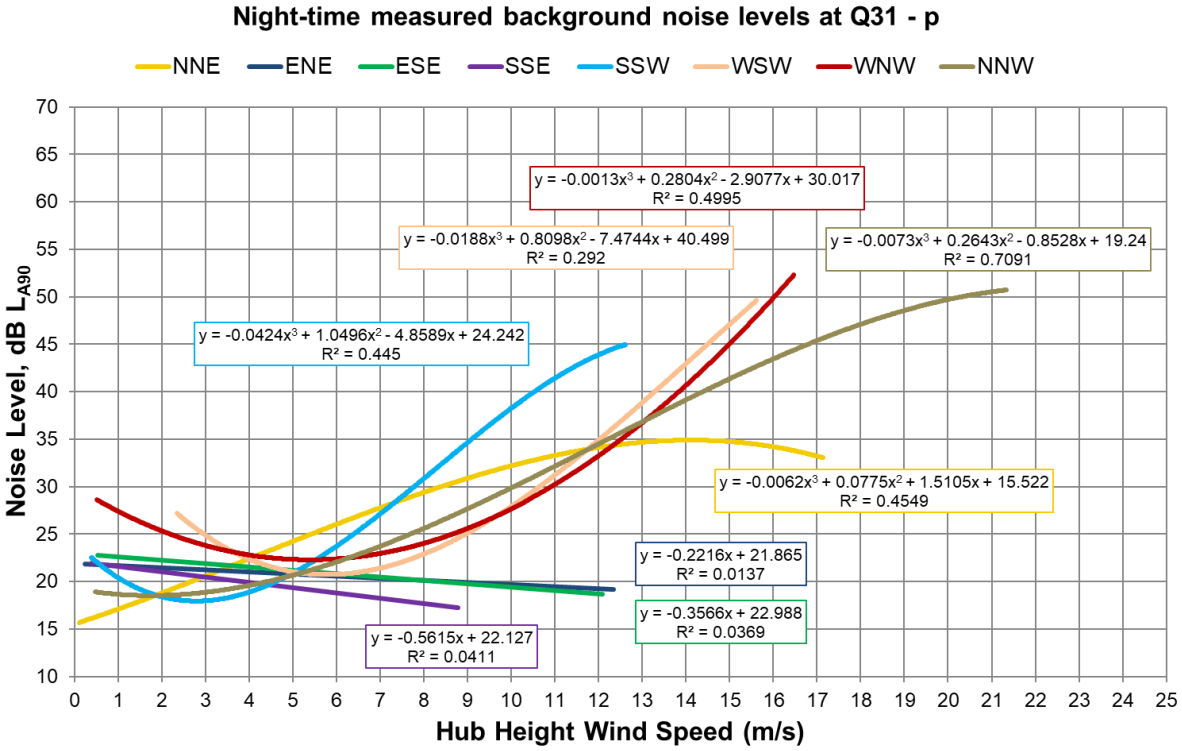
Background noise levels at Q31-o



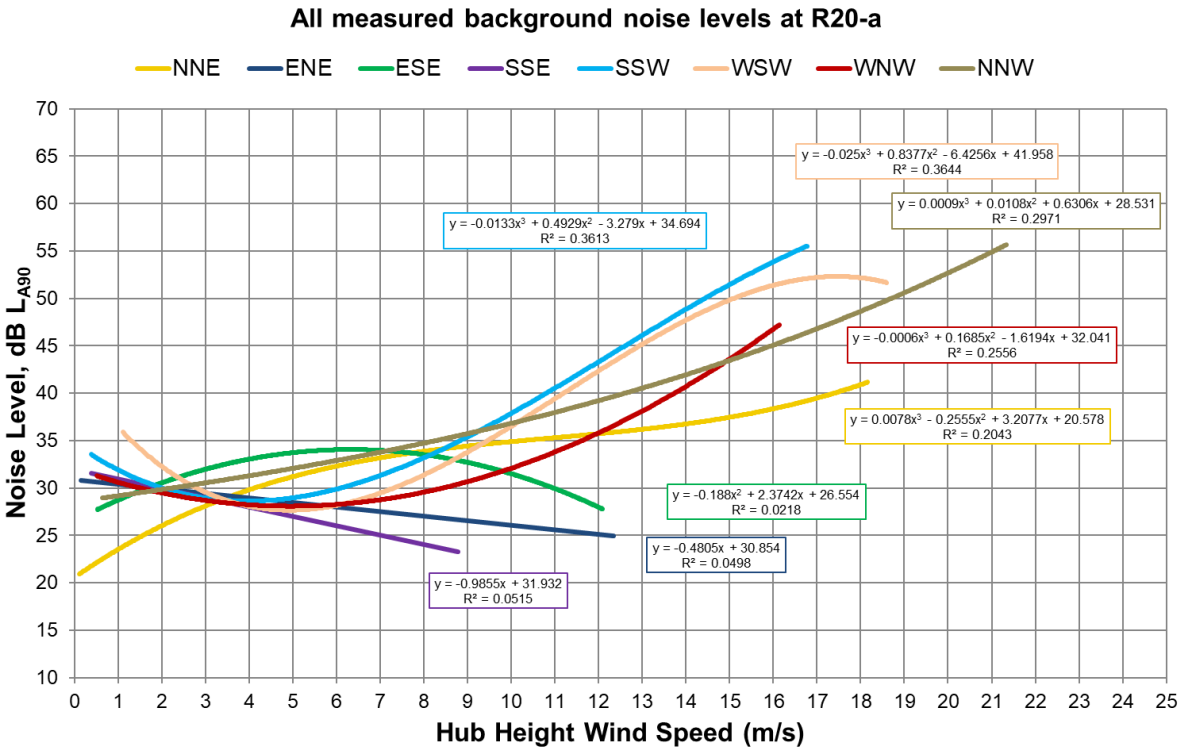


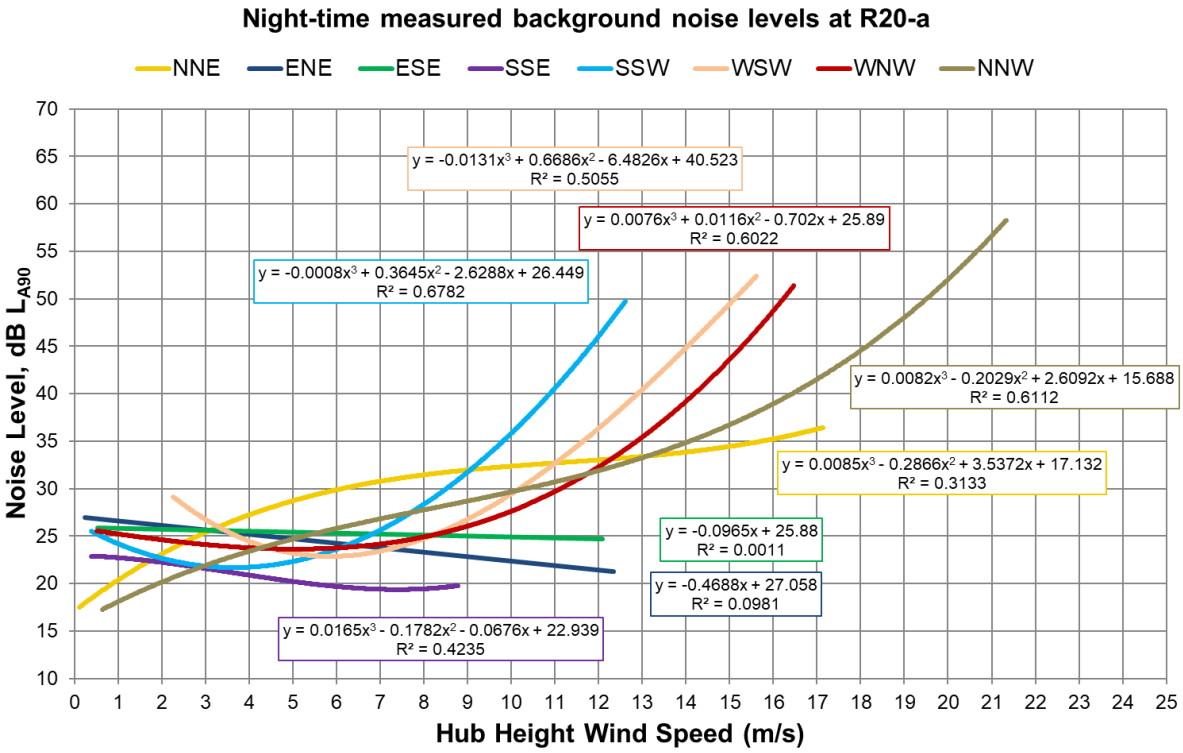
Background noise levels at Q31-p



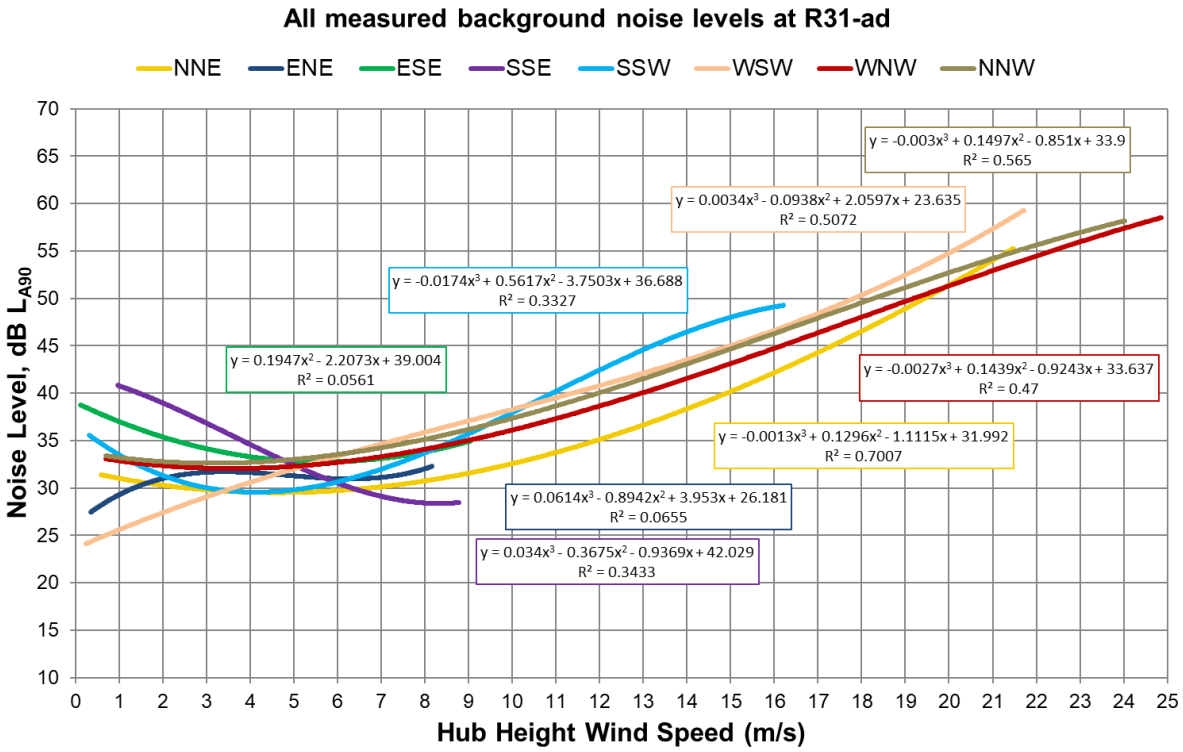


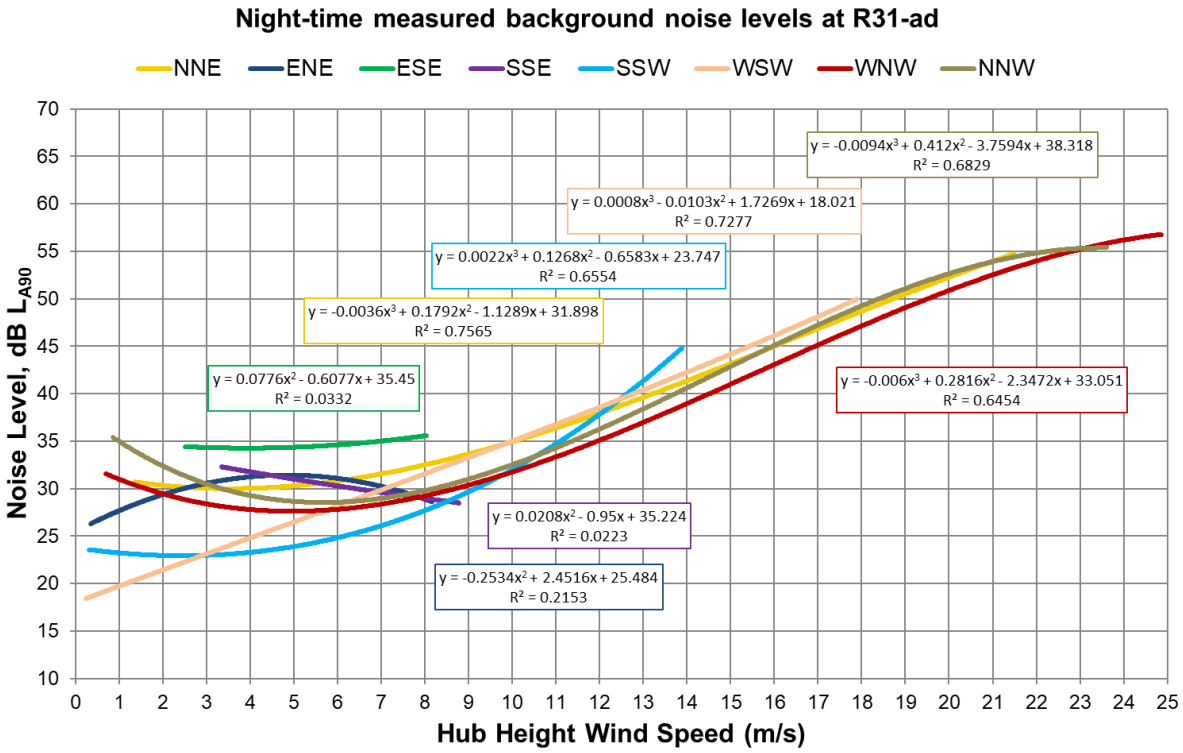
Background noise levels at R20-a



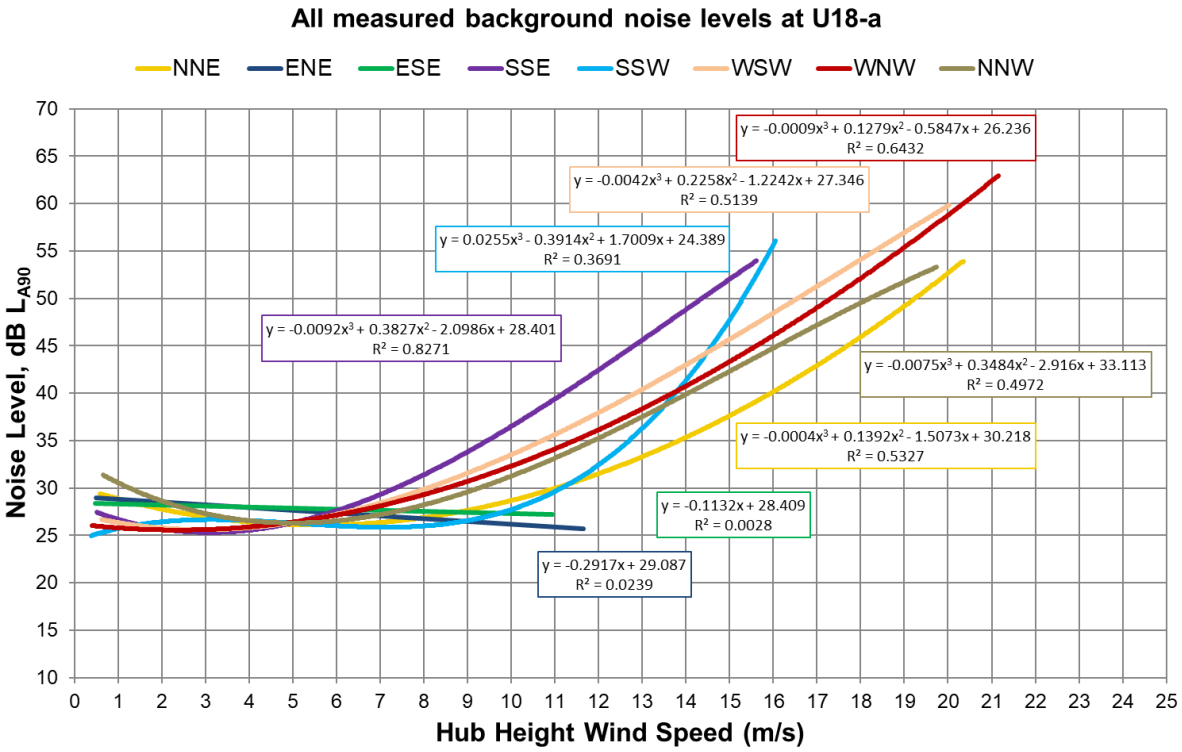


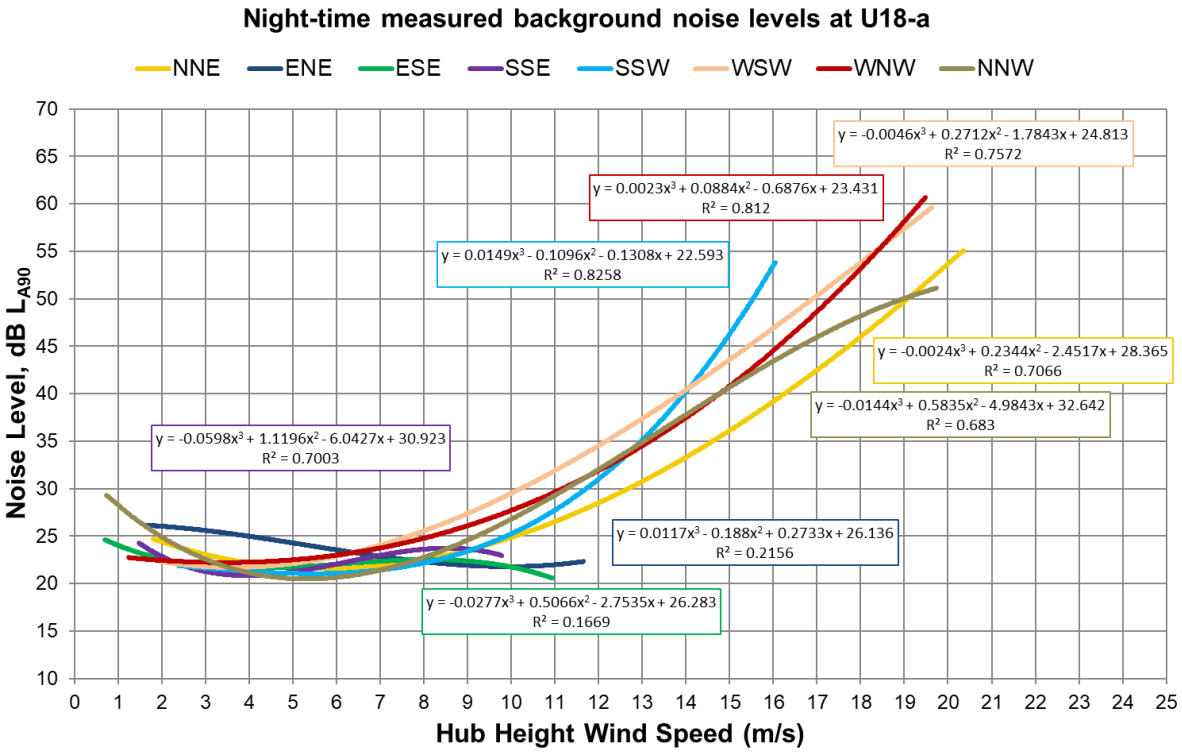
Background noise levels at R31-ad



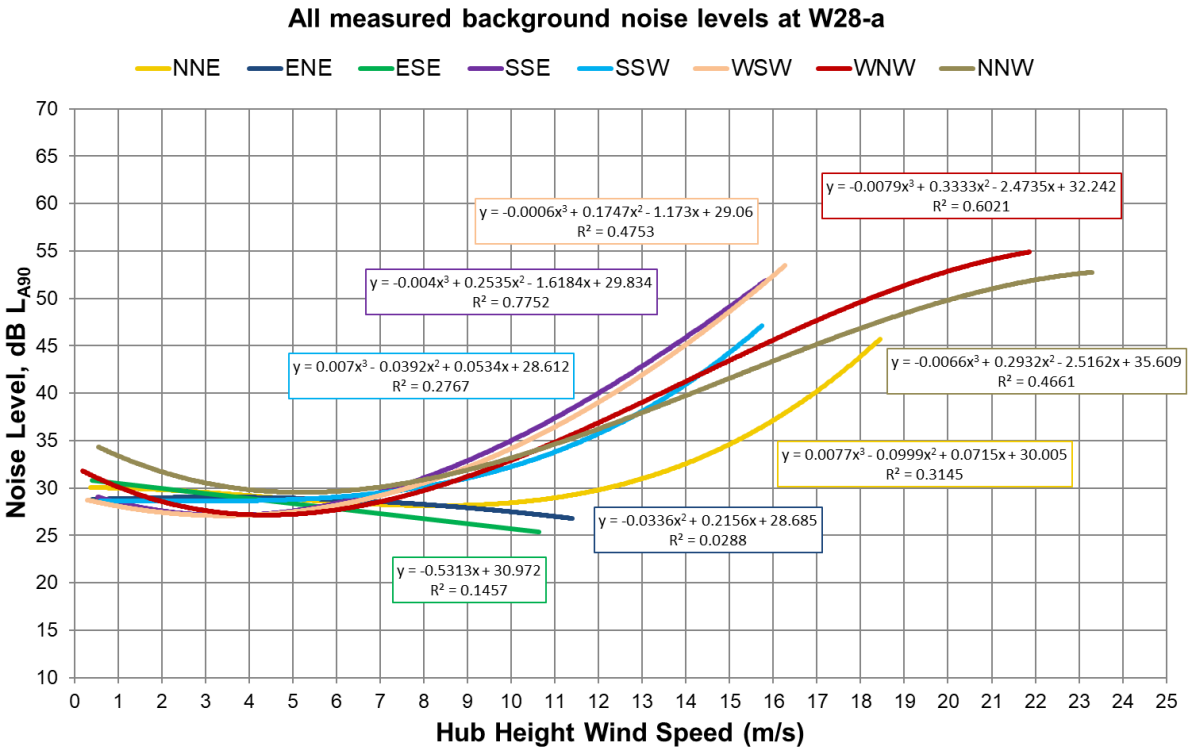


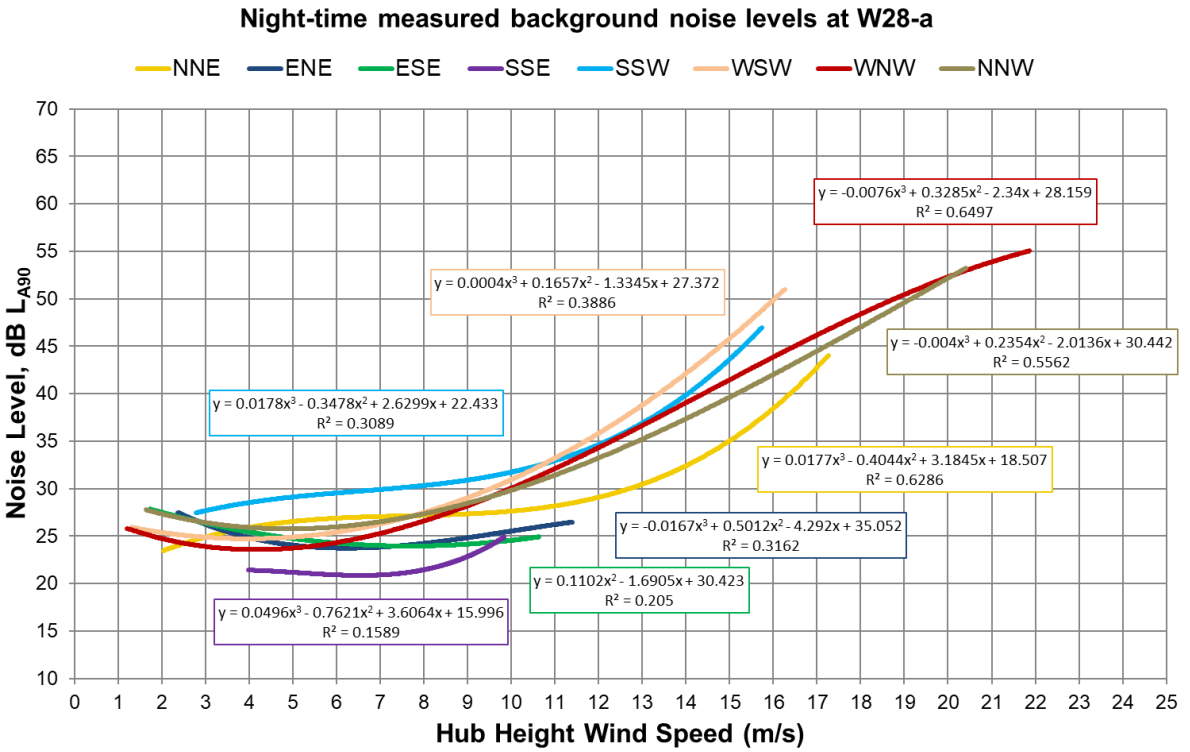
Background noise levels at U18-a



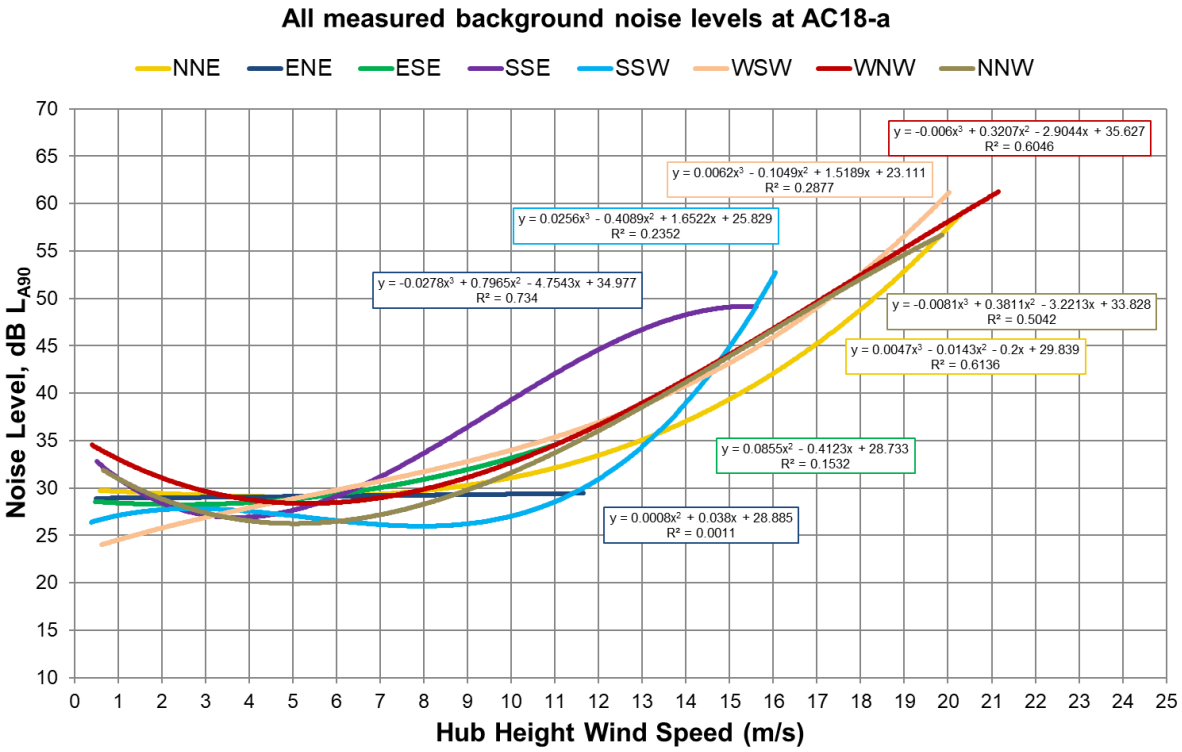


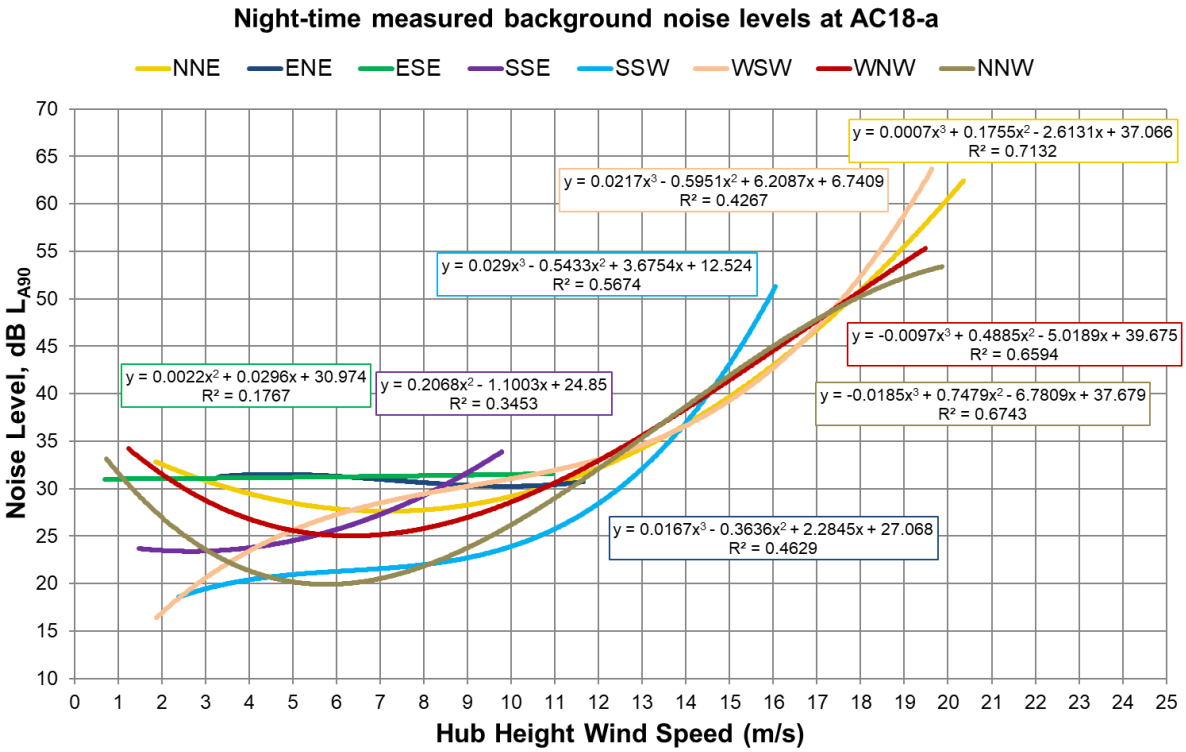
Background noise levels at W28-a



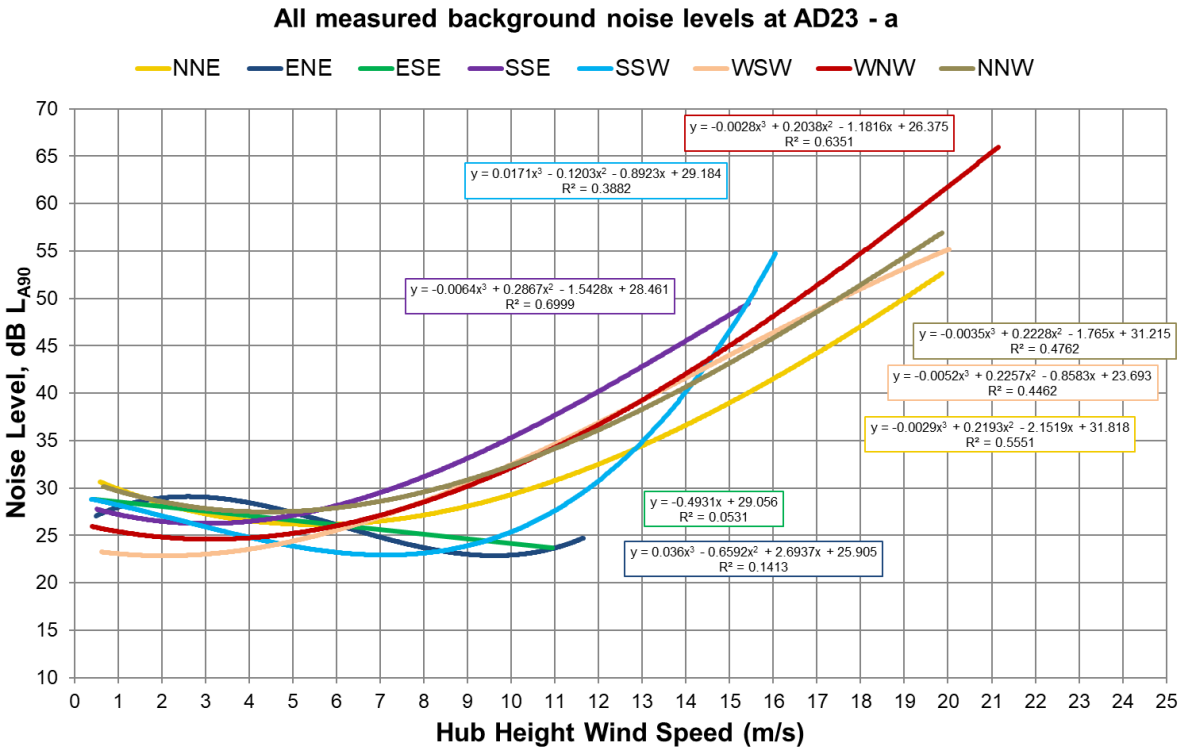


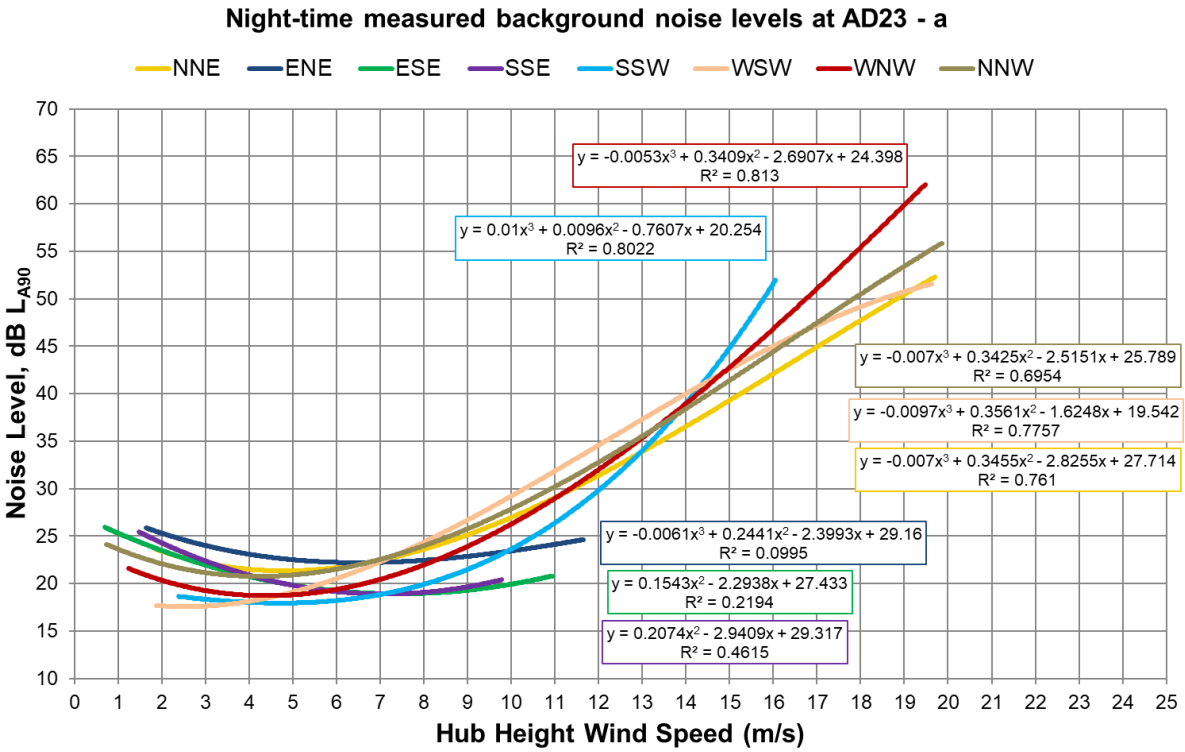
Background noise levels at AC18-a



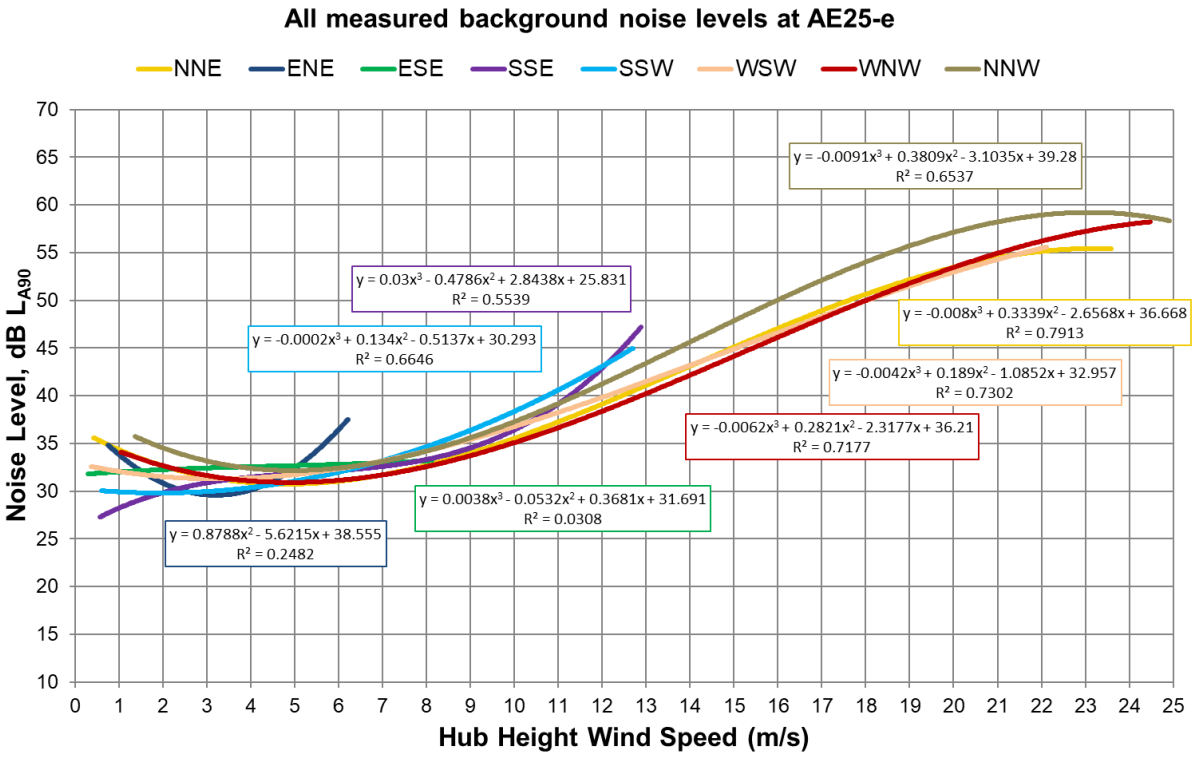


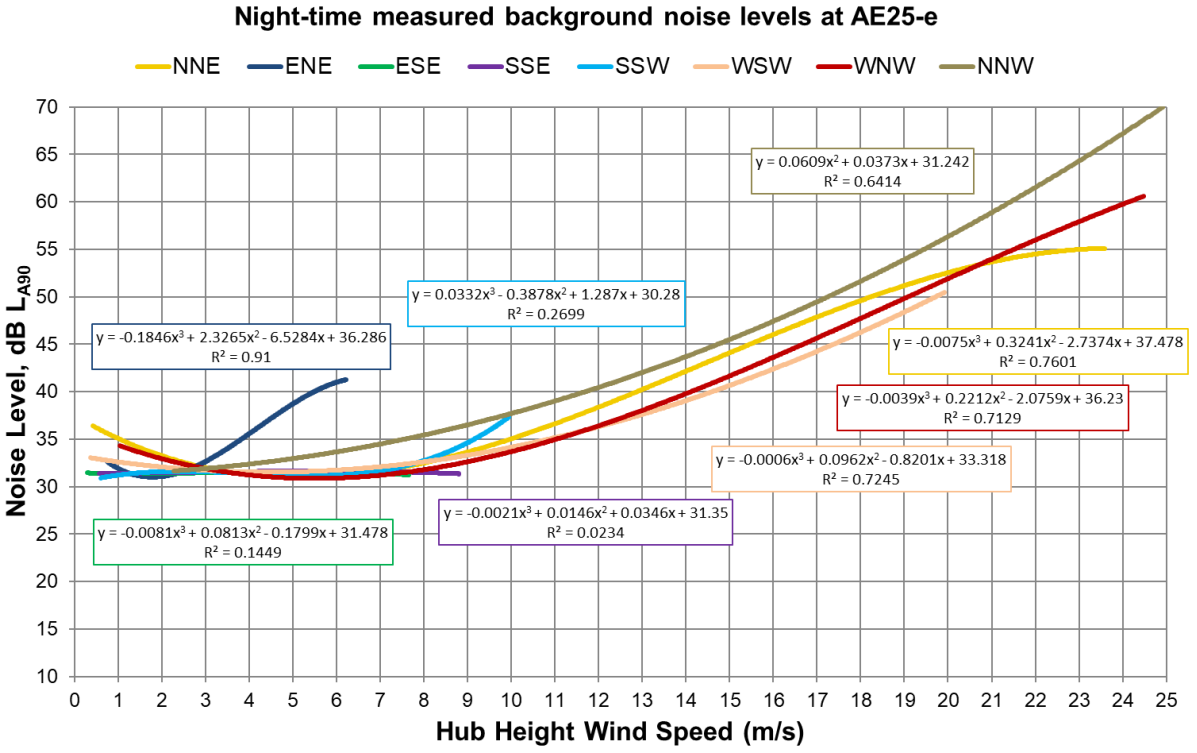
Background noise levels at AD23-a





Background noise levels at AE25-e





Appendix F—Background noise levels in high amenity zone

It is understood that an audit undertaken by EnviroRisk of a Marshall Day Acoustics noise assessment report conducted for the Planning Permit Amendment Application was inconclusive with respect to the appropriate wind speed threshold for the high amenity limit for the Project. This was based on a review of the summary of background noise measurements in Appendix E of a previous revision of this report, specifically at the three locations in the high amenity area. The audit report noted that:

> With consideration to the gap in seasonal background noise data and the ambiguities of the Standard, the applicability of wind speeds above 6 m/sec may be necessary in setting a night period high amenity noise limit for post-construction compliance monitoring and is recommended to be evaluated by the Responsible Authority.

Clause 5.3.2 of NZS 6808:2010 recommends that 6 m/s be the default wind speed threshold, above which a high amenity noise limit should not apply. It states that an alternative threshold may be applied where justified on meteorological, topographical and acoustical grounds. However, no clear criteria are provided as to how these factors could justify a change in wind speed threshold.

It is noted that EnviroRisk has only queried whether the background noise levels could justify a change in wind speed threshold, noting that there is nothing unusual about the topography of the Project site. Therefore, the following sections provide additional detail on the background noise measurements within the high amenity area.

Background noise levels at Q31-o, Q31-p and R31-ad

The auditor query relates to background noise measurements under three 45º-wide wind direction bins, namely ENE, ESE and SSE, where lower background noise levels were observed at night-time at Q31-o and Q31-p for wind speeds above 8 m/s in comparison to other wind direction sectors. This trend was not observed for R31-ad, although little or no data was captured for wind speeds above 8 m/s in these sectors at R31-ad at night-time.

The measured night-time noise levels during each of these sectors are shown for the three properties in the high amenity zone in Figure F1, F2 and F3, overlaid on the entire night-time dataset.

From the Figures, it is apparent that wind in the ENE, ESE and SSE sectors was relatively uncommon, particularly at wind speeds of 8 m/s and above. It can also be seen that:

- The data collected at Q31 - o and Q31 - p in these sectors is typical of data collected in other directions, with the exception of a small group of data points at 10.5 – 12 m/s for the ENE and ESE sectors. Combined across both of these sectors, there is a total of 33 10-minute data points in this wind speed range.
- The data collected at R31 - ad in these sectors is typical of data collected in other directions.
- The limited amount of data has resulted in a limited relationship between wind speed and noise level for these sectors.

It is noted that Condition 18b of the Planning Permit requires that wind data be analysed by eight wind direction sectors. However, there is no corresponding requirement that separate noise limits be established for each sector.

NZS 6808:2010 provides limited guidance for establishing different noise limits for different wind directions, only stating that this may be required where there are ‘markedly different groups’. From Figures F1, F2 and F3, and considering the limited higher wind speed data in these subsets, it is not considered that a markedly different relationship has been established and it is not considered that NZS 6808:2010 would justify separate noise limits for these sectors. Therefore, it is not considered that the background noise data in these sectors would provide sufficient basis to justify a change to the high amenity wind speed threshold.

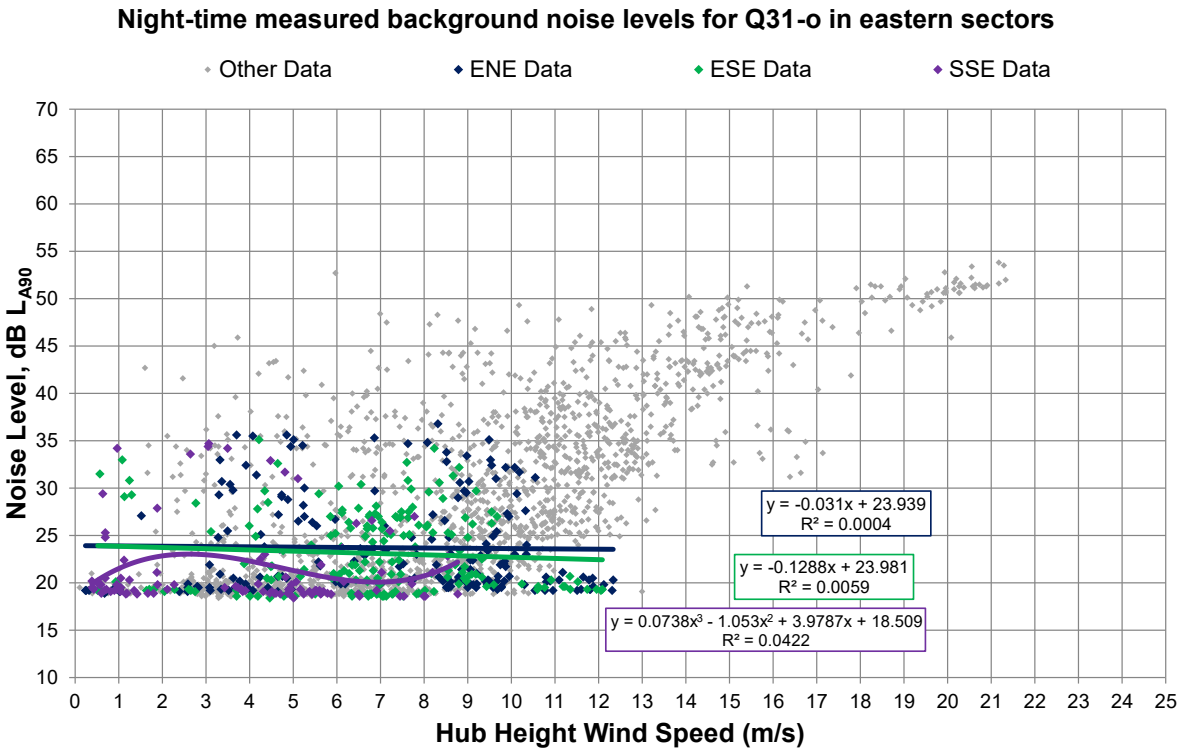


Figure F1 Night-time background noise levels at Q31-o for ENE, ESE and SSE sectors

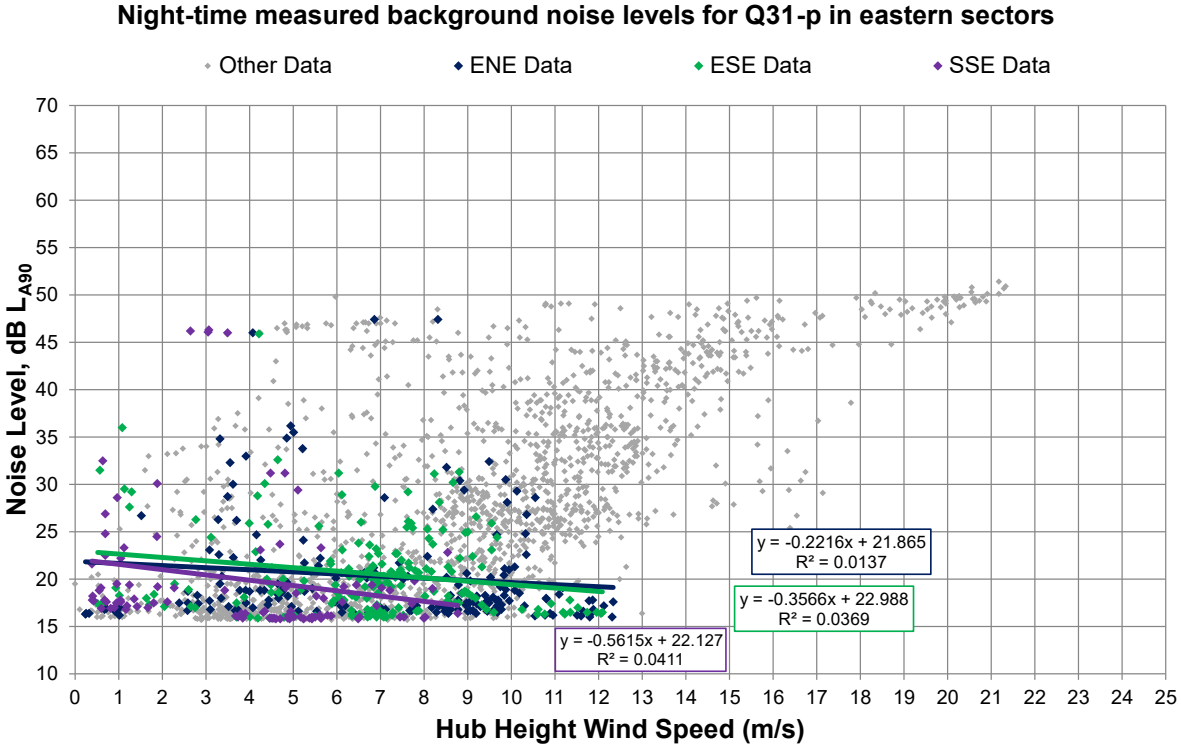


Figure F2 Night-time background noise levels at Q31-p for ENE, ESE and SSE sectors

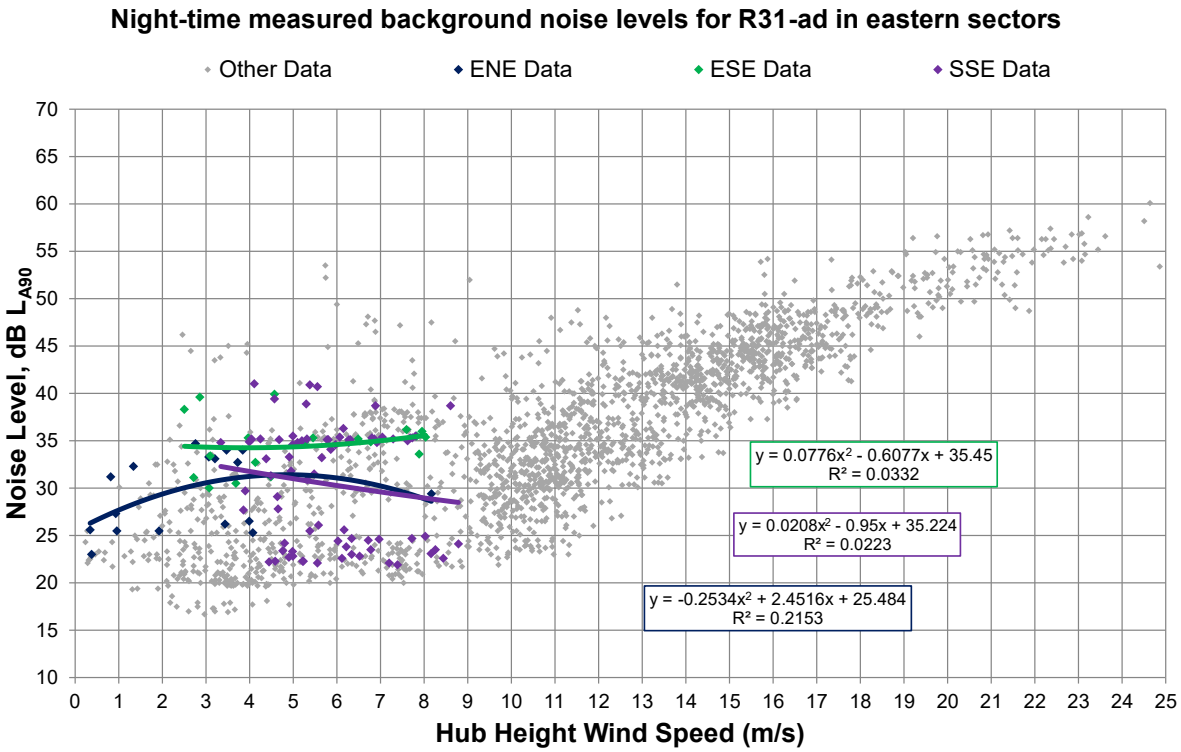


Figure F3 Night-time background noise levels at R31-ad for ENE, ESE and SSE sectors

Wind roses for noise survey period

To provide context on the representativeness of the survey periods, wind roses have been produced for each noise survey period and compared to long-term wind roses for the site meteorological masts supplied by GPWFM.

Figure F4 presents the wind roses for the noise survey periods at Q31 - o / Q31 - p (09/04/2019 – 21/05/2019) and at R31 - ad (10/07/2019 – 21/08/2019). Figure F5 presents the total wind rose for the same Rokewood South (RWS100) meteorological mast, supplied by GPWFM for the period since it commenced operation in August 2017.

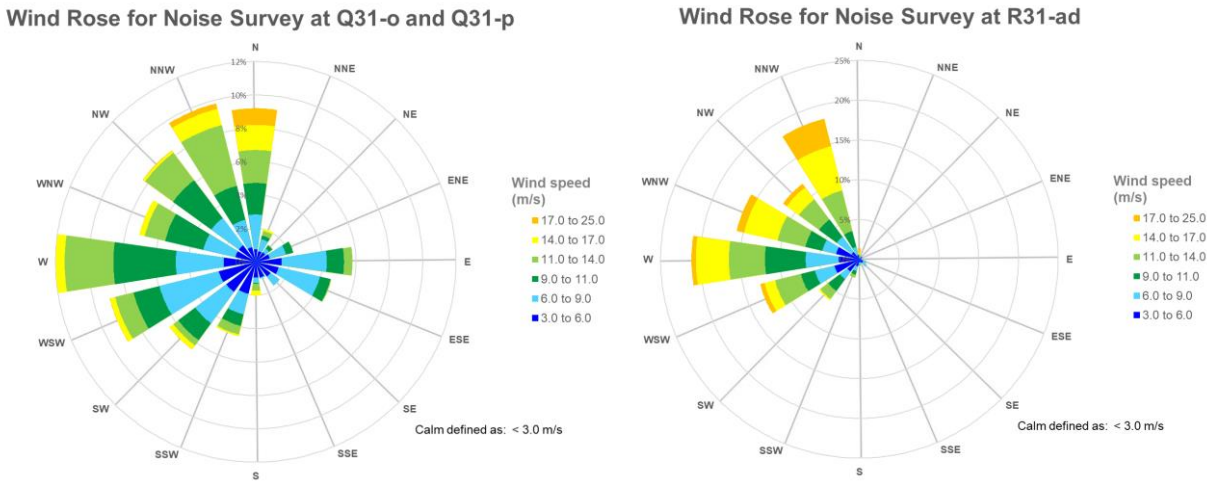


Figure F4 Night-time background noise levels at R31-ad for ENE, ESE and SSE sectors

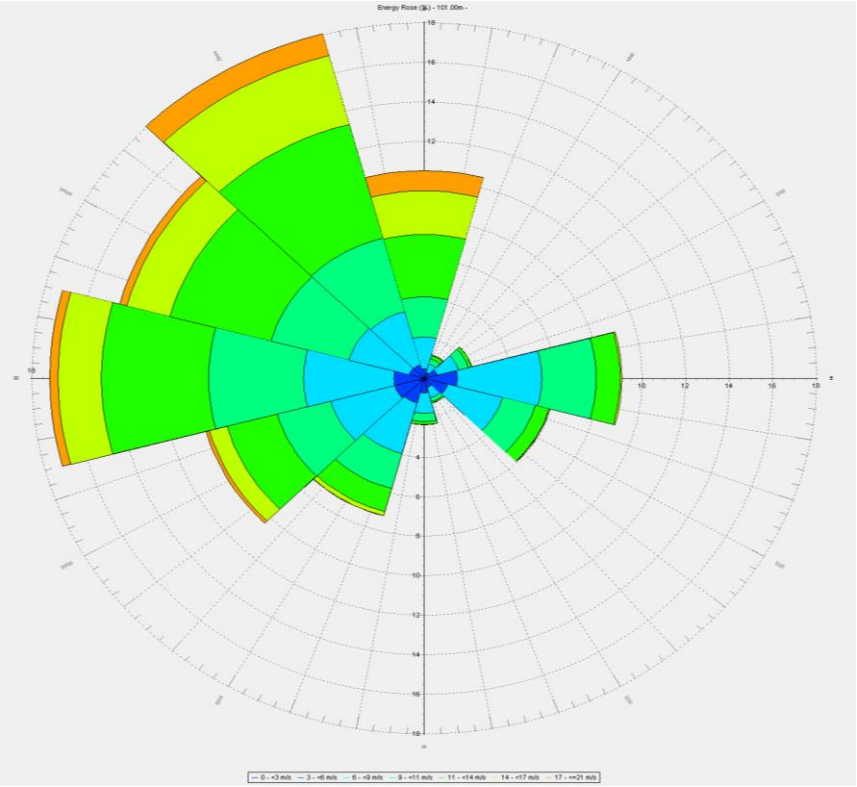


Figure F5 Wind rose at Rokewood South meteorological mast supplied by GPWFM

From Figure 4 and Figure 5 it can be seen that the total wind rose for the Rokewood South meteorological mast is similar to that during the noise survey period at Q31-o and Q31, while the noise survey at R31-ad occurred during a period of fewer easterly winds across all wind speeds. It is also apparent that winds in the ENE, ESE and SSE wind sectors are a relatively uncommon occurrence for the site, particularly at speeds above approximately 8 m/s.

One aspect of the data that is not reflected in the wind roses is the typical wind shear value. Wind shear is an important consideration as higher wind shear values indicate a greater difference in wind speed between ground level, where the wind speed will be lower, and hub height, where the wind speed will be higher. As background noise levels are generally controlled by wind speed at low level, with wind through local vegetation generally a controlling source of background noise, a higher wind shear will typically result in a lower background noise level for a given wind speed.

Based on an analysis of the historical wind data for the RWS100 mast supplied by GPWFM, wind shear for the ENE, ESE and SSE sectors was observed to be approximately 30% higher during the noise monitoring periods than at other times of year. In other words, the measured background noise levels for these wind sectors may be lower for a given hub height wind speed than if the measurements had been conducted at other times of year.

Summary

Based on this analysis of the measured background noise levels and wind speeds during the noise monitoring at the three measurement locations in the high amenity zones, it is not considered that the background noise data in these sectors would provide sufficient basis to justify a change to the high amenity wind speed threshold.

Appendix G—Wind turbine noise contour maps

North-west

GOLDEN PLAINS WIND FARM
Figure G1a: Predicted wind turbine noise levels for GE WTG at 10m/s - North-west

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers
- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level
- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

Centre

Rokewood Township

GOLDEN PLAINS WIND FARM
Figure G1b: Predicted wind turbine noise levels for GE WTG at 10m/s - Centre

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers

- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level

- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

South-east

GOLDEN PLAINS WIND FARM
Figure G1c: Predicted wind turbine noise levels for GE WTG at 10m/s - South-East

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers
- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level
- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

North-west

GOLDEN PLAINS WIND FARM
Figure G2a: Predicted wind turbine noise levels for Vestas V162 WTG at 10m/s - North-west

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers

- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level

- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

Centre

Rokewood Township

GOLDEN PLAINS WIND FARM
Figure G2b: Predicted wind turbine noise levels for Vestas V162 WTG at 10m/s - Centre

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers
- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level
- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

South-east

GOLDEN PLAINS WIND FARM
Figure G2c: Predicted wind turbine noise levels for Vestas V162 WTG at 10m/s - South-East

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers

- Stakeholder
- House
- School
- Child Care

Predicted wind turbine noise level

- 35-40 dB LA90
- 40-45 dB LA90
- 45-50 dB LA90
- >50 dB LA90

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

Centre

Rokewood Township

GOLDEN PLAINS WIND FARM
Figure G3: Predicted wind turbine noise levels for GE WTG at 6m/s - Centre

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers
- Stakeholder
- House
- School
- Child Care

35 dB LA90 contour at 6 m/s
- 35 dB

High amenity zones
- LDRZ
- Township Zone

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

Centre

Rokewood Township

GOLDEN PLAINS WIND FARM
Figure G4: Predicted wind turbine noise levels for Vestas V162 WTG at 6m/s - Centre

PROJECT NUMBER	M180934
DRAWN BY	JC2
DATE ISSUED	February 2021
CLIENT	Golden Plains Wind Farm Management Pty Ltd
LAYOUT RECEIVED	12 November 2020
IMAGERY	(c) Google

Legend

- Site Boundary
- WTG

Receivers
- Stakeholder
- House
- School
- Child Care

35 dB LA90 contour at 6 m/s
- 35 dB

High amenity zones
- LDRZ
- Township Zone

0 1 2 3 km

Datum WGS 84, Projection UTM ZONE 54S

Resonate

www.resonate-consultants.com

Appendix H—Berrybank Wind Farm coordinates

Table H1 Berrybank Wind Farm WTG coordinates

WTG ID	Easting	Northing	WTG ID	Easting	Northing
1	719751	5802721	36	725624	5797870
2	719252	5802580	37	720611	5796396
3	718723	5802176	38	719092	5795312
4	719266	5801952	39	719710	5795545
5	719967	5802221	40	720518	5795662
6	719652	5801705	41	720985	5795834
7	720348	5801559	42	721359	5795356
8	719008	5801346	43	720275	5795050
9	719580	5801302	44	719538	5794878
10	720545	5801081	45	719076	5794661
11	720545	5801081	46	719929	5794535
12	722364	5800847	47	720541	5794620
13	722780	5800575	48	721109	5794788
14	721859	5800552	49	721955	5795028
15	721251	5800323	50	722543	5794720
16	722296	5800211	51	722034	5794531
17	721740	5799891	52	721000	5794218
18	721258	5799760	53	720489	5794103
19	720733	5799429	54	721277	5793851
20	722817	5799718	55	721790	5793869
21	721057	5798686	56	722289	5794039
22	720062	5798490	57	721681	5793316
23	719710	5798063	58	722325	5793119
24	719453	5797154	59	721893	5792827
25	719954	5797147	60	721387	5792340
26	721076	5797527	61	722753	5792881
27	721921	5797435	62	722532	5792519
28	722535	5797663	63	722975	5792402
29	722922	5798109	64	720387	5791255
30	723772	5798717	65	720387	5790743
31	724851	5798766	66	720424	5790132

WTG ID	Easting	Northing	WTG ID	Easting	Northing
32	724250	5798189	67	717354	5793181
33	723942	5797816	68	717057	5792757
34	724683	5797804	69	717508	5792561
35	725133	5797978	70	717031	5792379

Friday, 19 March 2021

Project number: M180934
Reference: M180934LT11

Kyle Sandona
WestWind Energy Pty Ltd
Office 4, Nexus Centre 17 Goode Street
Gisborne VIC 3437

Dear Kyle,

Golden Plains Wind Farm
Predicted wind turbine noise levels for 8 m/s in Township Zone and Low Density Residential Zone

As requested, we provide predictions of wind turbine noise levels from Golden Plains Wind Farm at noise-sensitive land uses within the Township Zone and Low Density Residential Zone (LDRZ) around Rokewood.

The predictions have been conducted for:

- A hub height wind speed of 8 m/s.
- The GE 6.0-164 WTG with sound power level as per Table 1.
- Eight different wind direction sectors, with directivity corrections applied as per the UK Institute of Acoustics *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (Good Practice Guide).

Table 1 GE 6.0-164 WTG sound power level spectrum

Wind speed	Sound power level in dB L_{WA} at octave band centre frequency in Hz									Overall
m/s	31.5	63	125	250	500	1000	2000	4000	8000	dB L_{WA}
8	77.3	86.5	92.4	97.3	99.6	100.6	98.0	91.0	76.0	105.5

The prediction methodology and parameters are presented in detail in our Noise and Vibration Assessment prepared for the Golden Plains Wind Farm Planning Permit Amendment Application.[1]

The predicted noise levels are shown in Table 2 on the following pages for each identified noise-sensitive location within the Township Zone and LDRZ around Rokewood. The predictions are shown for each of eight wind direction sectors, with the maximum and minimum predicted noise level for any sector shown for each location.

[1] Resonate, 15 March 2021, *Golden Plains Wind Farm—Planning Permit Amendment Application—Noise and Vibration Assessment*, M180934RP10E

Table 2 Predicted noise levels at noise-sensitive locations in LDRZ and Township Zone for 8 m/s

ID	Predicted wind turbine noise level at 8 m/s for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
Q31 – e	30.3	31.8	33.1	33.9	34.2	33.3	31.9	30.5	34.2	30.3
Q31 – f	30.2	31.6	32.9	33.9	34.3	33.5	32.2	30.8	34.3	30.2
Q31 – g	30.2	31.7	33.0	33.9	34.3	33.5	32.1	30.7	34.3	30.2
Q31 – h	30.2	31.8	33.1	34.0	34.4	33.5	32.1	30.7	34.4	30.2
Q31 – i	30.5	31.9	33.3	34.1	34.5	33.5	32.2	30.8	34.5	30.5
Q31 – j	30.5	31.9	33.3	34.1	34.4	33.5	32.2	30.8	34.4	30.5
Q31 – k	30.5	32.0	33.3	34.1	34.5	33.5	32.2	30.8	34.5	30.5
Q31 – l	30.5	32.1	33.3	34.2	34.5	33.5	32.1	30.7	34.5	30.5
Q31 – m	30.7	32.0	33.4	34.3	34.6	33.7	32.4	31.0	34.6	30.7
Q31 – o	32.1	33.5	34.8	35.4	35.6	34.6	33.4	32.1	35.6	32.1
Q31 – p	32.1	33.4	34.4	35.2	35.5	34.6	33.2	32.1	35.5	32.1
Q32 – g	29.8	31.2	32.6	33.5	34.0	33.2	31.9	30.4	34.0	29.8
R31 – aa	32.2	33.9	35.1	35.6	35.7	34.5	33.2	31.9	35.7	31.9
R31 – ab	32.6	34.3	35.3	35.9	35.9	34.9	33.6	32.4	35.9	32.4
R31 – ad	33.5	35.2	36.2	36.7	36.5	35.6	34.2	33.1	36.7	33.1
R31 – ai	33.2	34.5	35.5	36.1	36.2	35.2	33.9	32.8	36.2	32.8
R31 – aj	32.4	34.0	35.1	35.8	35.9	34.8	33.5	32.2	35.9	32.2
R31 – ak	32.4	34.1	35.2	35.8	35.8	34.8	33.5	32.2	35.8	32.2
R31 – al	32.3	33.9	34.9	35.6	35.7	34.7	33.3	32.1	35.7	32.1
R31 – am	31.9	33.5	34.6	35.3	35.5	34.5	33.0	31.7	35.5	31.7
R31 – an	31.7	33.3	34.4	35.1	35.3	34.4	32.9	31.6	35.3	31.6
R31 – ao	31.5	33.0	34.2	35.0	35.2	34.3	32.8	31.5	35.2	31.5
R31 – ap	32.6	34.4	35.3	35.9	35.9	34.8	33.5	32.4	35.9	32.4
R31 – aq	32.4	34.0	35.2	35.8	35.7	34.7	33.3	32.1	35.8	32.1
R31 – ar	32.4	34.2	35.2	35.8	35.8	34.8	33.4	32.2	35.8	32.2
R31 – as	32.1	33.9	35.0	35.6	35.6	34.6	33.2	31.9	35.6	31.9
R31 – at	32.2	34.1	35.1	35.7	35.7	34.6	33.2	32.0	35.7	32.0
R31 – av	32.0	33.9	34.9	35.5	35.5	34.5	33.1	31.8	35.5	31.8
R31 – aw	31.9	33.7	34.8	35.4	35.4	34.4	33.0	31.7	35.4	31.7

ID	Predicted wind turbine noise level at 8 m/s for wind direction sector with GE 6.0-164 WTG, dB L_{A90}								Maximum / minimum predicted level for any sector, dB L_{A90}	
	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW	Maximum	Minimum
R31 – ax	32.0	33.7	34.9	35.5	35.5	34.5	33.1	31.9	35.5	31.9
R31 – az	32.0	33.7	34.9	35.5	35.6	34.4	33.0	31.7	35.6	31.7
R31 – b	32.5	34.2	35.3	35.8	35.9	34.7	33.2	32.0	35.9	32.0
R31 – ba	32.5	34.1	35.3	35.8	35.9	34.7	33.3	32.0	35.9	32.0
R31 – bb	31.6	33.3	34.4	35.1	35.2	34.2	32.8	31.5	35.2	31.5
R31 – bc	31.7	33.4	34.5	35.2	35.3	34.3	32.8	31.5	35.3	31.5
R31 – bd	31.7	33.4	34.5	35.2	35.3	34.3	32.8	31.6	35.3	31.6
R31 – be	34.2	35.5	36.5	37.0	36.9	35.8	34.4	33.5	37.0	33.5
R31 - bf	30.2	32.0	33.1	34.0	34.4	33.4	31.9	30.5	34.4	30.2
R31 - c	31.4	32.9	34.1	34.9	35.0	34.2	32.7	31.4	35.0	31.4
R31 - d	32.4	34.2	35.3	35.8	35.9	34.8	33.2	32.0	35.9	32.0
R31 - f	31.7	33.2	34.4	35.1	35.3	34.3	33.0	31.7	35.3	31.7
R31 - g	31.9	33.6	34.7	35.3	35.4	34.5	33.0	31.8	35.4	31.8
R31 - h	31.7	33.4	34.6	35.2	35.3	34.4	33.0	31.7	35.3	31.7
R31 - j	31.5	33.3	34.5	35.1	35.2	34.2	32.8	31.5	35.2	31.5
R31 - k	31.5	33.2	34.4	35.1	35.1	34.1	32.8	31.5	35.1	31.5
R31 - n	31.3	33.2	34.2	34.9	35.0	34.1	32.6	31.3	35.0	31.3
R31 - q	29.7	31.6	32.8	33.7	34.1	33.1	31.6	30.2	34.1	29.7
R31 - r	31.1	32.7	33.9	34.7	34.9	34.0	32.6	31.2	34.9	31.1
R31 - s	31.2	32.7	33.9	34.7	34.8	34.0	32.5	31.2	34.8	31.2
R31 - t	31.2	32.9	34.0	34.7	34.9	34.0	32.5	31.1	34.9	31.1
R31 - u	31.3	32.9	34.1	34.8	34.9	34.0	32.6	31.2	34.9	31.2
R31 - v	31.3	33.0	34.1	34.8	35.0	34.0	32.6	31.3	35.0	31.3
R31 - w	31.4	33.1	34.2	34.9	35.0	34.1	32.6	31.3	35.0	31.3
R31 – z	31.6	33.3	34.4	35.1	35.2	34.3	32.8	31.5	35.2	31.5
R32 – d	29.7	31.5	32.8	33.6	34.1	33.0	31.5	30.0	34.1	29.7

Please let me know if you have any queries or wish to discuss the above.

Yours sincerely,

Tom Evans
Technical Director
p+61 3 9020 3888
p+61 421 279 929
tom.evans@resonate-consultants.com

Copy To:
simonc@w-wind.com.au

INFORMATION REGARDING ENVIRONMENTAL AUDIT REPORTS

August 2007

VICTORIA'S AUDIT SYSTEM

An environmental audit system has operated in Victoria since 1989. The *Environment Protection Act 1970* (the Act) provides for the appointment by the Environment Protection Authority (EPA Victoria) of environmental auditors and the conduct of independent, high quality and rigorous environmental audits.

An environmental audit is an assessment of the condition of the environment, or the nature and extent of harm (or risk of harm) posed by an industrial process or activity, waste, substance or noise. Environmental audit reports are prepared by EPA-appointed environmental auditors who are highly qualified and skilled individuals.

Under the Act, the function of an environmental auditor is to conduct environmental audits and prepare environmental audit reports. Where an environmental audit is conducted to determine the condition of a site or its suitability for certain uses, an environmental auditor may issue either a certificate or statement of environmental audit.

A certificate indicates that the auditor is of the opinion that the site is suitable for any beneficial use defined in the Act, whilst a statement indicates that there is some restriction on the use of the site.

Any individual or organisation may engage appointed environmental auditors, who generally operate within the environmental consulting sector, to undertake environmental audits. The EPA administers the environmental audit system and ensures its ongoing integrity by assessing auditor applications and ensuring audits are independent and conducted with regard to guidelines issued by EPA.

AUDIT FILES STRUCTURE

Environmental audit reports are stored digitally by EPA in three parts: the audit report (part A), report appendices (part B) and, where applicable, the certificate or statement of environmental audit and an executive summary (part C). A report may be in colour and black-and-white formats. Generally, only black-and-white documents are text searchable.

Report executive summaries, findings and recommendations should be read and relied upon only in the context of the document as a whole, including any appendices and, where applicable, any certificate or statement of environmental audit.

AUDIT REPORT CURRENCY

Audit reports are based on the conditions encountered and information reviewed at the time of preparation and do not represent any changes that may have occurred since the date of completion. As it is not possible for an audit to present all data that could be of interest to all readers, consideration should be made to any appendices or referenced documentation for further information.

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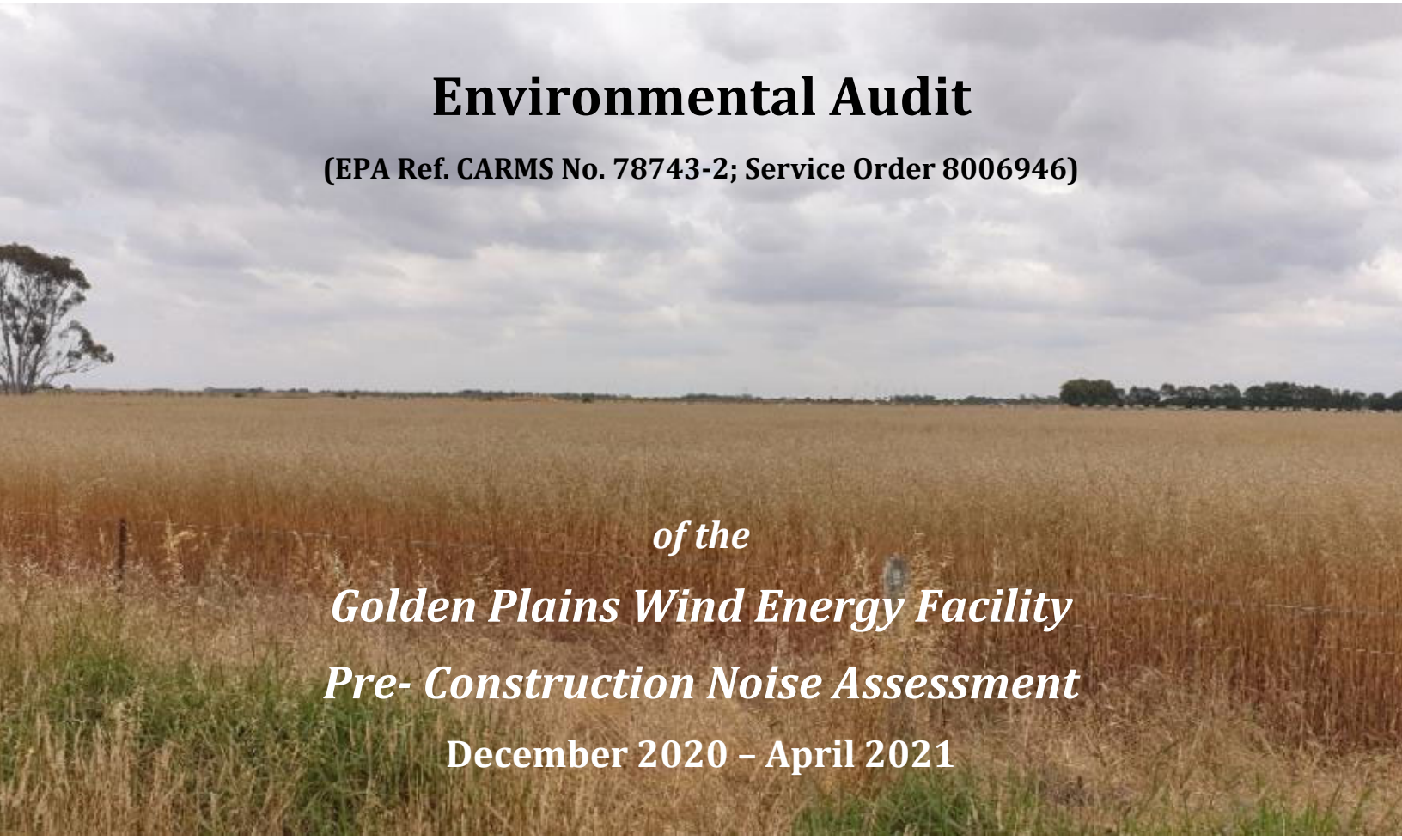

Environmental Audit

(EPA Ref. CARMS No. 78743-2; Service Order 8006946)

of the

Golden Plains Wind Energy Facility

Pre- Construction Noise Assessment

December 2020 – April 2021

for

Golden Plains Wind Farm Management Pty Ltd

GENERAL INFORMATION

Report Descriptor:	Descriptor: r_GoldenPlains_Rokewood_PreConstruction_210409_R1
Title:	Environmental Audit of the Golden Plains Wind Energy Facility Pre-Construction Noise Assessment
Completed By:	
Name:	Stephen Jenkins BAppSci GradDipMgt. CEnvP, MAAS, FEIANZ
Company Details:	EnviroRisk Management Pty Ltd ABN 24 069 947 904 www.envirorisk.com.au
Appointments/ Certifications	Auditor appointed pursuant to the Environment Protection Act 1970
Report(s) Subjected to Audit	
Noise Compliance Assessment Report(s)	Golden Plains Wind Farm Environmental Noise Assessment Rp 002 20200919 23 March 2021, Marshall Day Acoustics Pty Ltd
Report Distribution:	
Stephen Jenkins	EnviroRisk Management Pty Ltd (Master Copy)
Kyle Sandona	Project Manager, WestWind Energy Pty Ltd

Revision	Summary of Amendments	Reviewed by	Issued by	Issue Date
0		D Dolly	S Jenkins	6/01/21
1	Addition of 2nd candidate GE turbine	L Nethercott	S Jenkins	13/04/21
2	Added commentary to 'Figures' title page	L Nethercott	S Jenkins	

AUDITING METHOD

The audit is based on a systematic examination of a pre-construction noise assessment report. It specifically reviews wind turbine noise and does not review site construction noise nor external to turbine sub-station generated noise.

The auditor has used an *'evidence based approach*' as provided for in AS/NZS ISO 19011:2018 Guidelines for Auditing Management Systems, predominantly via interrogation of information and data provided within the provided report, supplementary information provided upon request and from communications directly with the report's author and the proponent planning specialist.

Information presented within the audit report relies on:

- the completeness and accuracy of records, information, plans, data and discussion contained within the report or made available to support review enquiries; and
- the accuracy and completeness of subsequent information provided during an communications with the proponent and report author(s);

The auditor has not conducted monitoring themselves nor performed any data analysis from simulation modelling. There was, however, interrogation of the technical content of the report, enquiries relating to modelling input and quality assurance processes and communications with personnel who prepared the acoustic report and with the proponent.

The report should only be reproduced and distributed in full.

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ABBREVIATIONS

ABBREVIATION	WORD/PHRASE
AS/NZS	Australian and New Zealand Standard
EPA	Environment Protection Authority
DELWP	Department of Environment Land Water and Planning, Victoria
m/sec	meters per second
NMP	Noise Management Plan
NSL	Noise Sensitive Locations
NZS	New Zealand Standard
SAC	Special Audible Characteristics
WEF	Wind Energy Facility

DEFINITIONS

Standard:
New Zealand Standard NZS 6808:2010 Acoustics – Wind farm noise

Noise Sensitive Location (source NZS 6808:2010):
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 include:
(a) Any part of land zoned predominantly for residential use in a district plan;
(b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f)
(c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities, papakainga and marae, excluding habitable spaces in buildings where the predominant activity is commercial or industrial. (Residential buildings designed for permanent habitation on land zoned for predominantly rural or rural-residential use are not classified as commercial or industrial for the purposes of this Standard);
(d) Teaching areas and sleeping rooms in educational institutions, including public and private primary, intermediate, and secondary schools, universities, polytechnics, and other tertiary institutions;
(e) Teaching areas and sleeping rooms in buildings used for licensed kindergartens, childcare, and day-care centres; and
(f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.

Stakeholder dwelling – a dwelling on the wind energy facility site, or one that has a written agreement with the WEF to exceed the noise limit as specified under the Standard.

Micro-siting:
- within 100m in any direction from the centre of the turbine at ground level as shown on the endorsed development plans.

EXECUTIVE SUMMARY

Table 1: Summary of Audit Information

EPA File reference no.	CARMS No. 78743-2
Auditor	Stephen Jenkins
Auditor account number	75700
Auditor appointment end date	1 November 2021
Audit type	Section 53V Risk of Harm
Date EPA notified	22/03/2021
Audit service order number	8006946
Name of person requesting audit	Kyle Sandona
Relationship to premises/location	Project Manager
Name of premises owner	Lease agreements between landowners and Golden Plains Wind Farm Management Pty Ltd or its related entities.
Date of Auditor engagement	22/03/2021
Completion date of the audit	13/04/2021
Reason for Audit	Wind energy facility pre-construction noise compliance and risk of harm assessment.
Audit characterisation	Golden Plains Wind Energy Facility (WEF) comprising 215x wind turbines based on noise characteristics equivalent or lower than the candidate turbines assessed namely: Vestas V162-6.0MW version PO6000 & GE Cypress 6.0(MW)-164.
Environmental Segments	Noise at non-stakeholder premises
Current Land Use Zoning	Farming zone (FZ), Low Density Residential Zone (LDRZ) and Township Zone (TZ).
EPA Region	South-West
Municipality	Golden Plains Shire Council
Dominant – Lot on Plan	n/a
Site / Premises name	Golden Plains Wind Farm
○ Building/complex unit no	n/a
○ Street Name	n/a
○ Street type (road, court, etc)	n/a
○ Suburb	Rokewood (nearest town)
○ Postcode	3330
GIS Coordinate of Site centroid[1] ○ Latitude (*GDA94*) ○ Longitude (*GDA94*)	-37.943055 143.732222
Member & category of support team	David Dolly, acoustics (noise modelling)
Further work or requirements	It is recommended the Responsible Authority assess the applicability of whether a high amenity noise limit may be justified within the high amenity zones during the evening and night periods for wind speeds above 6 m/sec. If so, additional background noise data should be attained during the summer months to derive an appropriate noise limit under the Standard. Note: Should a high amenity noise limit be deemed to be applicable for 8 – 10 m/sec hub height wind speeds, and the background noise confirmed low via additional monitoring, compliance is not predicted for either candidate turbine.

[1] Longitude and latitude (decimal degrees) co-ordinates in the 1994 Geocentric Datum of Australia (GDA94) is required to six decimal places. In the case of a WEF it is the point nominated by the proponent as representing the facility location.

	It is recommended best practice noise control be considered in the final selection process for the turbines, as one candidate turbine is notably quieter and predicted to readily comply, whilst the other achieves a marginal level of compliance. It is recommended should turbine positions vary towards a non-stakeholder's dwelling, including as a result of micro-siting where an increase could occur at any NSL currently predicted above 38 dB L_{A90}, an updated predictive noise compliance assessment should be completed prior to construction. This report should be subjected to a S53V environmental audit.
Nature and extent of continuing risk	Nil (the wind energy facility is yet to be constructed).

1. Approximate centroid used as provided by proponent.

Outcome of the Audit

I have audited the pre-construction noise compliance assessment report and associated technical reports, including turbine sound power data and background noise monitoring, against the compliance criteria specified in *NZS 6808:2010 Acoustics - Wind farm noise* (the Standard), and with reference to Victorian guidelines on wind energy facilities and relevant EPA advice and guidance materials.

The noise assessment report has made predictions at noise sensitive locations against:

a) a base high noise amenity limit of 35 dB L_{A90} within the Low Density Residential Zone and the Township Zone for the evening and night periods for wind speeds of 6 m/sec and lower, as these zones have been specified in the Planning Permit as 'high amenity areas for the purposes of the Standard'. For wind speeds above 6 m/sec and during the day period a noise limit of 40 dB L_{A90} has been applied.

b) a base standard noise amenity noise limit of 40 dB L_{A90} within a Farming Zone and the Public Use Zone (i.e., School & Child Care facility) as defined within the local planning scheme. This compliance limit is deemed appropriate considering EPA advice considers zones, such as a Farming Zone, do not attract a high noise amenity limit unless there is a plan made under the planning scheme that specifies otherwise.

The audit has interrogated the technical reports on noise from the candidate turbine suppliers Vestas and GE, reviewed the rigor of the modelling process, reviewed the separate background noise monitoring report, assessed considerations on uncertainties, reviewed low noise mode options, sought further clarifications within the report on noise compliance within the high amenity areas, and gained an appreciation of the locality based on a site inspection and aerial imagery.

The audit has considered cumulative noise from the nearby Berrybank wind energy facility and concurs with the noise assessment report's determination that it will not influence noise compliance predictions at noise sensitive locations surrounding the Golden Plains WEF.

I confirm the noise assessment report has been prepared against the Standard and that compliance is predicted against the noise limit of 40 dB L_{A90} at non-stakeholder noise sensitive locations in the Farming and Public Use zones, and 35 dB L_{A90} within the Low Density Residential and Township zones for the evening or night periods when winds are at 6m/sec or lower, which is in strict accordance with the wording of the Standard. A compliant outcome against the Standard supports a finding that noise will not present an unacceptable risk of harm.

An evaluation of predicted compliance against a 35 dB L_{A90} limit within the declared high amenity zones for wind speeds above 6m/sec during the night period was also considered given the Standard has ambiguity in its wording relating to the wind speed threshold. Section 5.3.2 of the Standard states:

'*it is recommended that the high amenity noise limit should apply when the wind farm wind speed is 6m/s and lower. An alternative wind farm wind speed may be applied where justified on meteorological, topographic and acoustical grounds.'*

Under a strict word interpretation of that written in the Standard, if there are no topographical grounds to justify an alternative wind farm speed, which for the Golden Plains WEF there is not, then there is no justification to consider higher wind speeds even if the other conditions are satisfied.

However, this may not have been the intent of the Standard. Given that the noise from turbines is greater at wind speeds above 6m/sec yet the background noise may continue to remain low, the potential for impact within the declared high amenity area remains prominent during winds above 6 m/sec (as measured at the turbine hub height).

The audit has therefore not confirmed a noise limit within the high amenity areas for potentially applicable hub height wind speeds greater than 6 m/sec. Modelling for both turbines predicts that noise can exceed the base 35 dB L_{A90} compliance limit at several locations in the declared high amenity zones during hub height wind speeds at and above 8 m/sec. As an example, at an 8 m/sec hub height wind speed, a predicted noise level at location marked R31-be of 35.6 dB L_{A90} is made under the Vestas candidate turbine scenario, and 37.0 dB L_{A90} under the GE candidate turbine. Furthermore, a noise level of over 37 dB L_{A90} is predicted at this location for both candidate turbines during hub height wind speeds of 10 m/sec.

Background noise monitoring is relevant to determine whether a high amenity noise limit is likely to be justified. Although background monitoring was undertaken during April to August 2019 to address conditions within the Planning Permit with data reported in a series of charts, further background noise monitoring during the summer period, when southerly winds are likely to be more prevalent, is necessary to assess whether a high amenity limit is justified based on the representative average background noise level. Extrapolation of the limited data available reveals low background conditions are possible associated with south-south easterly (SSE) wind directions and hub height wind speeds up to 10 m/sec.

With consideration to the gap in seasonal background noise data and the ambiguities of the Standard, the applicability of wind speeds above 6 m/sec may be necessary in setting a night period high amenity noise limit for post-construction compliance monitoring and is recommended to be evaluated by the Responsible Authority. If the Responsible Authority determines it is required, additional background monitoring may need to be undertaken, interpreted, and reported in accordance with the Standard. If confirmed as low background, and the responsible Authority deems the high amenity noise limit to apply during hub height wind speeds that exceed 6 m/sec then turbines noise is predicted to exceed the high amenity noise compliance limit. Turbine noise management, curtailment and/or re-configuration will need to be implemented to achieve compliance.

Best practice noise control is required to be considered during the Audit. It is recognised that various factors warrant consideration during a best practice evaluation. However, based strictly on sound power levels, the Vestas candidate turbine is notably quieter than the GE candidate turbine option at a similar wind speed and power output. It is reasonable to deduce that such a turbine represents the better example of best practice noise control technology that needs to be factored in during the turbine selection process and approval considerations by the Responsible Authority.

Operating the GE candidate turbines under a noise management mode may represent a best practice commitment to achieve compliance during wind conditions that warrant intervention. However, the adoption of best practice turbine noise control is considered to involve a technology component that achieves noise levels as low as reasonably practicable without compromising power constraints, with the objective being to sustain noise levels notably lower than solely achieving a noise compliance limit.

In this respect, it warrants stating that a noise level at the 40 dB L_{A90} standard amenity and the 35 dB L_{A90} high amenity base noise limits, as specified in the New Zealand Standard (and adopted under Victorian guidelines), means the wind turbine noise may at times be readily audible, particularly during hub height wind speeds that align with low background noise conditions at near ground level i.e. between 6 – 10 m/sec.

Table 2: Physical Site Information

Historic land use	Farming, Township, Residential
Current land use	Farming, Low Density Residential, Township, Public Use
Surrounding Land Use (N, S, E, W)	Farming
Proposed land zoning	To remain as zoned (within the 35dB L_{A90} contour)
Nearest surface water	Kuruc A Ruk Creek
Groundwater Segment	Not relevant for wind energy facility audit

Signed

Stephen Jenkins ENVIRONMENTAL AUDITOR (APPOINTED PURSUANT TO THE EP ACT 1970)

1.0 Introduction

This report describes the outcome of an environmental audit of the pre-construction noise compliance assessment report prepared by Marshall Day Acoustics titled 'Golden Plains Wind Farm Environmental Noise Assessment' (i.e., the noise assessment report) for the proposed Golden Plains wind energy facility (WEF), located south of Rokewood, Victoria.

This report has been prepared under Section 53V of the Environment Protection Act 1970 and discusses the potential for noise to represent a risk of harm at noise sensitive locations.

The audit was commissioned by Golden Plains Wind Farm Management Pty Ltd to fulfil obligations under the 'Development of Wind Energy Facilities in Victoria Policy and Planning Guidelines, Department of Environment, Land, Water and Planning (DELWP), March 2019'.

The specific item being audited is the noise assessment report prepared to demonstrate that the proposed wind energy facility can comply with the noise limits specified in the New Zealand Standard NZS6808:2010, Acoustics - Wind Farm Noise (the 'Standard'), including an assessment of whether a high amenity noise limit is applicable under Section 5.3 of the Standard.

The WEF is reported to comprise:

- 215 turbines (i.e., WTG 1 – 217; with no turbines labelled WTG 055 or 063) with sound level characteristics equivalent to candidate turbines namely:
  - Vestas V162-6.0MW (hub height of 149m and blade diameter of 162m); or
  - GE Cypress 6.0-164; (hub height of 148m and blade diameter of 164m).

2.0 Audit Components

2.1 Objectives

The objectives of the audit are to assess the noise assessment report and verify the assessment:

1. has been conducted in accordance with the 'Standard';

2. meets the requirements of the DELWP guidelines (with respect to noise compliance); and

3. provides sufficient data to establish that best practice has been integrated into the design and that noise represents an acceptable risk of harm.

EPA Victoria publication 1692 provides the following definition:

'Risk of harm in relation to WEFs is defined herein as the potential for noise generated by WEFs to impact upon nearby noise sensitive locations.'

Impact is taken to be noise that exceeds the compliance limits specified in the Standard.

In accordance with the Standard, a noise sensitive location (NSL) is not located on the wind farm site. For the purposes of this audit, a stakeholder property is deemed to be located on the wind farm site and is therefore, not captured by the Standard's noise compliance limits. As a stakeholder property is not considered a noise sensitive location, it has not been subjected to a risk of harm assessment.

2.2 Scope

The audit is to verify the compliance determination provided within the noise assessment report titled:

- Golden Plains Wind Farm Environmental Noise Assessment Rp 002 20200919 23 March 2021, Marshall Day Acoustics Pty Ltd.

A site inspection of the WEF's locality was conducted by the auditor on 17th December 2020.

2.2.1 Activity

The activity is the noise generated by wind turbine operation, as defined within the Standard, including any cumulative noise from adjacent wind energy facilities; either operating or under planning approval to develop.

2.2.2 Segment & Boundary

The segment being audited specifically relates to the noise being generated by the WEF with potential to impact on nearby noise sensitive locations.

The boundaries of the audit are the noise sensitive locations as identified in the acoustic assessment report within the 35 dB L_{A90} prediction contour for the Farming Zone and within the 30 dB L_{A90} for the Low Density Residential and Township Zones as these have been declared high noise amenity under the planning permit. Locations beyond these contour lines are not considered to be at a risk of harm from WEF noise.

Under best practice turbine design, operation and maintenance, and with consideration to the number and layout of the turbines and the nominated high amenity areas, the boundaries under audit generally lie within a 2 - 2.5km radius of the nearest wind turbine's centroid point to a noise sensitive location.

2.2.3 Element & Beneficial Uses

The element of the environment under consideration is the protection of human health and well-being from noise disturbance, annoyance and amenity loss.

The beneficial uses being protected are the normal domestic and recreational activities within a habitable space, including sleep, or an educational space in a building not on the WEF site.

2.2.4 Audit Period

The audit was conducted over the period: 14 December 2020 to 9 April 2021.

2.2.5 Criteria

The criteria used for the audit are specified in the New Zealand Standard, 6808:2010 Acoustics – Wind farm noise (NZS 6808:2010), which forms the 'Standard'.

Noise limits are defined in Table 2 of the Standard as:

Background sound level	Noise limit ($L_{A90(10\ min)}$)	High amenity noise limit ($L_{A90(10\ min)}$)
> 35 dB	background + 5 dB	background + 5 dB
30 – 35 dB	40 dB	
< 30 dB		35 dB

Notes:

Where a high amenity noise limit is shown to be justified in accordance with 5.3.1 (of the Standard), under wind conditions determined in accordance with 5.3.2, wind farm sound levels ($L_{A90(10\ min)}$) during evening and night-time should not exceed the background sound level by more than 5 dB or a level of 35 dB $L_{A90(10min)}$, whichever is the greater. During daytime the noise limit in (section) 5.2 should always apply.

The Standard recommends that the wind farm noise limits should not be set lower than 35 dB $L_{A90(10min)}$ at any time.

Under section 5.3.2. 'A high amenity noise limit should only be applied, and can only be maintained, under wind conditions when low background sound levels are common at a noise sensitive location, while the wind farm is operating. Therefore, even when a high amenity noise limit is justified in accordance with 5.3.1 it is appropriate to restrict application of that limit by conditions of consent to wind conditions when the wind farm wind speed falls below a fixed threshold. It is recommended that the high amenity noise limit should apply when the wind farm wind speed is 6 m/s and lower. An alternative wind farm wind speed threshold may be applied where justified on meteorological, topographical, and acoustical grounds.

Reference has also been made to guidelines on windfarm noise including:

- EPA publication 1692, *Wind energy facility noise auditor guidelines, October 2018*; and
- DELWP Publication: *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria, March 2019.*

EPA advice dated 25 October 2019 relating to the application/assessment of a '*high amenity area noise limit'* as applicable under the planning framework, has been adopted in deriving noise limits.

Guidance was also obtained from EPA publications:

- *953.2 Environmental Auditor Guidelines for Conducting Environmental Audits,*
- 952.5 *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment, and*
- 1147.2 *Environmental Auditor Guidelines – Provision of Environmental Audit Reports, Certificates and Statement.*

International and Australian Standards referenced during the audit were:

- ISO 1996-1:2016 Preview. Acoustics – Description, measurement and assessment of environmental noise.
- ISO 1996-2:2017 Acoustics – Description, measurement and assessment of environmental noise.
- AS 1055.1:1997 Acoustics – Description and measurement of environmental noise.

Under the Development of Wind Energy Guidelines (DELWP, 2019) a '45 decibel limit' (sic) is recommended for stakeholder dwellings. This is taken to mean a 45 dB $L_{A90\ (10min)}$ limit. However, the risk of harm to stakeholder dwellings is not considered within the scope of this compliance and 'risk of harm' environmental audit as:

i. the stakeholder noise limit falls outside the Auditor Guidelines (EPA Publication 1692),
ii. the stakeholder noise limit, which is above the limit specified in the Standard, appears to have no technical basis to verify it represents an acceptable risk of harm, and
iii. the auditor understands stakeholder agreements are confidential and may include provisions for acceptance of noise levels that may not be consistent with the 'stakeholder recommended' limit.

The Standard specifies a level of 40 dB $_{LA90}$ being the 'limit' to provide protection from noise in the absence of background sound influence. A noise level of 45dB $_{LA90}$ will therefore, at times be clearly audible and capable of causing annoyance and hold potential for sleep disturbance. Noise at this level may therefore not protect the receptor from a risk of harm from noise and therefore cannot reasonably be included within a 'risk of harm' audit report.

2.2.6 Exclusions

The audit includes operational wind turbine noise assessed against the requirements of NZS 6808:2010: Wind farm noise. As such, it does not include other noise sources such as off-turbine substations, transformers, construction, and maintenance activities that are not integral with the wind turbine operation. These are better assessed against different standards and criteria (e.g., EPA's Noise from Industry in Regional Victoria guideline EPA Publication 1411; Noise Control Guidelines, EPA Publication 1254).

The audit is specific to the detail contained in the noise assessment report, and the subsidiary reports that were referenced. It relates to the number and configuration of wind turbines, the candidate turbine and the sound power ratings at respective octave frequency specifications and wind speeds as detailed within the reports reviewed.

The auditor has, as reasonably practicable, interrogated the process to identify relevant non-stakeholder noise sensitive locations (NSL) to ensure they are appropriately represented within the noise assessment reports; including reviewing the figures and tables that illustrate noise modelling compliance predictions and also obtaining written confirmation from the proponent that all NSL including non-stakeholder dwellings are accurately represented. Correspondence that they have been appropriately identified and referenced in the acoustic reports was received from the proponent and is included in Appendix 4. A site visit was also undertaken, and noise sensitive areas observed surrounding the proposed development.

As detailed above, stakeholder properties are excluded from the audit as they are not considered to be an NSL under the Standard.

2.3 Methodology

The following method was adopted for the review:

1. Communications with the client as to the audit process.
2. Notification of the audit to EPA.
3. Obtaining a complete copy of the noise assessment report subject to the audit.
4. Aerial photography check of potential receptors using NearMap™ and Google Earth.
5. Detailed review of the noise assessment report's modelling methodology, source data, predictions and methods adopted against the Standard.
6. Review of EPA advice and the Planning Permit in relation to planning based high amenity areas and their associated noise limit.
7. Communications with the proponent as to the identification and mapping of all relevant noise sensitive locations.
8. Attainment of technical noise reports on the candidate turbine and additional technical reports on background noise monitoring.
9. Data interrogation, review of the locality of noise sensitive locations in reasonable proximity to the predicted 40dB L_{A90} contour in the Farming Zone and 35dB L_{A90} in the Low Density Residential and Township zones.
10. Undertaking a site inspection of the proposed WEF area.
11. Interviews with the proponent and communications with the acoustic consultant regarding clarifications within the noise assessment report in respect to zoning specifications, background monitoring representativeness, the possible application of high amenity noise limits where justified above 6 m/sec wind speeds, and considerations relating to nearby wind farms and noise modelling.
12. Attainment of an updated report from the acoustic consultant that addressed the auditors raised items. Provision of a further report with a second candidate turbine.
13. Completion of the audit protocol including undertaking a qualitative risk of harm assessment.
14. Preparation and issue of the audit report along with the statutory audit fee.

2.4 Process

The audit was conducted in general accordance with auditing techniques specified within AS/NZS ISO19011:2014 *Guidelines for auditing management systems*.

The process undertaken included a review of the noise assessment report, an evaluation of the justification for a high amenity noise limit, assessment of the veracity of the modelling process and predicted noise levels, and a risk of harm assessment. The process aimed to establish whether the noise assessment report provides sufficient detail to support a declaration of compliance against the Standard.

A determination of the risk of harm from noise has been formed from both:

i. a direct conformance reference against the audit protocol 'criteria' contained in the tables provided within Appendix 1; and
ii. a risk assessment (refer Section 5).

The completed audit protocol that was prepared to assess conformance against the criteria, is provided in spreadsheets within Appendix 1 of this report. The appended spreadsheets list the audit criteria in the first two columns. The other columns list the auditor's findings in relation to being compliant with the requirement and observations and comments to substantiate (as needed) determinations of compliance or non-compliance against each criterion.

The protocol content should be read with reference to the relevant sections of the Standard (i.e., NZ6808:2010), EPA Guidelines, EPA advice and the DELWP Guidelines as relevant.

Compliance with the condition or requirement is rated Yes, No or other; whereby 'other' can include an item being 'Not Applicable (N/A)' as it is not within the scope, a 'Not Determined (ND)' outcome based on information made available in the report and ambiguities between the Standard and Guidelines, or 'Part Compliant (PC)' where the requirement has inherently several parts to it.

Where any qualification to a determination is required, it has been captured in the comments section of the tables. Where an issue has been identified in respect to content within the noise assessment report a situation that could represent a future risk of harm or interpretation against the Standard, a recommendation has been provided.

Sections that are not in the scope of this pre-construction compliance and risk of harm audit are identified as such. The rationale for exclusion from the scope is provided in the comments column where required, or in Section 2.2.6 above.

The audit process has included communications with the following stakeholders: EPA; the proponent, a resident met during the site tour; and the WEF acoustic consultants.

3.0 Noise Limits

The noise assessment report has adopted a 40 dB $L_{A90\ (10min)}$ base noise limit to be achieved at all times in the Farming Zone.

A 35 dB $L_{A90\ (10min)}$ base noise limit has been specified for the declared high noise amenity Low Density Residential and Township Zones during the evening and night periods for wind conditions at 6 m/sec and lower.

A standard noise amenity has been adopted outside these periods and conditions.

3.1 Consideration of a High Amenity Noise Limit

A determination as to whether a high amenity area noise limit was applicable is made within the noise assessment report (i.e., Section 7.1 Noise limits).

The Farming Zone is specified as a standard amenity with a 'noise criteria of 40 dB L_{A90} or background LA90 + 5dB, whichever is higher.'

In assessing whether the standard amenity is applicable for a Farming Zone, the auditor has made reference to relevant guidelines and advisory notes on the applicability of a high noise amenity.

EPA guidelines (Pub. 1692, 2018) state:

'The audit should include review of the assessment as it relates to:
- whether a high amenity noise limit is applicable, as assessed under Section 5.3 of the Standard following procedures outlined in clause C5.3.1 of the Standard. Where the Standard refers to a District Plan (or Plan) this shall be taken to mean a Scheme as defined within the VPPs."

Section 5.1.2 *Amenity of the surrounding area* within the Guidelines (DELWP, 2019), references Section 5.3 of the Standard to determine whether a '*high amenity noise limit' of 35 decibels may be justified in special circumstances*. This section further states '*All wind energy facility applications must be assessed using Section 5.3 of the Standard to determine whether a high amenity noise limit is justified for special locations, following procedures outlined in 5.3.1 of the Standard*'.

The terms 'special circumstances' and 'special locations' are not defined either within the DELWP guidelines (DELWP, 2019), the EPA noise auditor guidelines (EPA, 2018), nor the Standard (NZS 2010).

Furthermore, these guidelines reference a Tribunal report in that '*Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm*'.

Taking wording directly from this report:

"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.

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.[2]"

Under this outcome, land within a Farming Zone would appear to not fall within a 'high amenity area'.

The auditors opinion as to the relevance of a high amenity area is provided against each relevant element of the Standard below:
(*Note*: Clauses taken directly from Section 5.3 of the Standard: High Amenity Areas)

[2] Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors (Includes Summary) (Red Dot) [2013] VCAT 521. [108 - 109].

"5.3.1

The wind farm noise limit of 40 dB LA90(10 min) in 5.2 is appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations. 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.'

High amenity protection is therefore only relevant in 'special circumstance' during the evening and night period.

"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 LAeq(15 min) or 40 dBA L10."

The plan being referenced refers to the New Zealand planning schemes under the NZ Resource Management Act (as the Standard is taken from New Zealand). To interpret Australian planning schemes promotion of high amenity, the auditor sought and received advice from the EPA. EPA 'Advice and Supplementary Advice' dated 25 October 2019 was provided on how EPA appointed auditors are to interpret the Victorian planning schemes, namely:

"*For proposed wind energy facilities:*
When auditing an acoustic consultant's determination as to whether a high amenity limit ought to or not apply to an area, the following steps should be taken:
1. First determine whether there are zones associated with an expectation of acoustical amenity (i.e. used predominately for residential purposes), including Township Zone, present within the 35 dB LA90 (10 min).
2. Secondly, where the above zones are present, as per guidance in Section 5.3 of the NZS, confirm that background noise levels of the area are not affected by other specific sources, such as traffic noise. Additionally, check there are no agreements in place between stakeholders and WEF proponent in which case the HAL would not apply."

Noise sensitive locations not within the Township or Low Density Residential Zones situated within the predicted 35 dB L_{A90} fall within a Farming Zone and a Public Use Zone, which are not 'predominantly used for residential purposes.' As such, noise sensitive locations within these zones are not specifically within a high amenity area and therefore no high amenity noise limit warrants consideration unless it is specifically included under the planning scheme. Interrogation of the Planning Scheme (refer Figure 1) by the auditor did not identify any overlay nor reference to a high noise amenity area in the Farming Zone, nor the Public Use Zone.

It is noted that both NZS 6808:2010 and the Victorian Guidelines state that the high amenity limit would only be justified in 'special circumstances'. Considering large areas are Farming Zones, application of the high amenity limit to a Farming Zone would contradict the requirement that it only apply in special circumstances.

On the basis of the above, with particular consideration of the VCAT determination for the Cherry Tree Wind Farm proposal, it is apparent that the Planning Scheme does not envisage a higher level of amenity for most of the areas around the proposed WEF. Therefore, the high amenity limit has not been applied to noise sensitive land uses outside the declared 'high noise amenity areas' as specified in the Planning Permit.

It is noted that a number of noise-sensitive locations in the township of Rokewood are located in Low Density Residential and Township Zones.

'Section 7.1.1 High amenity' of the noise assessment report discusses the justification for a high amenity noise limit.

Condition 18.c.i. of the Planning Permit (PA1700266) issued April 2019, declares that the Low Density Residential and Township Zones are to be acknowledged as high amenity areas for the purposes of the Standard. A high amenity noise limit within these declared zones may be justified subject to it being restricted to the evening or night periods, and confirming the average difference between the predicted noise level and the measured background sound levels is more than 8 dB (i.e., Clause 5.3.1 of the Standard).

The noise assessment report has assessed the difference, which has been given the term Noise Perception Index (NPI) within the report, to assess the justification to apply a high amenity noise limit. The outcome in the report is that the difference is not greater than 8 dB and therefore the high amenity noise limit is unlikely to be justified.

Whilst the auditor has reservations as to whether a representative background noise is being used to derive the difference and assess justification of a high amenity noise limit, it is ultimately not relevant to this compliance and risk of harm audit. The reason being the noise assessment report then goes on to assess noise against the base noise limit of 35 dB L_{A90} within the high amenity area for hub height wind speed conditions of 6m/sec and lower (as is recommended in the Standard).

It is noted the Standard has ambiguity in its wording relating to the wind speed thresholds. Section 5.3.2 of the Standard states:

'*it is recommended the high amenity noise limit should apply when the wind farm wind speed is 6m/s and lower. An alternative wind farm wind speed may be applied where justified on meteorological, topographic and acoustical grounds.'*

There is no further guidance within the Standard as to what may constitute meteorological, topographic or acoustic grounds.

Under a strict interpretation of what is written however, an alternative wind speed would only be justified if all three conditions combined, that is meteorological, topographical and acoustical grounds, warranted review. The proposed GPWF is, in the main, relatively flat land with no topographical grounds to justify an alternative wind farm wind speed. Given the conjunction 'and' is used, a strict interpretation rules out consideration of other grounds.

However, it may not be the intent of the Standard to adopt such a strict interpretation.

Given that noise from the wind turbines is greater at hub height wind speeds above 6m/sec (i.e., at a wind speed of 9 m/sec the sound power is only 0.2 dB off the maximum sound power generated by a turbine), yet the background noise may continue to remain low (i.e., location Q31-p indicates a low average background noise level during the night period above 6 m/sec and potentially up to 10 m/sec wind speeds for most of the southerly direction wind segments (source Resonate, 2021)), the potential for impact within a high noise amenity area is enhanced during these conditions and therefore warrants further evaluation.

It is therefore recommended the Responsible Authority assess the applicability of when a high amenity noise limit may be justified at wind speeds above 6 m/sec.

The audit has therefore not confirmed a noise limit within the high amenity area for wind speeds between 6 m/sec and 10m/sec. Modelling predicts that noise can exceed the base 35 dB L_{A90} at several locations in the declared high noise amenity area predominantly within the 8 - 10 m/sec hub height wind speed range; with the highest predicted noise to occur at locations marked R31-be and R31-ad (i.e., for location R31-be a marginal excursion over the base noise limit of 35.6 dB L_{A90} at 8m/sec and at, or above, 37.7 dB L_{A90} at 9 - 10 m/sec hub height wind speeds for the Vestas turbine, and at, or above, 37.1 dB L_{A90} for hub height wind speeds equal to and greater than 8 m/sec for the GE candidate turbine).

In terms of compliance with the strict wording within the Standard, the auditor concurs with the approach taken within the noise assessment report, namely:

- a standard noise limit of 40 dB L_{A90} applies for noise sensitive locations within the Farming Zone (with consideration that background noise does not influence the compliance limit for predictive purposes); and

- a high amenity noise limit of 35 dB L_{A90} applies within the Low Density and Township Zones for wind speeds at 6 m/sec or lower during the evening and night periods.

- a standard noise limit of 40 dB L_{A90} applies at other times in the high amenity area and within the Public Use Zone where there is a school and a childcare facility.

4.0 Evidence

The evidence used to form conclusions are summarised within the completed audit compliance protocol that is provided in Appendix 1.

Specific comments against conditions of the guidelines are discussed below.

4.1 Assessment Against EPA Guidelines

4.1.1 Familiarisation with the WEF development proposal and planned operation

Details of the development proposal were specified within the noise assessment reports including sound power data provided by the manufacturers, details of a test report for a range of audible octave band SPL and the reported specification of an absence of any tonal noise or special audible characteristics associated with the turbines.

A map of the proposed turbine locations with predicted noise contours for both candidate turbines has been taken from the noise assessment report and reproduced in Figure 2.

A review of the proposed development locality was made using ground surveillance, Google Earth and Google Maps, NearMap™ imaging and from communications with the proponent and their acoustic consultants.

4.1.2 Inspection of the WEF project site and the surrounding environment

A site inspection was made by the auditor to familiarise himself as to the project site and surrounds on 17th December 2020.

4.1.3 Assessment of the rigour of the process used to identify noise sensitive locations

The WEF covers a large area with a number of non-stakeholder properties falling within the predicted 35dB L_{A90} to 40dB L_{A90} noise contours (refer Figure 2).

Interviews were held with the proponent to establish the process used to identify non-stakeholder properties. A site tour was made of Rokewood and its surrounds. A list of locations visited being provided in the Appendix 5.

Given the challenges presented by the auditor to ground truth the identification of all NSL's, the auditor requested and received a statement from the proponent that the noise assessment report has appropriately captured all relevant NSL's and stakeholder dwellings. This communication is provided in Appendix 4.

The auditor is therefore satisfied that the process followed to identify non-stakeholder properties for the purpose of noise assessment to be rigorous and complete.

4.1.4 Review of the pre-construction noise assessment considering the WEF development proposal and operations

The guidelines specify the following items warrant consideration during the audit:
- turbine technical specifications and power ratings;
- tower locations;
- topography;
- transformer stations[3];
- any other relevant factors.

The noise assessment report identifies that the WEF's candidate turbines will comprise the Vestas 162-6.0MW (PO6000) and the GE Cypress 6.0-164.

This Vestas turbine variant is reported to have serrated tail edge (STE) inclusions on the blade. Noise emission data indicates the adoption of STE reduces noise from non-STE blades and would therefore represent best practice on blade noise control for the candidate options. No mention is made of whether serrated blades are included on the GE candidate.

[3] Discussions with the proponent reveal some transformers are integrated within the turbine structure and therefore form part of the noise curves and test data provided as source information for noise modelling. External to turbine sub-station transformers have not been included in noise predictions.

The contour maps provided as Figures 1 – 6 in the noise assessment report are considered a realistic representation of noise levels predicted from the WEF with respect to the candidate turbine. A terrain elevation map is provided in Appendix E of the noise report. The locality generally is relatively flat across the entire WEF. A slight rise occurs to the far south-east.

Assumptions, such as ground attenuation and the absence of tonality, appear reasonable based on the auditor's experience with operational wind energy facilities.

Communications with the acoustic consultant clarified some technical aspects of the modelling process, assessment of the high amenity noise limit and details on the background monitoring. Previously communications relating to internal quality checks were adopted for the audit.

The source information fed into the SoundPlan V8.2 model used to predict noise levels at locations surrounding the wind farm is deemed to be appropriate. Details of the review against the model are provided within the audit protocol in Appendix 1.

4.1.5 Review of background noise assessments (if available).

Background noise was determined by Resonate via monitoring during April – August in 2019 [Resonate, 2020]. The information within the background noise report comprised only charts of polynomials under various wind rose directions. A review of these regression curves reveals background noise can be low up to 10 m/sec; particularly during winds with a southerly component.

The background polynomials indicated a discernible difference between locations Q31-p (LZRZ) and R31-ad (TZ). The site inspection by the auditor revealed the locations to be similar in distance from the township and the roads. There were no obvious reasons for this discrepancy, and it was not discussed within the background nor the noise assessment reports. It was noted however that background noise monitoring occurred during the Autumn and Winter months: location Q31-p being monitored between April – May with R31-ad between July and August.

The seasonal difference may explain these differences considering southerly winds are generally more prevalent over the warmer period, particularly the summer month mornings (source: Bureau of Meteorology, Geelong, Sheoaks and Horsham wind rose data). This is of importance as the WEF is located to the south of the declared high noise amenity area and to be truly representative should include summer data.

The technical basis for the data presented within the background report[4] was minimal with several aspects of the Standard requirements not being included. This includes microphone

[4] The Resonate 2020 report also contained information on compliance predictions, both for the turbine and ancillary plant and equipment. This information did not form part of the scope of the audit. A sample of noise sensitive locations however, noted compliance modelling predictions for the Vestas turbine noise within 0.1 dB of the predictions made in the noise assessment report.

placement, calibration details, provision of scatter plots, and the type of sound level meter used was not included.

The background noise report was therefore not auditable.

However, the absence of this quality assurance information within the background noise report is not considered to detract from the audit as the noise assessment report opted to use the base noise compliance standards. By using the base noise compliance limits background data is not essential for noise compliance predictions.

Low background noise means that wind turbine noise may, at times, be distinctive. Night period background testing indicates the base noise compliance limit is relevant up to and including a hub height wind speed of 9 m/sec within the Farming Zone. It may also mean the high amenity noise limit is justified being at or greater that 8[5] dB L_{A90}.

The noise assessment report adopted the minimum applicable noise limit of 40dB L_{A90} under all wind speeds as the compliance objective for all NSL's within a Farming Zone. As EPA advice supports a standard noise amenity within a Farming Zone, this approach is reasonable to control a risk of harm and is accepted as an appropriate response.

4.1.6 Technical verification of the predictive noise assessment

The following items were evaluated by the auditor:

- methodology applied to conduct the assessment,
- base technical reports where input data was sourced,
- noise monitoring equipment and parameters used (as relevant for background),
- sound modelling programs employed, and
- verification that the assessment was conducted in line with the Standard.

A line- item review of technical considerations against items specified within the Standard is provided within the audit protocol (refer Appendix 1).

The EPA guidelines [EPA, 2018] specify an additional item that warrants review, namely:

- Review of identified potential noise impacts and any operational plans to manage the impacts (e.g., select turbines operating in reduced power modes during certain wind conditions) that are proposed as part of the WEF permit application.

No operating nor management plans are attached to the noise assessment report. It is noted that micro-siting is permitted under the Planning Permit (i.e., up to 100m). Given that this can result in turbines being repositioned closer to a noise sensitive location, micro-siting may present additional risk. A re-evaluation of compliance may become necessary if more than one turbine, in reasonable proximity to an NSL, is relocated closer as a result of micro-siting.

[5] The Standard does not include the integer 8 dB in its determination pathway; it states less than or more than but not equivalent to. To be conservative, the equal to has been added as part of the 'justification' process.

4.1.6.1 Cumulative Impact Considerations

Cumulative noise impact is relevant as there is a nearby windfarm to the west that has been constructed yet is not currently operational (i.e., Berrybank wind farm).

The noise assessment report includes commentary and modelling to reveal whether the 30dB L_{A90} noise prediction contours overlap. It was found that at one point only was there a marginal overlap and this was at a location without a nearby NSL. The absence of a significant overlay of the 30 dB contours coupled with the predictions assuming a conservative downwind propagation indicate no discernible influence on the risk of harm from noise. When directionality is considered, the Berrybank WEF contribution is not expected to alter noise level compliance against the noise limit.

The auditor confirms the process followed to be accurate and that no cumulative effect impacts the predictive compliance modelling.

4.1.6.2 Topographical Influences

Topographical influences were reported to be integrated into the model based on the terrain 'heat map' provided in the noise report. The topography around Rokewood is essentially flat to slightly undulating within the 35 L_{A90} contour and does not markedly influence noise predictions. It is noted however topographical influences have been included in the model with variations in the 30 dB L_{A90} contour to the west and north.

4.1.6.3 Noise Spectrum for Candidate Turbines

The noise assessment report references technical data from both Vestas and GE. These confidential technical reports were accessed and reviewed. The raw technical data on the turbines was confirmed to reflect data that was adopted into the modelling at a wind speed of 10 m/sec that equates to a maximum SPL.

Serrated tail edges were presented as an option for the Vestas blades and the proponent confirmed this candidate turbines will have serrated tail edges to minimise noise. This represents best practice and has been adopted within the modelling for this candidate turbine. No detail was provided on whether serrated edge blades would be included on the GE candidate.

Third octave charts were provided by Vestas and GE that were reported to reflect the V162-6.0MW PO600 mode and the Cypress GE 6.0-164 turbines used in modelling. It was noted the data provided for the Vestas was extracted from the V136 turbines as results are not available for the V162 variety, and the GE turbine third octave data was generated for turbines with a hub height of 112m and not 148m. In the absence of actual data this represents a reasonable approach so long as an uncertainty allowance is integrated into the modelling. This has occurred with a 1 dB allowance included within the noise modelling for the Vestas candidate, and a 0.8 dB uncertainty allowance added to the GE turbine. However, the final selected turbine will need examining to confirm the accuracy of the predictive modelling source data.

4.1.6.4 Effect of Turbine Changes Should 100m Micro-siting Occur

The Planning Permit allows for micro-siting of up to 100m.

Such a change would alter compliance predictions at several locations for the GE candidate turbine. For instance, the following locations may have their compliance influenced by micro-siting: K27-a/ W28-a (39.5 dB L_{A90}), W27-i (40.0 dB L_{A90}), P31-a/ P31-c (39.8 dB L_{A90}). Q30-a (39.7 L_{A90}), and H32-a (39.9 dB L_{A90}).

For the Vestas candidate turbines, compliance predictions would only alter should several turbines move closer towards a noise sensitive location whereby the currently predicted noise is above 38 dB L_{A90}, for instance locations W27-i (38.4 dB L_{A90}), P31- a/ P31 - c (38.3 dB L_{A90}) and Q30 – a/ H32-a (38.2 dB L_{A90}) (refer Figure 2).

A recalculation should follow the selection of a final turbine. Furthermore, the noise assessment should be recalculated should the location of turbines in close proximity to NSL (i.e. refer to the locations listed in the paragraphs above) vary with micro-siting relocation towards a NSL with potential to raise noise levels by >1dB against a Vestas candidate turbine or for any increase with a GE candidate turbine.

4.1.6.5 Uncertainties and Error Considerations

Modelling within the noise assessment report has applied a 1 dBA margin to turbine noise levels to account for uncertainties associated with the Vestas turbines and a 0.8 dBA uncertainty added to the sound power of the GE turbines noise spectrum.

The allowance difference was reported within the noise assessment report as being that Vestas had not provided any data on their level of uncertainty within their monitoring report, and GE provided a specification for a 'sigma p (σ_P)' product sound power variability of 0.8 dBA.

Interrogation of Table 7 provided within the noise assessment report confirmed the modelled SPL's to be:

- 1dB(A) higher than the noise spectrum data provided by Vestas for the corresponding octave band SPL's and for hub height wind speeds examined at 6 m/sec and 10 m/sec, and
- 0.8 dB(A) for the GE provided octave band SPL's and for hub height wind speeds examined at 6 m/sec and 10 m/sec.

For the Vestas candidate turbines compliance under the allowances made is predicted by over 1 dB, providing a noise level compliance margin to balance uncertainty.

For the GE turbine however, the uncertainty is specified at a 'sigma p (σ_P)' of 0.8 dBA. Under specifications within IEC TS 61400-14 the total standard deviation (a measure of uncertainty) in noise level is associated with both the product deviation σ_P and also the test reproducibility 'sigma R (σ_R)'. Uncertainties other than σ_P were not discussed in the noise

assessment report. Given predictions are essential at the compliance limit at some locations, uncertainties in the modelling process become important.

Consequentially to assess the significance of uncertainties, communications was requested from and provided by the manufacturer GE Renewable Energy. This communication confirmed that 'an uncertainty equating to σ_P is suitable for total far- field testing reproducibility' (and therefore overall standard deviations).

To further review potential for uncertainties within the modelling process MDA has provided a directionality assessment to assist with enhanced predictive modelling of noise (i.e. Appendix J of the noise assessment report). Turbines greater than 1.2km from a noise sensitive location are influenced by noise directionality with turbine noise attenuation enhanced when the NSL is not directly downwind. This information refined the modelling process whereby the model assumed noise sensitive receptors are located down-wind from all turbines.

Under the GE candidate turbines option, model predictions under directionality distance influences suggest compliance by over 0.5 dBA for all noise sensitive locations other than: K27-a (39.5 dB L_{A90}), W27-i (39.8 dB L_{A90}) and H32-a (39.9 dB L_{A90}).

The GE model is reported to have noise reduction modes that could be integrated into the design to enable compliance to be achieved, if required during certain wind speeds and directions, when operational. Given the marginal prediction of compliance at the above three (3) NSL's, if the GE turbine option is approved by the Responsible Authority, it may need to have a functional noise reduction mode included and operated to match the Vestas turbine noise performance i.e. a *NRO 105 apparent sound level rating* (as specified in the GE 'Product Acoustic Specification', 2020) or better.

For the Vestas turbines, results predict a maximum noise level at any NSL of 38.4 dB L_{A90} (i.e. location W27-i within the Farming Zone). This is within the compliance noise limit of 40 dB L_{A90} with a margin of compliance predicted that warrants no additional noise management.

Within the high amenity area for the night period with a hub height wind speed at 6 m/sec, the highest predicted noise was at location 'R31 – be' at:

- 29.8 dB L_{A90}, against a compliance noise limit of 35 dB L_{A90} for the Vestas candidate turbines, and
- 31.6 dB L_{A90} for the GE candidate turbines,

both are predicted to be well capable of achieving compliance at this wind speed.

Given the adjustments made to the maximum sound power level provided by the manufacturers, the data presented in the noise assessment report on directionality, and additional information provided by GE technical department it is considered that an acceptable margin of error has been applied to consider uncertainties in noise predictions.

Ultimately, compliance will need to be demonstrated by actual monitoring should approval be granted.

4.1.6.6 Best Practice Considerations

It is recognised that various factors warrant consideration during a best practice evaluation. However, based strictly on sound power levels, the Vestas candidate turbine is notably quieter than the GE turbine at a similar wind speed and power output. It is reasonable to deduce that such a turbine represents the better example of best practice noise control technology that needs to be factored in during the turbine selection process and approval considerations by the Responsible Authority.

Operating the GE candidate turbines under a noise management mode may represent a best practice commitment to achieve compliance during wind conditions that warrant intervention. However, the adoption of best practice turbine noise control is considered to involve a technology component that achieves noise levels as low as reasonably practicable without compromising power constraints, with the objective being to sustain noise levels notably lower than solely achieving a noise compliance limit.

5.0 Risk Assessment

The risk of impact to amenity was assessed qualitatively by direct reference to compliance with limits specified in the Standard. It is acknowledged that personal attitudes to noise can vary between individuals. However, the guidance provided in NZS6808:2010 has been adopted to assess whether the risk of harm from noise is unacceptable, namely:

> *Section 5.1.2 To provide a satisfactory level of protection against sleep disturbance, this Standard recommends a limit of wind turbine sound levels outdoors at noise sensitive locations of 40 dB LA90(10 min).*
>
> *Section 5.1.3 The wind farm noise limit of 40 dB LA90(10 min) outdoors recommended for protection of sleep is also appropriate for protecting the health and amenity of residents for most noise sensitive activities.*
>
> *Section 5.3.1 The wind farm noise limit of 40 dB LA90(10 min) in 5.2 is appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations. 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.…*

Accordingly, noise levels that comply with the Standard are deemed to protect both human health and the amenity of a noise sensitive location.

The risk that predictive modelling outcomes were inaccurate was gauged against:
- the internal quality assurance process reported by the acoustic consultant,
- experience of noise prediction modelling at other wind energy facilities,
- the level of uncertainty and confidence levels adopted in the modelling,
- technical information on monitoring, octave band SPL's and uncertainty detail provided by manufacturers, and
- the auditors experience with noise levels from operational wind energy facilities elsewhere.

Predicted noise levels at nearest NSL's were consistent with the auditor's expectations given the relatively flat to slightly undulating terrain.

Monitoring data (Resonate, 2021) indicates potential for low background noise under certain wind directions up to 10 m/sec and at times where winds are blowing from a southerly direction. Low background noise means that whilst wind turbine noise may be compliant with the 40dB L_{A90} standard noise amenity, or alternatively the 35dB L_{A90} high amenity area (if applicable) limits, it will be audible at times.

Wind turbines adopting best practice design can, and do, operate in the absence of special audible characteristics, including the absence of audible tones. Data within the subject report was not able to definitively confirm the absence of wind turbine tonality, as the final turbine has not been selected. Neither candidate turbines are expected to operate with a tonal audible characteristic. The GE candidate technical data specifies the tonal audibility of adjacent third octave bands is < 4dB. Under the simplified method of the Standard (i.e. Table B1) this is not considered tonal. No information was provided within the Vestas technical data.

To mitigate risk, the final turbine selected should be warranted as not producing a tone, as defined by NZS 6808:2010, at any non-stakeholder noise sensitive location.

In the absence of special audible characteristics, turbine noise is predicted to comply with the 40dB L_{A90} standard noise limit at all non-stakeholder NSL's within the Farming Zone and the Public Use Zone, and therefore presents an acceptably low risk of harm from noise.

In the absence of special audible characteristics, turbine noise is predicted to comply with the 40dB L_{A90} standard noise limit at NSL's within the high amenity Low Density Residential and Township Zones during the day period and represents an acceptably low risk of harm from noise during the day period.

In the absence of special audible characteristics, turbine noise is predicted to comply with the 35dB L_{A90} high amenity noise limit at NSL's within the Low Density Residential and Township Zones when wind speeds at hub height are 6 m/sec or lower, and therefore presents an acceptably low risk of harm from noise during these conditions.

Under a strict word interpretation of the Standard, the risk of harm from turbine noise within the high amenity area resulting from hub height wind speeds greater than 6 m/sec during the evening or night periods, is deduced as being acceptably low based on a high amenity noise limit of 40dB L_{A90}.

Given the ambiguities of the Standard's wording however, no definitive risk of harm determination is possible for wind speeds between 6 – 10 m/sec during the evening or night periods within the declared high amenity areas. Modelling predicts that noise can exceed the base 35 dB L_{A90} at several locations in the declared high noise amenity area predominantly within the 8 - 10 m/sec hub height wind speed range; with the highest predicted noise to occur at locations marked R31-be and R31-ad (i.e., for location R31-be a marginal excursion over the base noise limit of 35.6 dB L_{A90} at 8m/sec and at, or above, 37.7

dB L_{A90} at 9 - 10 m/sec hub height wind speeds for the Vestas turbine, and at, or above, 37.1 dB L_{A90} for hub height wind speeds equal to and greater than 8 m/sec for the GE candidate turbine).

Background noise monitoring is relevant to determine whether a high amenity limit is justified. Although background data was collected to achieve the Planning Permit specifications, it is considered further background noise data during the summer period, when southerly winds are more prevalent, is necessary to assess whether a high amenity limit is justified based on the representative average background noise level.

With consideration to there being a gap in seasonal background noise data, and the ambiguities of the Standard, the applicability of an assessment for wind speeds above 6 m/sec may be necessary in setting a night period high amenity noise limit for post-construction compliance monitoring and is recommended to be evaluated by the Responsible Authority.

Additionally, under the guidelines, and contained within the Planning Permit, micro-siting (i.e., relatively small spatial changes in the location of the turbine typically by up to 100m) is permissible. Given that micro-siting changes towards a NSL have potential to alter the noise setting, predictive monitoring is recommended prior to adopting spatial changes that may increase noise exposure so as to encroach or exceed the 40 dB L_{A90} (10 min) limit at a number of the nearest relevant noise sensitive locations.

6.0 Results & Conclusions

The auditor has formed the opinion that the noise assessment report processes are based on sound methodology and have been undertaken by skilled and experienced personnel in accordance with the Standard.

The following conclusions are drawn based on the noise assessment report:

- I have found the process employed by the proponent adopted to identify the relevant non-stakeholder properties with potential to be impacted by noise to have been rigorous.

- I have found the pre-construction noise report on the predicted maximum noise levels from the operating wind energy facility to have been determined in accordance with procedures set out in NZ6808:2010 when based on the technical information provided concerning the candidate turbine type, sound power output and siting.

- I have found that compliance with the specified noise limits is predicted at all non-stakeholder noise sensitive locations, and consequently the risk of harm is deemed acceptable under a strict interpretation of the Standard.

  This determination applies to the candidate turbine type, the siting plan used in the predictive modelling, the absence of special audible characteristics including tones, and

confirmation from the Responsible Authority that a high noise amenity limit is restricted to wind speeds of 6 m/sec or lower (as is recommended in the Standard).

- It is noted that noise modelling of the GE candidate turbine option has predicted a marginal level of compliance at some noise sensitive locations, whilst modelling of the Vestas turbines suggest compliance will more readily be achieved.

  Best practice noise control considerations are relevant and should form a component of the final turbine selection process.

It needs to be emphasised that even at the 40 dB L_{A90} standard amenity and the 35 dB L_{A90} high amenity base noise limits, as specified in the New Zealand Standard (and adopted under Victorian guidelines), the wind turbine noise may, at times, be readily audible; particularly during hub height wind speeds that align with low background noise conditions at near ground level.

7.0 Recommendations

It is recommended the Responsible Authority assess the applicability of whether a high amenity noise limit may be justified within the high amenity zones during the evening and night periods for wind speeds above 6 m/sec. If so, additional background noise data should be attained during the summer months to derive an appropriate noise limit under the Standard.

Note: Should a high amenity noise limit be deemed to be applicable for 8 – 10 m/sec hub height wind speeds, and the background noise confirmed low via additional monitoring, compliance is not predicted for either candidate turbine.

It is recommended best practice noise control be considered in the final selection process for the turbines, as one candidate turbine is notably quieter and predicted to readily comply, whilst the other achieves a marginal level of compliance.

It is recommended should turbine positions vary towards a non-stakeholder's dwelling, including as a result of micro-siting where an increase could occur at any NSL currently predicted above 38 dB L_{A90}, an updated predictive noise compliance assessment should be completed prior to construction. This report should be subjected to a S53V environmental audit.

8.0 References

1. New Zealand Standard NZS 6808:2010 *'Acoustics – Wind Farm Noise'*
2. Policy and Planning Guidelines for the Development of Wind Energy Facilities in Victoria, DELWP, March 2019
3. EPA Publication 1692 Wind energy facility noise auditor guidelines. Conducting environmental audits of noise from wind facilities
4. EPA Publication 865 Environmental Auditor Guidelines for Appointment and Conduct
5. EPA Publication 952 *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment*

6. EPA Pub. 953 *Environmental Auditor Guidelines for Conducting Environmental Audits*
7. EPA Publication 1147.2 *Environmental Auditor Guidelines – Provision of Environmental Audit Reports, Certificates and Statements*
8. AS/NZS ISO19011:2018 *Guidelines for auditing management systems*
9. ISO 1996-2:2017 *Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures*
10. NZS 6801:2008 Acoustics- Measurements of environmental sound.
11. Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors (Red Dot) [2013] VCAT 521.
12. EPA, Victoria, Email Advice to Auditors 'Wind Energy Facilities – Applying/Assessing High Amenity' 25 October 2019.
13. Golden Plains Wind Farm Environmental Noise Assessment Rp 001 R01 20200919 3 December 2020, Marshall Day Acoustics Pty Ltd
14. Vestas V162-6.0MW Third octave noise emission 2020/07/02 (Confidential Issue)
15. Vestas (Early Customer Engagement Package) 2020-05-26 EnVentus V162-6.0 MW 50/60 Hz (Confidential Issue)
16. Golden Plains Wind Farm, Planning Permit Amendment Application, Noise and Vibration Assessment M180934RP10 Revision C, Wednesday 25 November 2020, Resonate Consultants Pty Ltd
17. Golden Plains Wind Environmental Noise Assessment - Location of non-stakeholder dwellings, 15 December 2020, Golden Plains Wind Farm Management Pty Ltd
18. Golden Plains Wind Farm Environmental Noise Assessment Rp 002 20200919 23 March 2021, Marshall Day Acoustics Pty Ltd
19. Golden Plains Wind Farm Planning Permit Amendment Application Noise and Vibration Assessment 15 March 2021, Resonate
20. GE 6.0-164 Noise Management, 31 March 2021, GE Renewable Energy
21. GE 6.0-164 Sound Power Levels - Uncertainty, 31 March 2021, GE Renewable Energy
22. Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164 – 50 Hz. Product Acoustic Specifications According to IEC 61400-11 incl. Octave and 1/3rd octave band Spectra, Rev 02 16 March 2021
23. Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164 – 50 Hz. Product Acoustic Specifications According to IEC 61400-11 NRO98 – NRO 106, 26 August 2020

FIGURES

Important Note: The noise contour maps provided within the Figures represent maximum predicted noise levels during standard noise amenity conditions. They do not represent a high noise amenity condition which, according to the Standard, occurs during a hub height wind speed of no greater than 6m/sec, during which noise is considerably lower.

Figure 1: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - Overview

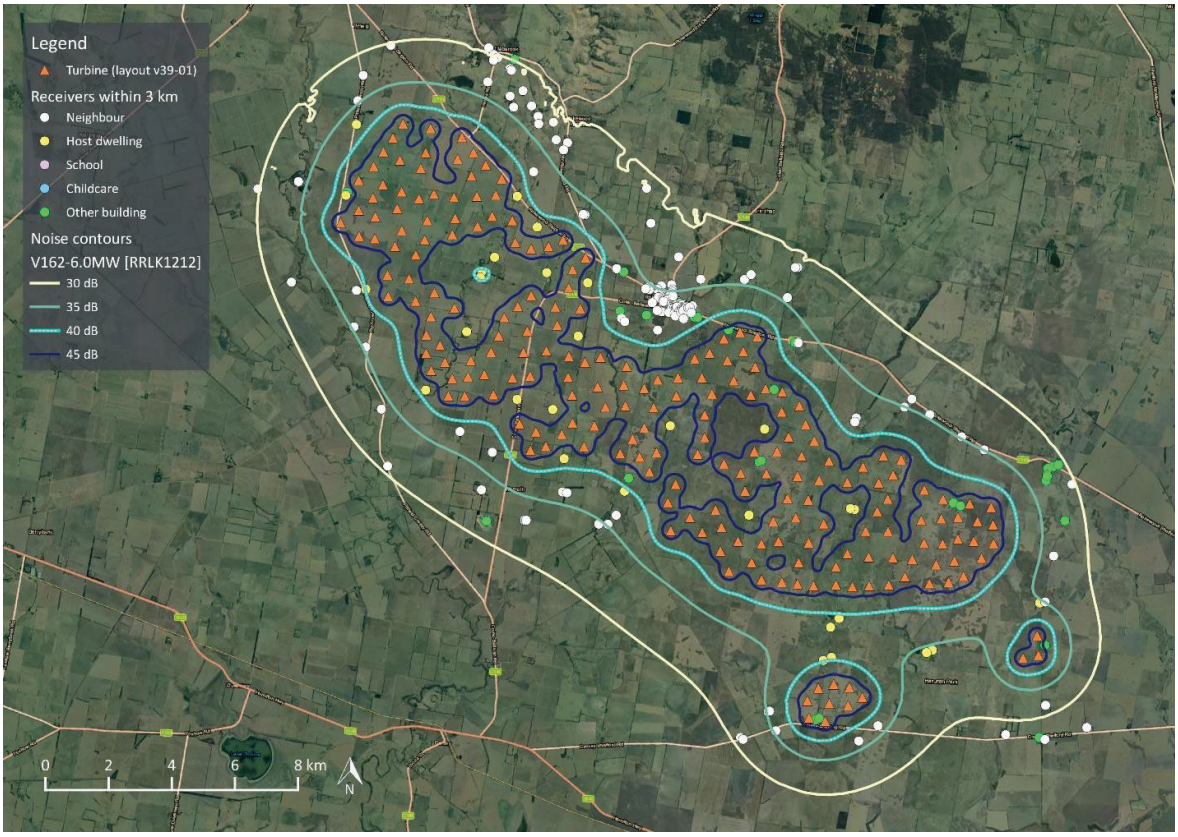


Figure 2: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW - North west

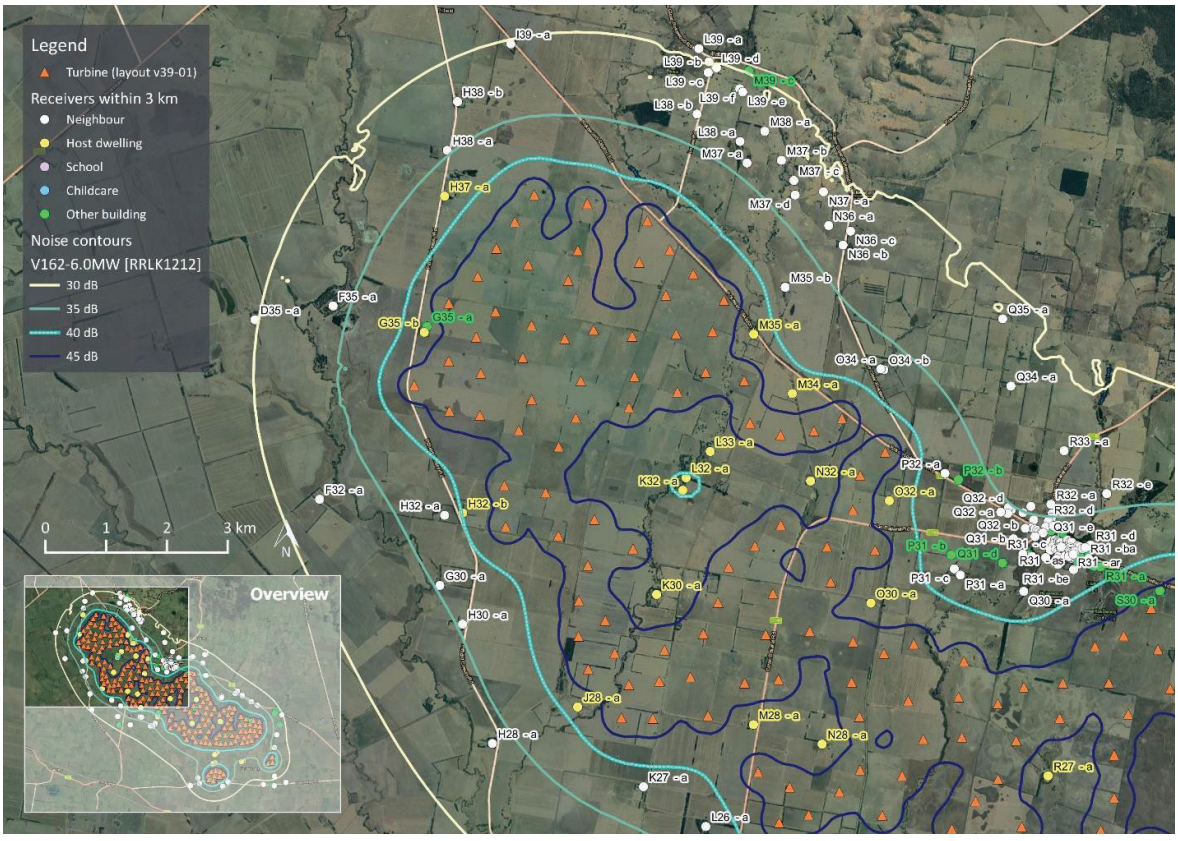


Figure 7: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - Overview

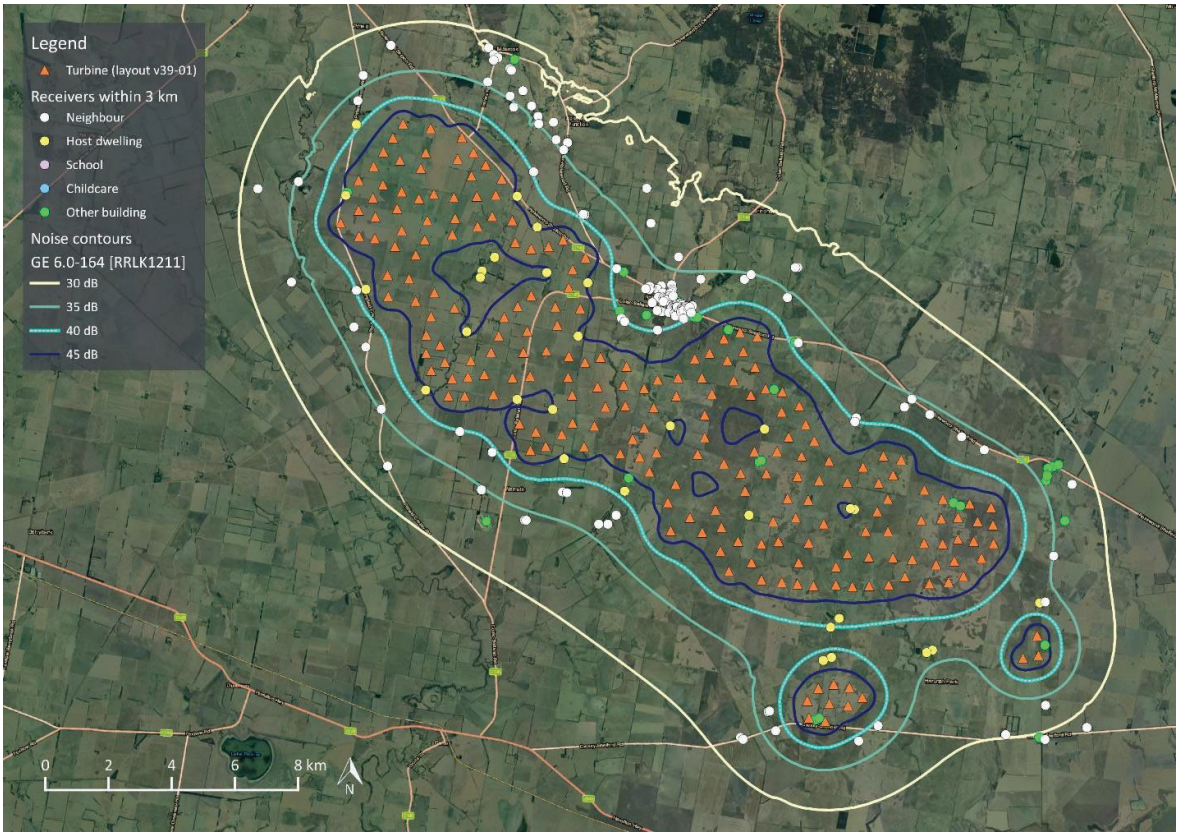
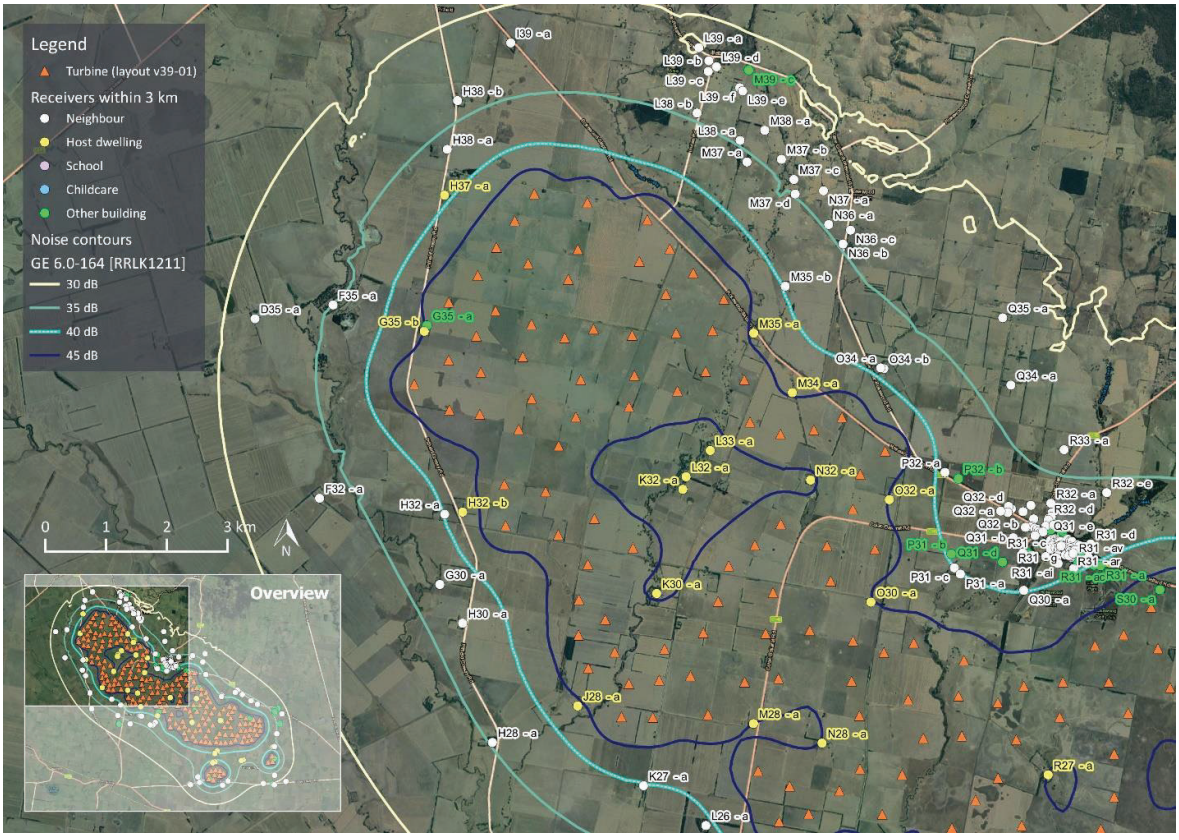
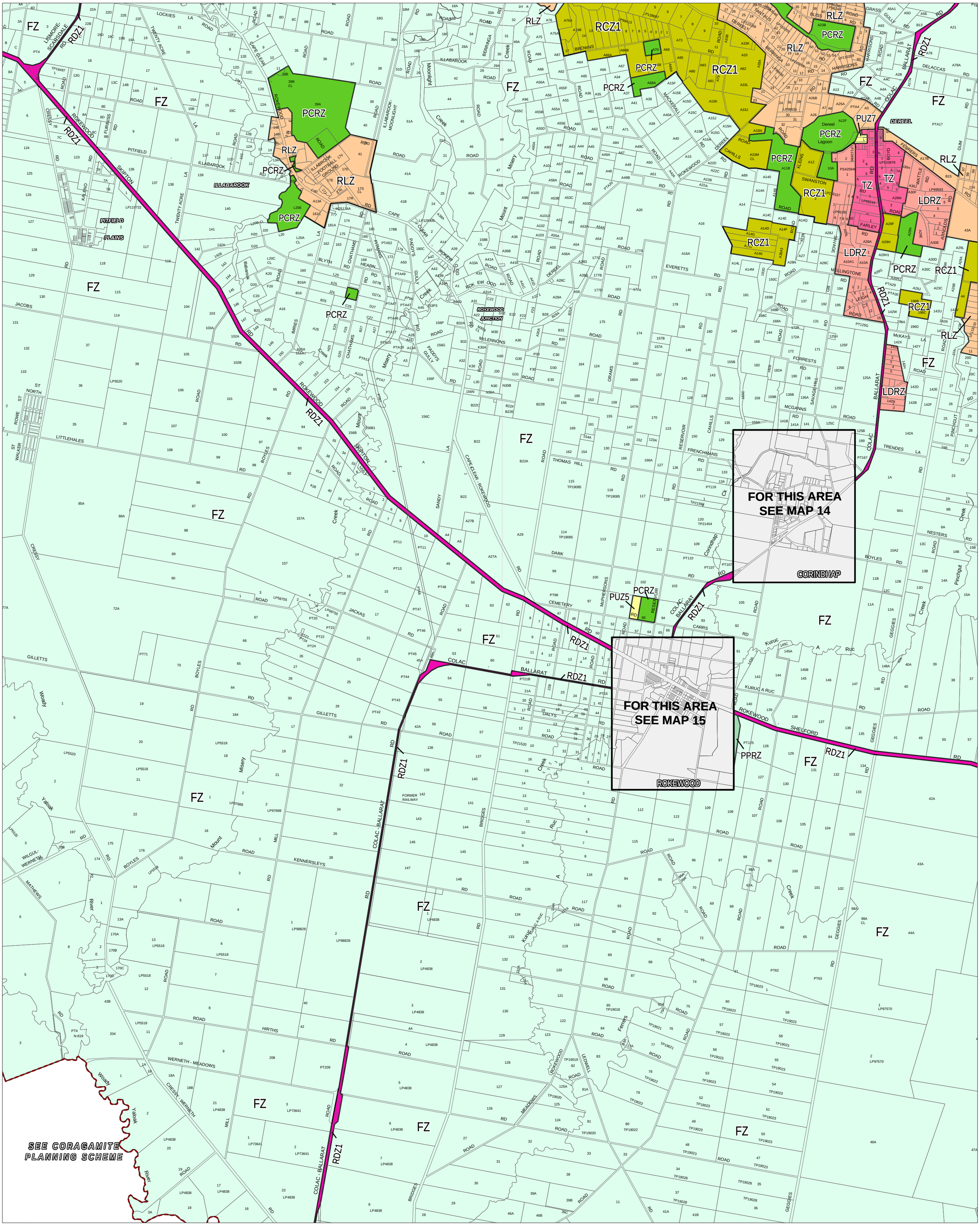


Figure 8: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164 - North west



GOLDEN PLAINS PLANNING SCHEME - LOCAL PROVISION



This map should be read in conjunction with additional Planning Overlay Maps (if applicable) as indicated on the INDEX TO MAPS.

Public Land

- PCRZ — Public Conservation And Resource Zone
- PPRZ — Public Park And Recreation Zone
- PUZ5 — Public Use Zone - Cemetery/crematorium
- PUZ7 — Public Use Zone - Other Public Use
- RDZ1 — Road Zone - Category 1

Residential

- LDRZ — Low Density Residential Zone
- TZ — Township Zone

Rural

- FZ — Farming Zone
- RCZ1 — Rural Conservation Zone - Schedule 1
- RLZ — Rural Living Zone

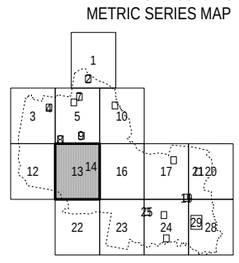
1000 0 1000 2000 3000 m

AUSTRALIAN MAP GRID ZONE 54

N

State Government Victoria

INDEX TO ADJOINING METRIC SERIES MAP



Printed: 16/12/2011

AMENDMENT C40 PART 2

ZONES

MAP No 13

GOLDEN PLAINS PLANNING SCHEME - LOCAL PROVISION

This map should be read in conjunction with additional Planning Overlay Maps (if applicable) as indicated on the INDEX TO MAPS.

Public Land
- PCRZ Public Conservation And Resource Zone
- PPRZ Public Park And Recreation Zone
- PUZ2 Public Use Zone - Education
- PUZ6 Public Use Zone - Local Government
- RDZ1 Road Zone - Category 1

Residential
- LDRZ Low Density Residential Zone
- TZ Township Zone

Rural
- FZ Farming Zone

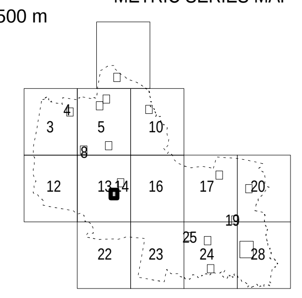
100 0 100 200 300 400 500 m

AUSTRALIAN MAP GRID ZONE 54

N

Victoria The Place To Be

INDEX TO ADJOINING METRIC SERIES MAP



Printed: 7/7/2009

AMENDMENT C47

ZONES

MAP No 15

WIND ENERGY FACILITY NOISE REPORT AUDIT PROTOCOL

Facility Golden Plains Wind Energy Facility

Standard NZS6808:2010

Evidence Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report 001 R01 20200919 Rev 01 3 December 2020

Golden Plains Wind Farm Response to Auditor Markup R001 R01 20200919 received from Marshall Day Acoustics 20 December 2020

Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report 001 R02 20200919 4 January 2021

Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report Rp 002 20200919 23 March 2021

Golden Plains Wind Farm, Planning Permit Amendment Application, Noise and Vibration Assessment M180934RP10 Revision C, Wednesday 25 November 2020, Resonate Consultants Pty Ltd

Golden Plains Wind Farm, Planning Permit Amendment Application, Noise and Vibration Assessment M180934RP10 Revision E, Monday 15 March 2021, Resonate Consultants Pty Ltd

Letter: Golden Plains Wind Environmental Noise Assessment - Location of non-stakeholder dwellings, 15 December 2020, Golden Plains Wind Farm Management Pty Ltd

Vestus 2020-07-02 Third Octave noise emission EnVentus V162-6.0MW

Vestas 2020-05-26 (Early Customer Engagement Package) EnVentus V162-6.0 MW 50/60 Hz

GE 6.0-164 Sound Power Levels - Uncertainty, 31 March 2021, GE Renewable Energy

Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164–50 Hz. Product Acoustic Specifications According to IEC 61400-11 incl. Octave & 1/3rd octave band Spectra Rev02 16 Mar21

Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164 – 50 Hz. Product Acoustic Specifications According to IEC 61400-11 NRO98 – NRO 106 , 26 August 2020

NZS specifications:

Section	Requirement	Comply	Observations/ Comments
Definitions	Measurement time: 10min accuracy 1% ie 6 secs		
	Noise Limit: not to be exceeded		
	Notional Boundary: A line 20m from any side of a noise sensitive location		
	Post-installation sound level: A weighted L90 centile level		
	Cut in speed typical: 4 m per sec. Shut down 25 m per sec		
3.1	Metric for wind farm sound: A weighted L90 centile level i..e dB L90(10min)	Yes	This metric has been used in predictive modelling.
3.2	Process: Figure 1		
	Determine location of 35 dB Contour	Yes	Modelling undertaken using SoundPLAN version 8.2 (i.e. latest version). Predicted maximum noise levels were derived from nearest NSL and contours mapped atop of aerial imagery. This is included in Section 7.4, in Figures 1 through to 12 and in Appendix I of the report.
	Determine wind farm noise limits	Yes	The report has adopted a base 40 dB LA90 limit for non stakeholder dwellings in a Farming Zone and 35 dB LA90 during the night period and for wind speeds equal to or less than 6 m/second in the Low Density Residential and Township Zones i.e. the high noise amenity areas. Advice was sought from EPA as to adherence to the Cherry Tree VCAT decision relating to a Farming Zone. Advice received supports there are no special circumstances nor special locations that would suggest a higher noise amenity than standard within a Farming Zone. The noise assessment report adoption of a base standard for predictive modelling is therefore appropriate in this zone. The Standard recommends the high amenity noise limit apply at hub height wind speeds of 6m/sec and less during the evening or night periods. This literal interpretation has been adopted in the noise assessment report. Comment is made in the noise assessment report that the high noise amenity limit is not justified under specifications within the Standard. Whilst the auditor does not strictly concur with a high amenity not being justified based on a conservative selection of the current background data, the adoption of a base noise compliance limit of 35 dB LA90 has been adopted for predictive purposes and is appropriate. The rationale is that the NZS recommends high amenity for wind speeds of 6 m/sec and less. An alterntive wind speed may be appropriate but adequate guidance is not provided as to what this is and when it should apply, within the Standard or Victorian guidelines.
	Refine Predictions at each noise sensitive location	Yes	Included in the noise assessment report are predicted noise levels at differing wind speeds. GPS locations for each NSL are provided in Appendix C to the Resonate 'background' report. A sample confirmed these as accurate. A ground truthing exercise involving aerial photos and car surveillance was conducted. Further confirmation was sought and received from the proponent that support all relevant NSL have been considered and are included in the noise assessment reports.

	Report		MDA issued a report (version R1 dated 3 December 2020). Specific enquiries on the report were responded in order to clarify content and technical descriptions. Following the auditors review, changes were made to zone descriptions and minor spelling items and the report was updated and re-issued 4 January 2021. A further MDA report was issued (version Rp 002 dated 23 March 2021 that included a second candidate turbine and also noise predictions based on directionality aspects.
	Post installation sound level measurements	NA	
4.1.1	Audibility is not an appropriate basis for setting noise limits. Limits based on Section 5.		
4.2	Reverse Sensitivity		
	Nomination of a 40dB wind farm sound level contour and the 35dB contour.	Yes	Predicted contour maps have been prepared and are included in noise assessment report inlcuding down to the 30 dB contour.
5	**NOISE LIMITS** - designed to protect sleep disturbance whilst inside house		
5.1.2	Upper limit at residential location of 40 dB L90	Yes	This limit has been used for compliance predictions for standard amenity, and within the high amenity zones for specific times and wind conditions outside that considered to attract a high amenity noise limit, against the maximum sound power rating level (per octave band) provided from noise data.
	(assumes 15 dB reduction indoors to <30 dB Leq)		
	Sleep protection also protects health and amenity.		
	C5.1.4. *The use of a background +5dB limit means that the wind farm sound may be the dominant sound heard at a noise sensitive location for a significant proportion of the time when the wind farm is operating* .		*Note: the site can have low background noise and the 40 dB and 35 LA90 limit may mean the wind energy facility is at times readily audible, particularly during low wind speeds (i.e. <10 m/s hub height) during the night period particularly when the wind is blowing from a southerly direction.*
5.2	Noise limit		*Note: the NZS acknowledges and states that at a noise level of BG + 5dB that 'the wind farm may be the dominant sound heard at a noise sensitive location for a significant proportion of the time the wind farm is operating'.*
	Wind farm sounds (as L90 10 min) should not exceed background by more than 5 dB or a level of 40 dB LA90 10min, whichever is the greater at notional boundary of any noise sensitive location	Yes	Within the noise assessment reports 40dB LA90 10 min has been used as the compliance limit for predictions of non-stakeholder dwellings attracting a standard noise amenity. This is the base noise limit and is not background influenced.
5.3	Secondary noise limit: only considered…		
	Background are commonly less than 25dB when predicted to exceed by 10dB or more	NA	Background monitoring has been undertaken at locations surrounding the WEF. At location Q31-p the polynomial representation of the data set suggests background levels in some southerly directions (e.g. SSE, ESE, WSW) during the night period to be below 27dB LA90 at wind speeds up to 9-10 m/sec. There is therefore a potential for a difference of 8 dB to occur during some wind directions when the WEF turbines are operational. There is potential therefore for justification of the High Noise Amenity Limit, under some wind directions where the wind blows from the source to the noise sensitive locations. The process to assess a high amenity noise limit therefore needs to be rigorous and based on representative background data over all relevant seasons.

	Higher degree of protection of amenity required	Yes	A 'high amenity area for the purposes of the Standard' is specified within the Planning Permit (PA1700266) as being applicable in the Low Density Residential and Township Zones. Consideration of a high amenity noise limit is specified in the Planning Permit and has been undertaken in the noise assessment report against a strict interpretation of the Standard. There is no specific planning requirement that the Auditor could identify that directly specifies a high amenity area in a Farming Zone within the Planning Scheme. A standard amenity noise limit is provided in the noise assessment report for the Farming Zone. Communications with EPA on planning scheme interpretation has resulted in 'EPA Advice to Auditors dated 25 October 2019'. According to the Cherry Tree VCAT decision and EPA Advice, a Farming Zone is not considered a High Amenity Area unless the planning schemes specified otherwise e.g. provides an overlay. Accordingly, a standard noise amenity is appropriate for noise sensitive locations within a Farming Zone and a higher degree of amenity protection is not required. There is a school and a child car facility located within Rokewood's Public Use (PUZ2) zone. Given they fall outside the Planning Permit declared 'high amenity areas' and are likely to be occupied during the day period, these facilities are noise sensitive locations that are afforded a standard noise amenity.
	Planning rules dictate	Yes	Although no specific planning scheme requirements were identified, the Planning Permit condition 18(c)-i specifically states that the proponent must acknowledge that 'the areas in and around Rokewood that are zoned Township Zone and Low Density Residential Zone are a high amenity area for the purposes of the Standard'.
	Only applies to locations within 35dB contour	Yes	
	Arithmetically average difference for all 10 minute intervals. If less than 8 dB secondary not justified	Yes	Reportedly the average difference was calculated according to the Standard and is represented in Tables 3 and 4 of the MDA noise assessment report. The Auditor has not sighted actual background data but has reviewed the polynomial charts provided in the background report (Resonate, 2021). The noise assessment report comments that the difference (represented by the term Noise Perception Index (NPI)) is less than 8 dB for the Vestas turbine and therefore a high amenity limit is unlikely to be justified. THe NPI is more than 8 for one location under the GE candidate turbine and therefore a high noise amenity it is likely to be justified. The Auditor notes via their own calculations that under a conservative approach, the nearby and potentially representative background location at Q31-p, a NPI of 8.3 is calculated indicating that the high amenity limit is likely to be justified regardless of the turbine selected. Within the predictive compliance report this does not matter as the base high amenity noise limit of 35 dB L90A has been adopted for wind speeds of 6 m/sec and lower.
5.3.2	Lowest stated level is 35dB or 5db above background if above 35db L90 10 min.	Yes	The Auditor concurs with the noise assessment report that a strict interpretation of the Standard means that a high amenity limit only applies to wind speeds of 6 m/sec or lower during the evening or night periods, the base limit that has been applied for these conditions has been achieved. Other times are represented by a standard noise amenity with a 40 dB LA90 base limit. The Farming Zone land is not considered high amenity as discussed above.
	Generally only applies when wind speed at hub height is less than 6m per sec	NA	See comments above and below.

			The data presented in the background report provides polynomials only. No data is available to assess the arithmetic difference for each 10-minute time interval in the evening or the night-time. Under SEPP (N-1) the evening is specified as 6pm -10pm and night 10pm-7am. MDA has advised they have this data and have used it in order to calculate their NPI's for each of these periods. NZS is ambiguous in its dealing with high amenity areas in that: 'it is recommended the high amenity noise limit should apply when the wind farm wind speed is 6m/s and lower. An alternative wind farm wind speed may be applied where justified on meteorological, topographic and acoustical grounds.' (sect 5.3.2) The MDA report does not include whether this is justified at greater wind speeds than 6m/s; e.g. 9m/s or even 8m/s for NSL locations in the TZ. On the data available for the locations of interest (i.e. the LDRZ and the TZ) background noise remains relatively low particularly when wind direction is from the southerly components which may in the future be from the WEF to the receivers (i.e. locations Q31-p, Q30-a and R31-ad can have low background at up to 9-10m/s hub height wind speeds). The polynomials provided in the background report reveal that under some wind directions, the lowest background can occur during wind speeds above 6m/s (i.e. location Q30-a night data). The compliance at speeds above 8m/s are of relevance to the acoustical setting as the noise predictions are 7.7 - 7.9dB higher at 9 m/s compared to 6m/s depending on the candidate turbine. The sound power emitted by the turbines at 9m/s is only 0.2 - 0.3 dB less than at hub height wind speed of 10 m/s. It is recognised that the Standard averages a range of wind conditions representative of long term sampling, yet a number of wind directions presently have a very poor fit even though the dataset met what the Planning Permit required in terms of the number of data points. Additionally no summer months background was included.
5.4	**SPECIAL AUDIBLE CHARACTERISTICS**		
5.4.1	Considerations to be given to and special audible characteristics of the wind farm sound when comparing levels against noise limits.	Yes	Data associated with a similar 'technology' turbine supports absence of any tonal characteristics. However no data to support tonality is available. A specification of 'no tonal audible characteristic when evaluated using the Standards procedures' needs to be confirmed, and is suggested to be warranted with the manufacturer, with the final selected turbine.
5.4.2	Tonal, impulsiveness, amplitude modulation shall be adjusted by arithmetically adding up to +6dB to the measured level,	Yes	No special audible characteristics are consider applicable based on information provided to the Auditor. This should be warranted in the turbine supplier agreement.
	If there is doubt about the presence of tonality, the following two methods provide an objective measure for tonality. The simplified test method may be carried out using one third octave-band measurement equipment. The reference test method requires the use of narrow band analysis. If the simplified method does not indicate tonality, it may still be necessary to use the reference method to confirm the presence or absence of tonality. In addition, the reference method can properly assess modulated tones where the tone is varying or where there are complex tones with many closely-spaced tone components. However, the method does not address wind farm amplitude modulation	NA	
	No appropriate objective test for amplitude modulation has been standardised. If a local authority enforcement officer or an acoustics advisor to a local authority considers that a wind farm creates sound with a clearly audible amplitude modulation at a noise sensitive location, an adjustment of +5 dB shall be applied to the wind farm sound level at that location for the wind conditions under which the modulation	NA	

	In making an assessment under B3.1, modulation special audible characteristics are deemed to exist if the measured A-weighted peak to trough levels exceed 5 dB on a regularly varying basis, or if the measured third-octave band peak to trough levels exceed 6 dB on a regular basis in respect of the blade pass frequency	NA	
	Where special audible characteristics are confirmed, the value of the adjustment (k2) shall be 5 dB for that sample, provided that where the reference test method for tonality is used, the value of the adjustment (k2) shall be between 1 and 6 dB where justified. The adjustment (k2) shall only be applied to samples in which special audible characteristics are present. Only one adjustment value (k2) shall be applied to each measurement, even if more than one type of special audible characteristic is present	NA	
5.4.3	Conducted in accordance with Appendix B of the NZS.	NA	
	Cumulative adjustments shall not be made. Max adjustment is 6 dB.	NA	
5.5	**Other Factors**	NA	
5.5.1&.2	Ultrasound and infrasound frequencies considered to be outside normal range of human hearing. Paucity of evidence to set a limit more stringent that recommended in Sect. 5.2.	NA	Commentary only.
5.6	**Cumulative Effects**		
5.6.1	Limits apply to cummulative levels of all wind farms.	Yes	The Berrybank wind farm has been constructed to the south-west. The acoustic report includes commentary and a map as to whether the 30dB contour overlaps noise prediction contours. It was found not to overlap for the Vestas turbines and therefore has no discernible influence on noise levels. A slight overlap in the 30 dBA contours occurs for the GE candidate turbine option. The most signfiicant locality from a compliance outlokk is location H32-a which is essentially at the noise limit of 40 dB LA90 under the GE candidate turbine option. The distance between turbines (i.e. 3-4km) from the Berrybank WEF to H32-a, coupled with noise directionality influences mean under a realistic scenario mean contribution will not influence measurable noise levels and compliance is predicted to be achieved. (i.e. as downwind propogation from both WFs will not occur simultaneously from both wind farms to jeopardise compliance predictions).
5.6.2	Staging of a wind farm is not to affect pre-wind farm background readings.	NA	
5.6.3	Where a new wind farm will impact on the same noise sensitive locations as an existing wind farm, the assessment of background sound should exclude wind farm sound generated by all existing wind farms.	Yes	Background noise monitoring was reportedly conducted prior a wind farm operating.
5.6.4	If predicted wind farm sound levels for a new wind farm are at least 10dB below and existing wind farm… then the cumulative effect shall not be taken into account.	Yes	Discussion on modelling outcomes is provided in the report and comment is provided above.
5.7	**Uncertainty** (refer Appendix C below)	Yes	Refer to discussion below.
6	**Predictions**		
6.1	**Methods.** Predictions to identify levels greater than 35dB LA90(10min) at 95% rated power. In octave bands from at least 63Hz-4KHz, and against wind speed (hub speed) and 35 and 40 predicted contours shown.	Yes	The frequency band spectra and a noise test reports have been specified as being provided from the manufacturers. Copies of these reports were reviewed as part of the audit (and referenced). A review of the manufacturers technical data confirms that octave bands used in the noise assessment report were calculated from the third octave data provided. Predictions have been made by MDA for turbines at maximum sound power output; but noise predictions of each operationsal wind speed up to a maximum sound power is also provided. The selected Vestas turbine was PO6000 that has the serrated blade edges. The GE turbine does not specify this option. A sample of the data set confirmed MDA had added 1 dBA to octave band SPL's which is reflected in their Table 6 data for Vestas and 0.8dB has been added to SPL's for the GE variant.
6.1.2	Predictions of wind farm sound levels should take into account (various aspects listed)	Yes	MDA has considered all aspects including (b) directivity of propagation with distance.

6.2	**Sound Power Levels.** Obtain from manufacturer obtained in accord with IEC 61400-11	Yes	Manufacturer sound power levels were reported. The test reports that were provided specified their results were derived in accord with the IEC 61400-11 Ed 3 for the Vestas 136 turbines as no data was available for V162. It is reasonable to assume a similar frequency distribution. The GE turbine provided data also against IEC 61400-11. It specified a compatible hub height of 112m which provides some limitation on the results although it does extrapolate wind speeds to a 10m height. For the purposes of predictive modelling this data is reasonable to based SPL upon. However, this highlights the importance of post construction monitoring.
	Requires SPL to be reported against a wind speed measured at 10m AGL converted to Hub Height	ND	It is not clear how the conversion progressed and it is not specified in the noise assessment report. However, modelling has assumed SPL at specified turbine hub heights (i.e. 149m for Vestas and 148m for GE) wind speeds. The absence of confirmation is not considered to significantly comprise modelling outcomes given the full range of wind speeds has been assessed against a base compliance limit. Given the calculation in the Standard, when measured at 10m AGL the kick in wind speed will be approximately equivalent to 2m/sec at 10m AGL for a hub height of 149m wind speed of 3m/sec.
7	**MEASUREMENTS**		
7.1	**Locations**		
7.1.2	(a) Has the operator chose to adopt a noise limit of 40 dB for all wind speeds?	Yes	No. The noise report assesses against 40 and 35 dB LA90 depending on zoning, wind speed and the night period. See comments in Sect 3.2 above.
	(b)Has the operator agreed to conduct on/off testing if required.	NA	
7.1.3	Have noise sensitive locations been clearly identified	Yes	The identification process was undertaken by West Wind Energy and involved a checking and verification program. A site tour within the area identified no additional habitable dwellings that were not marked on the map.
	b. Does the auditor consider all noise sensitive locations are appropriately captured	Yes	As best reasonably within or near the predicted 35dB contour. Written advice received from the proponent supports the NSL's as illustrated in the noise assessment reports are complete. This advice is Appended to this Audit Report.
7.1.4	Have background sound level measurements been appropriately established and representative of the group: proximity and character	ND	Background noise has been measured at a number of locations around the WEF including within the LDRZ and the TZ. Data points at each location meet the Planning Permit minimum requirements. However, the background noise measurements did not include the summer period when more southerly winds are experienced. Furthermore there appears to be a discernible difference in background between the LDRZ (i.e. Q31-p) and the TZ (R31-ad) that cannot be reconciled on the data alone (other than potential seasonal variations). There remains some uncertainty as to whether background can influcence the justification of a high amenity noise limit. The noise report states it is unlikley to be justified for the Vestas candidate turbine and likely at one location for GE turbines. However, on the basis of potential difference in background over the seasons and the vagrancies in the background levels between similar settings currently obtained, before noise level compliance can be confirmed, additional information is recommended. This only becomes necessary should the Responsible Authority deem the high noise amenity aspect of the Standard applies to wind speeds above 6m/sec.
	When and where were they taken.	Yes	Taken over April - August at locations that are likely to be representative.
	Were predictions at 95% rated power made in deriving 35 dB LA90 (10 min.) contour background locations	Yes	Properties selected for background assessment in close proximity to the 35dB and also within the 30-35 dB predicted locations within the high amenity area.
	If there are no noise sensitive locations within the 35dB LA90(10min) predicted wind farm sound level contour then background sound level measurements are not required.	NA	There are NSL within proximity of the 35 dB LA90 predicted contour in the farming zone but not the high amenity zones. Background noise monitoring was undertaken. A reported reasonably low background for wind speeds <9m/s confirmed the base limit of 40 dB LA90. Some locations being particularly low up to 9 m/sec e.g. P24-b was below 25 dB LA90 for all wind directions up to 11 m/sec (hub height) wind speeds.
7.1.5	If there are a group of noise sensitive locations… locations selected are representative of the group in terms of proximity and character	Yes	Arguably the locations are representative. The 3x locations within the high amenity area were noted to produce some variable results with Q31-p (located in the small LDRZ) being the quietest in the wind speeds below 9 m/sec (according to the polynomial estimation of the data set).

7.1.6	Selected on wind farm side of buildings. >3.5m from significant reflecting surfaces. Not near streams nor watercourses where possible (or substantiated if not)	*ND*	Monitoring locations were provided in the Resonate report. However details of the precise locality and descriptor (e.g. via attended monitoring checks) were not provided within the report. Given the base noise limits of 35 dB LA90 in the high amenity area (night period and wind speeds of 6m/sec or lower) and 40 dB LA90 have been adopted for compliance checks in a standard amenity situation, the background noise data is not essential for a compliance evaluation. However, it may be essential for determining future compliance limits.
7.2	**SOUND DATA**		
7.2.1	Made during a representative range of wind speeds and durations from cut-in to rated power.	Yes	Predictions included from 4 - 12m/s. Max. SPL experienced by 10m/s.
	For dual speed turbines, include cut-in wind speed for the higher generating capacity.	NA	
	The number of measurements made are to be sufficient to obtain dependable correlations between sound levels and wind speeds	Yes	The data set was in excess of that specified in the Planing Permit conditions. Given a range of monitoring locations were assessed, extrapolation can be made on the relevance of background. The polynomial charts indicate a base noise limit is applicable within the Farming Zone essentially at all locations. This has been adopted. The data set for the high amenity area presents some variation that is not readily explained within the background monitoring report.
C7.2.1	Minimum of 10 days continuous monitoring >1440 data points to be plotted against wind data.	N/A	See above.
	Further measurements if: data points is not uniform between min. and max. for each 1m/s interval; a lack of sparseness exists for one or more wind conditions; seasonal variations.	ND	Seasonal variations are not discussed in the report and may be relevant to a noise compliance limit at and above 6 m/sec. Based on the information provided to the Auditor, a noise compliance limit of 35 dB LA90 should readily be achieved at 6 m/sec hub height wind speeds and lower. At 8 m/sec to 10 m/sec hub height wind speeds however it has not been determined whether the high amenity limit is likely to be justified. However under strict reading of the wording of the Standard, wind speeds above 6 m/sec are outside the Standards recommended application wind speeds.
7.2.2	Sound measured in accordance with NZS6801		
	Section 7.1.5 of NZS 6801 states 'the provisions of this section do not apply for the purposes of NZS 6808'.		
	Instrument used shall meet requirements of Section 5 of NZS6801.	ND	The Resonate report states the measurements were conducted and analysed in accordance with NZS 6808:2010 but provide no details on each of 15x background monitoing positions. The breadth of coverage across the wind farm is considered appropriate.
	Measurements time intervals of 10 minutes to be used.	Yes	Reportedly this was achieved. The data was report on by MDA as being 10 minute.
7.2.3	Microphone protected from extraneous wind sound by wind shield in accordance with NZS 6801.	ND	No detail on the microphone set up was included.
	Cables etc. secured to avoid extraneous wind noise.	ND	No detail on the microphone set up was included.
	Class 1 meter may be necessary so that sound levels at low wind speeds can be accurately measured.	ND	No detail on the microphone set up was included.
7.2.4	Extraneous sounds caused by events, including precipitation, insects, fauna and so on, should, as far as is practical for an unattended monitoring exercise, be identified and removed from the data set.	Yes	Stated this occurred in both the Resonate and MDA reports. Given the data was assessed by different acoustic specialists it has been taken to have occurred.
	Streams and tree induced background sound may be considered part of the overall background at the locations. Traffic lulls need to be included.	Yes	as above
	Octave band spectrum analysis and resident logs may be used.	NA	
7.3	**WIND DATA**	N/A	N/A - considered relevant only for post construction noise.
7.3.1	Concurrent measurements of wind speed and direction taken from a known height preferably the wind turbine hub.		
	Monitored over 10 minute intervals syncronised with SLM time intervals and average values found for every interval		
7.3.2	If wind speeds are not taken from hub height… predictions may be used from wind shear relationships: at least two heights		
	Wind flow modelling may be required si wind measurements are not representative.		

7.3.3	Same location and height used for beforte and after installation wher not impacted by turbines.		
7.4	**BACKGROUND MEASUREMENTS**		
7.4.1	Background SLM to be plotted against the hub-height wind speeds to obtain a scatter plot	ND	Monitoring was reported over the period April - August 2019. Scatter plots were provided in the latest background report. The data has reportedly been accessed by MDA and integrated into their assessment within the noise assessment report. Given that base noise compliance limits have been selected for review under all wind speeds, the absence of specifics associated with background data does not prevent a risk of harm assessment under a strict interpretation of the Standard. However, background noise level details at 7-9 m/sec hub height wind speeds would become necessary should the Responsible Authority deem High Noise Amenity limits apply under certain conditions above 6m/sec hub height wind speeds.
	Plot to be examined to establish whether a singular regression relationship is evident.	Yes	Polymonials were provided in the background report. A representative scatter plot was provided for night time easterly sector winds.
	If there are markedly diffferent groups, separate scatter plots may be required for different conditions, including wind directions and times of day.	Yes	Night period background curves were included and also wind direction detail based on Planning Permit requirement.
7.4.2	Find the regression curve that gives the best correlation coefficient between the sound level and wind speed for each scatter plot and use it to describe the average background sound level at different wind speeds.	Yes	Taken to be provided. The absence of raw data and scatter plots on raw data however prevented confirmation. See comment above about the relevance of background for the modelling.
	Sparseness of data or obvious outliers should not be allowed to unreasonably influence the regression curve.	Yes	Reported to be addressed.
	Removal of outliers may be required.	Yes	
	Has a bin analysis procedure IEC 61400-11 been used? If so is it reasonable and appropriate.	N/A	
7.4.3	If there is a poor correlation between wind speed and sound level, further investigation of wind conditions should be undertaken e.g. wind flow modelling,local knowledge, site observations or local wind monitoring	ND	Charts revealing correlation between wind speed and background noise were presented in the background noise assessment report. Correlation coefficients were provided in charts. Scatter plots were only included for night period easterly wind at 3 locations. The raw data-set was not reviewed. Following auditor enquiries, a discussion on wind direction influence was made which appears to confirm a low background environment at some NSLa and potential for seasonal variations factors. Further information is required to address the above deficiencies.
7.4.4	Where multiple regressions are indicated and several regression curves obtained, noise limits should be set on the basis of each regression curve derived. Where not practical, use the most stringent regression curve with lowest SL.	Yes	Multiple regressions are provided based on wind direction as required under the Planning Permit. It has not been determined whether the curve showing the lowest sound levels has been adopted. Nonetheless in the compliance evaluation, for wind speeds less than 6 m/sec the base 35 dB LA90 limit has been adopted, enabling conformance with this requirement (as background need not be considered).
	Where the lowest BG is when wind is blowing from the noise sensitive location to the wind farm, it is reasonable to consider additional attenuation that may occur.	N/A	The lowest background appears to be when the wind will blow from the south-east which is a direction that is from the wind farm towards several NSL in the high amenity area.
7.5	**POST INSTALLATION MEASUREMENTS**	N/A	N/A - considered relevant for post construction
7.5.1	Measure where practical at the same locations where background SL were determined.		
7.5.2	Scatter curves shall be drawn of SL against wind speed and regression curved obtained (as per 7.4)		
7.5.3	Capture both the wind farm sound and the background sound.		
	The contribution of the background sound shall be removed from the regression curve drawn in S. 7.5.3 at each integer wind speed.		
7.5.4	An assessment for any special audible characteristics shall be undertaken (S. 5.4) covering the range of operational wind speeds.		
7.6	**COMPLIANCE ASSESSMENT**	N/A	Relevant for post construction noise assessment
7.6.1	The 35dB wind farm SL contour shall be predicted and measurements made within this contour.	Yes	The 35dB sound level contour has been predicted and included within the subject report.

7.6.2	Compare the best fit regression lines of the background SLs and the regression curves of the wind farm sound levels adjusted for any special audible characteristics at each noise sensitive location.		
	Adjustments apply to wind farm speeds at which it is assessed and applied before comparison with the noise limit.		
7.6.3	If background SLs were not measured prior to installation, it may be necessary to obtain SLM for limited periods at critical wind speeds. These may be for a limited range of end speeds and directions while the wind turbines are not operating, i.e. on/off testing to get a representative number of measurements		
	Turbines 10dB lower that the higher contribution need not be turned off for testing.		
7.6.4	Compliance at one period does not negate the need for further testing.		
	Note: Section 7.1.2 of NZ6801-2008 states: *'To demonstrate compliance, measurements should be appropriately adjusted to slightly positive propogation conditions which are the upper limits of the meteorological window* '. However, section 7.1.5 states '*the provisions of this section do not apply for the purposes of NZS 6808'*.		
7.7	**ON/OFF TESTING**	N/A	
	Often an appropriate method for measuring small wind turbine sound levels.		
8	**DOCUMENTATION**		
8.1	**Predictions**		
	Any report of wind farm sound level predictions in accordance with this Standard shall refer to this Standard and provide the following: (a) A map showing the topography (contour lines) in the vicinity of the wind farm, the position of the wind turbines, and noise sensitive locations;	Yes	The topography is illustrated by a heat map (not contours). However it does reveal elevation. The turbine locations are indicated as noise sensitive locations. Reportedly this topographical data was fed into the model.
	(b) Noise sensitive locations for which wind farm sound levels are calculated;	Yes	Both stakeholder dwellings and non-stakeholder noise sensitive locations, as well as the school and child care centre, are included on the map.
	(c) Wind turbine sound power levels;	Yes	Included for the candidate turbines selected as representative of the turbine likely to be installed.
	(d) The make and model of the wind turbines;	Part	Vestas EnVentus V162-6.0 MW and Cypress GE 6.0 - 164 turbines are nominated with make and model - noted the candidate is not the final turbine selected.
	(e) The hub-height of the wind turbines;	Yes	Specified at 149m (Vestas) and 148m (GE).
	(f) Distance of noise sensitive locations from the wind turbines;	Yes	Illustrated on a scaled map with North direction marked
	(g) Calculation procedure used;	Yes	Attentuation of noise is reported to follow ISO 9613 Acoustics- Attenuation of sound during propogation outdoors using SoundPLAN version 8.2. This is reference in NZS 6808:2010 as an appropriate prediction method.
	(h) Meteorological conditions assumed;	Yes	10 degrees C and 70 percent humidity used which is reasonably representative of the lowest atmospheric attenuation conditions and are referenced in the NZS6808:2010.
	(i) Air absorption parameters used;	Yes	Attenuated by frequency octave band nominated to be applied as per Appendix J. Octave band attenuation factors include 0.12 dB/km for 63Hz to 3.66dB/km for 1kHz and 32.8 dB/km for 4kHz.
	(j) Ground attenuation parameters used;	Yes	G=0.5 with rationale described in Appendix H, and specified in NZS 6808 as a default.
	(k) Topography/screening assumed	Yes	As per topographical terrain heat map. Limited near field adjustment at >35dB
	(l) Predicted far-field wind farm sound levels.	Yes	Predictions occur to 30dB(A).
			Model assumes down wind +/-45 degrees. Inversions not considered due to wind turbines unlikley to be operational during inversion conditions.
			The Vestas is predicted to comply with at least a 1 dB LA90 compliance buffer under reasonable worst case prediction methods under an allowance for uncertainties of 1 dBA.

			The GE variant is pedicted to achieve marginal compliance with one location being essentially at the noise limit of 40 dB LA90 (W27-i) and 39.9 dB LA90 (H32-a). A number of other locations are predicted above 39.5 dB LA90. Uncertainties become relevant and are discussed below. MDA undertook directional noise predictions based on a reduced noise contribution from the more distant turbines. This is accepted under the Standard (Sect 6.1.2). This further evaluation predicts that location H32-a achieves no improvement at 39.9 dB LA90 and other nearby NSL achieve slight imporvements including W27-i predicted to be at 39.8 dB LA90 when directionality is included into the modelling. Additionally, there exists a low noise operating mode that could be engaged to control noise under certain wind directions and speeds. Data provided suggests the Noise Reduction Operation at NRO 105 should achieve the equivalent to the Vestas candidate model. However this means noise management is required and could not be considered best practice noise technology against the other Vestas candidate turbine.
	Detail (note: not specified in standard but applicable for modelling):		
	Turbine Sound Power Levels	Yes	SPL provided for candidate turbines, Vestas V162:6.0 MW and Cypress GE 6.0-164. However the final turbine type is yet to be confirmed.
	Micro Siting Allowance (noting 'model planning permit conditions allow up to 100m change if nominated.	N/A	Likely to be 100m as per DELWP Guidelines. However, locations are reportedly not as yet fixed.
	Identification of relevant noise sensitive locations - process and outcomes	Yes	A planning permit has been issued. A letter was received confirming that all noise sensitive locations at non-stakeholder dwellings have been reported and included in the noise assessment report.
	SACs- Tonality allowance at various wind speeds	Yes	Candidate turbine under best practice design should not have any special tonal characteristics and this is specified in the subject report.
	Noise level (SPL) with respect to varying wind speed	Yes	Provided SPL including octave band SPL.
	Best practice blade design	Yes	Modelling assumes blade will be serrated tail edge for Vestas. The GE does not refernece the blade control. If blade changes are made on the turbines (or an alternative turbine to that modelled selected), a revised noise assessment should be conducted and a discussion on best practice low noise blade design incorporated into the noise assessment report.
	Cumulative influences	Yes	Cumulative impact is considered in the subject report and found to be <30dB at clostest points for the Vestas candidate and marginally over at one location to east for the GE turbines.. No overlap of 30dB prediction contours means no discerible cumulative contribution to the 40dB L90 limit within the Farming Zone. The distance from turbines to NSLs and absence of a down wind scenario for the WEF's,
			A review of the directionality information provided in the noise assessment report supports a reduction in noise level of over distance of approximatley 3km in the order of 10 dB or more. This essentially would mean the Berrybank wind farm would be within background noise at mid positioned NSL when the wind from the GPWF was blowing towards the NSL (i.e. the modelled compliance scenario). It is difficult to evisage any measurable contribution to the compliance prediction at NSLs that are marginally compliant.
	Ground absorption ratio 'G'	Yes	G ratio =0.5 reasonable approach given the terrain.
	Predictive model used	Yes	SoundPLAN version 8.2; an acceptable and internationally used model.
	Results discussion - non stakeholder sensitive locations	Yes	Compliance evaluated in standard and high amenity zones.

	Results discussion - Stakeholder Properties	Yes	Not included in the noise assessment report, as outside scope of the Standard (and the audit).
	Any report of background sound level measurements and assessment in accordance with this Standard shall refer to this Standard and provide the following:		
	(a) Description of the sound monitoring equipment including ancillary equipment;	ND	No details were provided in the background report. Refer to earlier comments concerning relevance given base limits were adopted.
	(b) The location of sound monitoring positions;	Yes	
	(c) Description of the anemometry equipment including the height AGL of the anemomometer	ND	No details were provided in the background report. Refer to earlier comments concerning relevance given base limits were adopted.
	(d) Position of wind speed measurements;	ND	No details were provided in the background report. Refer to earlier comments concerning relevance given base limits were adopted.
	(e) Time and duration of the monitoring period;	Yes	Monitoring dates and data points stated.
	(f) Averaging period for both sound and wind speed measurements;	Yes	10 minutes is stated.
	(g) Atmospheric conditions: the wind speed and direction at the wind farm position & rainfall	Yes	Wind direction and rainfall not reported but stated that data set was filtered.
	(h) Number of data pairs measured (wind speed in m/s, background sound in L90);	Yes	
	(i) Description of the regression analysis; and	Yes	Charts are provided within background noise report Appendix E
	(j) Graphical plots showing the data scatter and the regression curves	Yes	In background report for each 45 degree wind rose direction
			Total and night period only backgrounds have been reported.
8.3	**COMPLIANCE ASSESSMENT**	N/A	Relevant to a Post Construction Noise Assessment
	Any report of wind farm post-installation sound level measurements and compliance assessment, other than on/off tests, made in accordance with this Standard shall refer to this Standard and provide the following:		
	(a) Description of the sound monitoring equipment including any ancillary equipment		
	(b) A statement confirming the use of A-frequency-weighting;		
	(c) The location of sound monitoring positions;		
	(d) Description of the anemometry equipment including the height AGL of the anemometer		
	(e) Position of wind speed measurements;		
	(f) Make and model of the wind turbines;		
	(g) Number of operational wind turbines;		
	(h) Time and duration of monitoring period;		
	(i) Averaging period for both sound and wind speed measurements		
	(j) Atmospheric conditions: the wind speed and direction at the wind farm position & rainfall		
	(k) Number of data pairs measured (wind speed in m/s, sound in L90);		
	(l) Description of the regression analysis;		
	(m) Graphical plots showing the data scatter and the regression lines;		
	(n) Graphical plots showing the data scatter and the regression lines for both the background and the wind farm in operation.		
	(o) Assessment of special audible characteristics; and		
	(p) A statement that the wind farm complies with relevant limits – or not – as determined from the results of the measurements		
Other	No noise complaints have been recorded	NA	
Appendix C	**Uncertainty**		

	It is good practice to state the uncertainty and confidence level for all sound levels determined in accordance with this Standard. Uncertainty should be determined in accordance with the procedures in Craven and Kerry (2001). These procedures involve determining the standard uncertainty for every source of uncertainty in the measurement/ assessment process, and summing these standard uncertainties in quadrature (root sum of squares) to obtain the combined uncertainty. If a source of uncertainty is assumed to have a normal distribution, standard uncertainty is related to standard deviation, but this is not always the case and rectangular distributions are also common. *When comparing a sound level with an applicable noise limit, the sound level should be deemed to comply if the sound level is equal to or less than the noise limit. It should be deemed not to comply if the sound level is greater than the noise limit, regardless of the uncertainty. Where compliance or non-compliance is marginal and contested, steps should be taken to reduce the uncertainty, where practical*	Part	No specific discussion of uncertainty is provided for the Vestas candidate turbine. However, a 1 dB addition was made to the SPL provided by the manufacturers on the Vestas candidate turbine as a measure of conservatism. Compliance under the allowances made is predicted by over 1 dB, providing a noise level compliance margin to balance uncertainty. For the GE turbine however, the uncertainty is specified at sigma 'p' of 0.8 dB. This value was the level of uncertainty that was added for modelling purposes. Other potential product and testing reproducibility uncertainties were not discussed. Given predictions are essential at the compliance limit at some locations, uncertainties in the modelling process become important. Communications provided by the manufacturer GE support that sigma 'p' is suitable for total far field testing reproducibility. MDA has reviewed directionality to assist with enhanced predictive modelling of turbines. Those turbines greater than approx. 1.2km from a noise sensitive location have had there noise contribution reduced by wind directionality influences. This approach however, adds to the technical detail of likely noise levels as it does not assume the receptor is down wind from all turbines. However, modelling results reveal predicted noise level are still within 0.3 dB of the compliance limit at several locations. A recalculation should follow the selection of a final turbine. Furthermore the assessment should be recalculated should the location of turbines in proximity to Q30-a, W27-i, W28-a vary with micro-siting allowances towards a NSL which potentially could raise noise levels by >1dB against a Vestas turbine or for any increase with a GE candidate turbine.
	Definitions (from NZS6808:2010)		
	Noise Sensitive Location: 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 include: (a) Any part of land zoned predominantly for residential use in a district plan; (b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f (c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities, papakainga and marae, excluding habitable spaces in buildings where the predominant activity is commercial or industrial. (Residential buildings designed for permanent habitation on land zoned for predominantly rural or rural-residential use are not classified as commercial or industrial for the purposes of this Standard); (d) Teaching areas and sleeping rooms in educational institutions, including public and private primary, intermediate, and secondary schools, universities, polytechnics, and other tertiary institutions; (e) Teaching areas and sleeping rooms in buildings used for licensed kindergartens, childcare, and day-care centres; and (f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses. **In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights**.		
	Commentary of note in NZS: *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.*		
	Other commentary of note: *Background noise is a combination of sounds including tree leaf and grass rustle, crickets, insects, frogs, birds, dogs, cattle, sheep, distance traffic (car and air) and even wave motion. When a source, such as turbine noise, is introduced the background noise level may increase.* *The addition of a new source with a noise level 10dB below the background would increase noise to a new background 0.4dB higher.* *If the two sources have the same noise level then an increase of 3.0dB results. Therefore if the background is 35dB and the turbine is also 35dB, the resultant noise is 38dB.* *To increase the L90 by 5dB, the new turbine based source would need to be 3.3dB above the previously confirmed background.*		

WIND ENERGY FACILITY NOISE REPORT AUDIT PROTOCOL

DELWP Guideline Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria, March 2019

Evidence Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report 001 R01 20200919 Rev 01 3 December 2020
Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report 001 R02 20200919 4 January 2021
Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report Rp 002 20200919 23 March 2021
Golden Plains Wind Farm, Planning Permit Amendment Application, Noise and Vibration Assessment M180934RP10 Revision C, Wednesday 25 November 2020, Resonate Consultants Pty Ltd
Golden Plains Wind Farm Response to Auditor Markup R001 R01 20200919 received from Marshall Day Acoustics 20 December 2020

Section	Requirement	Comply	Observations/ Comments
5.1.2			
a) Noise	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).	Yes	
	The Standard specifies a general 40 decibel limit for wind farm sound levels, or the sound should not exceed the background sound level by more than five decibels, whichever is the greater	Yes	
	A limit of 45 decibels is recommended for stakeholder dwellings (taken to mean LA90).	NA	Noise predictions have not been undertaken in the report for stakeholder properties (also termed host properties in the report). As a limit for stakeholders is not specified in NZS 6808: 2010 (i.e. the Standard) it is therefore not within scope of a S53V risk of harm audit.
	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.	Yes	A high amenity area is specified within the Planning Permit (PA1700266) as being applicable in the Low Density Residential and Township Zones. Noise levels at NSL's in these zones have been predicted to be below 35 dB during wind speeds at and below 6 m/sec. Therefore compliance is predicted at wind speeds as recommended within the Standard. A high amenity noise limit is discussed in the noise assessment report and is not considered applicable in the Farming Zone. Communications with EPA on planning scheme interpretation has resulted in Advice to Auditors (25 October 2019). According to the Cherry Tree VCAT decision and EPA Advice, a Farming Zone is not considered a High Amenity Area. Accordingly, the process followed in the noise assessment report against a standard noise amenity is appropriate for noise sensitive locations within the Farming Zone.
			Planning Permit dated 29/4/2019 (originally issued 21 Dec 2018) was sighted and confirmed to have same wording as that used in report. The PP requires a noise assessment and collection of background noise monitoring data which was provided in a separate report prepared by Resonate Consultants.
	Planning permit conditions should require post installation noise compliance to be monitored and demonstrated to the satisfaction of the responsible authority.	N/A	

EnviroRisk

	Certification of whether a wind energy facility complies with the Standard and other applicable noise requirements must be undertaken by an acoustic engineer.	Yes	Provided in the acoustic report against standard and high amenity limits. The high amenity noise limit is specified in the noise assessment report as only being relevent at the NZS recommended wind speeds of 6 m/sec and lower. This is discussed further within the protocol as there are ambiguities that warrant the Regulators interpretation.
	The wind energy facility operator must provide the responsible authority with an assessment by an independent, appropriately qualified and experienced acoustician that demonstrates whether the facility is compliant with the noise standard.	Yes	An appropriate technical report has been prepared and is attached to this audit.
	Measurement and compliance assessment methods are set out in the Standard	Yes	Compliance predictions have been assessed to be based on sound methodology and by competent personnel. Whilst the auditor has not undertaken any specific background measurements or modelling themselves, indicative calculations performed on distance and ground attenuation aspects suggest noise predictions are realistic. All locations identified in the subject report indicate that compliance can be achieved against the limits derived in the report (if the facility is constructed in locations specified and adopt a turbine type modelled).
Wind Farm Noise Compliance			
	Wind farm noise compliance must be established by testing and assessment by acoustic consultants against the requirements of the Standard.	Yes	See detail in separate spreadsheet
	The party must engage an environmental auditor to conduct a Risk of Harm audit under the EP Act 1970 to verify that wind energy facility noise assessments have been conducted in accordance with the Standard.	Yes	
	Proposed or existing wind farm operators should consider obtaining an assessment of compliance, as part of any submission, to demonstrate ongoing compliance to satisfy permit requirements.	Yes	
	An assessment of compliance issued by an EPA appointed auditor?	Yes	
	The report issued by the EPA appointed auditor is a declaration that the noise assessments:		
	1. have been conducted in accordance with the Standard;	Yes	The auditor confirms that the appropriate standard, NZS6808:2010, has been referenced and assessed against its strict wording.
	2. meet the requirements of the permit or other regulatory instrument (*specified and relating to noise compliance*).	Yes	Compliance with the standard is predicted for a standard noise amenity area at all times and a high noise amenity area during wind speeds of 6 m/sec or lower during the evening or night period (as is recommended in the Standard).

	The declaration must be accompanied by a report, signed by the auditor, addressing the matters 1. and 2. above and detailing the considerations they have relied upon in forming their view.	Yes	This protocol forms an Appendix to the audit report.
	This report should be thorough but concise.	Yes	Agreed and considered achieved.
	The report must have adequate detail including an annexure listing all documents examined or relied up on to permit any reader to follow the deliberations that the auditor undertook in forming their view.	Yes	Documents included in the report have been referenced and appended to the Audit report.
Auditor notes.	*Micro siting permits relocation of turbines by up to 100m. Has this been taken into consideration within modelling?*	No	Micro-siting is not specifically mentioned in the acoustic report. Given the marginal compliance predicted with one candidate turbine variant a non compliant situation may result if a turbine is moved closer to a NSL. If a combined noise can exceed 1dB for teh Vestas candidate turbine and any invrease for the GE candidate turbine a re-evaluation of compliance is recommended.

WIND ENERGY FACILITY NOISE REPORT AUDIT PROTOCOL

Planning Permit

No PA1700266

Planning scheme Golden Plains

Evidence
A) Golden Plains Wind Farm Environmental Noise Assessment, Marshall Day Acoustics Report 001 R01 & R02 20200919 December 2020 and January 2021
B) Golden Plains Wind Farm, Planning Permit Amendment Application, Noise and Vibration Assessment M180934RP10 Revision C, Wednesday 25 November 2020 & Revision E, Mondat 15 March 2021 Resonate Consultants P/L
Note: The audit has only considered the background monitoring content within the Resonate report. Other report content has not been audited.

Relevant Conditions	**Noise**		**Comply**	**Comment**
		(Pre-constuction noise from wind turbines)		
	13	Subject to condition 14 and condition 18(c)(i), at any wind speed, noise from the operation of the wind turbines, when measured at noise sensitive locations, must comply with the appropriate limits in the Standard at all times.	N/A	Post construction condition
	14	If it is determined that sound from the wind energy facility has a special audible characteristic at any noise sensitive locations, the measured sound level shall have a penalty applied in accordance with the Standard.	N/A	Post construction condition
	15	The limits specified in condition 13 do not apply if an agreement has been entered into with the owner of the noise sensitive location that waives compliance with condition 13. Evidence of the agreement must be provided to the satisfaction of the responsible authority upon request, and be in a form that applies to the land upon which the noise sensitive location is located for the life of the wind energy facility.	ND	Letter received from proponent confirming that non-stakeholders have been appropriately identified and included within the preconstruction noise report.
	16	Subject to condition 17, noise from ancillary infrastructure associated with the wind energy facility must comply with the noise levels for noise sensitive areas in accordance with NIRV at all times	N/A	NIRV falls outside the scope of the Standard and therefore this audit.
	18	Before development starts, a Pre-construction Noise Assessment based on the final turbine layout and turbine model to be installed and the detailed design of the ancillary infrastructure must be submitted to, approved and endorsed by the responsible authority. The endorsed Pre-Construction Noise Assessment must be placed on the project website as soon as practicable.	ND	A noise assessment report has been prepared by Marshall Day Acoustics (MDA) seeking approval. It has not been confirmed it was submitted or approved.
		The Pre-construction Noise Assessment must		
		a) be prepared in accordance with the Standard and NIRV, and must demonstrate to the satisfaction of the responsible authority that the facility will comply with the performance requirements specified in conditions 13 and 16.	Yes	The MDA noise assessment report has been prepared in accordance with the Standard. Noise is predicted to comply with standard amenity and high amenity for wind speeds of 6 m/sec or less The ability to comply with NIRV however has not been assessed by this audit.
		b) include the collection of background noise monitoring data points over a 6-week period, or at least 4,032 valid data points (whichever is lesser) for each representative site, analysis by 24 hour and night (10 pm to 7 am) only period, and for each time sector analysis for each 45 degree wind rose direction	Yes	The noise assessment report references and uses data from a separate background monitoring report (prepared by Resonate) which conforms with condition 18(b. The Resonate report has not been audited. It is noted MDA reference a Resonate report. The Auditor has received a Resonate report dated Nov. 2020 and also March 2021. These were reported by the proponent to have the same background content.
		c) include:		
		i) a specific acknowledgement that the areas in and around Rokewood that are zoned Township Zone and Low Density Residential Zone are a high amenity area for the purposes of the Standard	Yes	The noise assessment report acknowledges the zones that are considered high amenity areas.
		ii) an assessment as to whether the high amenity noise limit should apply to these areas and the appropriate threshold wind speed, based on the guidance in Clause CS.3.1 of the Standard	Yes	The noise assessment report reviews against a high amenity limit for wind speeds 6m/sec and lower. However, the Standard has an abiguity in that, although it recommends the a high amenity noise limit apply to 6m/sec and lower wind speeds, an alternative wind farm wind speed may be applied where justified on meteorological, topographic and acoustical grounds.' (sect 5.3.2)
		d) be accompanied by an Environmental Audit Report prepared under Part IXD, Section 53V of the Environment Protection Act 1970 from an environmental auditor appointed under Part IXD of the Environment Protection Act 1970. The report must verify that the Preconstruction Noise assessment has been conducted in accordance ·with the Standard and meets the requirements of this permit.	Yes	The report has been conducted in accordance with a reasonable interpretation of the Standard. As the Standard has ambiguities, a recommendation is made for the responsible authority to confirm the conditions where alternative wind farm speeds may be applied given there is no guidance as to what these may be in the Standard. Conditions of the Planning Permit that can be assessed under the EPA WEF guidelines, have been assessed as part of the audit of the Marshall Day Acoustics report.

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15 December 2020

Dear Mr Jenkins,

Golden Plains Wind Farm Environmental Noise Assessment – Location of non-stakeholder dwellings

We have reviewed the Receiver Locations shown in Table 10 of the Marshall Day Acoustics report *Golden Plains Wind Farm Environmental Noise Assessment* (Ref: Rp 001 R01 20200919) dated 3 December 2020 (the Report).

We confirm that all non-stakeholder receiver locations within 3km of a proposed wind turbine have been identified and included in Table 10 that forms Appendix C to the Report.

Please contact the undersigned on 0401 552 780 if you require any further information.

Yours sincerely,

Kyle Sandona
Project Manager