MARSHALL DAY Acoustics

DELBURN WIND FARM
PRELIMINARY NOISE ASSESSMENT

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Project:	**Delburn Wind Farm** **Preliminary Noise Assessment**
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EXECUTIVE SUMMARY

This report presents the results of a preliminary assessment of operational noise associated with the Delburn Wind Farm that is proposed to be developed by OSMI Australia Pty Ltd.

The assessment is based on the proposed wind farm layout comprising thirty-five (35) multi-megawatt turbines and associated site infrastructure.

The planning application for the wind farm seeks permission to develop turbines with a maximum tip height of 250 m. 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 receiver locations. The assessment therefore considers a candidate turbine model that is representative of the size and type of turbine which could be used at the site. For this purpose, the Vestas V162-5.6MW, with a hub height of 160 m and a rotor diameter of 162 m, has been selected as the candidate turbine model.

Operational noise from 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.

In advance of background noise monitoring around the project, the preliminary assessment considers the minimum operational wind farm noise limits determined in accordance with NZS 6808:2010, accounting for the land zoning of the area surrounding the project.

Manufacturer specification data provided by OSMI for the candidate turbine model has been used as the basis for the assessment. This specification provides noise emission data in accordance with the international standard[1] referenced in NZS 6808:2010. The noise emission data used is consistent with the range of values expected for comparable types of multi megawatt wind turbine models that are being considered for the site.

The noise emission data has been used with international standard ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) to predict the level of noise expected occur at neighbouring sensitive receiver locations. The ISO 9613-2 standard has been applied based on well-established input choices and adjustments, based on research and international guidance, that are specific to wind farm noise assessment.

The results of the noise modelling for the Delburn Wind Farm demonstrate that the predicted noise levels for the proposed turbine layout and candidate turbine model achieve the noise limits determined in accordance with NZS 6808:2010 at all neighbouring noise sensitive receiver locations.

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

[1] IEC 61400-11:2012 Wind turbines - Part 11: Acoustic noise measurement techniques

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1.0 INTRODUCTION

OSMI Australia Pty Ltd is proposing to develop a wind farm known as the Delburn Wind Farm across the Victorian Local Government areas of South Gippsland, Baw Baw and Latrobe.

The Delburn Wind Farm is proposed to comprise thirty-five (35) wind turbines and ancillary infrastructure located approximately ten kilometres to the southwest of Morwell.

This report presents the results of an assessment of operational noise for the proposed wind farm.

The assessment of operational noise associated with the turbines has been undertaken in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010) as required by the required by the Victorian Government's *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019 (the Victorian Wind Energy Guidelines).

Noise associated with operation of the wind farm's ancillary infrastructure has not been considered in this preliminary assessment. Ancillary infrastructure does not generally represent a significant noise consideration for wind farm developments. Irrespective, noise from the proposed substation would be assessed in accordance with EPA Publication 1411 *Noise from industry in regional Victoria* dated 2011 (NIRV) during subsequent planning stages for the project when preliminary design details are available.

The preliminary noise assessment presented in this report is based on:

- Operational noise limits determined in accordance with NZS 6808:2010, accounting for local land zoning and existing background noise levels at neighbouring sensitive locations;
- Predicted noise levels for the proposed Delburn Wind Farm based on the proposed site layout and a candidate turbine model that is representative of the size and type of turbine that the planning application seeks consent for; and
- A comparison of the predicted noise levels with the criteria derived in accordance with NZS 6808:2010.

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

2.0 PROJECT DESCRIPTION

2.1 Overview

The Delburn Wind Farm is proposed to comprise thirty-five (35) wind turbines which extend over an area spanning approximately 12 km from north to south and 5 km from east to west. The coordinates of the proposed wind farm are tabulated in Appendix C.

A total of three hundred and thirty-three (333) noise sensitive receivers located within 3 km of the proposed Delburn Wind Farm have been considered in this noise assessment. They are referred to herein as receivers.

The coordinates of the receivers are tabulated in Appendix D.

A site layout plan illustrating the turbine layout and receiver locations is provided in Appendix E.

2.2 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 representative candidate turbine model for 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, based on noise emission levels that are typical of the size of turbines being considered for the site.

The Vestas V162-5.6MW has been selected as the candidate turbine model for this assessment.

This is a variable speed wind turbine, 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). It is our understanding that two different types of blade design are available for the candidate turbine model; a standard non-serrated version and a serrated version which reduces the total noise emissions of the turbine. These two different blade configurations are referred to by Vestas as ‘sound modes’. Note that these modes are distinct from ‘sound optimisation modes’ which involve the use of power curtailment measures to reduce the noise emission of the turbine. This assessment considers both modes of the candidate turbine operating without sound optimisation modes (i.e. un-curtailed operation of the two different blade configurations).

Details of the proposed candidate wind turbine are provided in Table 1.

Table 1: Proposed candidate wind turbine

Detail	Vestas V162-5.6MW
Rotor diameter	162 m
Hub height	160 m
Blade orientation	Upwind
Sound mode	Mode 0-0S (non-serrated blades) Mode 0 (serrated blades)
Turbine regulation method	Variable blade pitch
Rated power	5.6 MW
Cut-in wind speed (hub height)	3 m/s
Rated power wind speed (hub height)	12 m/s
Cut-out wind speed (hub height)	24 m/s

2.3 Wind turbine noise emissions

2.3.1 Candidate turbine

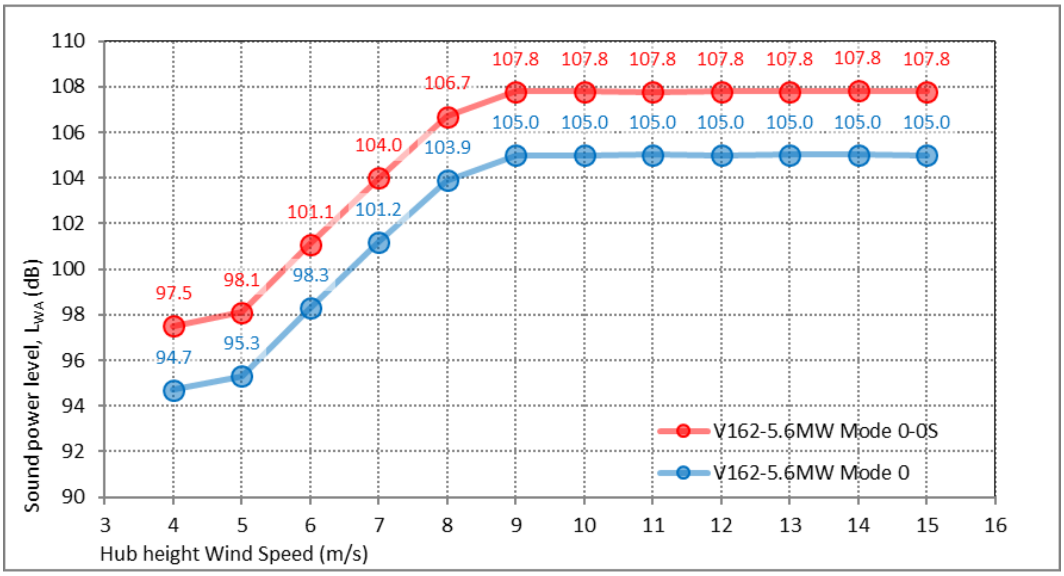
The noise emissions of the wind turbine are described in terms of the sound power level for different wind speeds. The sound *power* level is a measure of the total sound energy produced by each turbine and is distinct from the sound *pressure* level which depends on a range of factors such as the distance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

Sound power level data for the candidate turbine model, including sound frequency characteristics, was sourced from the Vestas specification document DMS 0079-5298_01 *V162-5.6MW Third octave noise emission* dated 23 January 2019.

The sound power data has been adjusted by the addition of +1.0 dB at each wind speed to provide a margin for typical values of test uncertainty.

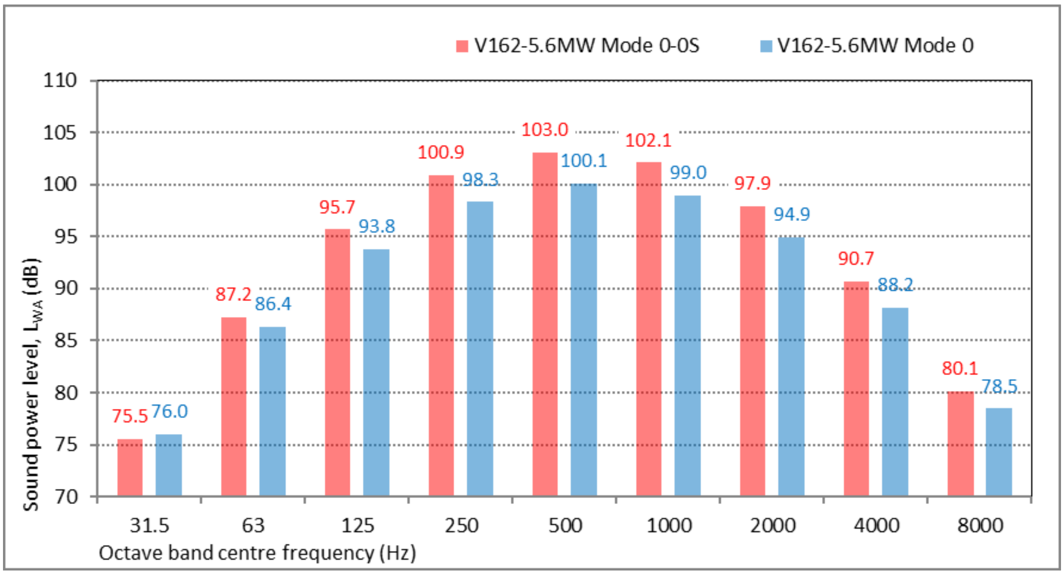
The sound power levels referenced in this assessment (including the +1 dB adjustment) are illustrated in Figure 1 and represent the total noise emissions of the turbine for each sound mode, including the secondary contribution of ancillary plant associated with the turbines (e.g. cooling fans).

Figure 1: Assessment sound power levels, dB L_{WA}



The reference spectra used as the basis for this assessment is illustrated in Figure 2 and correspond to the highest overall sound power level illustrated in Figure 1, for each sound mode.

Figure 2: Assessment sound power level spectra, dB L_{WA}



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

The manufacturer specification for the candidate turbine model does not provide information about tonality.

The occurrence of tonality in the noise of contemporary multi-megawatt turbine designs is generally limited. This is supported by evidence of operational wind farms in Australia which indicates that the occurrence of tonality at receiver locations is atypical. On this basis, adjustments for tonality have not been applied to the predicted noise levels presented in this preliminary assessment. Notwithstanding this, the subject of tonality would be addressed in subsequent assessment stages for the project.

2.3.2 Turbine size and noise emissions

The sound power levels in Section 2.3.1 are considered typical of the upper range of noise emissions associated with comparable multi-megawatt wind turbines. The data is therefore considered appropriate to reference in this assessment as a representation of the apparent sound power levels of the turbines when tested and rated in accordance with International Electrotechnical Commission publication IEC 61400-11:2012 *Wind turbines - Part 11: Acoustic noise measurement techniques* (IEC 61400-11), consistent with the recommendation of NZS 6808:2010.

To provide further context to the noise emissions of the candidate turbine, the sound power levels for a selection of other Vestas turbine models of varying size and power output are provided in Table 2 for comparison with the data for the candidate turbine. The sound power level data for the various models have been sourced from publicly available references and reports. The data is presented graphically in Figure 3, Figure 4 and Figure 5.

Table 2: Sound power levels for a selection of Vestas turbine models, dB L_{WA}

Rotor Diam.	MW	Serrations	63	125	250	500	1000	2000	4000	A
80	1.8	No	93.3	97	99.3	98.6	95.5	87.6	80.4	104.4
90	3	No	91.8	94.0	97.3	99.6	101.8	100.5	96.7	107.0
112	3.3	No	88.0	95.6	97.4	99.7	99.4	96.7	91.3	105.3
112	3.45	No	90.5	96.5	98.6	100	100.9	99.2	95.7	106.8
112	3	No	88.3	95.2	97.0	100.7	100.7	99.6	94.0	106.5
136	4.2	Yes	86.7	92.0	95.3	97.2	98.6	97.6	89.4	103.9
162	5.6	No	86.2	94.7	99.9	102	101.1	96.9	89.7	106.8
162	5.6	Yes	85.4	92.8	97.3	99.1	98.0	93.9	87.2	104.0

Notes: Manufacturer specification values which do not include margins for uncertainty

Figure 3: Sound power level spectra for a selection of Vestas turbine models, dB LWA

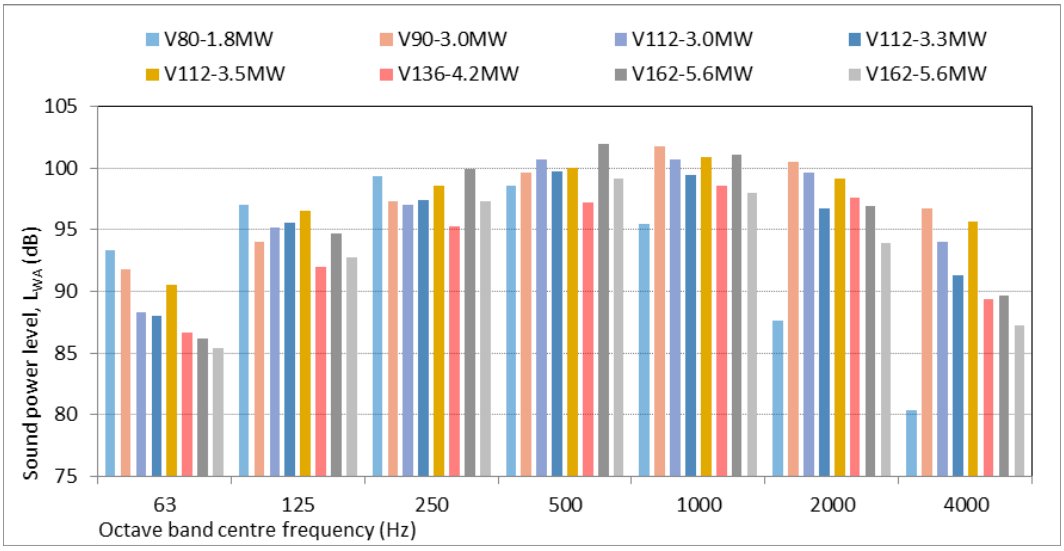


Figure 4: Sound power levels vs. Rotor diameter for a selection of Vestas turbine models, dB LWA

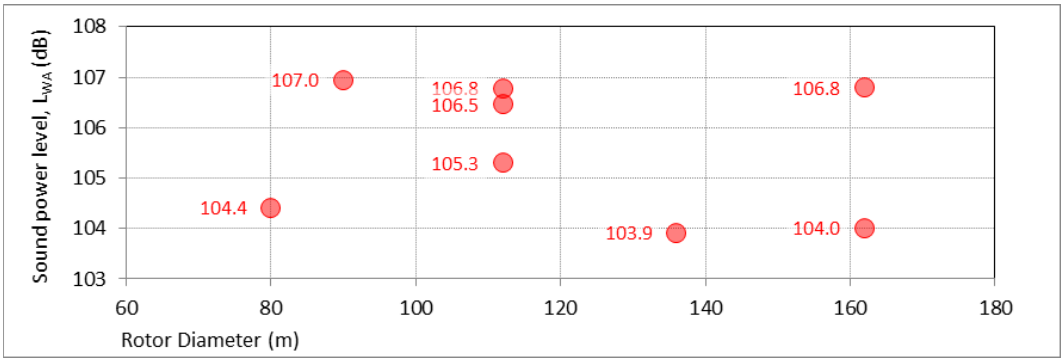
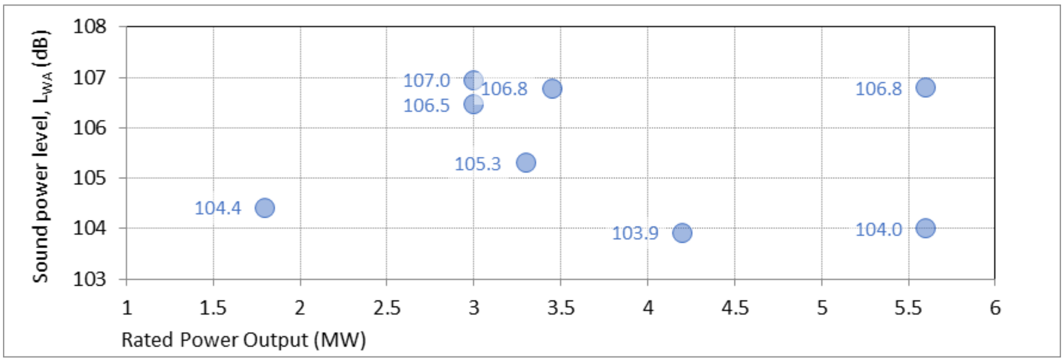


Figure 5: Sound power levels vs. Rated power output for a selection of Vestas turbine models, dB L_{WA}



The data presented in Table 2, Figure 3, Figure 4 and Figure 5 indicate that the noise emissions of the candidate turbine are typical of the upper range of noise emissions for multi-megawatt turbines. The data also shows that there isn't a clear relationship between turbine size or power output and the noise emission characteristics of a 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.

3.0 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.

3.1 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.

3.2 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.

3.2.1 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.

3.2.2 Noise sensitive locations

The provisions of NZS 6808:2010 are intended to protect noise sensitive locations 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 Standard 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 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.

3.2.3 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.*

3.2.4 High amenity areas

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} detailed in Section 3.2.3 above is "*appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*." It goes on to note that high amenity areas may require additional consideration:

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

The definition of a high amenity area provided in NZS 6808:2010 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria.

Section 5.3 of NZS 6808:2010 provides details of high amenity noise limits, requiring that where a residential property is deemed to be located within a high amenity area as defined in Sections 5.3.1 and 5.3.2 of NZS 6808:2010, 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. High amenity noise limits are not applicable during the daytime period.

3.2.5 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. However, an indication of the potential for tonality to be a characteristic of the noise emission from the assessed turbine model can be determined based on the results of tonality audibility assessment commonly provided by manufacturers with their IEC 61400-11[2] sound power level specifications.

It should be noted that the tonality assessment in accordance with IEC 61400-11 is undertaken in proximity of a single tested turbine (generally within 150 m) whereas the assessment of potential characteristics is performed during post-construction noise monitoring at receiver locations.

[2] *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* (IEC61400-11)

4.0 ASSESSMENT METHODOLOGY

4.1 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 noise sensitive locations 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 wind farm; and
- Assessing whether the development can achieve the requirements of Victorian policy and guidelines by comparing the predicted noise levels to the noise criteria.

4.2 Background noise levels

Background noise level information is used to assist in setting operational noise limits for a wind farm.

The procedures for assessing background noise levels 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 an NZS 6808:2010 assessment therefore comprises:

- Preliminary wind farm noise predictions to identify all noise sensitive receiver locations where predicted noise levels are higher than 35 dB L_{A90}
- Identification of selected noise sensitive receiver locations 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 receiver locations 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.

4.3 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
- International standards used for the calculation of 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.

The ISO 9613-2 method is used in conjunction with a set of input choices and procedural modifications that are specific to wind farm noise assessment, based on international research and guidance.

The noise prediction method is summarised in Table 3. Further discussion of the method and the calculation choices is provided in Appendix H.

Table 3: Downwind prediction methodology

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 8.1
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 based on 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 wind turbine is modelled as a point source of sound. The total sound of the wind farm is then calculated based on simultaneous operation of all wind turbines and summing the contribution of each. Calculations of turbine to receiver distances and average sound propagation heights are made based on the point source being located at the position of the hub of the turbine. Calculations of terrain related screening are made based on the point source being located at the maximum tip height of each turbine. Further discussion of terrain screening effects is provided below.
Terrain data	Data provided by OSMI 1 m resolution within the site boundary and 10 m resolution beyond.

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 was 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. The Delburn Wind Farm is located in a reasonably hilly area characterised by some variations in ground elevation between the turbines and surrounding receivers. These terrain characteristics were sufficient to result in the application of adjustments to the predicted noise levels. Specifically, based on comparison of predicted noise levels with and without terrain elevation data included indicates adjustments for terrain effects equated to up to 2.1 dB. For reference purposes, the ground elevations at the turbine and receiver locations are tabled in Appendix C and Appendix D respectively. The topography of the site is depicted in the elevation map provided in Appendix F.
Ground conditions	Ground factor of G = 0.5 on the basis of the UK good practice guide 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^{o}C and relative humidity 70% These represent conditions which result in relatively low levels of atmospheric sound absorption and are chosen based on the UK Institute of Acoustics guidance. The calculations are based on sound speed profiles[3] 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

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

5.0 NOISE ASSESSMENT

5.1 Noise limits

5.1.1 High amenity areas

NZS 6808:2010 defines a base limit value of 40 dB for most situations, and states that the limit is appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations.

However, NZS 6808:2010 also defines a reduced base limit of 35 dB for special circumstances considered high amenity areas, where the level of amenity protection provided during the evening and night should be greater than is afforded to most residential locations. Specifically, Section 5.3.1 of the standard states:

> *[...] 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 LAeq(15 min) or 40 dBA L10. 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.*

Based on the predicted noise level contours presented subsequently in Section 5.2, and the zoning map for the area presented in Appendix G, most areas within the predicted 35 dB L_{A90} contour[4] are designated as Farming Zone and Public Conservation and Resource Zone, with up to seven (7) receivers to the southeast of the subject site located in a Rural Living Zone within the Latrobe local government area.

The high amenity provision of NZS 6808:2010 is specific to the New Zealand planning system, and therefore a degree of interpretation is required when applying the standard to the Victorian context. The following subsections separately consider the two relevant zone types.

Farming Zone

Clause 35.07 of the relevant planning schemes[5] states the purpose of the Farming Zone as follows:

> *To implement the Municipal Planning Strategy and the Planning Policy Framework.*
>
> *To provide for the use of land for agriculture.*
>
> *To encourage the retention of productive agricultural land.*
>
> *To ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture.*
>
> *To encourage the retention of employment and population to support rural communities.*
>
> *To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.*

[4] For the non-serrated blade variant

[5] South Gippsland planning scheme dated 25 July 2019,
Latrobe planning scheme dated 11 July 2019
Baw Baw planning scheme dated 3 May 2019

To provide for the use and development of land for the specific purposes identified in a schedule to this zone.

Based on the stated purpose detailed above, the relevant planning schemes do not specify the Farming Zone as promoting a higher degree of protection of amenity related to the sound environment.

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Guidelines, the high amenity noise limit detailed in NZS 6808:2010 is therefore not applicable to receivers in areas designated as Farming Zone around the Delburn Wind Farm.

Rural Living Zone

In relation to the Rural Living Zone to the southeast, Clause 35.03 of the Latrobe planning scheme states the purpose of the zone as follows:

To implement the Municipal Planning Strategy and the Planning Policy Framework.

To provide for residential use in a rural environment.

To provide for agricultural land uses which do not adversely affect the amenity of surrounding land uses.

To protect and enhance the natural resources, biodiversity and landscape and heritage values of the area.

To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.

The Latrobe Planning Scheme therefore does not specify the Rural Living Zone as promoting a higher degree of protection of amenity related to the sound environment. It may therefore be concluded that the high amenity provision is also not applicable to the Rural Living Zone

However, the planning panel report[6] for the Golden Plains Wind Farm considered the subject of zones more broadly. In the case of the Golden Plains Wind Farm, the panel 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. If the same reasoning was applied to the Rural Living Zone around the Delburn Wind Farm, the high amenity considerations may apply to the nine (9) receivers where predicted noise levels are above 35 dB L_{A90} for the non-serrated turbine.

This is ultimately a planning related matter and will require further review as part of subsequent assessment stages for the project. Also, the relevance of the high amenity provision for the Rural Living Zone will be dependent on the results of background noise monitoring to be carried out around the wind farm in future. In advance of these further works, and in recognition of the potential for the high amenity provision to apply to the Rural Living Zone, the preliminary assessment considers base noise limits of 35 dB and 40 dB for the receiver locations in the Rural Living Zone.

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

5.1.2 Applicable noise limits

Accounting for the conclusions of the assessment of high amenity areas the noise criteria applicable to the Delburn Wind Farm is summarised in Table 4.

Table 4: Applicable noise criteria

Land Zoning	Noise criteria, dB L_{A90}
Farming Zone	40 dB or background L_{A90} + 5dB, whichever is higher
Rural Living Zone	35 to 40 dB* or background L_{A90} + 5 dB, whichever is higher

* subject to further planning guidance and site studies

In advance of background noise monitoring that is to be undertaken during the next stages of the planning process for the project, a simplified and conservative approach has been adopted for the preliminary assessment by comparing the predicted noise levels with the base noise limits presented above. The background noise monitoring conducted as part of the next stages of the planning process would be used to derive background noise dependant noise limits.

5.2 Predicted noise levels

This section of the report presents the predicted noise levels of the Delburn Wind Farm at surrounding receiver locations, and an assessment of compliance with the applicable minimum noise limits.

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 Delburn Wind Farm have been predicted using the sound power level data detailed in Section 2.3 for the candidate turbine model and are summarised in Table 5 for each sound mode for the wind speed which results in the highest predicted noise levels (hub height wind speed ≥9 m/s).

The location of the predicted 35 dB and 40 dB L_{A90} noise contours is illustrated in Figure 6 and Figure 7 respectively for each sound mode, also for the wind speed which results in the highest predicted noise levels.

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

Table 5: Highest predicted noise level at receivers with predicted levels over 35 dB L_{A90}

Receiver Location	V162-5.6MW Mode 0-0S	V162-5.6MW Mode 0
600*	35.4	32.3
601*	35.5	32.5
602*	36.2	33.2
603*	36.1	33.1
604*	36.2	33.2
605*	36.9	33.9
606	38.0	35.0
607	35.2	32.1
608	36.5	33.5
609	37.5	34.5
610	37.0	34.0
611	35.6	32.6
779*	35.2	32.1
783*	35.4	32.4
821	35.0	31.9
822	36.1	33.0
823	37.5	34.5
824	37.0	34.0
826	35.1	32.1
827	35.9	32.9
828	37.4	34.3
829	37.3	34.3
830	36.7	33.7
831	37.8	34.8
832	38.1	35.1
838	36.6	33.6
847	35.7	32.7
848	36.5	33.5
849	35.9	32.9
850	35.7	32.7
851	35.2	32.2
853	38.0	35.0

Receiver Location	V162-5.6MW Mode 0-0S	V162-5.6MW Mode 0
862	36.4	33.4
863	37.4	34.5
864	38.8	35.9
871	36.0	33.0
872	36.5	33.5
873	36.6	33.6
874	35.1	32.2
875	37.5	34.6
1170	37.0	34.0
1171	37.6	34.6
4152*	38.0	35.0
4375	35.5	32.6
4378	35.7	32.7
4379	39.6	36.8
4531	35.5	32.5

* Receivers located to the southeast of the proposed wind farm within the Rural Living Zone

It can be seen from Table 5 that the predicted noise levels from the proposed Delburn Wind Farm are below the base noise limit of 40 dB L_{A90} at all receivers by at least 0.4 dB for the non-serrated blade variant and 3.2 dB for the variant with blade serrations.

The results for the nine (9) receivers in Table 5 that are within the Rural Living Zone indicate the following:

- V162-5.6MW Mode 0-0S (no serrations): the wind farm noise levels (hub height wind speed ≥9 m/s) are predicted above the 35 dB base limit associated with high amenity areas for all of the nine (9) receivers
- V162-5.6MW Mode 0 (with serrations): the wind farm noise levels (hub height wind speed ≥9 m/s) are predicted at or below the 35 dB base limit associated with high amenity areas for all of the nine (9) receivers.

Recognising that the high amenity provision and the 35 dB base limit may warrant consideration for the receivers in the Rural Living Zone, Table 6 provides the predicted noise levels at the hub height wind speed of 6 m/s which NZS 6808:2010 specifies as the highest wind speed for applying high amenity limits.

Table 6: Rural Living Zone - predicted noise level at 6 m/s

Receiver Location	V162-5.6MW Mode 0-0S	V162-5.6MW Mode 0
600	28.7	25.6
601	28.8	25.8
602	29.5	26.5
603	29.4	26.4
604	29.5	26.5
605	30.2	27.2
779	28.5	25.4
783	28.7	25.7
4152	31.3	28.3

The results presented in Table 6 demonstrate that the predicted noise levels for the wind speed range where high amenity provision may warrant consideration are below 35 dB at all receivers for both turbine types by at least 3.7 dB. These findings demonstrate that the lower base limit could be achieved at these receivers if the high amenity provision was found to be applicable.

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

Figure 6: Highest predicted noise level contours – Vestas V162-5.6MW Mode 0-0S

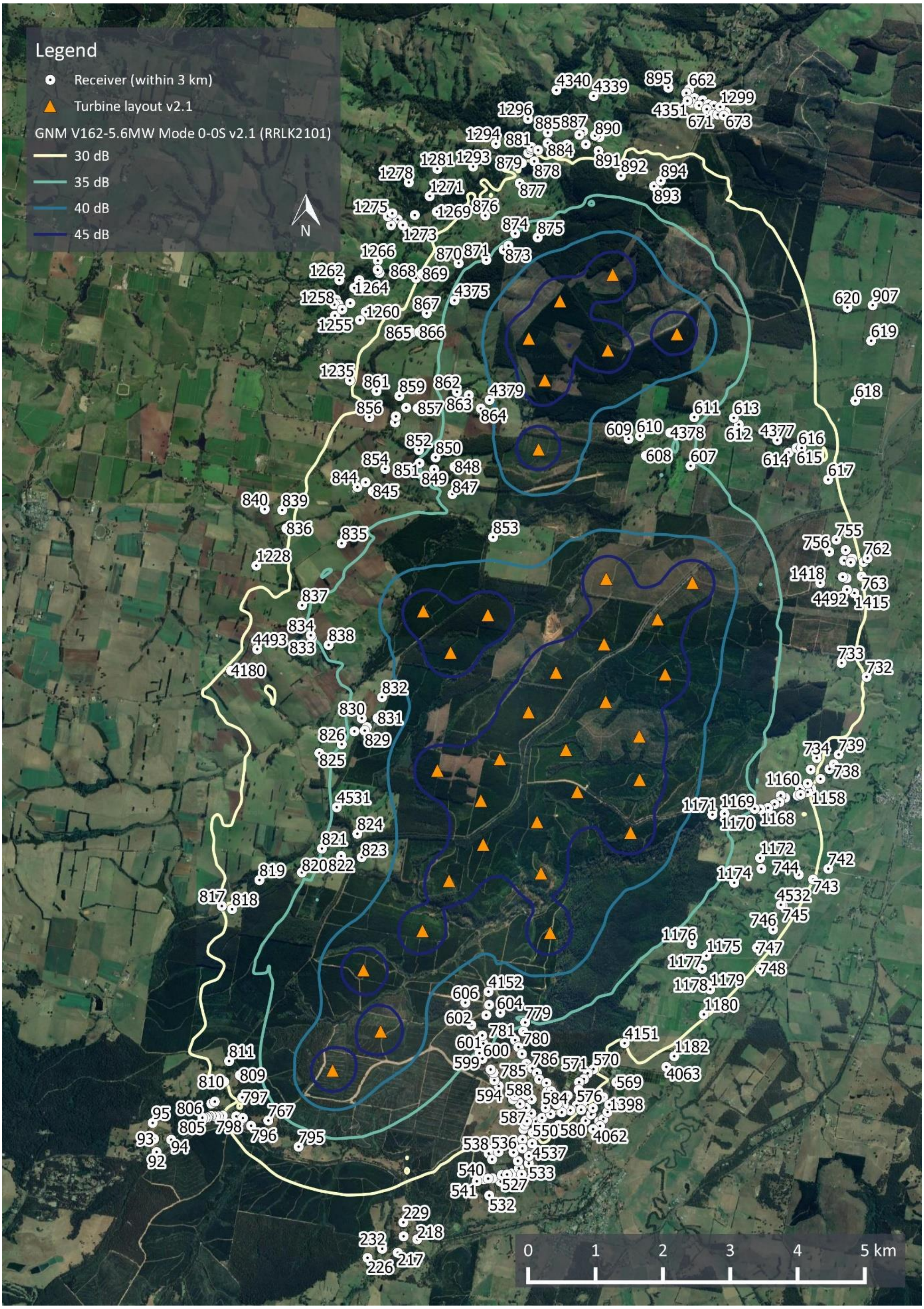
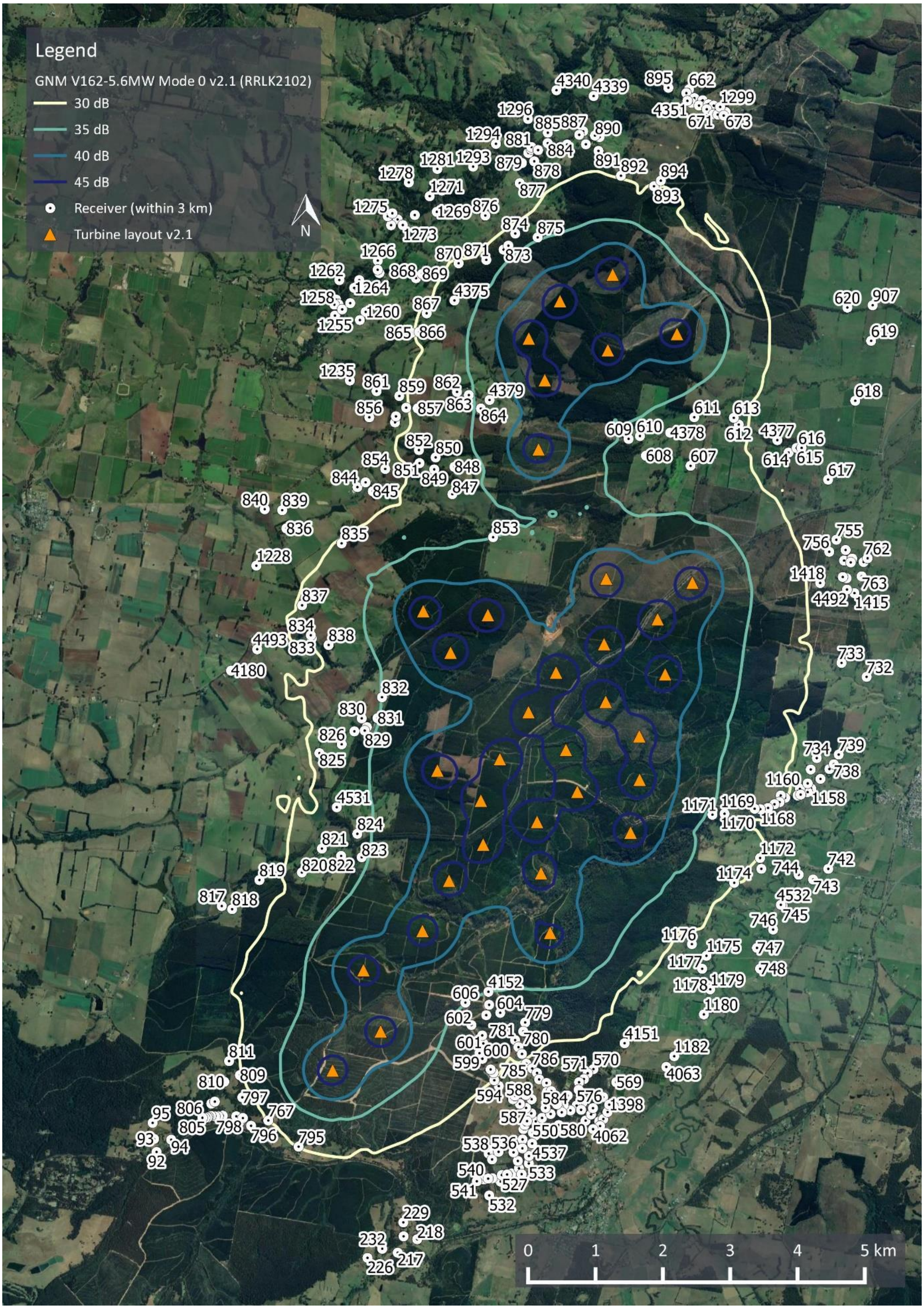


Figure 7: Highest predicted noise level contours – Vestas V162-5.6MW Mode 0



6.0 SUMMARY

A preliminary assessment of operational noise for the proposed Delburn Wind Farm has been carried out. The assessment has been carried out based on the proposed wind farm layout comprising thirty-five (35) multi-megawatt turbines.

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.

Noise modelling was carried out based on the Vestas V162 5.6MW candidate turbine model 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 Delburn Wind Farm is predicted to achieve compliance with the applicable noise criteria determined in accordance with NZS 6808:2010.

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

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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 DESCRIPTION OF SOUND

Sound is an important feature of the environment in which we live; it provides information about our surroundings and influences our overall perception of amenity and environmental quality.

While sound is a familiar concept, its description can be complex. A glossary of terms and abbreviations is provided at the start of this report.

This appendix provides general information about the definition of sound and the ways that different sound characteristics are described.

B1 Definition of sound

Sound is a term used to describe very small and rapid changes in the pressure of the atmosphere. Importantly, for pressure fluctuations to be considered sound, the rise and fall in pressure needs to be repeated at rates ranging from tens to thousands of times per second.

These small and repetitive fluctuations in pressure can be caused by many things such as a vibrating surface in contact with the air (e.g. the cone of a speaker) or turbulent air movement patterns. The common feature is a surface or region of disturbance that displaces the adjacent air, causing a very small and localised compression of the air, followed by a small expansion of the air.

These repeated compressions and expansions then spread into the surrounding air as waves of pressure changes. Upon reaching the ear of an observer, these waves of changing pressure cause structures within the ear to vibrate; these vibrations then generate signals which can be perceived as sounds.

The waves of pressure changes usually occur as complex patterns, comprising varied rates and magnitudes of pressure changes. The pattern of these changes will determine how a sound spreads through the air and how the sound is ultimately perceived when it reaches the ear of an observer.

B2 Physical description of sound

There are many situations where it can be useful to objectively describe sound, such as the writing or recording of music, hearing testing, measuring the sound environment in an area or evaluating new man-made sources of sound.

Sound is usually composed of complex and varied patterns of pressure changes. As a result, several attributes are used to describe sound. Two of the most fundamental sound attributes are:

- sound pressure
- sound frequency

Each of these attributes is explained in the following sections, followed by a discussion about how each of these attributes varies.

B2.1 Sound pressure

The compression and expansion of the air that is associated with the passage of a sound wave results in changes in atmospheric pressure. The pressure changes associated with sound represent very small and repetitive variations that occur amidst much greater pressures associated with the atmosphere.

The magnitude of these pressure changes influences how quiet or loud a sound will be; the smaller the pressure change, the quieter the sound, and vice versa. The perception of loudness is complex though, and different sounds can seem quieter or louder for reasons other than differences in pressure changes.

To provide some context, Table 7 lists example values of pressure associated with the atmosphere and different sounds. The key point from these example values is that even an extremely loud sound equates to a change in pressure that is thousands of times smaller than the typical pressure of the atmosphere.

Table 7: Atmospheric pressure versus sound pressure – example values of pressure

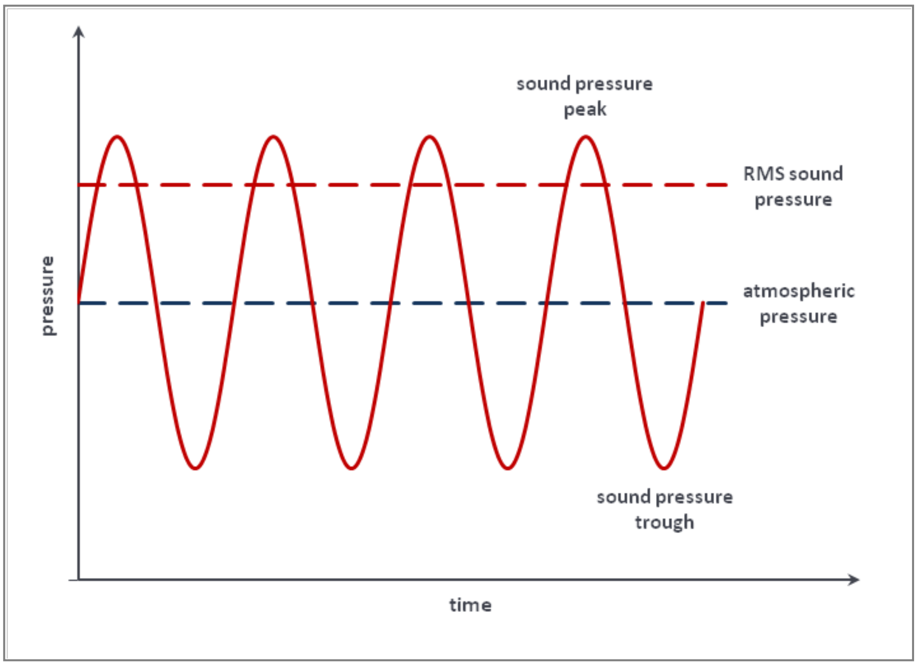
Example	Pascals (Pa)	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002	0.000000003

The pressure values in Table 7 also show that the range of pressure changes associated with quiet and loud sounds span over a very large range, albeit still very small changes compared to atmospheric pressure. To make the description of pressure changes more practical, sound pressure is expressed in decibels or dB.

To illustrate the pressure variation associated with sound, Figure 8 shows the repetitive rise and fall in pressure of a very simple and steady sound. This figure illustrates the peaks and troughs of pressure changes relative to the underlying pressure of the atmosphere in the absence of sound. The magnitude of the change in pressure caused by the sound is then described as the sound pressure level. Since the magnitude of the change is constantly varying, the sound pressure may be defined in terms of:

- Peak sound pressure levels: the maximum change in pressure relative to atmospheric pressure i.e. the amplitude as defined by the maximum depth or height of the peaks and troughs respectively; or
- Root Mean Square (RMS) sound pressure levels: the average of the amplitude of pressure changes, accounting for positive changes above atmospheric pressure, and negative pressure changes below atmospheric pressure.

Figure 8: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

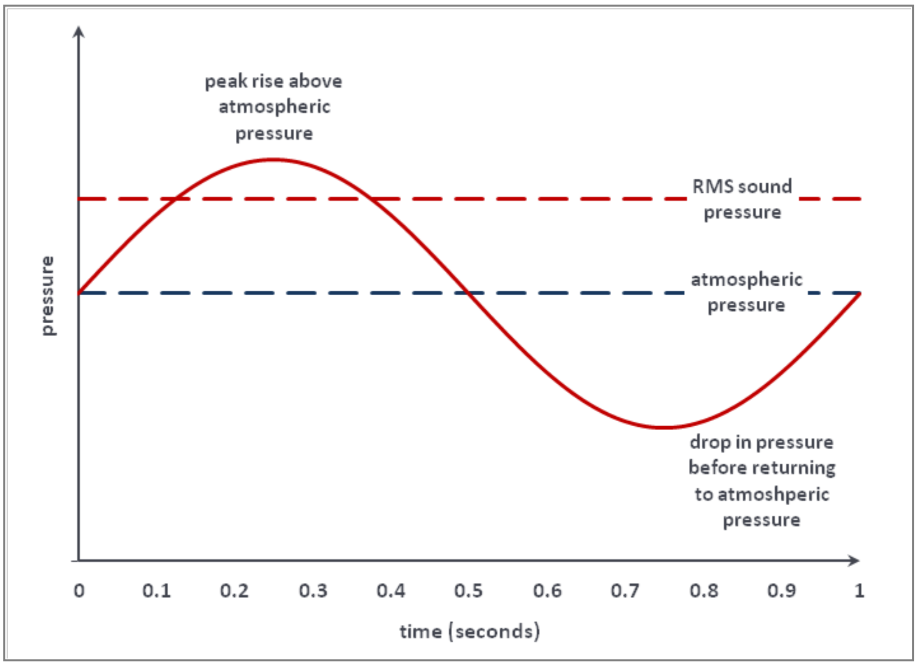
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period. The rate of change in pressure is an important feature that determines whether it can be perceived as a sound by the human ear.

Repetitive changes in pressure can occur as a result of a range of factors with widely varying rates of fluctuation. However, only a portion of these fluctuations can be perceived as sound. In many cases, the rate of fluctuation will either be too slow or too fast for the human ear to detect the pressure change as a sound. For example, local fluctuations in atmospheric pressure can be created by someone waving their hands back and forth through the air; the reason this cannot be perceived as a sound is the rate of fluctuation is too slow.

At the rates of fluctuation that can be detected as sound, the rate will influence the character of the sound that is perceived. For example, slow rates of pressure change correspond to rumbling sounds, while fast rates correspond to whistling sounds.

The rate of fluctuation is numerically described in terms of the number of pressure fluctuations that occur in a single second. Specifically, it is the number of cycles per second of the pressure rising above, falling below, and then returning to atmospheric pressure. The number of these cycles per second is expressed in Hertz (Hz). This concept of cycles per second is illustrated in Figure 9 which illustrates a 1 Hz pressure fluctuation. The figure provides a simple illustration of a single cycle of pressure rise and fall occurring in a period of a single second.

Figure 9: Illustration of a pressure fluctuation with a frequency of 1Hz

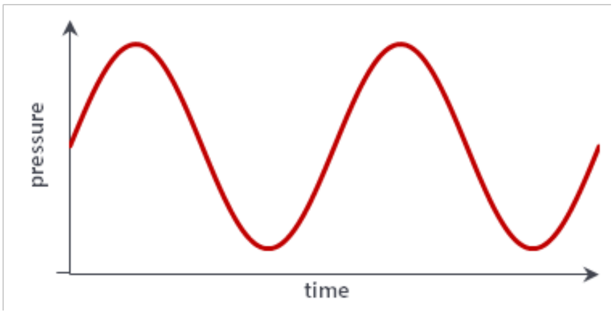


The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone waving their hands, the pressure would fluctuate at the same rate as the hands move back and forth; a few times a second translating to a very low frequency below our hearing range (termed an infrasonic frequency). Examples of low and high frequency sound are easily recognisable, such as the low frequency sound of thunder, and the high frequency sound of crashing cymbals. To demonstrate the differences in the patterns of different frequencies of sound, Figure 10 illustrates the relative rates of pressure change for low, mid and high frequency sounds. Note that in each case the amplitude of the pressure changes remains the same; the only change is the number of fluctuations in pressure that occur over time.

Figure 10: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

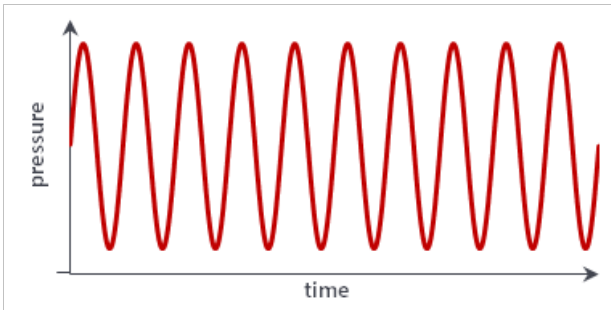
Low frequency sounds:

20 to 200 Hz



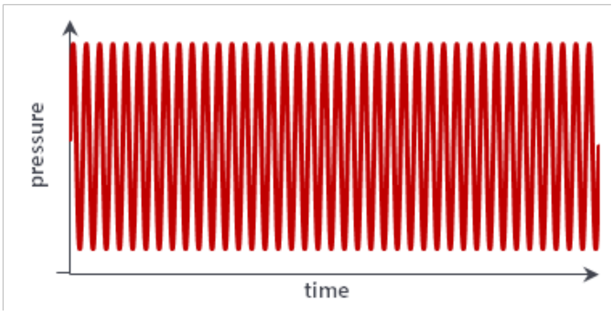
Mid-frequency sounds:

200 to 800 Hz



High frequency sounds:

greater than 800 Hz



B2.3 Sound pressure and frequency variations

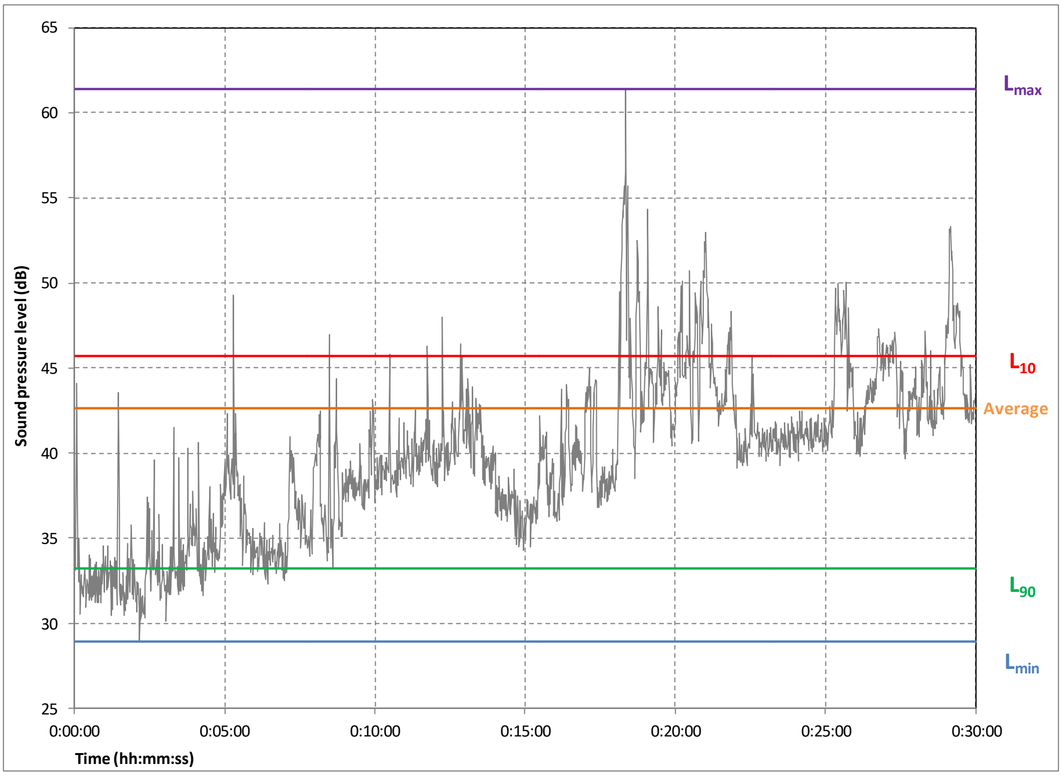
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

The simplest type of sound comprises a single constant sound pressure level and a single constant frequency. However, most sounds are made up of many frequencies, and may include low, mid and high frequencies. Sounds that are made up of a relatively even mix of frequencies across a broad range of frequencies are referred to as being 'broad band'. Common examples of broad band sounds include flowing water, the rustling of leaves, ventilation fans and traffic noise.

Further, sound quite often changes from moment to moment, in terms of both pressure levels and frequencies. The time varying characteristics of sound are important to how we perceive sound. For example, rapid changes in sound level produced by voices provide the component of sound that we interpret as intelligible speech. Variations in sound pressure levels and frequencies are also features which can draw our attention to a new source of sound in the environment.

To demonstrate this, Figure 11 illustrates an example time-trace of total sound pressure levels which varies with time. This variation presents challenges when attempting to describe sound pressure levels. As a result, multiple metrics are generally needed to describe sound pressure, such as the average, minimum or maximum noise levels. Other ways of describing sound include statistics for describing how often a defined sound pressure level is exceeded; for example, typical upper sound levels are often described as an L_{10} which refers to the sound pressure exceeded for 10 % of the time, or typical lower levels or lulls which are often described as an L_{90} which refers to the sound exceeded for 90 % of the time.

Figure 11: Example of noise metrics that may be used to measure a time-varying sound level



This example illustrates variations in terms of just total sound pressure levels, but the variations can also relate to the frequency of the sound, and frequently the number of sources affecting the sound.

These types of variations are an inherent feature of most sound fields and are an important point of context in any attempt to describe sound.

B3 Hearing and perception of sound

This section provides a discussion of:

- The use of the decibel to practically describe sound levels in a way that corresponds to the pressure levels the human ear can detect as sounds
- The relationship between sound frequency and human hearing.

The section concludes with a discussion of some of the complicating non-acoustic factors that influence our perception of sound.

B3.1 Sound pressure and the decibel

Previous sections discussed the wide range of small pressure fluctuations that the ear can detect as sound. Owing to the wide range of these fluctuations, the way we hear sound is more practically described using the decibel (dB). The decibel system serves two key purposes:

- Compressing the numerical range of the quietest and loudest sounds commonly experienced.

  As an indication of this benefit, the pressure of the loudest sound that might be encountered is around a million times greater than the quietest sound that can be detected. In contrast, the decibel system reduces this to a range of approximately 0-120 dB.

- Consistently representing sound pressure level changes in a way that correlate more closely with how we perceive sound pressure level changes.

  For example, a 10 dB change from 20-30 dB will be generally be subjectively like a 10 dB change from 40-50 dB. However, expressed in units of pressure as Pascals, the 40-50 dB change is ten times greater than the 20-30 dB change. For this reason, sound pressure changes cannot be meaningfully communicated in terms of units of pressure such as Pascals.

Sound pressure levels in most environments are highly variable, so it can be misleading to describe what different ranges of sound pressure levels correspond to. However, as a broad indication, Table 8 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 8: Example sound pressure levels that might be experienced in different environments

Environment	Example Sound Pressure Level	
Outside in an urban area with traffic noise	50-70 dB	0.006-0.06 Pa
Outside in a rural area with distant sounds or moderate wind rustling leaves	30-50 dB	0.0006-0.006 Pa
Outside in a quiet rural environment in calm conditions	20-30 dB	0.0002-0.0006 Pa
Inside a quiet bedroom at night	<20 dB	0.0002 Pa

The impression of how much louder or quieter a sound is will be influenced by the magnitude of the change in sound pressure. Other important factors will also influence this, such as the frequency of the sound which is discussed in the following section. However, to provide a broad indication, Table 9 provides some examples of how changes in sound pressure levels, for a sound with the same character, can be perceived.

Table 9: Perceived changes in sound pressure levels

Sound pressure level change	Indicative change in perceived sound
1 dB	Unlikely to be noticeable
2-3 dB	Likely to be just noticeable
4-5 dB	Clearly noticeable change
10 dB	Distinct change - often subjectively described as halving or doubling the loudness

The example sound pressure level changes in Table 9 are based on side by side comparison of a steady sample of sound heard at different levels. In practice, changes in sound pressure levels may be more difficult to perceive for a range of reasons, including the presence of other sources of sound, or gradual changes which occur over a longer period.

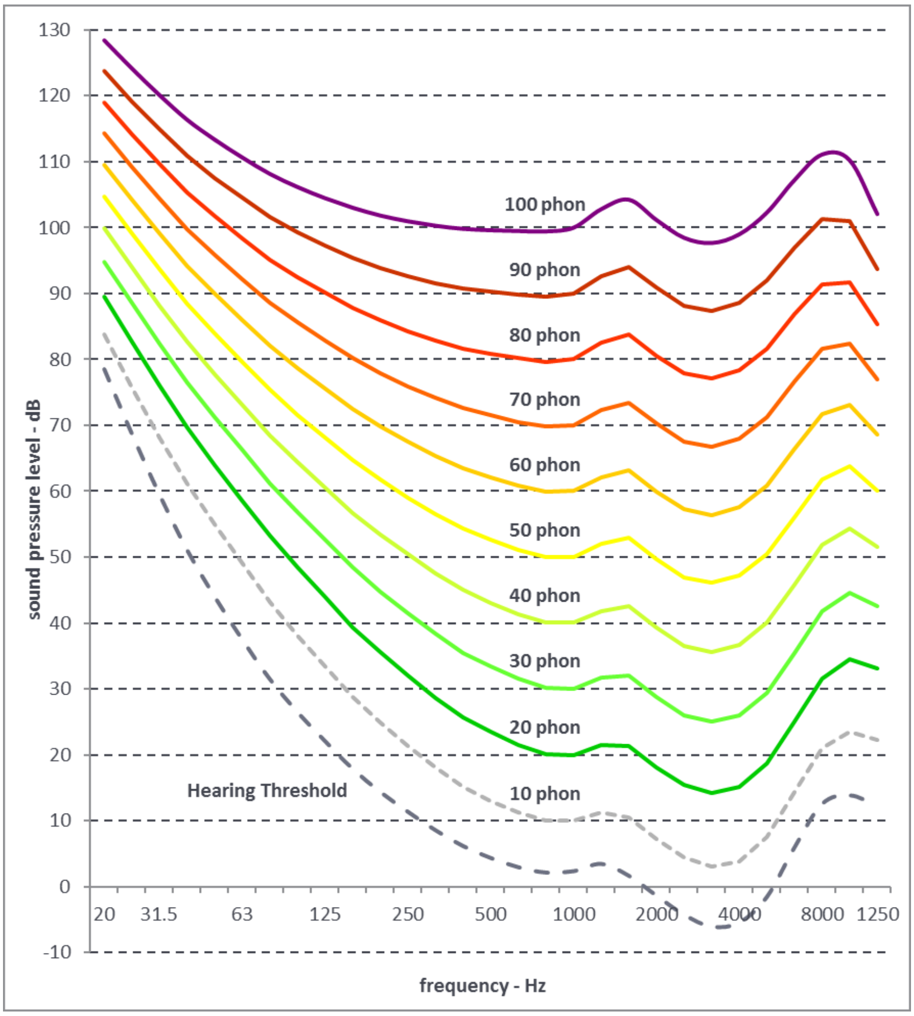
B3.2 Sound frequency and loudness

Although sound pressure level and the sensation of loudness are related, the sound pressure level is not a direct measure of how loud a sound appears to humans. Human perception of sound varies and depends on a number of physical attributes, including frequency, level and duration.

An example of the relationship between the sensation of loudness and frequency is demonstrated in Figure 12. The chart presents equal loudness curves for sounds of different frequencies expressed in 'phons'. Each point on the phon curves represents a sound of equal loudness. For example, the 40 phon curve shows that a sound level of 100 dB at 20 Hz (a very low frequency sound) would be of equal loudness to a level of 40 dB at 1,000 Hz (a whistling sound) or approximately 50 dB at just under 8,000 Hz (a very high pitch sound). The information presented is based on an international standard7 that defines equal loudness levels for sounds comprising individual frequencies. In practice, sound is usually composed of many different frequencies, so this type of data can only be used as an indication of how different frequencies of sound may be perceived. An individual's perceptions of sound can also vary significantly. For example, the lower dashed line in Figure 12 shows the threshold of hearing, which represents the sounds an average listener could correctly identify at least 50 % of the time. However, these thresholds represent the average of the population. In practice, an individual's hearing threshold can vary significantly from these values, particularly at the low frequencies.

[7] International Organisation of Standardisation, ISO 226:2003 *Acoustics - Normal equal-loudness-level contours*, 2003

Figure 12: Equal loudness contours for pure tone sounds



The noise curves in Figure 12 demonstrate that human hearing is most sensitive at frequencies from 500 to 4000 Hz, which usefully corresponds to the main frequencies of human speech. The contours also demonstrate that sounds at low frequencies must be at much higher sound pressure levels to be judged equally loud as sounds at mid to high frequencies.

To account for the sensitivity of the ear to different frequencies, a set of adjustments were developed to enable sound levels to be measured in a way that more closely aligns with human hearing. Sound levels adjusted in this way are referred to as A-weighted sound levels.

B3.3 Interpretation of sound and noise

Human interpretation of sound is influenced by many factors other than its physical characteristics, such as how often the sound occurs, the time of day it occurs and a person's attitude towards the source of the sound.

For example, the sound of music can cause very different reactions, from relaxation and pleasure through to annoyance and stress, depending on individual preferences, the type of music and the circumstances in which the music is heard. This example illustrates how sound can sometimes be considered noise; a term broadly used to describe unwanted sounds or sounds that have the potential to cause negative reactions.

The effects of excess environmental sound are varied and complicated, and may be perceived in various ways including sensations of loudness, interference with speech communication, interference with working concentration or studying, disruption of resting/leisure periods, and disturbance of sleep. These effects can give rise to behavioural changes such as avoiding the use of exposed external spaces, keeping windows closed, or timing restful activities to avoid the most intense periods of disruption. Prolonged annoyance or interference with normal patterns can lead to possible effects on mental and physical health. In this respect, the World Health Organization (preamble to the *Constitution of the World Health Organization*, 1946) defines health in the following broad terms:

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

The World Health Organization Guidelines for Community Noise (Berglund, Lindvall, & Schwela, 1999) documents a relationship between the definition of health and the effects of community noise exposure by noting that:

> *This broad definition of health embraces the concept of well-being, and thereby, renders noise impacts such as population annoyance, interference with communication, and impaired task performance as 'health' issues.*

The reaction that a community has to sound is highly subjective and depends on a range of factors including:

- The hearing threshold of individuals across the audible frequency range. These thresholds vary widely across the population, particularly at the lower and upper ends of the audible frequency range. For example, at low frequencies the distribution of hearing thresholds varies above and below the mean threshold by more than 10 dB
- The attitudes and sensitivities of individuals to sound, and their expectations of what is considered an acceptable level of sound or intrusion. This in turn depends on a range of factors such as general health and the perceived importance of sound amongst other factors relevant to overall amenity perception
- The absolute sound pressure level of the sound in question. The threshold for the onset of community annoyance varies according to the type of sound; above such thresholds, the percentage of the population annoyed generally increases with increasing sound pressure level
- The sound pressure level of the noise relative to background noise conditions in the area, and the extent to which general background noise may offer beneficial masking effects
- The characteristics of the sound in question such as whether the sound is constant, continually varies, or contains distinctive audible features such as tones, low frequency components or impulsive sound which may draw attention to the noise
- The site location and the compatibility of the source in question with other surrounding land uses. For example, whether the source is in an industrial or residential area

- The attitudes of the community to the source of the sound. This may be influenced by factors such as the extent to which those responsible for the sound are perceived to be adopting reasonable and practicable measures to reduce their emissions, whether the activity is of local or national significance and whether the noise producer actively consults and/or liaises with the community
- The times when the sound is present, the duration of exposure to increased sound levels, and the extent of respite periods when the sound is reduced or absent (for example, whether the sound ceases at weekends).

The combined influence of the above considerations means that physical sound levels are only one factor influencing community reaction to sound. Importantly, this means that individual reactions and attitudes to the same type and level of sound will vary within a community.

APPENDIX C TURBINE COORDINATES

The following table sets out the coordinates of the proposed turbine layout of the Delburn Wind Farm (Layout reference v2.1 supplied by OSMI on 9 July 2019).

Table 10: Turbine coordinates – MGA 94 zone 55

Turbine	Easting	Northing	Terrain elevation
T03	436,525	5,765,561	263
T04	435,750	5,765,156	296
T05	435,296	5,764,592	290
T06	437,495	5,764,699	188
T07	436,473	5,764,438	228
T08	435,544	5,763,978	229
T09	435,470	5,762,948	213
T12	436,508	5,761,045	169
T14	437,789	5,761,008	168
T15	433,800	5,760,517	234
T16	437,282	5,760,457	168
T17	434,760	5,760,476	194
T20	436,493	5,760,073	208
T21	434,216	5,759,907	196
T24	435,787	5,759,639	209
T25	437,408	5,759,641	182
T28	436,532	5,759,218	201
T29	435,389	5,759,043	226

Turbine	Easting	Northing	Terrain elevation
T30	437,040	5,758,715	186
T32	435,954	5,758,492	218
T33	434,976	5,758,338	230
T34	434,051	5,758,153	199
T35	437,056	5,758,069	174
T36	436,134	5,757,873	198
T37	434,704	5,757,718	233
T38	435,544	5,757,416	215
T39	436,935	5,757,281	180
T41	434,750	5,757,067	249
T42	434,253	5,756,519	249
T43	435,616	5,756,655	167
T45	435,767	5,755,772	173
T46	433,871	5,755,768	233
T47	433,005	5,755,169	207
T48	433,276	5,754,264	179
T49	432,573	5,753,672	178

APPENDIX D RECEIVER LOCATIONS

The following table sets out the three hundred and thirty-three (333) assessed noise sensitive receiver locations located within 3 km of the proposed turbines considered in the environmental noise assessment together with their respective distance to the nearest turbine.

(Data supplied by OSMI on 12 June 2019).

Table 11: Receiver locations within 3 km of the proposed turbines – MGA 94 zone 55

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
92	429,980	5,752,416	162	2,885
93	429,940	5,752,608	158	2,844
94	430,195	5,752,601	159	2,613
95	429,915	5,752,846	194	2,788
217	433,587	5,750,982	180	2,879
218	433,873	5,751,187	148	2,809
226	433,139	5,750,897	164	2,836
229	433,662	5,751,434	164	2,494
232	433,356	5,751,037	149	2,754
237	433,670	5,751,227	169	2,685
524	435,096	5,752,065	200	2,859
525	435,303	5,752,100	213	2,970
526	434,972	5,752,113	212	2,744
527	435,113	5,752,162	209	2,796
528	435,256	5,752,188	216	2,873
529	435,365	5,752,267	220	2,895
530	435,406	5,752,180	221	2,984
532	434,931	5,751,856	176	2,926
533	435,510	5,752,342	225	2,952
534	435,347	5,752,376	212	2,807
535	435,509	5,752,453	218	2,880
536	435,280	5,752,502	194	2,673
537	435,048	5,752,561	195	2,463
538	434,912	5,752,478	187	2,427
539	434,964	5,752,392	189	2,526
540	434,849	5,752,093	214	2,685
541	434,743	5,752,063	209	2,650
542	435,412	5,752,697	194	2,654

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
543	435,592	5,752,754	200	2,770
544	435,411	5,752,564	201	2,734
545	435,422	5,752,851	184	2,574
546	435,440	5,752,912	182	2,556
547	435,562	5,752,799	197	2,720
548	435,652	5,752,906	194	2,742
549	435,821	5,752,850	205	2,916
550	435,602	5,752,968	186	2,667
551	435,694	5,753,021	187	2,724
552	435,944	5,752,919	201	2,862
553	436,134	5,752,831	164	2,968
564	436,544	5,752,984	112	2,899
565	436,605	5,753,021	110	2,880
566	436,666	5,753,125	102	2,800
567	436,753	5,753,200	94	2,759
568	436,598	5,753,345	138	2,570
569	436,788	5,753,570	92	2,432
570	436,445	5,753,759	117	2,130
571	436,362	5,753,695	124	2,166
572	436,306	5,753,608	135	2,235
573	436,235	5,753,561	138	2,266
574	436,231	5,753,449	150	2,375
575	436,293	5,753,261	176	2,570
576	436,204	5,753,213	181	2,601
577	436,273	5,753,152	181	2,673
578	436,114	5,753,140	184	2,659
579	436,013	5,753,215	163	2,573
580	436,342	5,752,992	139	2,843
581	436,558	5,752,916	97	2,968
582	435,986	5,753,109	182	2,677
583	435,821	5,753,081	188	2,696
584	435,742	5,753,170	182	2,607
585	435,534	5,753,086	179	2,552

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
586	435,473	5,752,970	182	2,555
587	435,454	5,753,165	175	2,445
588	435,536	5,753,295	170	2,464
589	435,362	5,753,223	171	2,337
590	435,258	5,753,292	170	2,214
591	435,286	5,753,344	170	2,216
592	435,448	5,753,357	169	2,359
593	435,236	5,753,483	165	2,115
594	435,045	5,753,483	163	1,940
595	434,976	5,753,567	167	1,844
596	434,964	5,753,681	169	1,792
597	434,919	5,753,728	167	1,735
598	434,794	5,753,883	182	1,573
599	434,750	5,753,966	186	1,512
600	434,804	5,754,112	190	1,544
601	434,785	5,754,230	183	1,518
602	434,622	5,754,382	175	1,360
603	434,840	5,754,533	185	1,556
604	435,047	5,754,571	177	1,409
605	434,880	5,754,687	191	1,411
606	434,527	5,754,713	189	1,252
607	437,731	5,762,743	125	1,743
608	437,065	5,762,882	147	1,604
609	436,804	5,763,127	144	1,355
610	436,971	5,763,172	123	1,369
611	437,773	5,763,466	88	1,274
612	438,435	5,763,368	119	1,637
613	438,360	5,763,467	111	1,514
614	439,182	5,762,964	107	2,407
615	439,301	5,763,035	107	2,461
616	439,375	5,763,039	107	2,513
617	439,776	5,762,574	95	2,535
618	440,159	5,763,752	79	2,832

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
619	440,379	5,764,646	73	2,889
620	440,018	5,765,134	85	2,565
662	437,610	5,768,333	310	2,981
663	437,571	5,768,277	302	2,915
664	437,693	5,768,204	285	2,894
665	437,816	5,768,174	280	2,919
666	437,650	5,768,133	292	2,811
667	437,763	5,768,095	290	2,824
668	437,903	5,768,118	286	2,908
669	437,982	5,768,098	291	2,930
670	437,879	5,768,042	295	2,831
671	437,980	5,767,970	309	2,818
672	438,044	5,767,966	313	2,849
673	438,158	5,768,007	300	2,946
732	440,399	5,759,655	81	2,944
733	440,023	5,759,855	112	2,519
734	439,680	5,758,435	133	2,577
735	439,594	5,758,265	146	2,550
736	439,741	5,758,128	120	2,690
737	439,871	5,758,277	101	2,820
738	439,935	5,758,350	95	2,842
739	440,005	5,758,494	94	2,844
742	439,880	5,756,794	75	2,989
743	439,658	5,756,632	75	2,803
744	439,443	5,756,699	77	2,579
745	439,210	5,756,237	79	2,508
746	439,076	5,755,879	80	2,565
747	438,842	5,755,602	80	2,546
748	438,894	5,755,293	80	2,795
755	439,914	5,761,683	90	2,235
756	439,812	5,761,503	97	2,089
757	440,054	5,761,534	86	2,331
758	440,035	5,761,376	89	2,281

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
759	440,155	5,761,408	84	2,405
760	440,134	5,761,351	84	2,375
761	440,325	5,761,360	77	2,566
762	440,383	5,761,416	76	2,631
763	440,299	5,761,147	75	2,519
764	431,206	5,752,889	145	1,583
765	431,155	5,752,966	143	1,592
766	431,253	5,752,942	136	1,517
767	431,631	5,752,912	176	1,220
779	435,420	5,754,434	164	1,391
780	435,393	5,754,300	161	1,527
781	435,275	5,754,170	178	1,684
782	435,327	5,754,066	166	1,769
783	435,038	5,754,352	178	1,604
784	435,381	5,753,966	158	1,854
785	435,446	5,753,823	157	1,982
786	435,536	5,753,753	160	2,038
787	435,608	5,753,688	165	2,096
788	435,642	5,753,593	166	2,189
789	435,753	5,753,541	168	2,237
790	435,761	5,753,407	173	2,370
791	435,825	5,753,422	170	2,356
792	436,070	5,753,360	148	2,436
793	436,422	5,753,086	147	2,770
794	436,449	5,753,179	165	2,686
795	432,088	5,752,531	135	1,250
796	431,377	5,752,829	133	1,472
797	431,240	5,753,249	186	1,408
798	430,905	5,752,949	175	1,825
799	430,954	5,752,971	173	1,771
800	430,887	5,752,960	175	1,837
801	430,841	5,752,958	173	1,880
802	430,780	5,752,965	166	1,934

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
803	430,741	5,752,950	164	1,975
804	430,724	5,752,940	164	1,995
805	430,689	5,752,933	163	2,029
806	430,653	5,752,935	162	2,063
807	430,781	5,753,148	160	1,874
808	430,833	5,753,178	161	1,816
809	431,198	5,753,578	204	1,388
810	430,967	5,753,475	171	1,625
811	431,033	5,753,784	226	1,552
817	430,885	5,756,084	242	2,315
818	431,040	5,756,040	250	2,156
819	431,437	5,756,481	226	2,050
820	432,065	5,756,604	242	1,722
821	432,356	5,756,964	231	1,915
822	432,644	5,756,859	209	1,650
823	432,949	5,756,845	210	1,353
824	432,879	5,757,192	233	1,524
825	432,295	5,758,380	244	1,778
826	432,624	5,758,517	236	1,482
827	432,809	5,758,713	251	1,372
828	432,992	5,758,778	257	1,240
829	432,961	5,758,727	261	1,242
830	432,914	5,758,908	253	1,374
831	433,149	5,758,915	242	1,192
832	433,210	5,759,227	245	1,225
833	432,153	5,760,084	306	1,710
834	432,137	5,760,129	309	1,715
835	432,570	5,761,502	284	1,584
836	431,746	5,761,709	262	2,380
837	432,000	5,760,571	324	1,808
838	432,403	5,759,989	305	1,502
839	431,680	5,761,979	266	2,580
840	431,419	5,761,989	264	2,803

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
844	432,790	5,762,341	239	2,091
845	433,018	5,762,282	224	1,937
846	432,910	5,762,413	230	2,101
847	434,201	5,762,260	216	1,452
848	434,225	5,762,666	249	1,287
849	433,926	5,762,624	280	1,586
850	433,944	5,762,802	285	1,541
851	433,706	5,762,713	291	1,787
852	433,693	5,762,907	285	1,784
853	434,817	5,761,632	168	1,168
854	433,199	5,762,618	236	2,191
855	433,332	5,763,312	264	2,175
856	432,949	5,763,380	253	2,563
857	433,664	5,763,526	264	1,902
858	433,494	5,763,533	267	2,067
859	433,389	5,763,705	269	2,110
860	433,344	5,763,402	261	2,180
861	433,050	5,763,770	262	2,397
862	434,244	5,763,780	244	1,324
863	434,421	5,763,736	244	1,160
864	434,603	5,763,540	266	1,050
865	433,551	5,764,647	263	1,753
866	433,666	5,764,659	257	1,639
867	433,773	5,764,939	260	1,570
868	433,606	5,765,459	175	1,906
869	433,696	5,765,524	185	1,859
870	434,234	5,765,691	270	1,536
871	434,644	5,765,749	280	1,264
872	434,899	5,765,905	294	1,145
873	434,969	5,765,965	297	1,136
874	435,068	5,766,147	269	1,214
875	435,402	5,766,095	293	1,014
876	434,619	5,766,407	161	1,694

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
877	435,121	5,766,897	172	1,858
878	435,331	5,767,225	177	2,054
879	435,148	5,767,196	149	2,133
880	435,241	5,767,348	139	2,206
881	435,282	5,767,406	137	2,230
882	435,284	5,767,436	138	2,254
883	435,385	5,767,392	154	2,163
884	435,526	5,767,497	156	2,185
885	435,525	5,767,653	136	2,324
886	435,815	5,767,482	199	2,055
887	436,050	5,767,683	194	2,180
888	435,992	5,767,630	205	2,142
889	436,295	5,767,601	203	2,059
890	436,226	5,767,623	205	2,090
891	436,282	5,767,396	239	1,858
892	436,622	5,767,033	279	1,484
893	437,116	5,766,885	322	1,459
894	437,216	5,766,970	320	1,577
895	437,303	5,768,352	290	2,902
907	440,393	5,765,175	77	2,941
1158	439,606	5,757,981	139	2,556
1159	439,553	5,757,928	144	2,506
1160	439,438	5,757,975	155	2,389
1161	439,552	5,758,058	150	2,501
1162	439,406	5,757,876	154	2,363
1163	439,222	5,757,838	154	2,184
1164	439,155	5,757,872	153	2,115
1165	439,139	5,757,772	153	2,110
1166	439,064	5,757,739	155	2,041
1167	438,970	5,757,683	153	1,959
1168	438,855	5,757,662	155	1,851
1169	438,770	5,757,667	154	1,768
1170	438,326	5,757,585	163	1,368

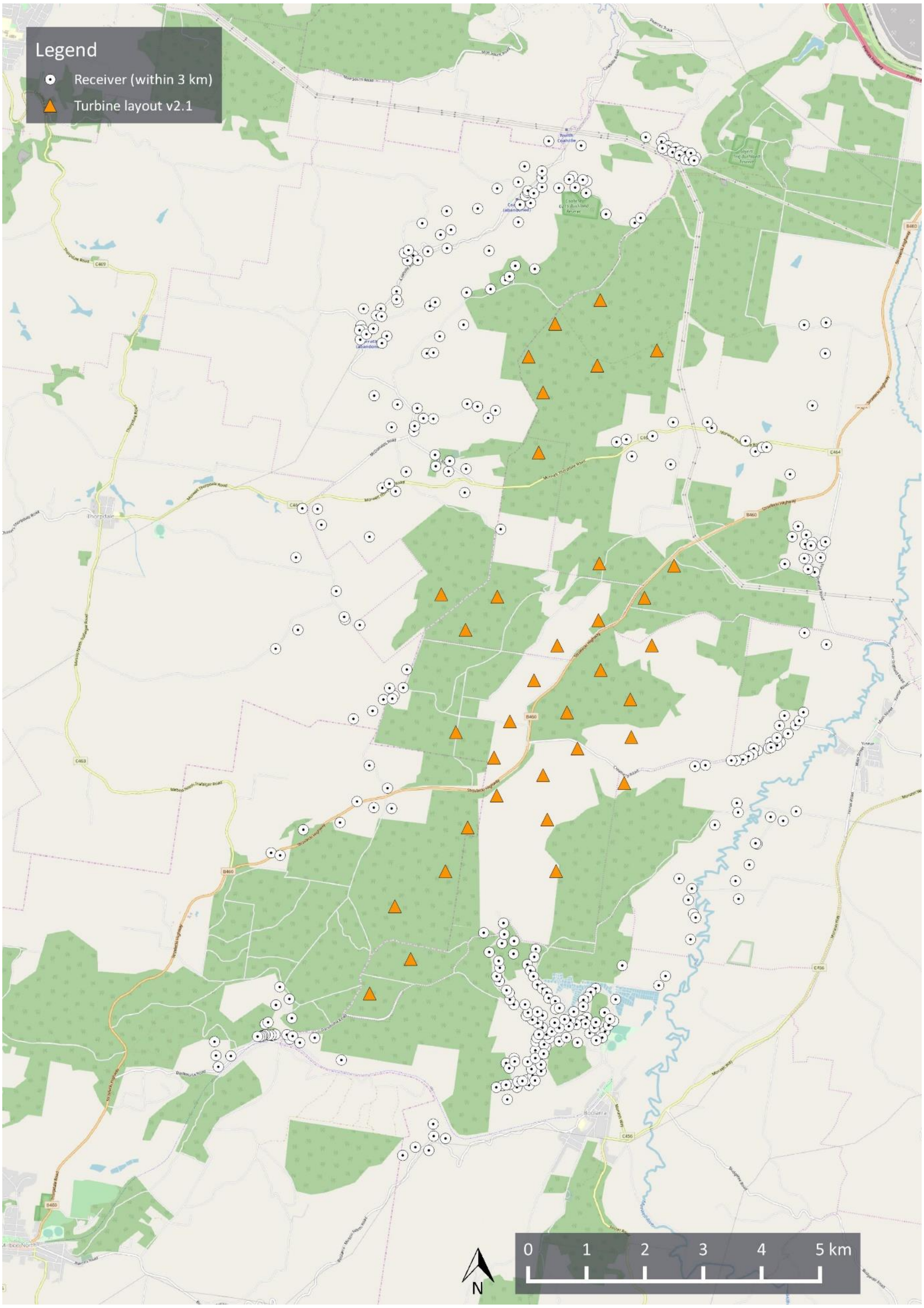
Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
1171	438,146	5,757,568	157	1,210
1172	438,865	5,756,937	102	1,967
1173	438,886	5,756,777	91	2,022
1174	438,487	5,756,562	142	1,718
1175	438,094	5,755,471	80	2,155
1176	437,875	5,755,641	101	1,897
1177	438,034	5,755,277	78	2,291
1178	438,121	5,755,037	80	2,471
1179	438,158	5,754,974	80	2,526
1180	438,071	5,754,600	82	2,590
1182	437,642	5,753,971	82	2,604
1228	431,310	5,761,148	295	2,574
1235	432,650	5,763,922	260	2,734
1255	432,412	5,764,882	160	2,903
1256	432,424	5,765,120	164	2,924
1257	432,460	5,765,051	160	2,877
1258	432,401	5,765,045	160	2,935
1259	432,518	5,764,976	161	2,809
1260	432,867	5,764,944	200	2,460
1261	432,783	5,764,822	208	2,528
1262	432,468	5,765,411	205	2,948
1263	432,764	5,765,415	168	2,667
1264	432,690	5,765,298	160	2,704
1265	432,778	5,765,280	159	2,615
1266	433,034	5,765,710	186	2,528
1267	433,061	5,765,526	172	2,427
1268	433,034	5,765,574	176	2,471
1269	433,897	5,766,449	130	2,265
1270	433,571	5,766,396	142	2,501
1271	433,788	5,766,680	168	2,490
1272	433,318	5,766,325	175	2,635
1273	433,396	5,766,244	170	2,523
1274	433,221	5,766,239	185	2,653

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
1275	433,170	5,766,371	198	2,777
1276	433,238	5,766,417	193	2,755
1278	433,474	5,766,878	223	2,859
1280	433,967	5,766,766	176	2,408
1281	433,894	5,767,087	231	2,683
1293	434,425	5,767,130	193	2,382
1294	434,758	5,767,475	143	2,527
1295	435,121	5,767,584	108	2,468
1296	435,227	5,767,853	121	2,639
1297	435,526	5,767,774	129	2,433
1298	436,093	5,767,490	238	1,984
1299	438,077	5,768,080	296	2,963
1300	438,132	5,767,953	309	2,886
1398	436,689	5,753,236	100	2,703
1415	440,197	5,760,895	86	2,416
1416	440,076	5,761,114	84	2,295
1417	440,020	5,761,132	86	2,240
1418	439,685	5,761,036	98	1,903
4061	435,912	5,753,227	160	2,554
4062	436,455	5,752,868	105	2,989
4063	437,526	5,753,811	83	2,639
4151	436,901	5,754,152	105	1,984
4152	434,866	5,754,880	191	1,278
4180	430,962	5,759,583	360	2,992
4339	436,196	5,768,209	169	2,673
4340	435,642	5,768,286	130	2,869
4351	437,589	5,768,162	300	2,815
4374	432,636	5,765,071	166	2,707
4375	434,182	5,765,138	257	1,250
4377	439,013	5,763,147	101	2,176
4378	437,420	5,763,230	110	1,480
4379	434,729	5,763,669	236	886
4492	440,085	5,760,946	88	2,303

Receiver ID	Easting	Northing	Terrain elevation (m)	Distance to the nearest turbine (m)
4493	431,344	5,759,906	354	2,536
4530	439,451	5,757,889	152	2,407
4531	432,567	5,757,582	260	1,598
4532	439,185	5,756,248	79	2,481
4536	434,911	5,752,106	214	2,712
4537	435,555	5,752,638	197	2,803
4538	435,058	5,752,507	190	2,508
4574	435,191	5,752,172	212	2,840

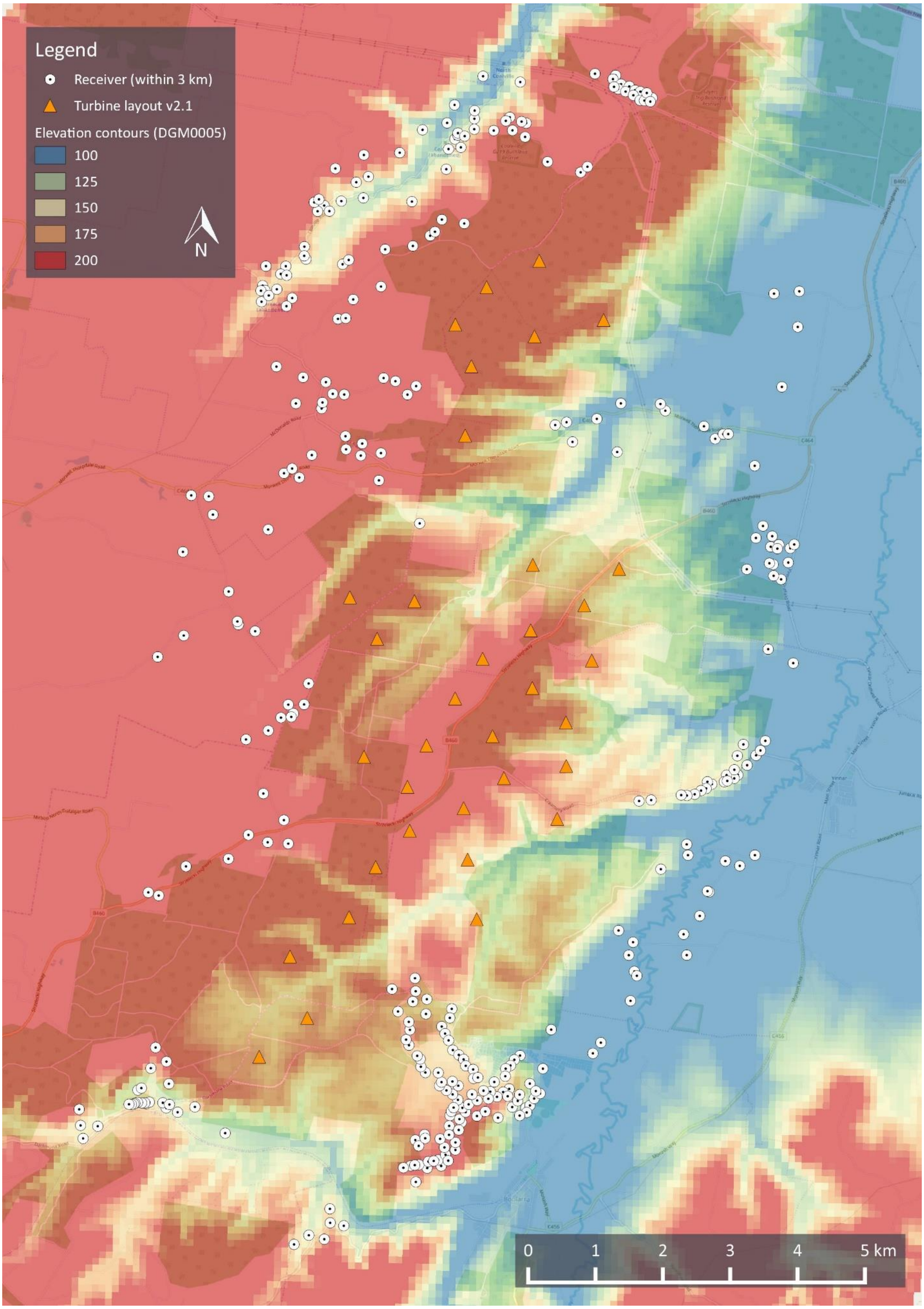
APPENDIX E SITE LAYOUT PLAN

Figure 13: Proposed turbine locations and sensitive receiver locations



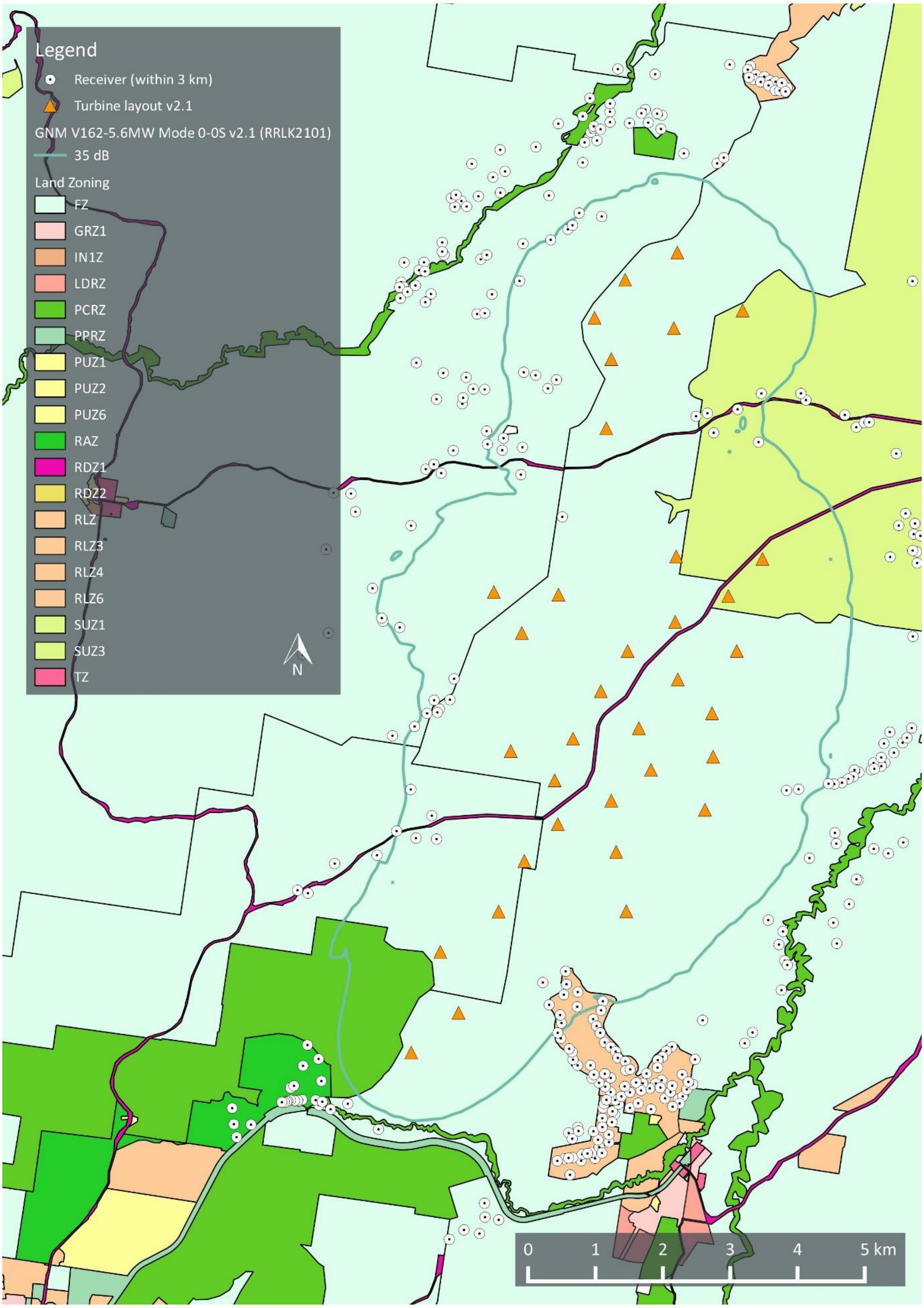
APPENDIX F SITE TOPOGRAPHY

Figure 14: Terrain elevation map for the Delburn Wind Farm and surrounding area



APPENDIX G ZONING MAP

Figure 15: Zoning map for the Delburn Wind Farm and surrounding area



APPENDIX H NOISE PREDICTION MODEL

Environmental noise levels associated with wind farms are predicted using engineering methods. The international standard ISO 9613 *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 receptor locations. 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 the South Australian EPA 2009 wind farm noise guidelines, AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators* and NZS 6808:2010 *Acoustics – Wind farm noise*.

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, 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 receiver locations.

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

Wind farm noise propagation has been the subject of considerable research in recent years. These studies have provided support for the reliability of engineering methods such as ISO 9613 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°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 IOA good practice guide). 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[8, 9, 10] 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.

[8] 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.

[9] 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.

[10] 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 IOA Good Practice Guide. 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 8.1 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.

APPENDIX I TABULATED PREDICTED NOISE LEVEL DATA

Table 12: Predicted Noise Levels - V162-5.6MW Mode 0-0S

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
92	15.4	16.0	19.0	21.9	24.6	25.7	25.7
93	15.4	16.0	19.0	21.9	24.6	25.7	25.7
94	16.2	16.8	19.8	22.7	25.4	26.5	26.5
95	15.7	16.3	19.3	22.2	24.9	26.0	26.0
217	16.8	17.4	20.4	23.3	26.0	27.1	27.1
218	16.7	17.3	20.3	23.2	25.9	27.0	27.0
226	15.5	16.1	19.1	22.0	24.7	25.8	25.8
229	17.7	18.3	21.3	24.2	26.9	28.0	28.0
232	16.5	17.1	20.1	23.0	25.7	26.8	26.8
237	17.1	17.7	20.7	23.6	26.3	27.4	27.4
524	16.4	17.0	20.0	22.9	25.6	26.7	26.7
525	17.3	17.9	20.9	23.8	26.5	27.6	27.6
526	18.9	19.5	22.5	25.4	28.1	29.2	29.2
527	18.8	19.4	22.4	25.3	28.0	29.1	29.1
528	19.0	19.6	22.6	25.5	28.2	29.3	29.3
529	19.2	19.8	22.8	25.7	28.4	29.5	29.5
530	17.8	18.4	21.4	24.3	27.0	28.1	28.1
532	15.7	16.3	19.3	22.2	24.9	26.0	26.0
533	19.3	19.9	22.9	25.8	28.5	29.6	29.6
534	19.4	20.0	23.0	25.9	28.6	29.7	29.7
535	19.5	20.1	23.1	26.0	28.7	29.8	29.8
536	19.4	20.0	23.0	25.9	28.6	29.7	29.7
537	19.9	20.5	23.5	26.4	29.1	30.2	30.2
538	19.1	19.7	22.7	25.6	28.3	29.4	29.4
539	19.2	19.8	22.8	25.7	28.4	29.5	29.5
540	19.2	19.8	22.8	25.7	28.4	29.5	29.5
541	18.9	19.5	22.5	25.4	28.1	29.2	29.2
542	19.7	20.3	23.3	26.2	28.9	30.0	30.0
543	19.7	20.3	23.3	26.2	28.9	30.0	30.0
544	19.5	20.1	23.1	26.0	28.7	29.8	29.8

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
545	20.0	20.6	23.6	26.5	29.2	30.3	30.3
546	20.1	20.7	23.7	26.6	29.3	30.4	30.4
547	19.8	20.4	23.4	26.3	29.0	30.1	30.1
548	19.9	20.5	23.5	26.4	29.1	30.2	30.2
549	20.2	20.8	23.8	26.7	29.4	30.5	30.5
550	20.0	20.6	23.6	26.5	29.2	30.3	30.3
551	20.0	20.6	23.6	26.5	29.2	30.3	30.3
552	20.2	20.8	23.8	26.7	29.4	30.5	30.5
553	16.7	17.3	20.3	23.2	25.9	27.0	27.0
564	16.5	17.1	20.1	23.0	25.7	26.8	26.8
565	16.5	17.1	20.1	23.0	25.7	26.8	26.8
566	17.0	17.6	20.6	23.5	26.2	27.3	27.3
567	17.8	18.4	21.4	24.3	27.0	28.1	28.1
568	18.8	19.4	22.4	25.3	28.0	29.1	29.1
569	19.1	19.7	22.7	25.6	28.3	29.4	29.4
570	20.1	20.7	23.7	26.6	29.3	30.4	30.4
571	20.5	21.1	24.1	27.0	29.7	30.8	30.8
572	20.5	21.1	24.1	27.0	29.7	30.8	30.8
573	20.5	21.1	24.1	27.0	29.7	30.8	30.8
574	20.2	20.8	23.8	26.7	29.4	30.5	30.5
575	20.2	20.8	23.8	26.7	29.4	30.5	30.5
576	20.2	20.8	23.8	26.7	29.4	30.5	30.5
577	19.8	20.4	23.4	26.3	29.0	30.1	30.1
578	20.1	20.7	23.7	26.6	29.3	30.4	30.4
579	19.9	20.5	23.5	26.4	29.1	30.2	30.2
580	16.8	17.4	20.4	23.3	26.0	27.1	27.1
581	16.3	16.9	19.9	22.8	25.5	26.6	26.6
582	20.0	20.6	23.6	26.5	29.2	30.3	30.3
583	20.0	20.6	23.6	26.5	29.2	30.3	30.3
584	20.4	21.0	24.0	26.9	29.6	30.7	30.7
585	20.2	20.8	23.8	26.7	29.4	30.5	30.5
586	20.2	20.8	23.8	26.7	29.4	30.5	30.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
587	20.6	21.2	24.2	27.1	29.8	30.9	30.9
588	20.8	21.4	24.4	27.3	30.0	31.1	31.1
589	20.9	21.5	24.5	27.4	30.1	31.2	31.2
590	21.3	21.9	24.9	27.8	30.5	31.6	31.6
591	21.4	22.0	25.0	27.9	30.6	31.7	31.7
592	21.1	21.7	24.7	27.6	30.3	31.4	31.4
593	21.9	22.5	25.5	28.4	31.1	32.2	32.2
594	22.2	22.8	25.8	28.7	31.4	32.5	32.5
595	22.7	23.3	26.3	29.2	31.9	33.0	33.0
596	23.0	23.6	26.6	29.5	32.2	33.3	33.3
597	23.1	23.7	26.7	29.6	32.3	33.4	33.4
598	23.8	24.4	27.4	30.3	33.0	34.1	34.1
599	24.5	25.1	28.1	31.0	33.7	34.8	34.8
600	25.1	25.7	28.7	31.6	34.3	35.4	35.4
601	25.2	25.8	28.8	31.7	34.4	35.5	35.5
602	25.9	26.5	29.5	32.4	35.1	36.2	36.2
603	25.8	26.4	29.4	32.3	35.0	36.1	36.1
604	25.9	26.5	29.5	32.4	35.1	36.2	36.2
605	26.6	27.2	30.2	33.1	35.8	36.9	36.9
606	27.7	28.3	31.3	34.2	36.9	38.0	38.0
607	24.9	25.5	28.5	31.4	34.1	35.2	35.2
608	26.2	26.8	29.8	32.7	35.4	36.5	36.5
609	27.2	27.8	30.8	33.7	36.4	37.5	37.5
610	26.7	27.3	30.3	33.2	35.9	37.0	37.0
611	25.3	25.9	28.9	31.8	34.5	35.6	35.6
612	23.2	23.8	26.8	29.7	32.4	33.5	33.5
613	23.6	24.2	27.2	30.1	32.8	33.9	33.9
614	21.8	22.4	25.4	28.3	31.0	32.1	32.1
615	22.0	22.6	25.6	28.5	31.2	32.3	32.3
616	21.7	22.3	25.3	28.2	30.9	32.0	32.0
617	20.1	20.7	23.7	26.6	29.3	30.4	30.4
618	18.0	18.6	21.6	24.5	27.2	28.3	28.3

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
619	17.0	17.6	20.6	23.5	26.2	27.3	27.3
620	17.7	18.3	21.3	24.2	26.9	28.0	28.0
662	16.3	16.9	19.9	22.8	25.5	26.6	26.6
663	16.2	16.8	19.8	22.7	25.4	26.5	26.5
664	14.9	15.5	18.5	21.4	24.1	25.2	25.2
665	14.9	15.5	18.5	21.4	24.1	25.2	25.2
666	15.3	15.9	18.9	21.8	24.5	25.6	25.6
667	15.2	15.8	18.8	21.7	24.4	25.5	25.5
668	15.0	15.6	18.6	21.5	24.2	25.3	25.3
669	15.0	15.6	18.6	21.5	24.2	25.3	25.3
670	15.3	15.9	18.9	21.8	24.5	25.6	25.6
671	15.5	16.1	19.1	22.0	24.7	25.8	25.8
672	15.4	16.0	19.0	21.9	24.6	25.7	25.7
673	15.1	15.7	18.7	21.6	24.3	25.4	25.4
732	19.6	20.2	23.2	26.1	28.8	29.9	29.9
733	21.1	21.7	24.7	27.6	30.3	31.4	31.4
734	21.7	22.3	25.3	28.2	30.9	32.0	32.0
735	21.9	22.5	25.5	28.4	31.1	32.2	32.2
736	19.2	19.8	22.8	25.7	28.4	29.5	29.5
737	18.9	19.5	22.5	25.4	28.1	29.2	29.2
738	18.7	19.3	22.3	25.2	27.9	29.0	29.0
739	19.0	19.6	22.6	25.5	28.2	29.3	29.3
742	19.3	19.9	22.9	25.8	28.5	29.6	29.6
743	19.7	20.3	23.3	26.2	28.9	30.0	30.0
744	20.4	21.0	24.0	26.9	29.6	30.7	30.7
745	20.4	21.0	24.0	26.9	29.6	30.7	30.7
746	20.2	20.8	23.8	26.7	29.4	30.5	30.5
747	20.2	20.8	23.8	26.7	29.4	30.5	30.5
748	19.5	20.1	23.1	26.0	28.7	29.8	29.8
755	20.5	21.1	24.1	27.0	29.7	30.8	30.8
756	21.1	21.7	24.7	27.6	30.3	31.4	31.4
757	20.2	20.8	23.8	26.7	29.4	30.5	30.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
758	20.4	21.0	24.0	26.9	29.6	30.7	30.7
759	20.0	20.6	23.6	26.5	29.2	30.3	30.3
760	20.1	20.7	23.7	26.6	29.3	30.4	30.4
761	19.5	20.1	23.1	26.0	28.7	29.8	29.8
762	19.3	19.9	22.9	25.8	28.5	29.6	29.6
763	19.7	20.3	23.3	26.2	28.9	30.0	30.0
764	20.5	21.1	24.1	27.0	29.7	30.8	30.8
765	20.5	21.1	24.1	27.0	29.7	30.8	30.8
766	20.7	21.3	24.3	27.2	29.9	31.0	31.0
767	23.0	23.6	26.6	29.5	32.2	33.3	33.3
779	24.9	25.5	28.5	31.4	34.1	35.2	35.2
780	24.3	24.9	27.9	30.8	33.5	34.6	34.6
781	24.1	24.7	27.7	30.6	33.3	34.4	34.4
782	23.5	24.1	27.1	30.0	32.7	33.8	33.8
783	25.1	25.7	28.7	31.6	34.3	35.4	35.4
784	23.1	23.7	26.7	29.6	32.3	33.4	33.4
785	22.6	23.2	26.2	29.1	31.8	32.9	32.9
786	22.2	22.8	25.8	28.7	31.4	32.5	32.5
787	21.9	22.5	25.5	28.4	31.1	32.2	32.2
788	21.6	22.2	25.2	28.1	30.8	31.9	31.9
789	21.2	21.8	24.8	27.7	30.4	31.5	31.5
790	20.8	21.4	24.4	27.3	30.0	31.1	31.1
791	20.8	21.4	24.4	27.3	30.0	31.1	31.1
792	20.1	20.7	23.7	26.6	29.3	30.4	30.4
793	17.0	17.6	20.6	23.5	26.2	27.3	27.3
794	17.9	18.5	21.5	24.4	27.1	28.2	28.2
795	22.7	23.3	26.3	29.2	31.9	33.0	33.0
796	20.7	21.3	24.3	27.2	29.9	31.0	31.0
797	21.6	22.2	25.2	28.1	30.8	31.9	31.9
798	19.5	20.1	23.1	26.0	28.7	29.8	29.8
799	19.7	20.3	23.3	26.2	28.9	30.0	30.0
800	19.4	20.0	23.0	25.9	28.6	29.7	29.7

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
801	19.2	19.8	22.8	25.7	28.4	29.5	29.5
802	18.9	19.5	22.5	25.4	28.1	29.2	29.2
803	18.6	19.2	22.2	25.1	27.8	28.9	28.9
804	18.6	19.2	22.2	25.1	27.8	28.9	28.9
805	18.5	19.1	22.1	25.0	27.7	28.8	28.8
806	18.3	18.9	21.9	24.8	27.5	28.6	28.6
807	19.2	19.8	22.8	25.7	28.4	29.5	29.5
808	19.4	20.0	23.0	25.9	28.6	29.7	29.7
809	22.3	22.9	25.9	28.8	31.5	32.6	32.6
810	20.1	20.7	23.7	26.6	29.3	30.4	30.4
811	21.8	22.4	25.4	28.3	31.0	32.1	32.1
817	19.9	20.5	23.5	26.4	29.1	30.2	30.2
818	20.4	21.0	24.0	26.9	29.6	30.7	30.7
819	21.5	22.1	25.1	28.0	30.7	31.8	31.8
820	24.4	25.0	28.0	30.9	33.6	34.7	34.7
821	24.7	25.3	28.3	31.2	33.9	35.0	35.0
822	25.8	26.4	29.4	32.3	35.0	36.1	36.1
823	27.2	27.8	30.8	33.7	36.4	37.5	37.5
824	26.7	27.3	30.3	33.2	35.9	37.0	37.0
825	23.9	24.5	27.5	30.4	33.1	34.2	34.2
826	24.8	25.4	28.4	31.3	34.0	35.1	35.1
827	25.6	26.2	29.2	32.1	34.8	35.9	35.9
828	27.1	27.7	30.7	33.6	36.3	37.4	37.4
829	27.0	27.6	30.6	33.5	36.2	37.3	37.3
830	26.4	27.0	30.0	32.9	35.6	36.7	36.7
831	27.5	28.1	31.1	34.0	36.7	37.8	37.8
832	27.8	28.4	31.4	34.3	37.0	38.1	38.1
833	23.9	24.5	27.5	30.4	33.1	34.2	34.2
834	23.9	24.5	27.5	30.4	33.1	34.2	34.2
835	23.5	24.1	27.1	30.0	32.7	33.8	33.8
836	19.4	20.0	23.0	25.9	28.6	29.7	29.7
837	24.1	24.7	27.7	30.6	33.3	34.4	34.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
838	26.3	26.9	29.9	32.8	35.5	36.6	36.6
839	19.1	19.7	22.7	25.6	28.3	29.4	29.4
840	18.3	18.9	21.9	24.8	27.5	28.6	28.6
844	21.3	21.9	24.9	27.8	30.5	31.6	31.6
845	21.4	22.0	25.0	27.9	30.6	31.7	31.7
846	21.3	21.9	24.9	27.8	30.5	31.6	31.6
847	25.4	26.0	29.0	31.9	34.6	35.7	35.7
848	26.2	26.8	29.8	32.7	35.4	36.5	36.5
849	25.6	26.2	29.2	32.1	34.8	35.9	35.9
850	25.4	26.0	29.0	31.9	34.6	35.7	35.7
851	24.9	25.5	28.5	31.4	34.1	35.2	35.2
852	24.4	25.0	28.0	30.9	33.6	34.7	34.7
853	27.7	28.3	31.3	34.2	36.9	38.0	38.0
854	21.5	22.1	25.1	28.0	30.7	31.8	31.8
855	21.7	22.3	25.3	28.2	30.9	32.0	32.0
856	20.4	21.0	24.0	26.9	29.6	30.7	30.7
857	23.3	23.9	26.9	29.8	32.5	33.6	33.6
858	22.7	23.3	26.3	29.2	31.9	33.0	33.0
859	22.3	22.9	25.9	28.8	31.5	32.6	32.6
860	21.8	22.4	25.4	28.3	31.0	32.1	32.1
861	21.0	21.6	24.6	27.5	30.2	31.3	31.3
862	26.1	26.7	29.7	32.6	35.3	36.4	36.4
863	27.1	27.7	30.7	33.6	36.3	37.4	37.4
864	28.5	29.1	32.1	35.0	37.7	38.8	38.8
865	22.5	23.1	26.1	29.0	31.7	32.8	32.8
866	23.1	23.7	26.7	29.6	32.3	33.4	33.4
867	23.3	23.9	26.9	29.8	32.5	33.6	33.6
868	19.6	20.2	23.2	26.1	28.8	29.9	29.9
869	19.8	20.4	23.4	26.3	29.0	30.1	30.1
870	23.5	24.1	27.1	30.0	32.7	33.8	33.8
871	25.7	26.3	29.3	32.2	34.9	36.0	36.0
872	26.2	26.8	29.8	32.7	35.4	36.5	36.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
873	26.3	26.9	29.9	32.8	35.5	36.6	36.6
874	24.8	25.4	28.4	31.3	34.0	35.1	35.1
875	27.2	27.8	30.8	33.7	36.4	37.5	37.5
876	20.6	21.2	24.2	27.1	29.8	30.9	30.9
877	21.3	21.9	24.9	27.8	30.5	31.6	31.6
878	20.3	20.9	23.9	26.8	29.5	30.6	30.6
879	20.1	20.7	23.7	26.6	29.3	30.4	30.4
880	18.1	18.7	21.7	24.6	27.3	28.4	28.4
881	17.9	18.5	21.5	24.4	27.1	28.2	28.2
882	18.4	19.0	22.0	24.9	27.6	28.7	28.7
883	18.9	19.5	22.5	25.4	28.1	29.2	29.2
884	17.8	18.4	21.4	24.3	27.0	28.1	28.1
885	17.2	17.8	20.8	23.7	26.4	27.5	27.5
886	18.2	18.8	21.8	24.7	27.4	28.5	28.5
887	17.4	18.0	21.0	23.9	26.6	27.7	27.7
888	17.6	18.2	21.2	24.1	26.8	27.9	27.9
889	17.8	18.4	21.4	24.3	27.0	28.1	28.1
890	17.7	18.3	21.3	24.2	26.9	28.0	28.0
891	18.8	19.4	22.4	25.3	28.0	29.1	29.1
892	20.7	21.3	24.3	27.2	29.9	31.0	31.0
893	23.0	23.6	26.6	29.5	32.2	33.3	33.3
894	22.4	23.0	26.0	28.9	31.6	32.7	32.7
895	16.0	16.6	19.6	22.5	25.2	26.3	26.3
907	16.6	17.2	20.2	23.1	25.8	26.9	26.9
1158	19.6	20.2	23.2	26.1	28.8	29.9	29.9
1159	20.3	20.9	23.9	26.8	29.5	30.6	30.6
1160	22.2	22.8	25.8	28.7	31.4	32.5	32.5
1161	21.9	22.5	25.5	28.4	31.1	32.2	32.2
1162	22.2	22.8	25.8	28.7	31.4	32.5	32.5
1163	22.9	23.5	26.5	29.4	32.1	33.2	33.2
1164	23.2	23.8	26.8	29.7	32.4	33.5	33.5
1165	23.1	23.7	26.7	29.6	32.3	33.4	33.4

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
1166	23.4	24.0	27.0	29.9	32.6	33.7	33.7
1167	23.7	24.3	27.3	30.2	32.9	34.0	34.0
1168	24.2	24.8	27.8	30.7	33.4	34.5	34.5
1169	24.5	25.1	28.1	31.0	33.7	34.8	34.8
1170	26.7	27.3	30.3	33.2	35.9	37.0	37.0
1171	27.3	27.9	30.9	33.8	36.5	37.6	37.6
1172	22.7	23.3	26.3	29.2	31.9	33.0	33.0
1173	21.6	22.2	25.2	28.1	30.8	31.9	31.9
1174	23.7	24.3	27.3	30.2	32.9	34.0	34.0
1175	21.0	21.6	24.6	27.5	30.2	31.3	31.3
1176	21.6	22.2	25.2	28.1	30.8	31.9	31.9
1177	21.2	21.8	24.8	27.7	30.4	31.5	31.5
1178	20.7	21.3	24.3	27.2	29.9	31.0	31.0
1179	20.5	21.1	24.1	27.0	29.7	30.8	30.8
1180	19.9	20.5	23.5	26.4	29.1	30.2	30.2
1182	19.2	19.8	22.8	25.7	28.4	29.5	29.5
1228	18.6	19.2	22.2	25.1	27.8	28.9	28.9
1235	19.7	20.3	23.3	26.2	28.9	30.0	30.0
1255	16.5	17.1	20.1	23.0	25.7	26.8	26.8
1256	16.8	17.4	20.4	23.3	26.0	27.1	27.1
1257	17.0	17.6	20.6	23.5	26.2	27.3	27.3
1258	16.8	17.4	20.4	23.3	26.0	27.1	27.1
1259	17.2	17.8	20.8	23.7	26.4	27.5	27.5
1260	18.4	19.0	22.0	24.9	27.6	28.7	28.7
1261	17.4	18.0	21.0	23.9	26.6	27.7	27.7
1262	17.3	17.9	20.9	23.8	26.5	27.6	27.6
1263	17.8	18.4	21.4	24.3	27.0	28.1	28.1
1264	17.5	18.1	21.1	24.0	26.7	27.8	27.8
1265	17.8	18.4	21.4	24.3	27.0	28.1	28.1
1266	18.4	19.0	22.0	24.9	27.6	28.7	28.7
1267	18.4	19.0	22.0	24.9	27.6	28.7	28.7
1268	18.5	19.1	22.1	25.0	27.7	28.8	28.8

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
1269	19.4	20.0	23.0	25.9	28.6	29.7	29.7
1270	18.5	19.1	22.1	25.0	27.7	28.8	28.8
1271	18.6	19.2	22.2	25.1	27.8	28.9	28.9
1272	18.2	18.8	21.8	24.7	27.4	28.5	28.5
1273	18.3	18.9	21.9	24.8	27.5	28.6	28.6
1274	18.2	18.8	21.8	24.7	27.4	28.5	28.5
1275	17.8	18.4	21.4	24.3	27.0	28.1	28.1
1276	17.9	18.5	21.5	24.4	27.1	28.2	28.2
1278	17.7	18.3	21.3	24.2	26.9	28.0	28.0
1280	18.8	19.4	22.4	25.3	28.0	29.1	29.1
1281	18.2	18.8	21.8	24.7	27.4	28.5	28.5
1293	19.1	19.7	22.7	25.6	28.3	29.4	29.4
1294	18.2	18.8	21.8	24.7	27.4	28.5	28.5
1295	17.8	18.4	21.4	24.3	27.0	28.1	28.1
1296	17.5	18.1	21.1	24.0	26.7	27.8	27.8
1297	17.4	18.0	21.0	23.9	26.6	27.7	27.7
1298	18.3	18.9	21.9	24.8	27.5	28.6	28.6
1299	14.9	15.5	18.5	21.4	24.1	25.2	25.2
1300	15.3	15.9	18.9	21.8	24.5	25.6	25.6
1398	17.1	17.7	20.7	23.6	26.3	27.4	27.4
1415	20.2	20.8	23.8	26.7	29.4	30.5	30.5
1416	20.5	21.1	24.1	27.0	29.7	30.8	30.8
1417	20.6	21.2	24.2	27.1	29.8	30.9	30.9
1418	21.9	22.5	25.5	28.4	31.1	32.2	32.2
4061	19.9	20.5	23.5	26.4	29.1	30.2	30.2
4062	16.3	16.9	19.9	22.8	25.5	26.6	26.6
4063	19.0	19.6	22.6	25.5	28.2	29.3	29.3
4151	19.6	20.2	23.2	26.1	28.8	29.9	29.9
4152	27.7	28.3	31.3	34.2	36.9	38.0	38.0
4180	20.9	21.5	24.5	27.4	30.1	31.2	31.2
4339	15.4	16.0	19.0	21.9	24.6	25.7	25.7
4340	15.7	16.3	19.3	22.2	24.9	26.0	26.0

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
4351	16.5	17.1	20.1	23.0	25.7	26.8	26.8
4374	17.5	18.1	21.1	24.0	26.7	27.8	27.8
4375	25.2	25.8	28.8	31.7	34.4	35.5	35.5
4377	21.4	22.0	25.0	27.9	30.6	31.7	31.7
4378	25.4	26.0	29.0	31.9	34.6	35.7	35.7
4379	29.3	29.9	32.9	35.8	38.5	39.6	39.6
4492	20.5	21.1	24.1	27.0	29.7	30.8	30.8
4493	21.9	22.5	25.5	28.4	31.1	32.2	32.2
4530	22.1	22.7	25.7	28.6	31.3	32.4	32.4
4531	25.2	25.8	28.8	31.7	34.4	35.5	35.5
4532	20.5	21.1	24.1	27.0	29.7	30.8	30.8
4536	19.2	19.8	22.8	25.7	28.4	29.5	29.5
4537	19.3	19.9	22.9	25.8	28.5	29.6	29.6
4538	18.1	18.7	21.7	24.6	27.3	28.4	28.4
4574	19.0	19.6	22.6	25.5	28.2	29.3	29.3

Table 13: Predicted Noise Levels - V162-5.6MW Mode 0

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
92	12.6	13.2	16.2	19.1	21.8	22.9	22.9
93	12.6	13.2	16.2	19.1	21.8	22.9	22.9
94	13.4	14.0	17.0	19.9	22.6	23.7	23.7
95	12.9	13.5	16.5	19.4	22.1	23.2	23.2
217	14.0	14.6	17.6	20.5	23.2	24.3	24.3
218	13.9	14.5	17.5	20.4	23.1	24.2	24.2
226	12.8	13.4	16.4	19.3	22.0	23.1	23.1
229	14.8	15.4	18.4	21.3	24.0	25.1	25.1
232	13.7	14.3	17.3	20.2	22.9	24.0	24.0
237	14.3	14.9	17.9	20.8	23.5	24.6	24.6
524	13.5	14.1	17.1	20.0	22.7	23.8	23.8
525	14.4	15.0	18.0	20.9	23.6	24.7	24.7
526	16.0	16.6	19.6	22.5	25.2	26.3	26.3
527	15.9	16.5	19.5	22.4	25.1	26.2	26.2
528	16.1	16.7	19.7	22.6	25.3	26.4	26.4
529	16.3	16.9	19.9	22.8	25.5	26.6	26.6
530	14.9	15.5	18.5	21.4	24.1	25.2	25.2
532	12.8	13.4	16.4	19.3	22.0	23.1	23.1
533	16.4	17.0	20.0	22.9	25.6	26.7	26.7
534	16.5	17.1	20.1	23.0	25.7	26.8	26.8
535	16.6	17.2	20.2	23.1	25.8	26.9	26.9
536	16.4	17.0	20.0	22.9	25.6	26.7	26.7
537	16.9	17.5	20.5	23.4	26.1	27.2	27.2
538	16.1	16.7	19.7	22.6	25.3	26.4	26.4
539	16.3	16.9	19.9	22.8	25.5	26.6	26.6
540	16.3	16.9	19.9	22.8	25.5	26.6	26.6
541	16.0	16.6	19.6	22.5	25.2	26.3	26.3
542	16.8	17.4	20.4	23.3	26.0	27.1	27.1
543	16.8	17.4	20.4	23.3	26.0	27.1	27.1
544	16.5	17.1	20.1	23.0	25.7	26.8	26.8
545	17.0	17.6	20.6	23.5	26.2	27.3	27.3

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
546	17.1	17.7	20.7	23.6	26.3	27.4	27.4
547	16.8	17.4	20.4	23.3	26.0	27.1	27.1
548	17.0	17.6	20.6	23.5	26.2	27.3	27.3
549	17.2	17.8	20.8	23.7	26.4	27.5	27.5
550	17.1	17.7	20.7	23.6	26.3	27.4	27.4
551	17.1	17.7	20.7	23.6	26.3	27.4	27.4
552	17.2	17.8	20.8	23.7	26.4	27.5	27.5
553	13.8	14.4	17.4	20.3	23.0	24.1	24.1
564	13.6	14.2	17.2	20.1	22.8	23.9	23.9
565	13.6	14.2	17.2	20.1	22.8	23.9	23.9
566	14.1	14.7	17.7	20.6	23.3	24.4	24.4
567	14.8	15.4	18.4	21.3	24.0	25.1	25.1
568	15.9	16.5	19.5	22.4	25.1	26.2	26.2
569	16.1	16.7	19.7	22.6	25.3	26.4	26.4
570	17.1	17.7	20.7	23.6	26.3	27.4	27.4
571	17.4	18.0	21.0	23.9	26.6	27.7	27.7
572	17.5	18.1	21.1	24.0	26.7	27.8	27.8
573	17.5	18.1	21.1	24.0	26.7	27.8	27.8
574	17.3	17.9	20.9	23.8	26.5	27.6	27.6
575	17.2	17.8	20.8	23.7	26.4	27.5	27.5
576	17.2	17.8	20.8	23.7	26.4	27.5	27.5
577	16.9	17.5	20.5	23.4	26.1	27.2	27.2
578	17.1	17.7	20.7	23.6	26.3	27.4	27.4
579	16.9	17.5	20.5	23.4	26.1	27.2	27.2
580	13.9	14.5	17.5	20.4	23.1	24.2	24.2
581	13.4	14.0	17.0	19.9	22.6	23.7	23.7
582	17.1	17.7	20.7	23.6	26.3	27.4	27.4
583	17.1	17.7	20.7	23.6	26.3	27.4	27.4
584	17.4	18.0	21.0	23.9	26.6	27.7	27.7
585	17.3	17.9	20.9	23.8	26.5	27.6	27.6
586	17.2	17.8	20.8	23.7	26.4	27.5	27.5
587	17.6	18.2	21.2	24.1	26.8	27.9	27.9

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
588	17.8	18.4	21.4	24.3	27.0	28.1	28.1
589	17.9	18.5	21.5	24.4	27.1	28.2	28.2
590	18.3	18.9	21.9	24.8	27.5	28.6	28.6
591	18.4	19.0	22.0	24.9	27.6	28.7	28.7
592	18.1	18.7	21.7	24.6	27.3	28.4	28.4
593	18.9	19.5	22.5	25.4	28.1	29.2	29.2
594	19.2	19.8	22.8	25.7	28.4	29.5	29.5
595	19.6	20.2	23.2	26.1	28.8	29.9	29.9
596	19.9	20.5	23.5	26.4	29.1	30.2	30.2
597	20.1	20.7	23.7	26.6	29.3	30.4	30.4
598	20.8	21.4	24.4	27.3	30.0	31.1	31.1
599	21.5	22.1	25.1	28.0	30.7	31.8	31.8
600	22.0	22.6	25.6	28.5	31.2	32.3	32.3
601	22.2	22.8	25.8	28.7	31.4	32.5	32.5
602	22.9	23.5	26.5	29.4	32.1	33.2	33.2
603	22.8	23.4	26.4	29.3	32.0	33.1	33.1
604	22.9	23.5	26.5	29.4	32.1	33.2	33.2
605	23.6	24.2	27.2	30.1	32.8	33.9	33.9
606	24.7	25.3	28.3	31.2	33.9	35.0	35.0
607	21.8	22.4	25.4	28.3	31.0	32.1	32.1
608	23.2	23.8	26.8	29.7	32.4	33.5	33.5
609	24.2	24.8	27.8	30.7	33.4	34.5	34.5
610	23.7	24.3	27.3	30.2	32.9	34.0	34.0
611	22.3	22.9	25.9	28.8	31.5	32.6	32.6
612	20.2	20.8	23.8	26.7	29.4	30.5	30.5
613	20.6	21.2	24.2	27.1	29.8	30.9	30.9
614	18.7	19.3	22.3	25.2	27.9	29.0	29.0
615	18.9	19.5	22.5	25.4	28.1	29.2	29.2
616	18.7	19.3	22.3	25.2	27.9	29.0	29.0
617	17.1	17.7	20.7	23.6	26.3	27.4	27.4
618	15.1	15.7	18.7	21.6	24.3	25.4	25.4
619	14.2	14.8	17.8	20.7	23.4	24.5	24.5

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
620	14.8	15.4	18.4	21.3	24.0	25.1	25.1
662	13.6	14.2	17.2	20.1	22.8	23.9	23.9
663	13.4	14.0	17.0	19.9	22.6	23.7	23.7
664	12.2	12.8	15.8	18.7	21.4	22.5	22.5
665	12.2	12.8	15.8	18.7	21.4	22.5	22.5
666	12.5	13.1	16.1	19.0	21.7	22.8	22.8
667	12.5	13.1	16.1	19.0	21.7	22.8	22.8
668	12.3	12.9	15.9	18.8	21.5	22.6	22.6
669	12.3	12.9	15.9	18.8	21.5	22.6	22.6
670	12.6	13.2	16.2	19.1	21.8	22.9	22.9
671	12.8	13.4	16.4	19.3	22.0	23.1	23.1
672	12.7	13.3	16.3	19.2	21.9	23.0	23.0
673	12.4	13.0	16.0	18.9	21.6	22.7	22.7
732	16.6	17.2	20.2	23.1	25.8	26.9	26.9
733	18.1	18.7	21.7	24.6	27.3	28.4	28.4
734	18.7	19.3	22.3	25.2	27.9	29.0	29.0
735	18.9	19.5	22.5	25.4	28.1	29.2	29.2
736	16.2	16.8	19.8	22.7	25.4	26.5	26.5
737	15.9	16.5	19.5	22.4	25.1	26.2	26.2
738	15.7	16.3	19.3	22.2	24.9	26.0	26.0
739	16.1	16.7	19.7	22.6	25.3	26.4	26.4
742	16.4	17.0	20.0	22.9	25.6	26.7	26.7
743	16.8	17.4	20.4	23.3	26.0	27.1	27.1
744	17.4	18.0	21.0	23.9	26.6	27.7	27.7
745	17.4	18.0	21.0	23.9	26.6	27.7	27.7
746	17.2	17.8	20.8	23.7	26.4	27.5	27.5
747	17.2	17.8	20.8	23.7	26.4	27.5	27.5
748	16.6	17.2	20.2	23.1	25.8	26.9	26.9
755	17.6	18.2	21.2	24.1	26.8	27.9	27.9
756	18.1	18.7	21.7	24.6	27.3	28.4	28.4
757	17.3	17.9	20.9	23.8	26.5	27.6	27.6
758	17.5	18.1	21.1	24.0	26.7	27.8	27.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
759	17.1	17.7	20.7	23.6	26.3	27.4	27.4
760	17.2	17.8	20.8	23.7	26.4	27.5	27.5
761	16.6	17.2	20.2	23.1	25.8	26.9	26.9
762	16.4	17.0	20.0	22.9	25.6	26.7	26.7
763	16.8	17.4	20.4	23.3	26.0	27.1	27.1
764	17.5	18.1	21.1	24.0	26.7	27.8	27.8
765	17.5	18.1	21.1	24.0	26.7	27.8	27.8
766	17.8	18.4	21.4	24.3	27.0	28.1	28.1
767	20.1	20.7	23.7	26.6	29.3	30.4	30.4
779	21.8	22.4	25.4	28.3	31.0	32.1	32.1
780	21.3	21.9	24.9	27.8	30.5	31.6	31.6
781	21.0	21.6	24.6	27.5	30.2	31.3	31.3
782	20.4	21.0	24.0	26.9	29.6	30.7	30.7
783	22.1	22.7	25.7	28.6	31.3	32.4	32.4
784	20.1	20.7	23.7	26.6	29.3	30.4	30.4
785	19.5	20.1	23.1	26.0	28.7	29.8	29.8
786	19.2	19.8	22.8	25.7	28.4	29.5	29.5
787	18.9	19.5	22.5	25.4	28.1	29.2	29.2
788	18.5	19.1	22.1	25.0	27.7	28.8	28.8
789	18.2	18.8	21.8	24.7	27.4	28.5	28.5
790	17.8	18.4	21.4	24.3	27.0	28.1	28.1
791	17.8	18.4	21.4	24.3	27.0	28.1	28.1
792	17.1	17.7	20.7	23.6	26.3	27.4	27.4
793	14.0	14.6	17.6	20.5	23.2	24.3	24.3
794	14.9	15.5	18.5	21.4	24.1	25.2	25.2
795	19.8	20.4	23.4	26.3	29.0	30.1	30.1
796	17.8	18.4	21.4	24.3	27.0	28.1	28.1
797	18.7	19.3	22.3	25.2	27.9	29.0	29.0
798	16.5	17.1	20.1	23.0	25.7	26.8	26.8
799	16.7	17.3	20.3	23.2	25.9	27.0	27.0
800	16.4	17.0	20.0	22.9	25.6	26.7	26.7
801	16.2	16.8	19.8	22.7	25.4	26.5	26.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
802	15.9	16.5	19.5	22.4	25.1	26.2	26.2
803	15.7	16.3	19.3	22.2	24.9	26.0	26.0
804	15.7	16.3	19.3	22.2	24.9	26.0	26.0
805	15.5	16.1	19.1	22.0	24.7	25.8	25.8
806	15.4	16.0	19.0	21.9	24.6	25.7	25.7
807	16.2	16.8	19.8	22.7	25.4	26.5	26.5
808	16.4	17.0	20.0	22.9	25.6	26.7	26.7
809	19.3	19.9	22.9	25.8	28.5	29.6	29.6
810	17.1	17.7	20.7	23.6	26.3	27.4	27.4
811	18.9	19.5	22.5	25.4	28.1	29.2	29.2
817	16.9	17.5	20.5	23.4	26.1	27.2	27.2
818	17.4	18.0	21.0	23.9	26.6	27.7	27.7
819	18.5	19.1	22.1	25.0	27.7	28.8	28.8
820	21.3	21.9	24.9	27.8	30.5	31.6	31.6
821	21.6	22.2	25.2	28.1	30.8	31.9	31.9
822	22.7	23.3	26.3	29.2	31.9	33.0	33.0
823	24.2	24.8	27.8	30.7	33.4	34.5	34.5
824	23.7	24.3	27.3	30.2	32.9	34.0	34.0
825	20.9	21.5	24.5	27.4	30.1	31.2	31.2
826	21.8	22.4	25.4	28.3	31.0	32.1	32.1
827	22.6	23.2	26.2	29.1	31.8	32.9	32.9
828	24.0	24.6	27.6	30.5	33.2	34.3	34.3
829	24.0	24.6	27.6	30.5	33.2	34.3	34.3
830	23.4	24.0	27.0	29.9	32.6	33.7	33.7
831	24.5	25.1	28.1	31.0	33.7	34.8	34.8
832	24.8	25.4	28.4	31.3	34.0	35.1	35.1
833	20.9	21.5	24.5	27.4	30.1	31.2	31.2
834	20.9	21.5	24.5	27.4	30.1	31.2	31.2
835	20.5	21.1	24.1	27.0	29.7	30.8	30.8
836	16.5	17.1	20.1	23.0	25.7	26.8	26.8
837	21.1	21.7	24.7	27.6	30.3	31.4	31.4
838	23.3	23.9	26.9	29.8	32.5	33.6	33.6

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
839	16.2	16.8	19.8	22.7	25.4	26.5	26.5
840	15.4	16.0	19.0	21.9	24.6	25.7	25.7
844	18.3	18.9	21.9	24.8	27.5	28.6	28.6
845	18.4	19.0	22.0	24.9	27.6	28.7	28.7
846	18.3	18.9	21.9	24.8	27.5	28.6	28.6
847	22.4	23.0	26.0	28.9	31.6	32.7	32.7
848	23.2	23.8	26.8	29.7	32.4	33.5	33.5
849	22.6	23.2	26.2	29.1	31.8	32.9	32.9
850	22.4	23.0	26.0	28.9	31.6	32.7	32.7
851	21.9	22.5	25.5	28.4	31.1	32.2	32.2
852	21.3	21.9	24.9	27.8	30.5	31.6	31.6
853	24.7	25.3	28.3	31.2	33.9	35.0	35.0
854	18.5	19.1	22.1	25.0	27.7	28.8	28.8
855	18.7	19.3	22.3	25.2	27.9	29.0	29.0
856	17.3	17.9	20.9	23.8	26.5	27.6	27.6
857	20.2	20.8	23.8	26.7	29.4	30.5	30.5
858	19.6	20.2	23.2	26.1	28.8	29.9	29.9
859	19.2	19.8	22.8	25.7	28.4	29.5	29.5
860	18.8	19.4	22.4	25.3	28.0	29.1	29.1
861	18.0	18.6	21.6	24.5	27.2	28.3	28.3
862	23.1	23.7	26.7	29.6	32.3	33.4	33.4
863	24.2	24.8	27.8	30.7	33.4	34.5	34.5
864	25.6	26.2	29.2	32.1	34.8	35.9	35.9
865	19.5	20.1	23.1	26.0	28.7	29.8	29.8
866	20.1	20.7	23.7	26.6	29.3	30.4	30.4
867	20.3	20.9	23.9	26.8	29.5	30.6	30.6
868	16.6	17.2	20.2	23.1	25.8	26.9	26.9
869	16.8	17.4	20.4	23.3	26.0	27.1	27.1
870	20.5	21.1	24.1	27.0	29.7	30.8	30.8
871	22.7	23.3	26.3	29.2	31.9	33.0	33.0
872	23.2	23.8	26.8	29.7	32.4	33.5	33.5
873	23.3	23.9	26.9	29.8	32.5	33.6	33.6

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
874	21.9	22.5	25.5	28.4	31.1	32.2	32.2
875	24.3	24.9	27.9	30.8	33.5	34.6	34.6
876	17.6	18.2	21.2	24.1	26.8	27.9	27.9
877	18.2	18.8	21.8	24.7	27.4	28.5	28.5
878	17.3	17.9	20.9	23.8	26.5	27.6	27.6
879	17.1	17.7	20.7	23.6	26.3	27.4	27.4
880	15.1	15.7	18.7	21.6	24.3	25.4	25.4
881	14.9	15.5	18.5	21.4	24.1	25.2	25.2
882	15.4	16.0	19.0	21.9	24.6	25.7	25.7
883	15.9	16.5	19.5	22.4	25.1	26.2	26.2
884	14.8	15.4	18.4	21.3	24.0	25.1	25.1
885	14.2	14.8	17.8	20.7	23.4	24.5	24.5
886	15.2	15.8	18.8	21.7	24.4	25.5	25.5
887	14.4	15.0	18.0	20.9	23.6	24.7	24.7
888	14.7	15.3	18.3	21.2	23.9	25.0	25.0
889	14.8	15.4	18.4	21.3	24.0	25.1	25.1
890	14.7	15.3	18.3	21.2	23.9	25.0	25.0
891	15.8	16.4	19.4	22.3	25.0	26.1	26.1
892	17.8	18.4	21.4	24.3	27.0	28.1	28.1
893	20.1	20.7	23.7	26.6	29.3	30.4	30.4
894	19.5	20.1	23.1	26.0	28.7	29.8	29.8
895	13.2	13.8	16.8	19.7	22.4	23.5	23.5
907	13.8	14.4	17.4	20.3	23.0	24.1	24.1
1158	16.6	17.2	20.2	23.1	25.8	26.9	26.9
1159	17.3	17.9	20.9	23.8	26.5	27.6	27.6
1160	19.2	19.8	22.8	25.7	28.4	29.5	29.5
1161	18.9	19.5	22.5	25.4	28.1	29.2	29.2
1162	19.2	19.8	22.8	25.7	28.4	29.5	29.5
1163	19.9	20.5	23.5	26.4	29.1	30.2	30.2
1164	20.1	20.7	23.7	26.6	29.3	30.4	30.4
1165	20.1	20.7	23.7	26.6	29.3	30.4	30.4
1166	20.4	21.0	24.0	26.9	29.6	30.7	30.7

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1167	20.6	21.2	24.2	27.1	29.8	30.9	30.9
1168	21.1	21.7	24.7	27.6	30.3	31.4	31.4
1169	21.5	22.1	25.1	28.0	30.7	31.8	31.8
1170	23.7	24.3	27.3	30.2	32.9	34.0	34.0
1171	24.3	24.9	27.9	30.8	33.5	34.6	34.6
1172	19.6	20.2	23.2	26.1	28.8	29.9	29.9
1173	18.5	19.1	22.1	25.0	27.7	28.8	28.8
1174	20.7	21.3	24.3	27.2	29.9	31.0	31.0
1175	17.9	18.5	21.5	24.4	27.1	28.2	28.2
1176	18.5	19.1	22.1	25.0	27.7	28.8	28.8
1177	18.1	18.7	21.7	24.6	27.3	28.4	28.4
1178	17.7	18.3	21.3	24.2	26.9	28.0	28.0
1179	17.5	18.1	21.1	24.0	26.7	27.8	27.8
1180	16.9	17.5	20.5	23.4	26.1	27.2	27.2
1182	16.2	16.8	19.8	22.7	25.4	26.5	26.5
1228	15.7	16.3	19.3	22.2	24.9	26.0	26.0
1235	16.7	17.3	20.3	23.2	25.9	27.0	27.0
1255	13.6	14.2	17.2	20.1	22.8	23.9	23.9
1256	13.9	14.5	17.5	20.4	23.1	24.2	24.2
1257	14.1	14.7	17.7	20.6	23.3	24.4	24.4
1258	13.9	14.5	17.5	20.4	23.1	24.2	24.2
1259	14.3	14.9	17.9	20.8	23.5	24.6	24.6
1260	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1261	14.4	15.0	18.0	20.9	23.6	24.7	24.7
1262	14.4	15.0	18.0	20.9	23.6	24.7	24.7
1263	14.9	15.5	18.5	21.4	24.1	25.2	25.2
1264	14.5	15.1	18.1	21.0	23.7	24.8	24.8
1265	14.8	15.4	18.4	21.3	24.0	25.1	25.1
1266	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1267	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1268	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1269	16.4	17.0	20.0	22.9	25.6	26.7	26.7

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
1270	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1271	15.6	16.2	19.2	22.1	24.8	25.9	25.9
1272	15.2	15.8	18.8	21.7	24.4	25.5	25.5
1273	15.3	15.9	18.9	21.8	24.5	25.6	25.6
1274	15.2	15.8	18.8	21.7	24.4	25.5	25.5
1275	14.8	15.4	18.4	21.3	24.0	25.1	25.1
1276	14.9	15.5	18.5	21.4	24.1	25.2	25.2
1278	14.8	15.4	18.4	21.3	24.0	25.1	25.1
1280	15.8	16.4	19.4	22.3	25.0	26.1	26.1
1281	15.2	15.8	18.8	21.7	24.4	25.5	25.5
1293	16.1	16.7	19.7	22.6	25.3	26.4	26.4
1294	15.2	15.8	18.8	21.7	24.4	25.5	25.5
1295	14.8	15.4	18.4	21.3	24.0	25.1	25.1
1296	14.5	15.1	18.1	21.0	23.7	24.8	24.8
1297	14.5	15.1	18.1	21.0	23.7	24.8	24.8
1298	15.3	15.9	18.9	21.8	24.5	25.6	25.6
1299	12.3	12.9	15.9	18.8	21.5	22.6	22.6
1300	12.6	13.2	16.2	19.1	21.8	22.9	22.9
1398	14.2	14.8	17.8	20.7	23.4	24.5	24.5
1415	17.2	17.8	20.8	23.7	26.4	27.5	27.5
1416	17.5	18.1	21.1	24.0	26.7	27.8	27.8
1417	17.7	18.3	21.3	24.2	26.9	28.0	28.0
1418	18.9	19.5	22.5	25.4	28.1	29.2	29.2
4061	17.0	17.6	20.6	23.5	26.2	27.3	27.3
4062	13.4	14.0	17.0	19.9	22.6	23.7	23.7
4063	16.1	16.7	19.7	22.6	25.3	26.4	26.4
4151	16.6	17.2	20.2	23.1	25.8	26.9	26.9
4152	24.7	25.3	28.3	31.2	33.9	35.0	35.0
4180	18.0	18.6	21.6	24.5	27.2	28.3	28.3
4339	12.5	13.1	16.1	19.0	21.7	22.8	22.8
4340	12.9	13.5	16.5	19.4	22.1	23.2	23.2
4351	13.7	14.3	17.3	20.2	22.9	24.0	24.0

Receiver	Hub-height wind speed (m/s)						
	4	**5**	**6**	**7**	**8**	**9**	**≥10**
4374	14.6	15.2	18.2	21.1	23.8	24.9	24.9
4375	22.3	22.9	25.9	28.8	31.5	32.6	32.6
4377	18.4	19.0	22.0	24.9	27.6	28.7	28.7
4378	22.4	23.0	26.0	28.9	31.6	32.7	32.7
4379	26.5	27.1	30.1	33.0	35.7	36.8	36.8
4492	17.6	18.2	21.2	24.1	26.8	27.9	27.9
4493	19.0	19.6	22.6	25.5	28.2	29.3	29.3
4530	19.1	19.7	22.7	25.6	28.3	29.4	29.4
4531	22.2	22.8	25.8	28.7	31.4	32.5	32.5
4532	17.5	18.1	21.1	24.0	26.7	27.8	27.8
4536	16.3	16.9	19.9	22.8	25.5	26.6	26.6
4537	16.4	17.0	20.0	22.9	25.6	26.7	26.7
4538	15.1	15.7	18.7	21.6	24.3	25.4	25.4
4574	16.1	16.7	19.7	22.6	25.3	26.4	26.4

APPENDIX J DOCUMENTATION

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

(b) Noise sensitive locations: See Section 2.1 and Appendix D

(c) Wind turbine sound power levels, L_{WA} dB (also refer to Section 2.3)

Sound power levels (manufacturer specification + 1dB margin for uncertainty), dB L_{WA}

	Hub height wind speed (m/s)						
Turbine model	**4**	**5**	**6**	**7**	**8**	**9**	**≥10**
V162-5.6MW Mode 0-0S	97.5	98.1	101.1	104.0	106.7	107.8	107.8
V162-5.6MW Mode 0	94.7	95.3	98.3	101.2	103.9	105.0	105.0

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

	Octave Band Centre Frequency (Hz)								
Turbine model	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
V162-5.6MW Mode 0-0S*	75.5	87.2	95.7	100.9	103.0	102.1	97.9	90.7	80.1
V162-5.6MW Mode 0**	76.0	86.4	93.8	98.3	100.1	99.0	94.9	88.2	78.5

* Based on one-third octave band spectral information at 20 m/s
** Based on one-third octave band spectral information at 12 m/s

(d) Wind turbine model: See Table 1 of Section 2.2

(e) Turbine hub height: See Table 1 of Section 2.2

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

(g) Calculation procedure used: ISO 9613-2:1996 prediction algorithm as implemented in SoundPLAN v8.1 (See Section 4.3 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: Elevation contours provided by the proponent
1 m resolution within the site boundary and 10 m resolution beyond – See Appendix F

(k) Predicted far-field wind farm sound levels: See Section 5.2 and Appendix I.