Appendix H

MARSHALL DAY Acoustics

DELBURN WIND FARM
ENVIRONMENTAL NOISE ASSESSMENT

Rp 003 R01 20190463 | 26 January 2021

6 Gipps Street
Collingwood VIC 3066
Australia
T: +613 9416 1855
ABN: 53 470 077 191
www.marshallday.com

Project:	**Delburn Wind Farm** **Environmental Noise Assessment**
Prepared for:	**Delburn Wind Farm Pty Ltd** **(part of the OSMI Australia group)**
Attention:	**Peter Marriott**
Report No.:	**003 R01 20190463**

Disclaimer

Reports produced by Marshall Day Acoustics Pty Ltd are based on a specific scope, conditions and limitations, as agreed between Marshall Day Acoustics and the Client. Information and/or report(s) prepared by Marshall Day Acoustics may not be suitable for uses other than the specific project. No parties other than the Client should use any information and/or report(s) without first conferring with Marshall Day Acoustics.

The advice given herein is for acoustic purposes only. Relevant authorities and experts should be consulted with regard to compliance with regulations or requirements governing areas other than acoustics.

Copyright

The concepts and information contained in this document are the property of Marshall Day Acoustics Pty Ltd. Use or copying of this document in whole or in part without the written permission of Marshall Day Acoustics constitutes an infringement of copyright. Information shall not be assigned to a third party without prior consent.

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Final	-	Issued to client	20 Oct. 2020	C. Delaire	J. Adcock
Revision	01	Update to content of Section 6.5	26 Jan. 2021	J. Adcock	-

Certified System ISO 9001

EXECUTIVE SUMMARY

This report presents the results of an assessment of environmental noise associated with the Delburn Wind Farm that is proposed to be developed by Delburn Wind Farm Pty Ltd (part of the OSMI Australia group).

The assessment is based on the proposed wind farm layout comprising thirty-three (33) 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, after the project has been granted planning approval. The final selection would be based on a range of design requirements including achieving compliance with the planning permit noise limits at surrounding noise sensitive locations (receivers). In advance of a final selection, the assessment considers three (3) candidate turbine models that are representative of the size and type of turbine which could be used at the site. For this purpose, the Vestas V162-5.6MW, GE Renewable Energy 5.5-158 and Siemens Gamesa SG 6.0-170, all with a nominal hub height of 160 m and rotor diameter between 158-170 m, have been nominated by the proponent for this assessment.

Operational noise from the proposed wind turbines has been assessed in accordance with the New Zealand Standard 6808:2010[1], as required by the Victorian Government's *Development of Wind Energy Facilities in Victoria - Policy and Planning Guidelines* dated March 2019.

The assessment considers operational wind farm noise limits determined in accordance with NZS 6808:2010, accounting for the land zoning of the area and the results of the background noise monitoring survey undertaken between March and June 2020 at selected receivers surrounding the project.

Manufacturer specification data provided by the proponent for the candidate turbine models has been used as the basis for the assessment. These specifications provide noise emission data in accordance with the international standard[2] 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[3] to predict the level of noise expected occur at neighbouring receivers. 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 models achieve the noise limits determined in accordance with NZS 6808:2010 at all neighbouring receivers.

The assessment has also considered operational noise associated with related infrastructure associated with the wind farm, including a battery energy storage system and a terminal station, to be located to the north of the site. Noise levels from the related infrastructure have been assessed in accordance with Victorian EPA Publication 1411 *Noise from Industry in Regional Victoria* dated 2011 (NIRV). The assessment demonstrates that the related infrastructure can be designed and operated to achieve the recommended maximum noise levels determined in accordance with NIRV.

---

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

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

3 ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*

Information about construction noise including details of the relevant Victorian guidelines and the types of activities that are expected to be associated with construction of the wind farm has been included in this report. The primary methods of managing construction noise will be to conduct the majority of work during normal working hours, with activities outside of normal working hours limited to infrequent or unavoidable works. Additional measures for the management of construction noise would be implemented via a Construction Environmental Management Plan.

The noise assessment therefore demonstrates that the proposed Delburn Wind Farm is able to be designed and developed to achieve Victorian policy requirements for construction and operational noise, and that appropriate control mechanisms are available to ensure compliance is maintained over the life of the project.

In order to ensure that operational noise is appropriately addressed during subsequent stages of the development, a consent for the wind farm should include conditions that specify noise control requirements which address:

- Operational wind turbine noise
- Operational noise of related infrastructure.

Recommendations for the technical elements of these conditions are detailed within this report. A key aspect of these conditions is the establishment of mandatory checks at different stages in the project. For example, requirements for the predicted noise levels from turbines and related infrastructure to be recalculated and verified once the equipment selections and detailed layout design are finalised, and further requirements for operational noise levels to then be verified by on-site measurements as soon as equipment starts operating.

Furthermore, to address the subject of high amenity, it is recommended that the pre-construction noise assessment include the following:

- a specific acknowledgement that the area to the northwest of Boolarra that are zoned Rural Living Area are a high amenity area for the purposes of the Standard
- an assessment as to whether the high amenity noise limit should apply to these areas and the appropriate threshold wind speed, based on the guidance in Clause C5.3.1 of the Standard.

MARSHALL DAY Acoustics

TABLE OF CONTENTS

1.0 INTRODUCTION

Delburn Wind Farm Pty Ltd (part of the OSMI Australia group) 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-three (33) wind turbines and related infrastructure located on a site centred approximately ten kilometres to the southwest of Morwell. The proposed related infrastructure relevant to the environmental noise assessment comprises a battery energy storage system and a terminal station, located to the north of the site. Throughout this report, the term 'wind farm' refers to both the wind turbines and the related infrastructure.

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 proposed related infrastructure associated with the wind farm has been assessed in accordance with EPA Publication 1411 *Noise from industry in regional Victoria* dated 2011 (NIRV).

The noise assessment presented in this report is based on:

- Background noise data from surveys undertaken at a range of noise sensitive locations around the site
- Operational noise limits determined in accordance with NZS 6808:2010 and NIRV, accounting for local land zoning and background noise levels;
- Predicted noise levels for the proposed Delburn Wind Farm turbines, based on the proposed site layout and candidate turbine models that are representative of the size and type of turbine that the planning application seeks consent for;
- Predicted noise levels for the proposed Delburn Wind Farm related infrastructure, based on empirical noise emission data; and
- A comparison of the predicted noise levels for different turbine models with the criteria derived in accordance with NZS 6808:2010 and NIRV.

This report also provides information about construction noise including details of relevant Victorian Wind Energy Guidelines and the types of activities that are expected to be associated with construction of the wind farm. This information is primarily intended as a reference for matters that should be considered as part of the preparation of a Construction Environmental Management Plan for the project.

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

General information about the definition of sound and the ways that different sound characteristics are described is also presented in Appendix B.

2.0 PROJECT DESCRIPTION

The Delburn Wind Farm is proposed to comprise thirty-three (33) 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 turbines are tabulated in Appendix C.

The proponent is seeking consent for wind farm comprising wind turbines extending to a tip height of up to 250 m. Three (3) candidate turbine models have been selected for this assessment ranging in power output from 5.6 to 6.0 MW and in rotor diameter from 158 to 170 m. Further detail on the proposed candidate turbine models is presented in Section 6.1.

Related infrastructure associated with the wind farm, including a battery energy storage system and a terminal station, is also proposed to be located to the north of the site.

A total of three hundred and twenty-eight (328) noise sensitive locations (generally referred to as *receivers* herein) located within 3 km of the proposed turbines have been considered in this noise assessment. This includes two (2) receivers located within the project boundary (subsequently referred to as *stakeholder receivers* herein) and three (3) receivers identified by the proponent as future dwellings location on a title without an existing dwelling (subsequently referred to as *future receivers* herein).

A further forty-four (44) receivers, located within 3 km of the proposed related infrastructure, have also been considered in this noise assessment.

The coordinates of the receivers are tabulated in Appendix D.

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

3.0 VICTORIAN POLICY & GUIDELINES

The following publications are relevant to the assessment of operational and construction 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)
- EPA publication 1411 titled *Noise from Industry in Regional Victoria – Recommended maximum noise levels from commerce, industry and trade premises in regional Victoria* (NIRV)
- EPA Publication 1254 *Noise Control Guidelines* (EPA Publication 1254).

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 (also generally referred to as *receivers* herein) that existed before the development of a wind farm. Noise sensitive locations are defined by the Standard as:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site. Noise sensitive locations include:*
>
> *(a) Any part of land zoned predominantly for residential use in a district plan;*
>
> *(b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*
>
> *(c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities …*
>
> *(d) Teaching areas and sleeping rooms in educational institutions …*
>
> *(e) Teaching areas and sleeping rooms in buildings for licensed kindergartens, childcare, and day-care centres; and*
>
> *(f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.*
>
> *In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.*

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

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

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

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

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

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

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 the application of a high amenity noise limit may require additional consideration:

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

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

In accordance with Section 5.3 of NZS 6808:2010, if a high amenity noise limit is justified, wind farm noise levels (L_{A90}) during evening and nigh-time periods should not exceed the background noise level (L_{A90}) by more than 5 dB or 35 dB L_{A90}, whichever is the greater. The standard recommends that this reduced noise limit would typically apply for wind speeds below 6 m/s at hub height. A high amenity noise limit is not applicable during the daytime period.

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

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

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

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

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

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. An indication of the potential for tonality to be a characteristic of the noise emission from the assessed turbine model is sometimes available from tonality audibility assessments conducted as part of manufacturer turbine noise emission testing. However, this data is frequently not available at the planning stage of an assessment.

3.3 EPA Publication 1411 – NIRV

EPA Publication 1411 *Noise from industry in regional Victoria* dated 2011 (NIRV) provides guidance on the methods to be used to set noise levels for industry in regional Victoria, and are applicable to the assessment of noise from equipment such as transformers to be located in the substations associated with the proposed Delburn Wind Farm.

The noise criteria provided by NIRV are defined in terms of recommended maximum levels (recommended levels). The objective of the recommended levels is to provide:

> […] *a balance between protecting community wellbeing and amenity near industrial premises and supporting the social and economic value of industry in regional Victoria.*

The recommended levels apply to noise-sensitive areas (also generally referred to as *receivers* herein) which are defined as follows:

> *these are mainly homes, but can include, for example, motels and tourist establishments. They do not include schools. The noise is assessed in outdoor locations at these premises. For full definition, see SEPP N-1.*

State Environment Protection Policy (Control of Noise From Industry, Commerce and Trade) No. N-1 (SEPP N-1), as referenced in NIRV, provides the following definition for noise-sensitive areas:

(a) *that part of the land within the apparent boundaries of any piece of land which is within a distance of 10 metres outside the external walls of any of the following buildings -*

Dwelling (except Caretaker's House)

Residential Building

(b) *that part of the land within the apparent boundaries of any piece of land on which is situated any of the following buildings which is within a distance of 10 metres outside the external walls of any dormitory, ward or bedroom of such buildings -*

Caretaker's House

Hospital

Hotel

Institutional Home

Motel

Reformative Institution

Tourist Establishment

Work Release Hostel

The procedures for setting recommended levels are defined separately for major urban and rural areas. However, in both cases, the recommended levels are defined by considering the land zoning in the area and the noise environment of the receiver location. The recommended levels are defined separately for day, evening and night periods.

To assess the noise of an activity against the recommended levels, the measurement and analysis procedures specified in SEPP N-1 are used. These procedures include adjustments which are to be applied to noise that is characterised by audible tones, impulses or intermittency.

Further details of the recommended levels applicable to this project are provided in Section 7.1 of this report.

3.4 EPA Publication 1254

EPA Publication 1254 *Noise control guidelines* describes recommended measures for managing noise and vibration which are applicable to construction of a wind farm project. It also defines noise restrictions for construction activity during evening and night periods, based on a combination of objective limits and audibility-based targets. The guidance relating to construction noise is summarised in Table 1.

Table 1: EPA Publication 1254 – construction noise guidance summary

Period	Day of the week	Time Period	Construction activity up to 18 months	Construction activity after 18 months
Normal working hours	Monday-Friday	0700-1800hrs	Receiver limits do not apply – noise requirements are defined in terms of emission and managerial controls	
	Saturday	0700-1300hrs		
Weekend/evening work hours	Monday-Friday	1800-2200hrs	Noise to be less than 10 dB above background (L_{A90}), outside residential dwelling	Noise to be less than 5 dB above background (L_{A90}), outside residential dwelling
	Saturday	1300-2200hrs		
	Sunday, Public Holidays	0700-2200hrs		
Night period	Monday-Sunday	2200-0700hrs	Noise from construction activities must be inaudible inside a habitable room with windows open	

The criteria summarised in Table 1 provide a basis for setting objective noise criteria if construction work was to occur during the evening. In relation to the night period, EPA Publication 1254 does not specify an objective criterion for inaudibility.

In accordance with EPA Publication 1254, exceptions to the general evening and night requirements detailed above apply to the following types of work:

- Unavoidable works that cannot practicably be restricted to normal working hours because the activity involves continuous work or would otherwise pose an unacceptable risk to life or property, or risk a major traffic hazard. In relation to the construction of a wind farm, examples of these types of works may include the delivery of oversized turbine components outside of normal working hours to avoid traffic disruptions and hazards, or turbine component assembly operations that must occur during low wind conditions for safety reasons
- Low-noise or managed-impact works are activities that are approved by the local authority:
  - that are inherently quiet or unobtrusive (for example, manual painting, internal fit-outs, cabling); or
  - where the noise impacts are mitigated through actions specified in a noise management plan supported by expert acoustic assessment.

  Low-noise or managed-impact works must not feature intrusive characteristics such as impulsive noise or tonal movement alarms, and average noise levels over any half hour must not exceed the background sound pressure level.

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 (including the turbines and the related infrastructure associated with the wind farm) involves:

- assessing background noise levels at receivers around the project;
- assessing the land zoning of the project site and surrounding areas;
- establishing suitable noise criteria accounting for background noise levels and land zoning;
- predicting the level of noise expected to occur as a result of the proposed turbines and substation; 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 inform the setting of limits for both the related infrastructure and the wind turbine components of a wind farm project. However, in rural areas where wind farms are typically developed, the background noise level data is most relevant to the assessment of the wind turbines. This is due to the need to consider the changes in background noise levels and wind turbine noise levels for different wind conditions.

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

> *Background sound level measurements and subsequent analysis to define the relative noise limits should be carried out where wind farm sound levels of 35 dB $L_{A90(10\,min)}$ or higher are predicted for noise sensitive locations, when the wind turbines are at 95% rated power. If there are no noise sensitive locations within the 35 dB $L_{A90(10\,min)}$ predicted wind farm sound level contour then background sound level measurements are not required.*

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

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

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

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

4.3 Noise predictions

Operational wind farm noise levels (turbines and related infrastructure) are predicted using:

- Noise emission data for the wind turbines and related infrastructure
- 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 method is generally applied in a comparable manner to both wind turbine and substation noise levels. For example, for both types of sources, equivalent ground and atmospheric conditions are used for the calculations. However, when applied to wind turbine noise, additional and specific input choices apply, as detailed below.

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

Table 2: Noise prediction elements

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 8.2
Method	International Standard ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (ISO 9613-2). Adjustments to the ISO 9613-2 method are applied on the basis of the guidance contained in the UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (the UK Institute of Acoustics guidance). The adjustments are applied within the SoundPLAN modelling software and relate to the influence of terrain screening and ground effects on sound propagation. Specific details of adjustments are noted below and are discussed in Appendix H.
Source characterisation	Each source of operational noise is modelled as a point source of sound. The total sound of the component of the wind farm being modelled (i.e. the wind turbines or the related infrastructure) is then calculated on the basis of simultaneous operation of all elements (e.g. all wind turbines) and summing the contribution of each. To model the turbine components of the wind farm, the following specific procedures are noted: • Calculations of turbine to receiver distances and average sound propagation heights are made on the basis of the point source being located at the position of the hub of the turbine. • Calculations of terrain related screening are made on the basis of the point source being located at the maximum tip height of each turbine. Further discussion of terrain screening effects is provided below.
Terrain data	Data provided by the proponent 1 m resolution within the site boundary and immediate surrounds 10 m resolution beyond.

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

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

5.0 EXISTING NOISE ENVIRONMENT

Preliminary noise modelling of an earlier wind farm layout was undertaken to determine whether background noise monitoring was warranted in accordance with NZS 6808:2010, and if so, the locations where noise monitoring should be undertaken.

Background noise monitoring was subsequently undertaken at nine (9) receivers in the vicinity of the proposed wind farm between 6 March and 18 June 2020. Analysis and results of the survey are detailed in MDA Report Rp 002 20190463 *Delburn Wind Farm – Background noise monitoring report*, dated 20 October 2020 (the Background Noise Report).

It is noted that consent to undertake background noise monitoring was not granted at all preferred receivers. Prior to construction of the wind farm, background noise monitoring may be undertaken at additional receivers, should consent be provided.

The tabulated data presented in Table 3 summarises the background noise levels determined in accordance with NZS 6808:2010.

The data in these tables is provided for the key wind speeds relevant to the assessment of wind farm noise. The results for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in the appendices of the Background Noise Report.

Table 3: Background noise levels, dB L_{A90}

Receiver	Hub height wind speed (m/s)											
	4	5	6	7	8	9	10	11	12	13	14	15
600 [3]	23.5	24.0	24.8	25.8	27.2	28.8	30.7	32.8	35.1	37.5	40.1	42.9
609 [2]	31.3	32.0	32.8	33.5	34.3	35.0	35.8	36.6	37.3	38.1	38.9	39.6
824 [3]	27.6	28.5	29.6	31.0	32.4	34.0	35.7	37.5	39.3	41.2	43.0	44.8
832 [1]	27.8	28.3	29.3	30.8	32.7	34.8	37.2	39.6	42.2	44.7	47.0	49.2
853 [1]	28.7	29.0	29.6	30.4	31.5	32.9	34.4	36.1	37.9	39.8	41.8	43.8
864 [2]	25.5	25.8	26.6	27.8	29.3	31.1	33.1	35.3	37.6	39.9	42.4	44.7
867 [2]	27.0	27.5	28.3	29.6	31.1	32.9	35.0	37.2	39.6	42.1	44.6	47.2
1171 [1]	25.2	25.6	26.2	27.1	28.2	29.5	31.0	32.7	34.6	36.6	38.8	41.0
4585 [3]	30.1	30.6	31.1	31.8	32.5	33.4	34.3	35.3	36.4	37.7	39.0	40.4

Notes [1] 160 m above ground level at DEL01
[2] 160 m above ground level at LiDAR2
[3] 160 m above ground level at LiDAR3

6.0 WIND TURBINE ASSESSMENT

6.1 Noise limits

6.1.1 High amenity

As detailed in Section 3.2.4, the applicability of a high amenity noise limit is based on a two-step approach comprising:

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

Land zoning

Based on the predicted noise level contours presented subsequently in Section 6.2, and the zoning map for the area presented in Appendix G, the areas within the predicted 35 dB L_{A90} contour[5] are detailed in Table 4.

Table 4: Land zoning within the 35 dB noise contour

Zone	Number of assessed receivers	Comment
Farming Zone	13	-
Special Use Zone	2	Area west of the Hazelwood coal mine
Rural Living Zone	2	Area northwest of the Boolarra township

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Wind Energy Guidelines, the areas within the Farming Zone do not warrant consideration of the high amenity noise limit.

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.

This conclusion was on the basis that those zones encouraged residential living, which correlates to a higher expectation for a greater acoustic amenity expectation. As one of the purposes of the Rural Living Zone is residential then the same reasoning as that applied by the Golden Plains panel could be applied to that zone. A high amenity limit may therefore warrant consideration for the two (2) receivers that are in the Rural Living Zone and where predicted noise levels[5] are above 35 dB L_{A90}.

[5] For the candidate turbine model with the highest predicted noise levels (GE 5.5-158)

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

Clause C5.3.1

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

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

As permission was not granted to undertake background noise monitoring at either of the two receivers where consideration of the high amenity limit is warranted (605 and 4155), measurements were performed at a representative receiver location 600-800 m to the south along Todds Road (600).

Background noise levels at receivers within the Rural Living Area to the northwest of Boolarra vary according to the extent of vegetation. The nearest receivers (including receivers 600, 605 and 4155) are highly vegetated and would therefore be expected to experience elevated wind induced background noise levels. However, to provide an indication of background noise levels in less vegetated areas, noise monitoring was also undertaken at receiver 4585, located approximately 1.1 km south of receiver 605.

The calculated evening and night-time NPIs presented in Table 5 are therefore based on predicted noise levels[7] at both receivers 605 and 4155 and background noise levels measured at receivers 600 and 4585.

Table 5: Noise perception index for receivers that may warrant consideration of high amenity limits, dB

	Background noise monitoring location	
Receiver location	**600**	**4585**
Evening period		
605	5.8	2.3
4155	6.4	2.7
Night period		
605	6.5	3.8
4155	7.2	4.3

In can be seen from Table 5 that the NPIs calculated at receivers 605 and 4155 are below 8 dB for both the evening and night periods. In accordance with the guidance of NZS 6808:2010, a high amenity noise limit is therefore unlikely to be justified for the Delburn Wind Farm based on the current layout and candidate turbine models.

7 For the candidate turbine model with the highest predicted noise levels (GE 5.5-158)

Based on the example permit conditions provided as Attachment B of the Victorian Wind Energy Guidelines it is anticipated that a pre-construction noise assessment will be required to be prepared prior to construction of the wind farm. To address the subject of high amenity, it is recommended that the pre-construction noise assessment include the following:

- a specific acknowledgement that the area to the northwest of Boolarra that are zoned Rural Living Area are a high amenity area for the purposes of the Standard
- an assessment as to whether the high amenity noise limit should apply to these areas and the appropriate threshold wind speed, based on the guidance in Clause C5.3.1 of the Standard.

6.1.2 Stakeholder receivers

The definition of noise sensitive locations in NZS 6808:2010 specifically excludes dwellings located within a wind farm site boundary. The discussion earlier in this report in Section 3.2.2, also provides details of the statutory context of NZS 6808:2010 and indicates the method is not intended to be applied to noise sensitive locations outside the site boundary where a noise agreement exists between the occupants and the proponent of the development.

This is consistent with model conditions in the Victorian Guidelines which state that the noise limits specified in NZS 6808:2010 would not apply if an agreement is in place between the proponents and the landowners.

Notwithstanding the above and consistent with the Victorian Wind Energy Guidelines which recommends a level of 45 dB for stakeholder dwelling, a reference level of 45 dB is typically applied as a base criterion for stakeholder dwellings in order to provide context to the predicted noise levels for these locations.

It is proposed to apply a reference level of 40 dB at the two (2) stakeholder receivers located within the project boundary (828 and 829).

6.1.3 Applicable noise limits

Accounting for the conclusions of the assessment of high amenity detailed in the previous section, the noise criteria applicable to the Delburn Wind Farm are summarised in Table 6.

Table 6: Applicable noise criteria, dB L_{A90}

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

* the applicable base noise criterion is to be based on the NPI calculation detailed in clause C5.3.1 of NZS 6808:2010

Applicable noise limits based on the background noise levels presented in Table 3 are summarised in Table 7.

Table 7: Background dependent noise limits (dB L_{A90})

Receiver	Hub height wind speed (m/s)											
	4	5	6	7	8	9	10	11	12	13	14	15
600 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	42.5	45.1	47.9
609 [2]	40.0	40.0	40.0	40.0	40.0	40.0	40.8	41.6	42.3	43.1	43.9	44.6
824 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.7	42.5	44.3	46.2	48.0	49.8
832 [1]	40.0	40.0	40.0	40.0	40.0	40.0	42.2	44.6	47.2	49.7	52.0	54.2
853 [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.9	44.8	46.8	48.8
864 [2]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.3	42.6	44.9	47.4	49.7
867 [2]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	44.6	47.1	49.6	52.2
1171 [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.6	43.8	46.0
4585 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.3	41.4	42.7	44.0	45.4

Notes [1] 160 m above ground level at DEL01
[2] 160 m above ground level at LiDAR2
[3] 160 m above ground level at LiDAR3

6.2 Wind turbine model

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

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

For this assessment, the proponent has nominated the following three (3) candidate turbine models:

- Vestas V162-5.6MW;
- GE Renewable Energy 5.5-158; and
- Siemens Gamesa SG 6.0-170.

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

Two different types of blade design are available for the Vestas turbine model; a standard non-serrated version and a serrated version which reduces the total noise emissions of the turbine.

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

Details of the assessed candidate wind turbines are provided in Table 8.

Table 8: Selected candidate wind turbine models

Detail	V162-5.6MW	GE 5.5-158	SG 6.0-170
Make	Vestas	GE Renewable Energy	Siemens Gamesa
Rotor diameter	162 m	158 m	170 m
Hub height	160 m	160 m	160 m
Operating mode	Mode 0 [1]	Standard	Normal
Rated power	5.6 MW	5.5 MW	6.0 MW
Cut-in wind speed (hub height)	3 m/s	3 m/s	3 m/s
Rated power wind speed (hub height)	12 m/s	12 m/s	10 m/s
Cut-out wind speed (hub height)	24 m/s	25 m/s	25 m/s

1 'Mode 0' is a manufacturer designation which indicates an unconstrained mode of operation (i.e. without noise curtailment)

The hub height of 160 m detailed above is suitable for noise assessment purposes. It is our understanding that the final hub height of the selected wind turbine model may differ slightly. However, the magnitude of the potential changes is minor with respect to predicted noise levels. Further information is presented in Section 6.4.2.

6.3 Wind turbine noise emissions

6.3.1 Sound power levels

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

Sound power level data for the candidate turbine models, including sound frequency characteristics, has been sourced from the manufacturers' documents detailed in Table 9.

Table 9: Candidate turbine noise emission documentation

Turbine	Reference document
V162-5.6MW	Vestas document No. 0079-5298_V01 - V162-5_6MW Third Octaves, dated 23 January 2019
GE 5.5-158	GE Renewable Energy document *Technical Documentation Wind Turbine Generator Systems 5.3/5.5-158 - 50 Hz - Product Acoustic Specifications Normal Operation according to IEC Incl. Octave and 1/3rd Octave Band Spectra* dated 2019
SG 6.0-170	Siemens Gamesa Renewable Energy document No. D2359593/002 *Standard Acoustic Emission, Rev. 0, AM 0 - AM-6, N1 - N7 - SG 6.0-170* dated 27 February 2020

Based on the data sourced from the above specifications, the noise modelling undertaken for this assessment involved conversion of third octave band level to octave band levels (where applicable) and adjustment by addition of +1.0 dB at each wind speed to provide a margin for typical values of test uncertainty.

The overall A-weighted sound power levels (including the +1 dB addition) as a function of hub height wind speed are presented in Table 10 with the octave band values presented in Table 11. These represent the total noise emissions of the turbine for each sound mode, including the secondary contribution of ancillary plant associated with each turbine (e.g. cooling fans).

Table 10: Sound power levels versus hub height wind speed, dB L_{WA}

	Hub height wind speed m/s								
Turbine	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**≥12**
V162-5.6MW	94.7	95.3	98.3	101.2	103.9	105.0	105.0	105.0	105.0
GE 5.5-158	94.8	95.5	98.6	102.0	104.9	107.0	107.0	107.0	107.0
SG 6.0-170	93.0	95.5	99.4	102.8	105.7	107.0	107.0	107.0	107.0

Table 11: Octave band sound power levels, dB L_{WA}

	Octave band centre frequency (Hz)									
Turbine	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Total**
V162-5.6MW [1]	76.0	86.4	93.8	98.3	100.1	99.0	94.9	88.2	78.5	105.0
GE 5.5-158 [2]	79.0	88.2	93.6	98.2	100.7	102.3	100.1	92.7	77.0	107.0
SG 6.0-170 [3]	-	88.5	95.3	97.5	98.5	101.7	101.4	96.9	85.1	107.0

1 Based on one-third octave band levels at 12 m/s
2 Based on octave band levels at 9 m/s
3 Based on octave band sound power levels at 8 m/s adjusted to the highest overall sound power level

These sound power levels are also illustrated in Appendix J.

The values presented above are considered typical of the upper range of noise emissions associated with comparable multi-megawatt wind turbines.

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

6.3.2 Special Audible Characteristics

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

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

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

Given the above, adjustments for special audible characteristics have not been applied to the predicted noise levels presented in this assessment. Notwithstanding this, the subject of special audible characteristics would be addressed in subsequent assessment stages for the project, following approval of the wind farm, and again following construction of the wind farm, as discussed in Section 9.0.

6.4 Predicted noise levels

6.4.1 Results

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

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

Noise levels from the proposed Delburn Wind Farm have been predicted using the sound power level data detailed in Section 6.3.1 for the candidate turbine models and are summarised in Table 12 for for the wind speeds which result in the highest predicted noise levels (hub height wind speed ≥9 m/s).

The locations of the predicted 35 dB and 40 dB L_{A90} noise contours are illustrated in Figure 1 to Figure 3 for each candidate turbine model (similarly, 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 receivers, including dwellings where the highest predicted noise level is below 35 dB L_{A90}.

Table 12: Highest predicted noise level at receivers with predicted levels over 35 dB L_{A90}

Receiver Location	V162-5.6MW	GE 5.5-158	SG 6.0-170
605*	33.8	35.0	34.4
606	35.1	36.4	35.8
608	34.1	35.2	34.6
609	35.1	36.4	35.8
610	34.6	35.8	35.2
823	34.8	36.0	35.5
824	34.3	35.5	34.9
828 (S)	34.5	35.6	35.0
829 (S)	34.4	35.5	34.9
830	33.9	35.0	34.5
832	35.3	36.5	35.9
838	34.2	35.3	34.8
853	35.3	36.6	36.0
863	34.4	35.7	35.2
864	35.7	37.1	36.5
872	33.7	35.0	34.5
873	33.8	35.1	34.5
875	34.7	36.1	35.5
1170	34.0	35.1	34.6
1171	34.4	35.7	35.1
4155*	34.9	36.1	35.6

(S) Stakeholder receiver
* Receivers located within the Rural Living Zone to the southeast of the proposed wind farm

It can be seen from Table 12 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 2.9-4.3 dB, depending on the candidate turbine model.

Figure 1: Highest predicted noise level contours, dB L_{A90} – V162-5.6MW

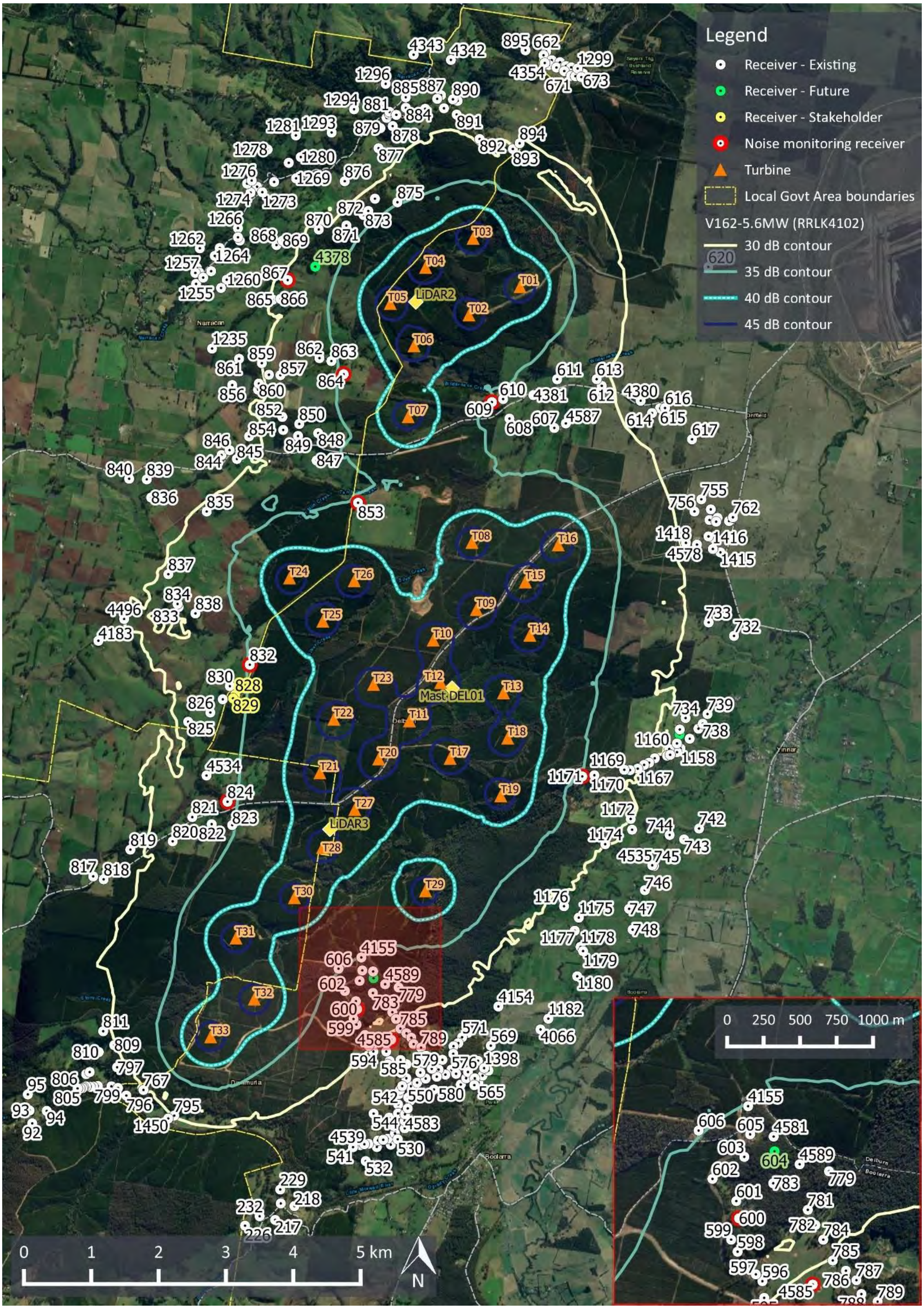


Figure 2: Highest predicted noise level contours, dB L_{A90} – GE 5.5-158

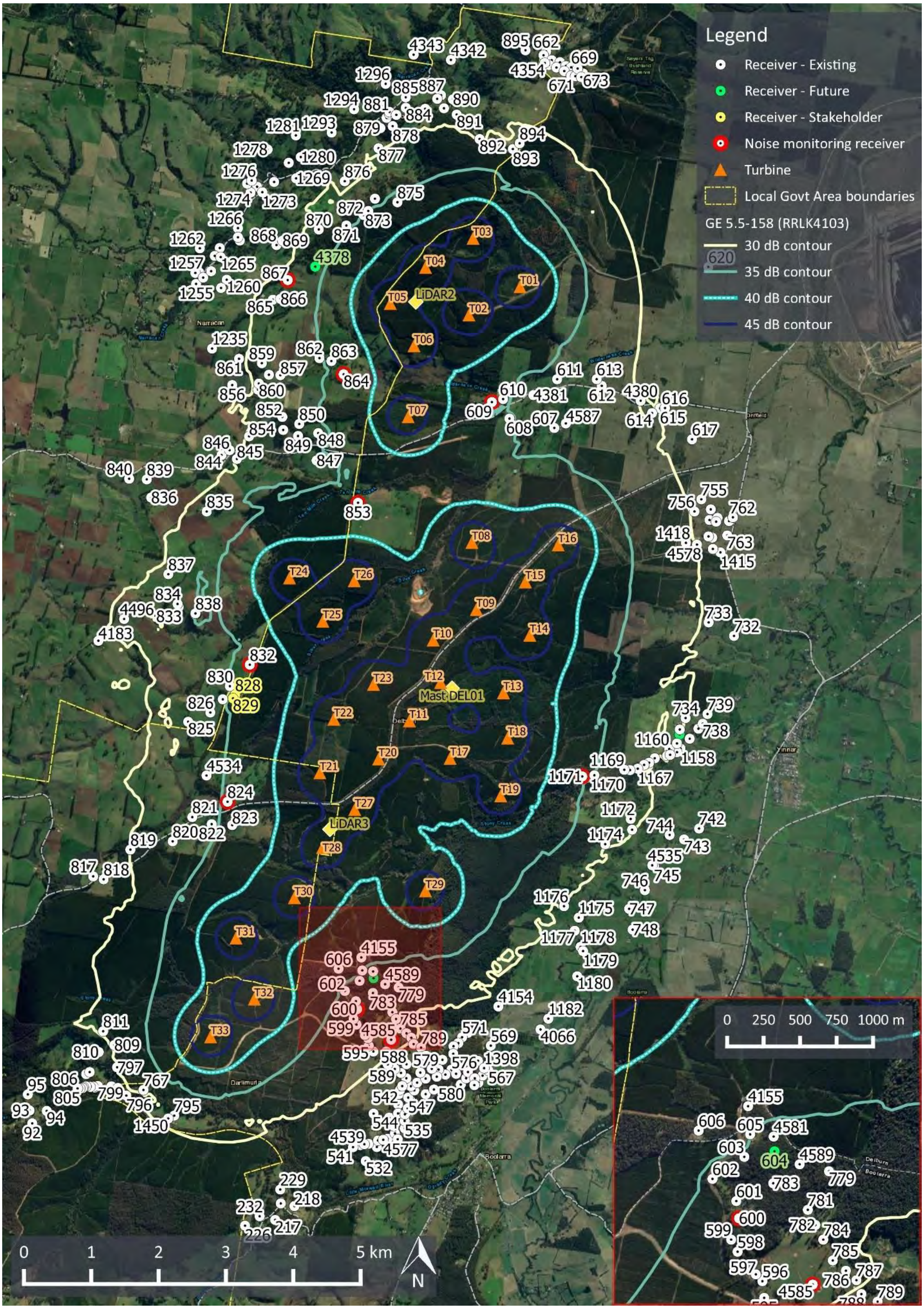
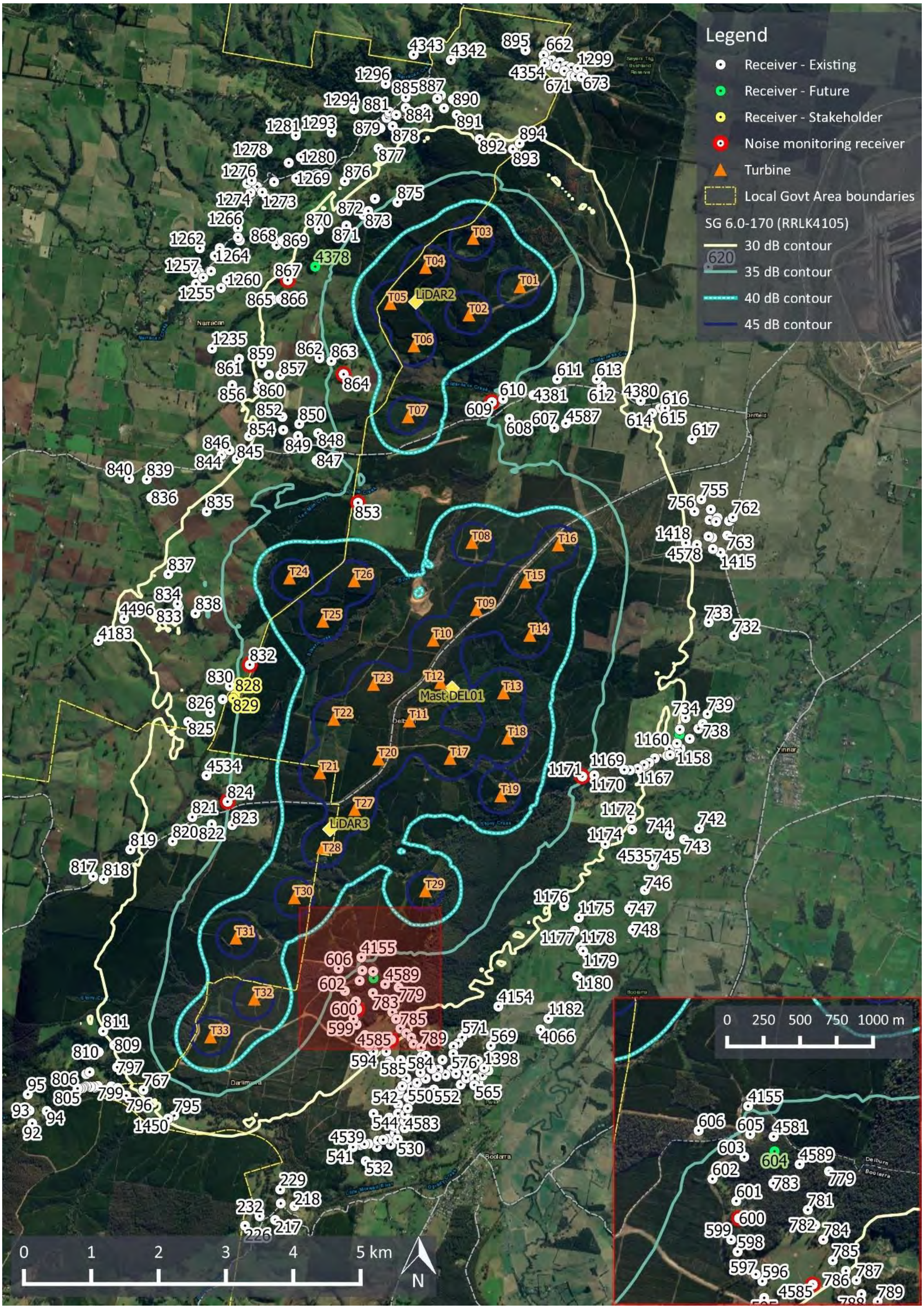


Figure 3: Highest predicted noise level contours, dB L_{A90} – SG 6.0-170



6.4.2 Hub height variations

Predicted noise presented herein are based on a nominal hub height of 160 m. It is understood that the selected hub height may vary depending on the final selected turbine make and model, and may range from 149 to 170 m.

To provide an indication of the effect of this variation on predicted wind turbine noise levels, the results for the V162-5.6MW have been recalculated for hub heights of 149 and 170 m.

These calculations indicate changes in predicted noise levels typically less than 1 dB. This order of magnitude is not consequential to the assessment outcome, as the margins of compliance with NZS 6808:2010 are least 2.9-4.3 dB at all receivers, depending on the candidate turbine model.

6.4.3 High amenity considerations

Recognising that the high amenity provision and the 35 dB base limit may warrant consideration for the receivers in the Rural Living Zone, Table 13 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 13: Rural Living Zone - predicted noise levels at 6 m/s, dB L_{A90}

Receiver Location	V162-5.6MW	GE 5.5-158	SG 6.0-170
605	27.1	26.6	26.6
4155	27.1	26.6	27.8

The results presented above demonstrate that, irrespective of whether a high amenity noise limit may be justified, the predicted noise levels for the wind speed range where high amenity provision may warrant consideration are below 35 dB at all receivers for all candidate turbine models by at least 7.9 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.

6.5 Cumulative assessment

To our knowledge, the nearest approved and/or operating wind farm is the Toora Wind Farm (approximately 30 km to the south).

Due to the significant separating distance, cumulative assessment of noise levels from the Delburn Wind Farm and other surrounding wind farm(s) is not warranted.

7.0 RELATED INFRASTRUCTURE NOISE ASSESSMENT

This section presents an assessment of the proposed battery energy storage system (BESS) and terminal station (referred to herein as related infrastructure) to be installed to the north of the site.

It is our understanding that the terminal station is subject to a separate planning permit application. However, as Victorian policy requirements apply to the total commercial and industry noise, the assessment of the BESS includes the contribution of the terminal station.

7.1 NIRV Recommended Maximum Noise Levels

The procedure for determining the recommended maximum noise levels (recommended levels) according to NIRV depends on whether the noise source or the receivers are located in a rural or major urban area.

According to the maps of the urban centres available on the EPA website, neither the subject site nor the nearby residential receivers fall within any of these areas. The recommended levels in this instance are therefore determined on the basis of the procedures defined for rural areas.

The procedures for rural areas are based on determining the zone levels according to the land zoning of the area in which the noise source and receivers are located. These zone levels are then adjusted, were appropriate, for a range of factors.

The zone levels are determined on the basis of the related infrastructure being located on land designated as Special Use Zone (SUZ1) and surrounding residential receivers being located on land designated as Farming Zone (FZ) (see land zoning map in Appendix G).

Considering that the land zoning is not continuous between the related infrastructure and the receivers, a distance adjustment is applicable. Considering that the application of a distant adjustment would result in different noise limits at the two nearest receivers (674 and 676), both are considered below:

- Receiver 674: A distance adjustment of -12 dB is applicable based on a distance of approximately 1,200 m between the receiver and the boundary of the Special Use Zone where the related infrastructure is located
- Receiver 676: A distance adjustment of -4 dB is applicable based on a distance of approximately 400 m between the receiver and the boundary of the Special Use Zone where the related infrastructure is located.

As the distance adjusted levels at receiver 674 are lower than the NIRV base noise levels, the latter apply at this receiver.

Adjustments for ‘background relevant areas’ are not warranted in this instance, as the background noise levels during the relevant assessment conditions for the related infrastructure (i.e. low wind speeds) are relatively low; adjustments for background noise levels are therefore not warranted in this instance.

Based on the above, the recommended levels, applicable at the two nearest receivers, are summarised in Table 14.

Table 14: NIRV time periods and recommended levels, L_{eff}[8] dB

Period	Day of week	Start time	End time	Zone levels	Recommended levels	
					Receiver 674	Receiver 676
Day	Monday-Friday	0700hrs	1800hrs	50	45	46
	Saturday	0700hrs	1300hrs			
Evening	Monday-Friday	1800hrs	2200hrs	45	37	41
	Saturday	1300hrs	2200hrs			
	Sunday, Public holidays	0700hrs	2200hrs			
Night	Monday-Sunday	2200hrs	0700hrs	40	32	36

As the related infrastructure is proposed to operate 24 hours a day and 7 days a week, compliance with the NIRV recommended levels applicable for night period would allow compliance during all other time periods.

7.2 Related infrastructure noise emissions

The battery energy storage system is proposed to have a capacity of 50 MW / 200 MWh.

Equipment details are not known at this stage however total equipment noise levels from other similar projects indicate sound power levels in the range of 95-100 dB L_{WA}.

The transformers and any associated cooling equipment will be the main sources of noise located within the terminal station.

At this stage in the project, specific details of the transformer make and model are yet to be determined. However, to provide a basis for assessing the feasibility of the proposed terminal station, the proponent advised that a single transformer rated to 240 MVA is proposed.

In lieu of measured sound power level data for a specific transformer selection, reference has been made to Australian Standard AS 60076-10:2009 *Power transformers – Part 10: Determination of sound levels* (AS 60076-10:2009) which provides a method for estimating transformer sound power levels. Specifically, Figure ZA1 from AS 60076-10:2009 has been used to determine an estimated standard maximum sound power level of 99 dB L_{WA}.

The sound power levels include the noise from ancillary plant such as cooling plant.

AS 60076-10:2009 does not provide estimated sound frequency spectra for transformer noise emissions. However, the noise emissions of transformers and ancillary plant typically exhibit tonal characteristics which must be accounted for in the noise assessment. This is addressed in subsequent sections of the report.

8 L_{eff} is the effective noise level of commercial or industrial noise determined in accordance with SEPP N-1. This is L_{Aeq} noise level over a half-hour period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.

7.3 Predicted noise levels

Predicted noise levels have been determined on the basis of:

- the indicative equipment noise emission data detailed in Section 7.2; and
- the ISO 9613-2 noise prediction method described in Section 4.3.

An adjustment of +2 dB has then been applied to the predicted noise levels to account for the potential tonal characteristics of transformer noise. The relevance and magnitude of the adjustment in practice is dependent on several variables. This is discussed below.

Predicted effective noise levels (including the +2 dB adjustment) at the two nearest receivers, located approximately 1.5-1.8 km to the northwest are detailed in Table 15.

Table 15: Related infrastructure predicted noise levels, dB

Item	Receiver 674	Receiver 676
BESS, L_{Aeq}	14-19	16-21
Terminal station, L_{Aeq}	21	21
Tonality adjustment	+2	+2
Total, L_{eff}	**22-26**	**24-26**

The predicted effective noise levels in Table 15 are below the day, evening and night recommended levels for the site by a significant margin. The following contextual notes are provided:

- The predicted effective noise levels are at least 10 dB below the minimum recommended levels for the night period
- The predicted effective noise levels are very low and would be comparable to or less than background noise levels in many instances. The adjustment for tonality may therefore not be applicable if the noise of the transformer is not clearly audible. Conversely, in the unlikely event that the character of the noise warranted a larger adjustment of +5 dB (the maximum potential adjustment, which would only be triggered in the event that the selected transformers were atypically tonal and the noise was observed during very low background noise levels), the predicted margin of compliance would still be at least 7 dB.

These results indicate that noise levels from the proposed related infrastructure associated with the Delburn Wind Farm are unlikely to be a significant design consideration. However, noise levels should be reviewed at the time when equipment numbers and selections are finalised, accounting for manufacturer noise emission data.

8.0 CONTRUCTION NOISE ASSESSMENT

8.1 Overview

Construction of a wind farm project will generate noise and vibration as a result of activities occurring both on and off the site of the proposed development.

Off-site noise generating activities primarily relate to heavy goods vehicle movements to and from the site. On-site works include a range of activities such as construction of access tracks, connection infrastructure, turbine foundations and erection of the turbines.

Construction of a wind farm mostly occurs at relatively large separating distances from receivers and, as proposed for the Delburn Wind Farm, the majority of the work is limited to normal working hours. The only exceptions are for unavoidable works or low-noise managed-works. Unavoidable works outside of normal hours are expected to comprise the delivery of oversized turbine components at times selected to minimise traffic disruption associated with intersection closures, and potentially turbine installation activities that are sensitive to weather conditions (e.g. installation of rotors). For these reasons, and consistent with the Victorian Noise Control Guidelines, noise associated with construction of a wind farm can usually be satisfactorily addressed by the adoption of general management measures and considerate working practices. These measures are normally documented and agreed in a Construction Environmental Management Plan (CEMP) which is typically prepared for review and approval by the responsible authority prior to commencing the work.

This section therefore provides general information about the types of activities that are expected to be associated with construction of the wind farm, and reference data which should be considered as part of the preparation of a construction management plan for the project.

8.2 Construction activities

Construction of a wind farm project typically involves the following key stages:

- Site enabling works including construction compounds and access tracks
- Cable trenching
- Turbine foundation construction
- Turbine erection and assembly
- Commissioning to configure and verify correct functioning of the turbines and the related infrastructure of the wind farm.

Specific details of the construction program and the number, type and duty of construction plant to be used would be determined during the advanced stages of a wind farm project when a construction contractor has been selected.

8.3 Typical construction plant & noise emissions

The types of equipment involved at different stages of construction include excavation plant, pneumatic equipment and lifting equipment. A detailed schedule of noise emissions for the major items of typical construction equipment is provided in Appendix K on the basis of reference data from relevant Australian and international standards. As an indication, typical construction plant sound power levels range from approximately 100 to 120 dB L_{WA} per equipment item. This data is also grouped in Appendix K to provide an indication of the total aggregated noise emissions of key working stages of the project. This data indicates the aggregated noise emissions for key working stages typically ranges from 115 to 120 dB L_{WA}.

The construction activity that would typically occur nearest to receivers is access road construction. This activity involves a brief period of elevated noise while work is carried out to improve existing roads (where required), create new intersections at site access points, and initiate site access tracks. During these initial works, construction noise levels of the order of 70 to 75 dB L_{Aeq} could be expected for brief periods when road and access work is carried out at distances within 100 m from a receiver. We understand that, during minor public road upgrade works, only three (3) receivers along Golden Gully Road would be located less than 500 m from this type of construction activities. These noise levels are comparable to, and typical of, noise levels produced by general road maintenance works and activity.

Once the initial work for access road construction is complete, the majority of the work occurs in proximity to the turbine locations, related infrastructure locations and on-site cabling routes. These works therefore typically occur at much larger separating distances. As a result, construction noise levels are then significantly lower. For example, at distances comparable to 1,000 m, construction noise levels of the order of 50 to 55 dB L_{Aeq} would be expected for receivers located downwind of the work.

However, depending on background noise levels and wind directions, construction noise associated with more distant works would be still be audible at surrounding receivers at times. In particular, given the low background noise levels that occur in rural environments at low wind speeds (as demonstrated by the background noise monitoring), construction noise could be significantly higher than background noise levels on some occasions.

It is for this reason that the majority of works would need to be restricted to normal working hours (see Table 1 of Section 3.4), as is proposed for the Delburn Wind Farm. Any general construction work that occurred outside of these hours would need to adhere to limits determined on the basis of background noise levels. For example, if general works needed to occur on Saturday afternoons (a period considered outside of normal working hours according to Victorian guidance contained in EPA Publication 1254), construction works would need to achieve a level not more than 5 to 10 dB above the background, depending on the actual duration of the construction program. This means that any work outside of normal hours would need to be limited to low noise activities and/or works at significantly increased distances from receivers. Exemptions would apply for works that are classified as unavoidable, such as timing oversized deliveries to avoid hazardous traffic conditions, or some aspects of turbine assembly which must occur in still wind conditions for safety reasons.

In preparing the CEMP, it would also be prudent to consider the use of lower noise emission construction equipment, primarily for activities that generate the highest noise levels, and particularly for any plant that may be used outside of normal working hours. The CEMP should also address considerate working practices for maintenance activities, timing of the noisiest works during the least sensitive periods of normal working hours wherever possible, and community notification and communication protocols.

General experience of wind farm development has indicated that construction noise tends to represent a limited risk factor. With the above types of measures implemented, it is expected that construction noise associated with the Delburn Wind Farm can be acceptably managed.

9.0 RECOMMENDED OPERATIONAL NOISE MANAGEMENT MEASURES

In order to ensure that operational noise from the wind farm is appropriately managed during subsequent stages of the development, a consent for the wind farm should include conditions that specify noise control requirements which address:

- Operational wind turbine noise
- Operational noise of related infrastructure.

An important element of these conditions would be to establish checks at different stages in the project.

Specifically, in relation to operational wind turbine noise, the following types of checks should ideally be established:

- An updated assessment of the wind farm's compliance with NZS 6808:2010 should be carried out for the final turbine layout and turbine selection for the project. This assessment should be undertaken prior to commencement of development of the wind farm and should include information based on test data for the selected turbine
- A noise management plan should be prepared which identifies how compliance with the wind farm's operational noise limits will be demonstrated, including details of testing procedures and reporting time frames following commencing of operation of the wind farm.

In addition to the above, it is also recommended that consideration is given to conducting indicative on-site noise emission testing for a sample of the first turbines to start generating power at the site. Due to the proposed wind farm being located amidst an operating plantation, it may not be practical to perform a formal sound power level test in accordance with IEC 61400-11. However, indicative testing would still provide an opportunity to review at an early stage whether the turbine's noise emissions are consistent with expectations (based on the information used for the updated noise assessment), particularly with respect to the frequency characteristics of the turbines. This could involve an assessment of tonality based on IEC 61400-11, or other methods of assessment such as ISO PAS 20065:2016[9].

To address the operational noise of related infrastructure, the updated noise assessment prepared prior to development of the wind farm should also include an assessment for the proposed equipment to demonstrate compliance with the recommended noise levels in accordance with NIRV.

---

9 ISO PAS 20065:2016 *Acoustics - Objective method for assessing the audibility of tones in noise - Engineering method*

10.0 SUMMARY

An assessment of operational noise for the proposed Delburn Wind Farm has been carried out. The assessment is based on the proposed wind farm layout comprising thirty-three (33) multi-megawatt turbines and related infrastructure.

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 three candidate turbine models which have been selected as being representative of the size and type of turbines which could be used at the site.

The results of the modelling demonstrate that the proposed Delburn Wind Farm turbines are predicted to achieve compliance with the applicable noise limits determined in accordance with NZS 6808:2010.

The assessment has also considered operational noise associated with the proposed related infrastructure comprising a battery energy storage system and terminal station. These noise levels have been assessed in accordance with Victorian EPA Publication 1411 *Noise from Industry in Regional Victoria* dated 2011 (NIRV). The assessment demonstrates that the related infrastructure is expected to result in noise levels significantly lower than the recommended levels determined in accordance with NIRV.

The report provides information about construction noise associated with the project, including relevant Victorian Wind Energy Guidelines and the nature of the proposed works. This information has been provided as a reference for the matters that should be considered as part of the preparation of a Construction Environmental Management Plan for the project.

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

APPENDIX A GLOSSARY OF TERMINOLOGY

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

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

APPENDIX B 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 in Appendix A.

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 16 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 16: Atmospheric pressure versus sound pressure – example values of pressure

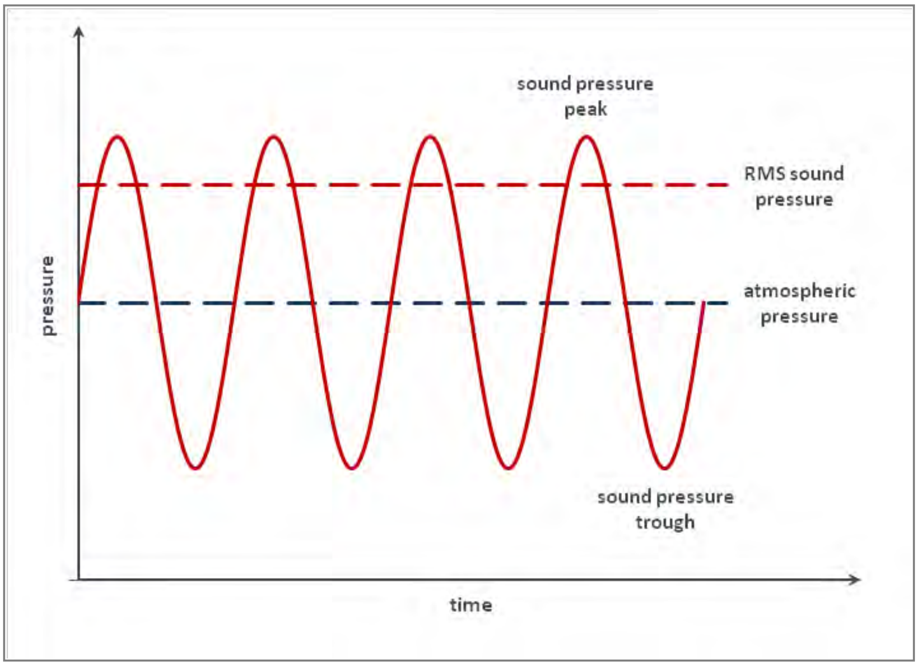
Example	Pascals (Pa)	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002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

The pressure values in Table 16 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 4 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 4: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

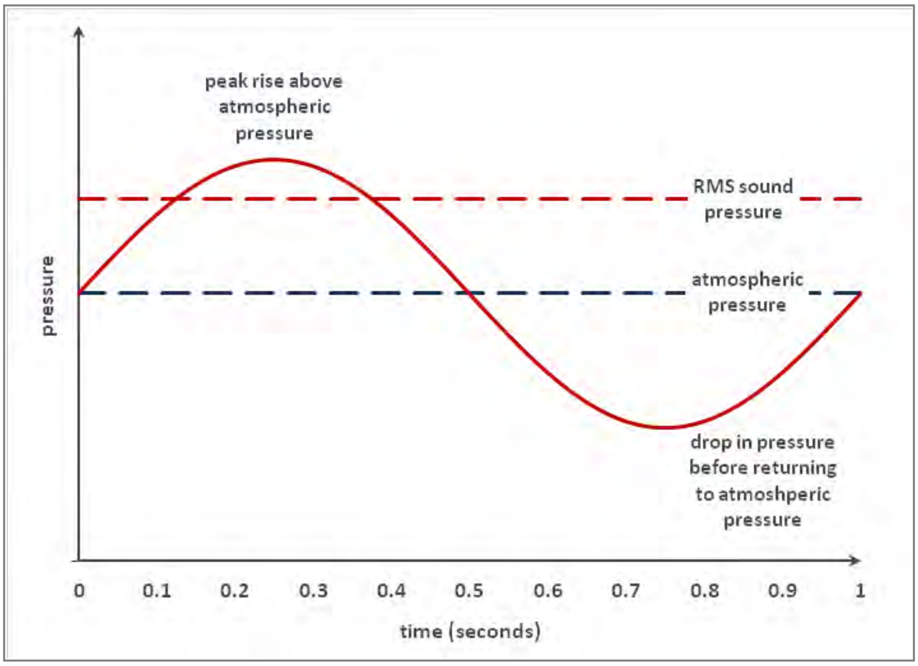
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period. The rate of change in pressure is an important feature that determines whether it can be perceived as a sound by the human ear.

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 5 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 5: 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 6 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.

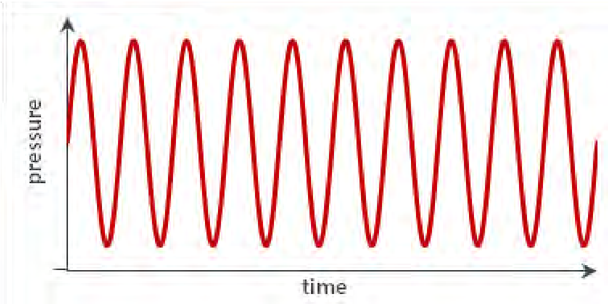
Figure 6: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

Low frequency sounds:

20 to 200 Hz

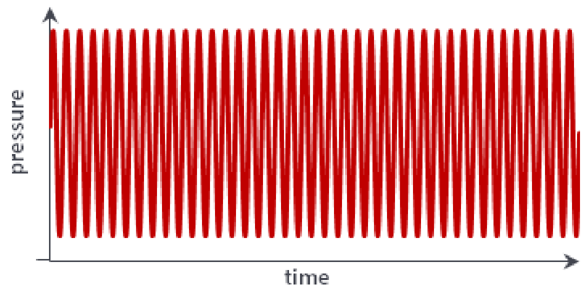
Mid-frequency sounds:

200 to 800 Hz



High frequency sounds:

greater than 800 Hz



B2.3 Sound pressure and frequency variations

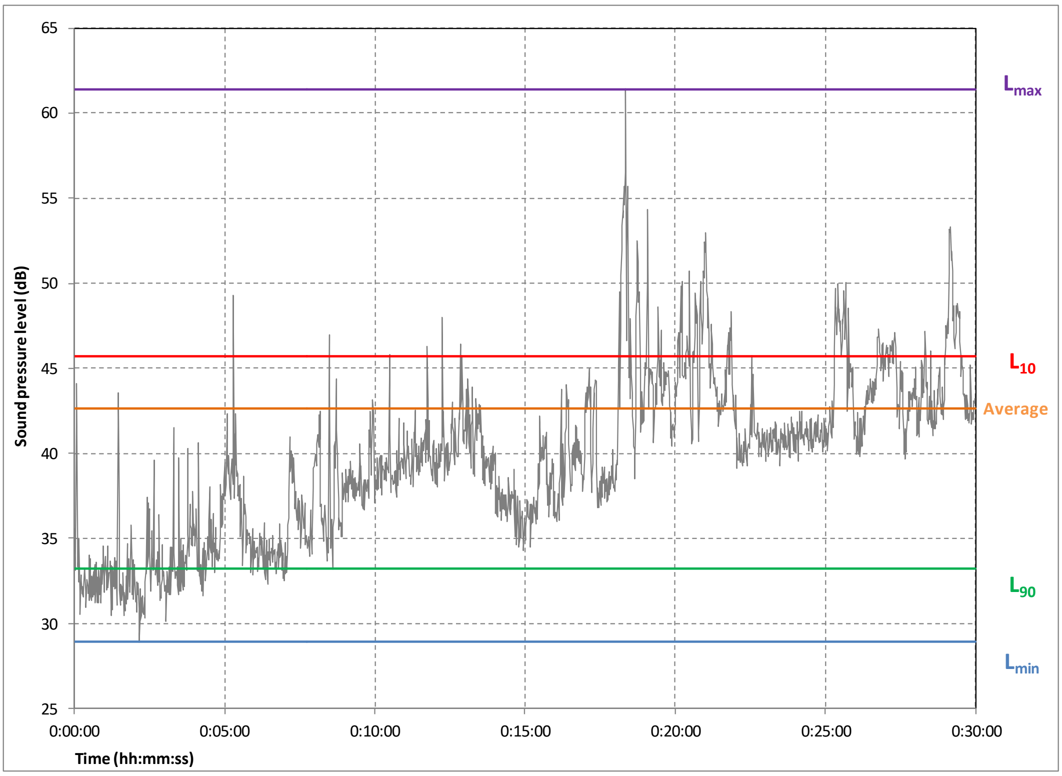
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

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 7 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 7: 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 17 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 17: 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 18 provides some examples of how changes in sound pressure levels, for a sound with the same character, can be perceived.

Table 18: 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 18 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.

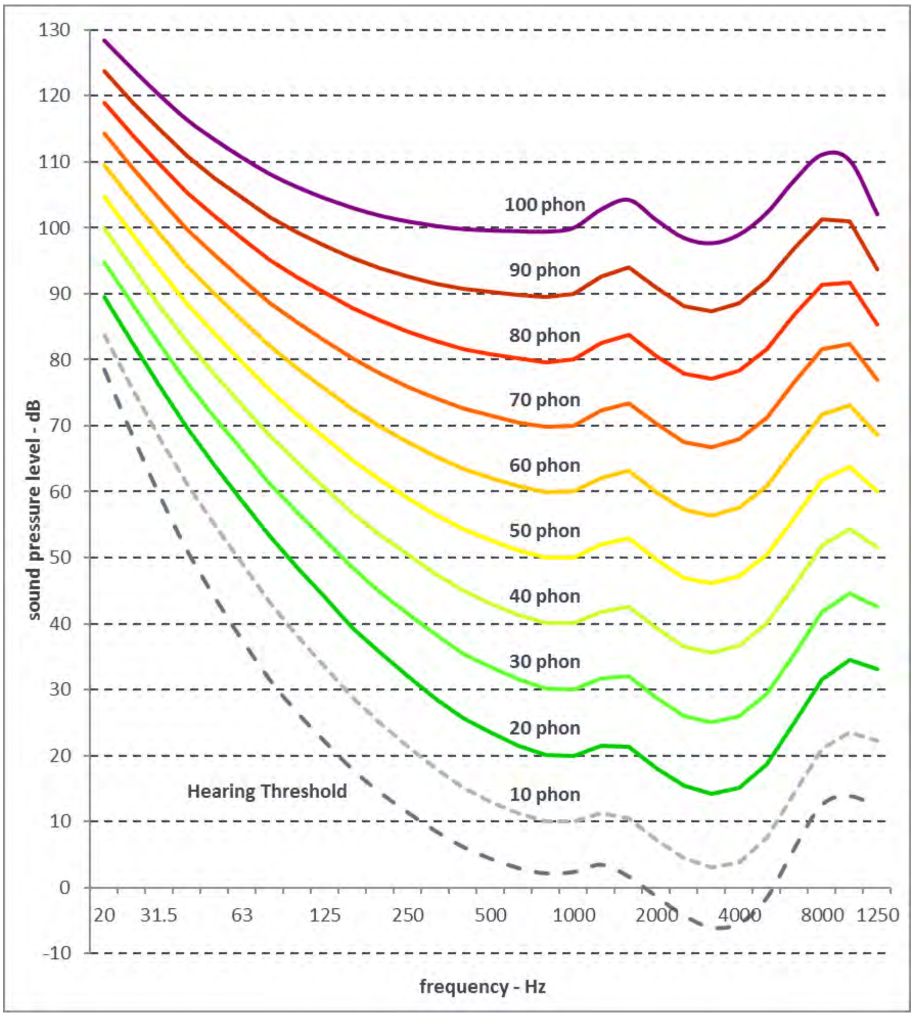
B3.2 Sound frequency and loudness

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 8. 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 standard10 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 8 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.

[10] ISO 226:2003 *Acoustics - Normal equal-loudness-level contours*, 2003

Figure 8: Equal loudness contours for pure tone sounds



The noise curves in Figure 8 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 3.4 supplied by the proponent on 5 May 2020).

Table 19: Turbine coordinates – MGA 94 zone 55

Turbine	Easting, m	Northing, m	Terrain elevation, m
T01	436,525	5,765,561	206
T02	435,750	5,765,156	237
T03	435,296	5,764,592	272
T04	437,495	5,764,699	300
T05	436,473	5,764,438	299
T06	435,544	5,763,978	227
T07	435,470	5,762,948	212
T08	436,508	5,761,045	178
T09	437,789	5,761,008	215
T10	433,800	5,760,517	231
T11	437,282	5,760,457	250
T12	434,760	5,760,476	241
T13	436,493	5,760,073	202
T14	434,216	5,759,907	190
T15	435,787	5,759,639	176
T16	437,408	5,759,641	177
T17	436,532	5,759,218	204
T18	435,389	5,759,043	179
T19	437,040	5,758,715	189
T20	435,954	5,758,492	259
T21	434,976	5,758,338	222
T22	434,051	5,758,153	210
T23	437,056	5,758,069	220
T24	436,134	5,757,873	243
T25	434,704	5,757,718	200
T26	435,544	5,757,416	203
T27	436,935	5,757,281	257
T28	434,750	5,757,067	258
T29	434,253	5,756,519	175
T30	435,616	5,756,655	242
T31	435,767	5,755,772	216
T32	433,871	5,755,768	188
T33	433,005	5,755,169	184

APPENDIX D RECEIVER LOCATIONS

The following table sets out the three hundred and twenty-eight (328) assessed receivers located within 3 km of the proposed turbines considered in the environmental noise assessment together with their respective distance to the nearest turbine. This includes three (3) receivers identified by the proponent as *Future Dwellings*.

(Data supplied by the proponent on 2 March 2020).

Table 20: Receivers within 3 km of the proposed turbines – MGA 94 zone 55

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
92	429,980	5,752,416	162	2,948	T33
93	429,940	5,752,608	158	2,907	T33
94	430,195	5,752,601	159	2,675	T33
95	429,915	5,752,846	194	2,849	T33
217	433,587	5,750,982	180	2,889	T33
218	433,873	5,751,187	148	2,811	T33
226	433,139	5,750,897	164	2,856	T33
229	433,662	5,751,434	164	2,498	T33
232	433,356	5,751,037	149	2,768	T33
237	433,670	5,751,227	169	2,691	T33
524	435,096	5,752,065	200	2,859	T32
525	435,303	5,752,100	213	2,969	T32
526	434,972	5,752,113	212	2,744	T32
527	435,113	5,752,162	209	2,796	T32
528	435,256	5,752,188	216	2,873	T32
529	435,365	5,752,267	220	2,894	T32
530	435,406	5,752,180	221	2,984	T32
532	434,931	5,751,856	176	2,926	T32
533	435,510	5,752,342	225	2,951	T32
534	435,347	5,752,376	212	2,807	T32
535	435,509	5,752,453	217	2,879	T32
536	435,280	5,752,502	194	2,673	T32
537	435,048	5,752,561	195	2,463	T32
540	434,849	5,752,093	214	2,686	T32
541	434,743	5,752,063	209	2,650	T32
542	435,412	5,752,697	194	2,654	T32
543	435,592	5,752,754	200	2,769	T32

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
544	435,411	5,752,564	201	2,734	T32
545	435,422	5,752,851	184	2,574	T32
546	435,440	5,752,912	182	2,557	T32
547	435,562	5,752,799	197	2,720	T32
548	435,652	5,752,906	194	2,741	T32
549	435,821	5,752,850	205	2,916	T32
550	435,602	5,752,968	186	2,667	T32
551	435,694	5,753,021	187	2,723	T32
552	435,944	5,752,919	201	2,959	T29
564	436,544	5,752,984	112	2,981	T29
565	436,605	5,753,021	110	2,961	T29
566	436,666	5,753,125	102	2,878	T29
567	436,753	5,753,200	94	2,834	T29
568	436,598	5,753,345	138	2,648	T29
569	436,788	5,753,570	92	2,502	T29
570	436,445	5,753,759	117	2,209	T29
571	436,362	5,753,695	124	2,249	T29
572	436,306	5,753,608	135	2,320	T29
573	436,235	5,753,561	138	2,353	T29
574	436,231	5,753,449	150	2,462	T29
575	436,293	5,753,261	176	2,658	T29
576	436,204	5,753,213	181	2,691	T29
577	436,273	5,753,152	181	2,761	T29
578	436,114	5,753,140	184	2,752	T29
579	436,013	5,753,215	163	2,668	T29
580	436,342	5,752,992	139	2,931	T29
582	435,986	5,753,109	182	2,772	T29
583	435,821	5,753,081	188	2,795	T29
584	435,742	5,753,170	182	2,702	T32
585	435,534	5,753,086	179	2,552	T32
586	435,473	5,752,970	182	2,555	T32
587	435,454	5,753,165	175	2,445	T32
588	435,536	5,753,295	170	2,464	T32

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
589	435,362	5,753,223	171	2,337	T32
590	435,258	5,753,292	170	2,213	T32
591	435,286	5,753,344	170	2,216	T32
592	435,448	5,753,357	169	2,359	T32
593	435,236	5,753,483	165	2,116	T32
594	435,045	5,753,483	163	1,940	T32
595	434,976	5,753,567	167	1,844	T32
596	434,964	5,753,681	169	1,793	T32
597	434,919	5,753,728	167	1,735	T32
598	434,794	5,753,883	182	1,573	T32
599	434,750	5,753,966	186	1,512	T32
600	434,804	5,754,112	190	1,544	T32
601	434,785	5,754,230	183	1,518	T32
602	434,622	5,754,382	175	1,360	T32
603	434,840	5,754,533	185	1,578	T30
604*	435,047	5,754,571	177	1,520	T29
605	434,880	5,754,687	191	1,487	T30
606	434,527	5,754,713	189	1,252	T30
607	437,731	5,762,743	125	1,743	T16
608	437,065	5,762,882	147	1,512	T07
609	436,804	5,763,127	144	1,270	T07
610	436,971	5,763,172	123	1,358	T02
611	437,773	5,763,466	88	1,490	T01
612	438,435	5,763,368	119	1,915	T01
613	438,360	5,763,467	111	1,791	T01
614	439,182	5,762,964	107	2,407	T16
615	439,301	5,763,035	108	2,534	T16
616	439,375	5,763,039	107	2,582	T16
617	439,776	5,762,574	95	2,535	T16
620	440,018	5,765,134	85	2,815	T01
662	437,610	5,768,333	310	2,981	T03
663	437,571	5,768,277	302	2,915	T03
664	437,693	5,768,204	285	2,894	T03

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
665	437,816	5,768,174	279	2,919	T03
666	437,650	5,768,133	292	2,812	T03
667	437,763	5,768,095	290	2,825	T03
668	437,903	5,768,118	286	2,909	T03
669	437,982	5,768,098	291	2,930	T03
670	437,879	5,768,042	295	2,831	T03
671	437,980	5,767,970	309	2,819	T03
672	438,044	5,767,966	313	2,849	T03
673	438,158	5,768,007	300	2,945	T03
732	440,399	5,759,655	81	2,944	T16
733	440,023	5,759,855	112	2,519	T16
734	439,680	5,758,435	133	2,624	T14
735	439,594	5,758,265	146	2,563	T18
736	439,741	5,758,128	120	2,707	T18
737	439,871	5,758,277	101	2,840	T18
738	439,935	5,758,350	95	2,889	T14
739	440,005	5,758,494	94	2,890	T14
742	439,880	5,756,794	75	2,989	T19
743	439,658	5,756,632	75	2,804	T19
744	439,443	5,756,699	77	2,580	T19
745	439,210	5,756,237	79	2,508	T19
746	439,076	5,755,879	80	2,564	T19
747	438,842	5,755,602	80	2,546	T19
748	438,894	5,755,293	80	2,796	T19
755	439,914	5,761,683	90	2,235	T16
756	439,812	5,761,503	97	2,089	T16
757	440,054	5,761,534	86	2,331	T16
758	440,035	5,761,376	89	2,281	T16
759	440,155	5,761,408	84	2,405	T16
760	440,134	5,761,351	84	2,375	T16
761	440,325	5,761,360	77	2,565	T16
762	440,383	5,761,416	76	2,631	T16
763	440,299	5,761,147	75	2,519	T16

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
764	431,206	5,752,889	145	1,646	T33
765	431,155	5,752,966	143	1,654	T33
766	431,253	5,752,942	136	1,579	T33
767	431,631	5,752,912	176	1,282	T33
779	435,420	5,754,434	164	1,499	T29
781	435,275	5,754,170	178	1,793	T29
782	435,327	5,754,066	166	1,877	T29
783	435,038	5,754,352	178	1,715	T29
784	435,381	5,753,966	158	1,961	T29
785	435,446	5,753,823	157	2,088	T29
786	435,536	5,753,753	160	2,143	T29
787	435,608	5,753,688	165	2,199	T29
788	435,642	5,753,593	166	2,290	T29
789	435,753	5,753,541	168	2,336	T29
790	435,761	5,753,407	173	2,470	T29
791	435,825	5,753,422	170	2,454	T29
792	436,070	5,753,360	148	2,529	T29
793	436,422	5,753,086	147	2,854	T29
794	436,449	5,753,179	165	2,770	T29
795	432,088	5,752,531	135	1,300	T33
796	431,377	5,752,829	133	1,534	T33
797	431,240	5,753,249	186	1,469	T33
798	430,905	5,752,949	175	1,887	T33
799	430,954	5,752,971	173	1,834	T33
800	430,887	5,752,960	175	1,899	T33
801	430,841	5,752,958	173	1,942	T33
802	430,780	5,752,965	166	1,996	T33
803	430,741	5,752,950	164	2,038	T33
804	430,724	5,752,940	164	2,057	T33
805	430,689	5,752,933	163	2,092	T33
806	430,653	5,752,935	162	2,125	T33
807	430,781	5,753,148	160	1,935	T33
808	430,833	5,753,178	161	1,877	T33

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
809	431,198	5,753,578	204	1,444	T33
810	430,967	5,753,475	171	1,684	T33
811	431,033	5,753,784	226	1,605	T33
817	430,885	5,756,084	242	2,314	T31
818	431,040	5,756,040	250	2,155	T31
819	431,437	5,756,481	226	2,051	T31
820	432,065	5,756,604	242	1,723	T31
821	432,356	5,756,964	231	1,915	T31
822	432,644	5,756,859	209	1,650	T30
823	432,949	5,756,845	210	1,391	T28
824	432,879	5,757,192	233	1,446	T21
825	432,295	5,758,380	244	2,102	T21
826	432,624	5,758,517	236	1,843	T22
827	432,809	5,758,713	251	1,682	T22
828 (S)	432,992	5,758,778	257	1,518	T22
829 (S)	432,961	5,758,727	261	1,537	T22
830	432,914	5,758,908	253	1,627	T22
832	433,210	5,759,227	245	1,273	T25
833	432,153	5,760,084	306	1,710	T24
834	432,137	5,760,129	309	1,715	T24
835	432,570	5,761,502	284	1,584	T24
836	431,746	5,761,709	262	2,380	T24
837	432,000	5,760,571	324	1,808	T24
838	432,403	5,759,989	305	1,502	T24
839	431,680	5,761,979	266	2,580	T24
840	431,419	5,761,989	264	2,804	T24
844	432,790	5,762,341	239	2,091	T24
845	433,018	5,762,282	224	1,937	T24
846	432,910	5,762,413	230	2,100	T24
847	434,201	5,762,260	216	1,517	T07
848	434,225	5,762,666	249	1,369	T07
849	433,926	5,762,624	280	1,669	T07
850	433,944	5,762,802	285	1,629	T07

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
851	433,706	5,762,713	291	1,873	T07
852	433,693	5,762,907	285	1,876	T07
853	434,817	5,761,632	168	1,168	T26
854	433,199	5,762,618	236	2,191	T24
855	433,332	5,763,312	264	2,271	T07
856	432,949	5,763,380	253	2,646	T05
857	433,664	5,763,526	264	1,956	T05
858	433,494	5,763,533	267	2,096	T05
859	433,389	5,763,705	269	2,109	T05
860	433,344	5,763,402	261	2,277	T07
861	433,050	5,763,770	262	2,397	T05
862	434,244	5,763,780	244	1,338	T05
863	434,421	5,763,736	244	1,234	T05
864	434,603	5,763,540	266	1,139	T06
865	433,551	5,764,647	263	1,753	T05
866	433,666	5,764,659	257	1,639	T05
867	433,773	5,764,939	260	1,570	T05
868	433,606	5,765,459	175	1,906	T05
869	433,696	5,765,524	185	1,858	T05
870	434,234	5,765,691	270	1,536	T05
871	434,644	5,765,749	279	1,337	T05
872	434,899	5,765,905	294	1,215	T04
873	434,969	5,765,965	297	1,203	T04
874	435,068	5,766,147	269	1,276	T04
875	435,402	5,766,095	293	1,065	T04
876	434,619	5,766,407	161	1,761	T04
877	435,121	5,766,897	172	1,908	T04
878	435,331	5,767,225	177	2,054	T03
879	435,148	5,767,196	149	2,143	T03
880	435,241	5,767,348	139	2,206	T03
881	435,282	5,767,406	137	2,230	T03
882	435,284	5,767,436	138	2,254	T03
883	435,385	5,767,392	154	2,163	T03

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
884	435,526	5,767,497	156	2,184	T03
885	435,525	5,767,653	136	2,324	T03
886	435,815	5,767,482	199	2,054	T03
887	436,050	5,767,683	194	2,180	T03
888	435,992	5,767,630	205	2,142	T03
889	436,295	5,767,601	203	2,059	T03
890	436,226	5,767,623	205	2,090	T03
891	436,282	5,767,396	239	1,858	T03
892	436,622	5,767,033	279	1,484	T03
893	437,116	5,766,885	322	1,459	T03
894	437,216	5,766,970	320	1,577	T03
895	437,303	5,768,352	290	2,902	T03
1158	439,606	5,757,981	139	2,577	T18
1159	439,553	5,757,928	144	2,528	T18
1160	439,438	5,757,975	155	2,410	T18
1161	439,552	5,758,058	150	2,519	T18
1162	439,406	5,757,876	154	2,387	T18
1163	439,222	5,757,838	154	2,209	T18
1165	439,139	5,757,772	153	2,138	T18
1166	439,064	5,757,739	155	2,070	T18
1167	438,970	5,757,683	153	1,990	T18
1168	438,855	5,757,662	155	1,884	T18
1169	438,770	5,757,667	154	1,801	T18
1170	438,326	5,757,585	163	1,410	T18
1171	438,146	5,757,568	157	1,255	T19
1172	438,865	5,756,937	102	1,967	T19
1173	438,886	5,756,777	91	2,021	T19
1174	438,487	5,756,562	142	1,718	T19
1175	438,094	5,755,471	80	2,155	T19
1176	437,875	5,755,641	101	1,897	T19
1177	438,034	5,755,277	78	2,291	T19
1178	438,121	5,755,037	80	2,454	T29
1179	438,158	5,754,974	80	2,511	T29

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
1180	438,071	5,754,600	82	2,592	T29
1182	437,642	5,753,971	82	2,639	T29
1235	432,650	5,763,922	260	2,734	T05
1255	432,412	5,764,882	160	2,903	T05
1256	432,424	5,765,120	164	2,924	T05
1257	432,460	5,765,051	160	2,877	T05
1258	432,401	5,765,045	160	2,935	T05
1259	432,518	5,764,976	161	2,809	T05
1260	432,867	5,764,944	200	2,459	T05
1261	432,783	5,764,822	208	2,528	T05
1262	432,468	5,765,411	205	2,948	T05
1263	432,764	5,765,415	168	2,667	T05
1264	432,690	5,765,298	160	2,705	T05
1265	432,778	5,765,280	159	2,615	T05
1266	433,034	5,765,710	186	2,528	T05
1267	433,061	5,765,526	172	2,427	T05
1268	433,034	5,765,574	176	2,471	T05
1269	433,897	5,766,449	130	2,330	T05
1270	433,571	5,766,396	142	2,501	T05
1271	433,788	5,766,680	168	2,561	T04
1272	433,318	5,766,325	175	2,635	T05
1273	433,396	5,766,244	170	2,523	T05
1274	433,221	5,766,239	185	2,654	T05
1275	433,170	5,766,371	198	2,777	T05
1276	433,238	5,766,417	193	2,755	T05
1278	433,474	5,766,878	223	2,928	T05
1280	433,967	5,766,766	176	2,478	T04
1281	433,894	5,767,087	231	2,751	T04
1293	434,425	5,767,130	193	2,445	T04
1294	434,758	5,767,475	143	2,581	T04
1295	435,121	5,767,584	108	2,468	T03
1296	435,227	5,767,853	121	2,639	T03
1297	435,526	5,767,774	129	2,433	T03

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
1298	436,093	5,767,490	238	1,983	T03
1299	438,077	5,768,080	296	2,963	T03
1300	438,132	5,767,953	309	2,886	T03
1398	436,689	5,753,236	100	2,780	T29
1415	440,197	5,760,895	86	2,416	T16
1416	440,076	5,761,114	84	2,295	T16
1417	440,020	5,761,132	85	2,240	T16
1418	439,685	5,761,036	98	1,903	T16
1450	431,998	5,752,488	134	1,377	T33
4064	435,912	5,753,227	161	2,650	T29
4066	437,526	5,753,811	83	2,681	T29
4154	436,901	5,754,152	105	2,038	T29
4155	434,866	5,754,880	191	1,343	T30
4183	430,962	5,759,583	360	2,992	T24
4342	436,196	5,768,209	169	2,673	T03
4343	435,642	5,768,286	130	2,869	T03
4354	437,589	5,768,162	300	2,815	T03
4377	432,636	5,765,071	166	2,707	T05
4378*	434,182	5,765,138	257	1,251	T05
4380	439,013	5,763,147	101	2,470	T16
4381	437,420	5,763,230	110	1,536	T02
4495	440,085	5,760,946	88	2,302	T16
4496	431,344	5,759,906	354	2,536	T24
4533	439,451	5,757,889	152	2,430	T18
4534	432,567	5,757,582	260	1,691	T21
4535	439,185	5,756,248	79	2,481	T19
4539	434,911	5,752,106	214	2,712	T32
4540	435,555	5,752,638	197	2,804	T32
4577	435,191	5,752,172	212	2,841	T32
4578	439,849	5,761,011	93	2,066	T16
4579*	439,592	5,758,192	147	2,558	T18
4581	435,041	5,754,672	177	1,438	T29
4582	436,550	5,753,085	132	2,885	T29

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
4583	435,513	5,752,551	204	2,822	T32
4585	435,309	5,753,658	160	2,127	T32
4587	437,902	5,762,810	134	1,812	T16
4589	435,219	5,754,482	162	1,521	T29

* Identified as future dwelling location on a title without an existing dwelling

Table 21: Additional receivers within 3 km of the proposed related infrastructure – MGA 94 zone 55

Receiver ID	Easting, m	Northing, m	Distance to the nearest item*, m	Nearest item
619	440,379	5,764,646	2,434	BESS
621	440,514	5,765,196	1,986	Terminal station
622	440,993	5,765,062	2,327	Terminal station
623	440,805	5,764,439	2,797	Terminal station
640	438,517	5,769,622	2,871	Terminal station
641	438,475	5,769,494	2,774	BESS
642	438,617	5,769,479	2,699	Terminal station
643	438,720	5,769,510	2,686	Terminal station
644	438,813	5,769,470	2,614	Terminal station
645	438,685	5,769,389	2,589	Terminal station
646	438,301	5,769,254	2,627	BESS
647	438,261	5,769,225	2,619	BESS
648	438,144	5,769,343	2,779	BESS
649	438,124	5,769,052	2,539	BESS
650	438,446	5,769,159	2,478	BESS
651	438,439	5,769,069	2,399	BESS
652	438,396	5,768,979	2,339	BESS
653	438,333	5,769,037	2,420	BESS
654	438,289	5,768,865	2,293	BESS
655	438,218	5,768,809	2,284	BESS
656	438,077	5,768,655	2,244	BESS
657	438,007	5,768,630	2,270	BESS
658	437,959	5,768,519	2,220	BESS
659	437,898	5,768,445	2,211	BESS
660	437,781	5,768,427	2,285	BESS
661	437,682	5,768,388	2,335	BESS

Receiver ID	Easting, m	Northing, m	Distance to the nearest item*, m	Nearest item
674	438,262	5,768,042	1,670	BESS
675	438,651	5,768,474	1,773	BESS
676	439,202	5,768,419	1,494	Terminal station
896	437,490	5,768,466	2,534	BESS
897	438,542	5,769,135	2,417	BESS
898	438,607	5,769,197	2,449	BESS
899	438,315	5,769,506	2,848	BESS
900	438,427	5,769,445	2,747	BESS
901	438,533	5,769,418	2,681	Terminal station
904	441,310	5,764,903	2,638	Terminal station
905	440,811	5,765,163	2,147	Terminal station
906	440,885	5,765,035	2,295	Terminal station
907	440,393	5,765,175	1,958	BESS
1386	437,866	5,769,051	2,686	BESS
1387	437,931	5,768,900	2,527	BESS
1388	438,054	5,769,012	2,544	BESS
1389	438,083	5,769,227	2,709	BESS
4341	438,108	5,769,434	2,876	BESS

* Based on the centre of the respective identified areas

APPENDIX E SITE LAYOUT PLAN

Figure 9: Proposed turbine layout and receivers

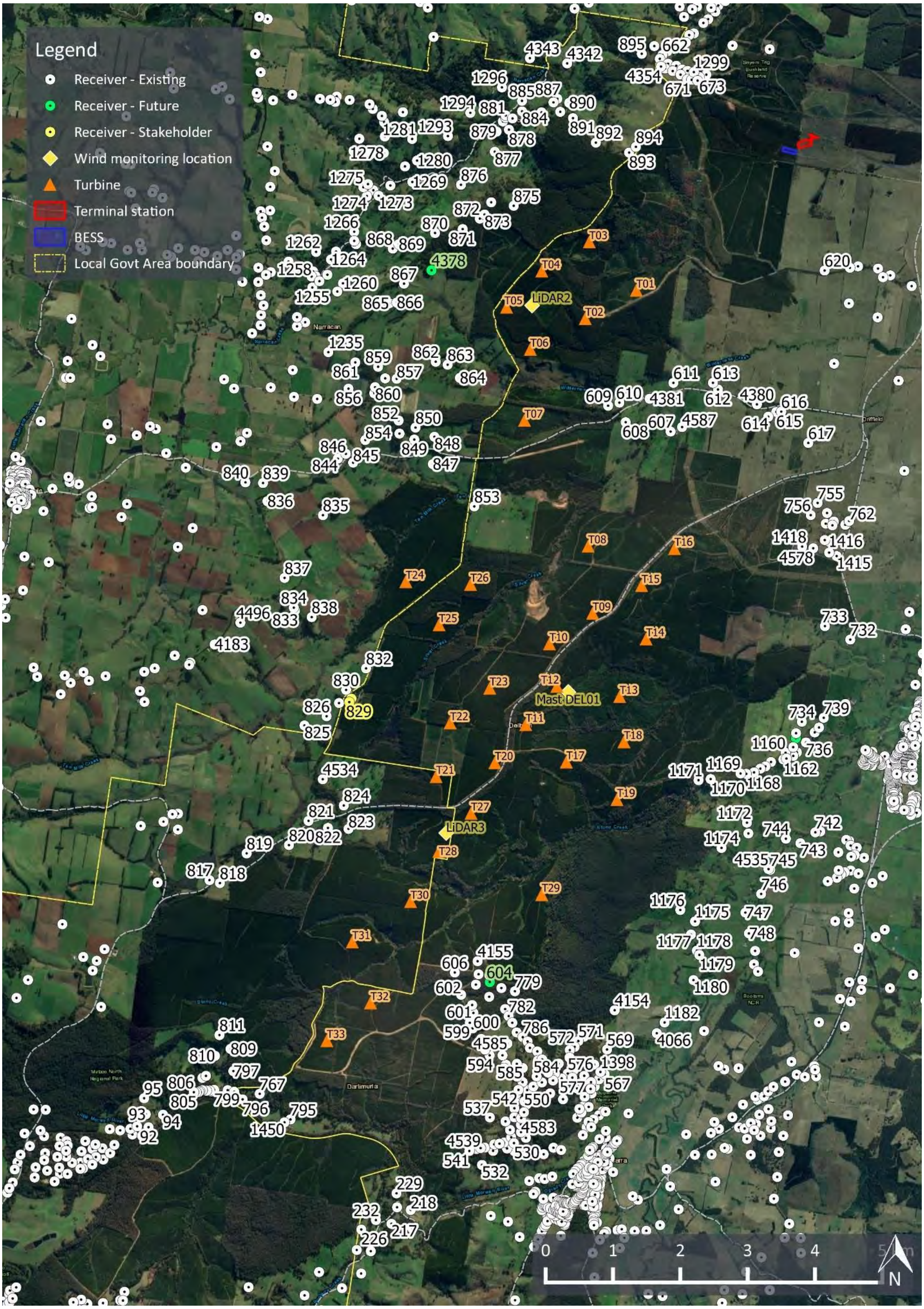
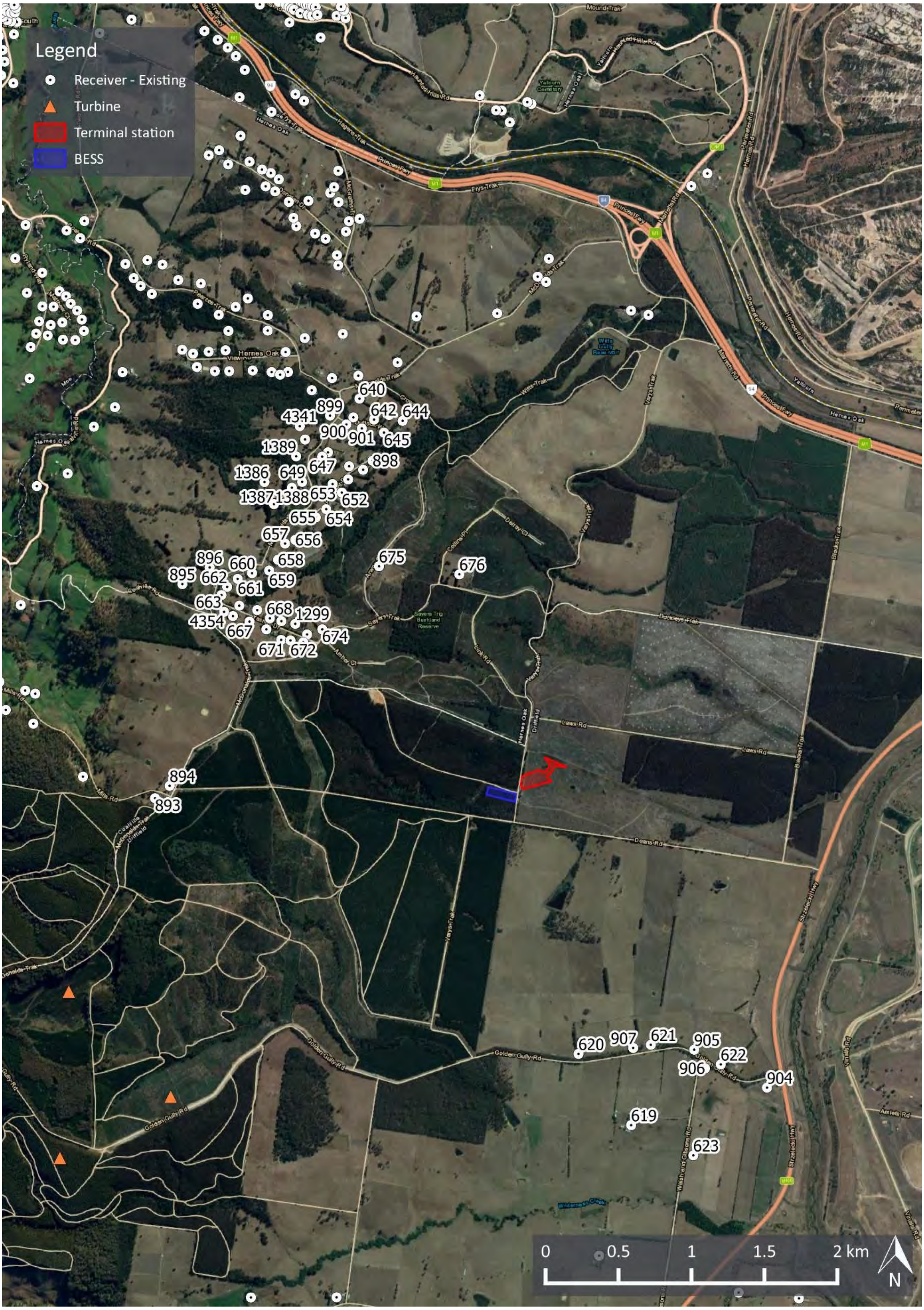
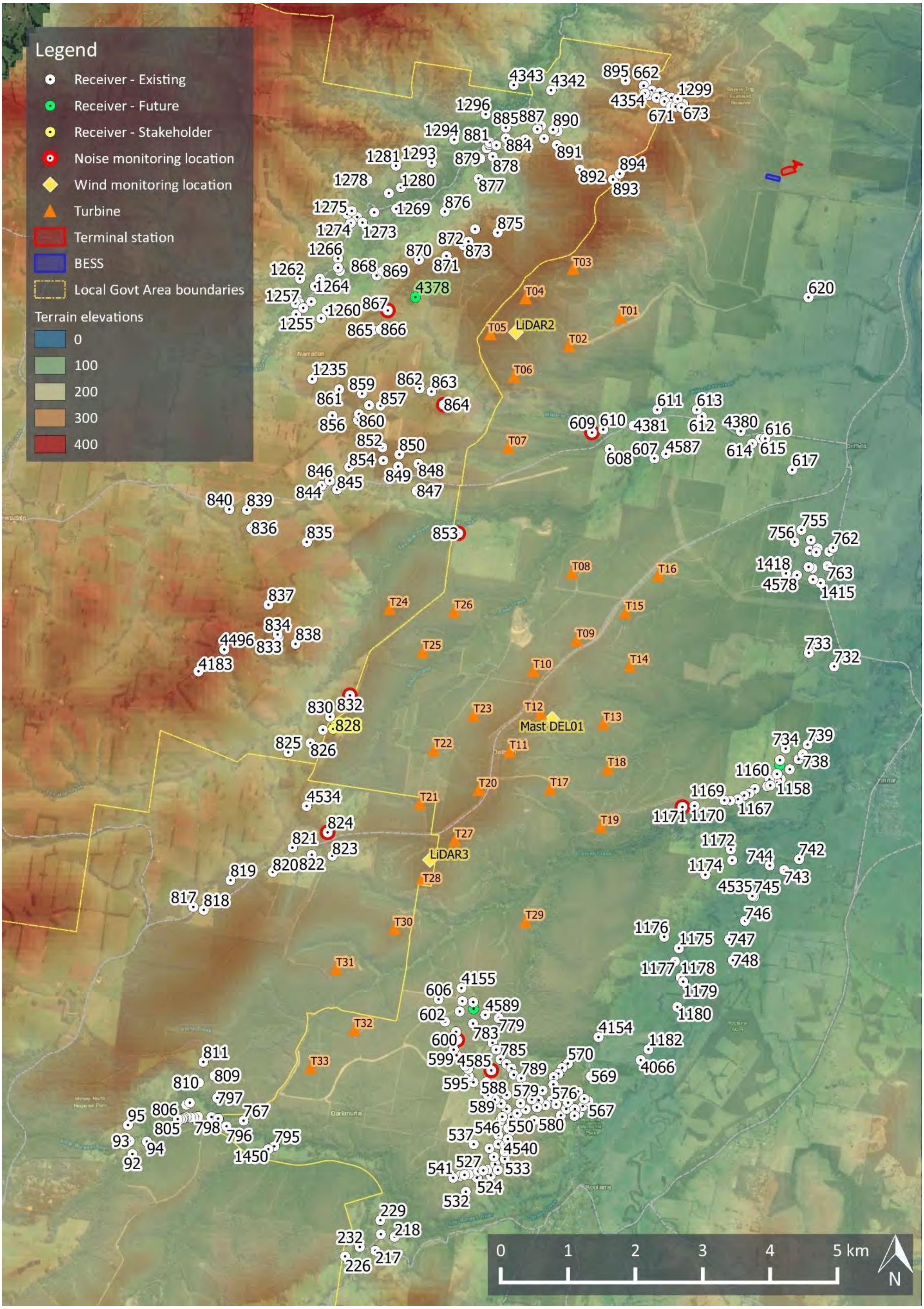


Figure 10: Proposed related infrastructure and receivers



APPENDIX F SITE TOPOGRAPHY

Figure 11: Terrain elevation map for the Delburn Wind Farm and surrounding area



APPENDIX G ZONING MAP

Figure 12: Zoning map for the Delburn Wind Farm and surrounding area

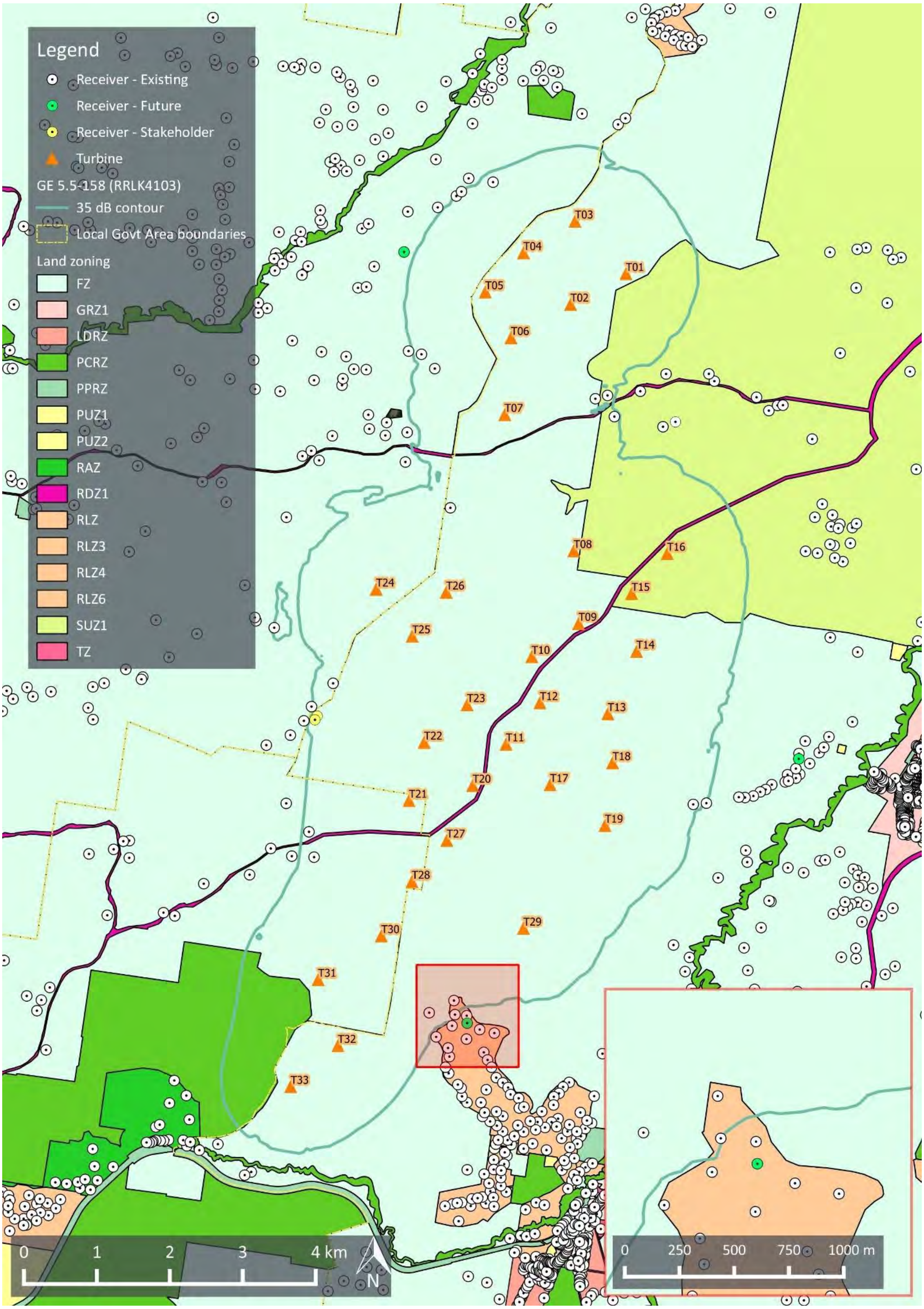
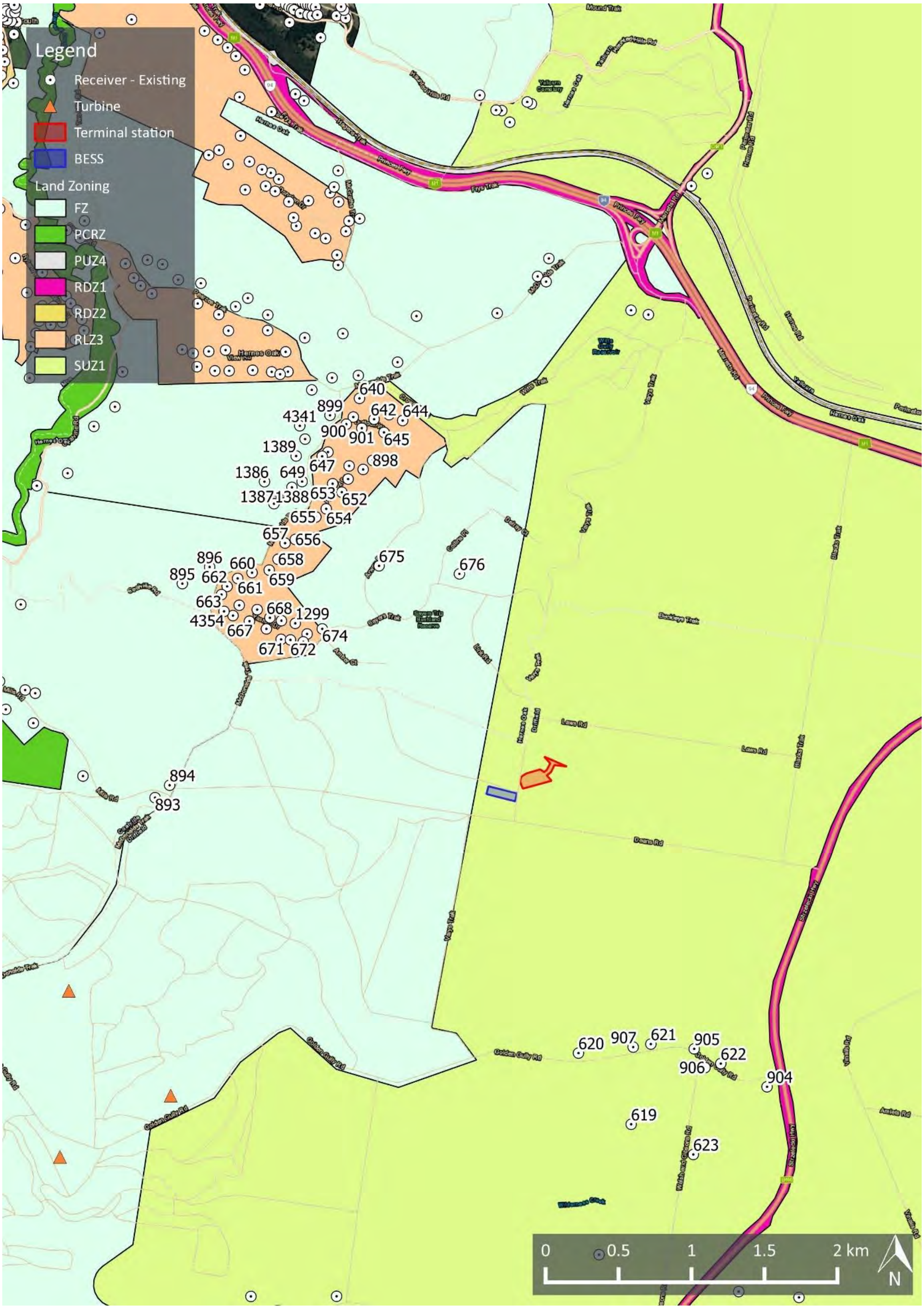


Figure 13: Zoning map for the related infrastructure associated with the Delburn Wind Farm and surrounding area



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 NZS 6808:2010 *Acoustics – Wind farm noise*, AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators* and the South Australian EPA 2009 wind farm noise guidelines.

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

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

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

The octave band attenuation factors are then applied to the noise emission data to determine the corresponding octave band and total calculated noise level at receivers.

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

Wind farm noise propagation has been the subject of considerable research in recent years. These studies have provided support for the reliability of engineering methods such as ISO 9613 when a certain set of input parameters are chosen in combination. Specifically, the studies to date tend to support that the assignment of a ground absorption factor of G = 0.5 for the source, middle and receiver ground regions between a wind farm and a calculation point tends to provide a reliable representation of the upper noise levels expected in practice, when modelled in combination with other key assumptions; specifically all turbines operating at identical wind speeds, emitting sound levels equal to the test measured levels plus a margin for uncertainty (or guaranteed values), at a temperature of 10 ^{o}C and relative humidity of 70 % to 80 %, with specific adjustments for screening and ground effects as a result of the ground terrain profile.

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

- A factor of G = 0.5 is frequently applied in Australia for general environmental noise modelling purposes as a way of accounting for the potential mix of ground porosity which may occur in regions of dry/compacted soils or in regions where persistent damp conditions may be relevant
- NZS 6808:2010 refers to ISO 9613 as an appropriate prediction methodology for wind farm noise, and notes that soft ground conditions should be characterised by a ground factor of G = 0.5
- In 1998, a comprehensive study (commonly cited as the Joule Report), part funded by the European Commission found that the ISO 9613 model provided a robust representation of upper noise levels which may occur in practice, and provided a closer agreement between predicted and measured noise levels than alternative standards such as CONCAWE and ENM. Specifically, the report indicated the ISO 9613 method generally tends to marginally over predict noise levels expected in practice
- The UK Institute of Acoustics journal dated March/April 2009 published a joint agreement between practitioners in the field of wind farm noise assessment (the UK IOA 2009 joint agreement), including consultants routinely employed on behalf of both developers and community opposition groups, and indicated the ISO 9613 method as the appropriate standard and specifically designated G = 0.5 as the appropriate ground characterisation. This agreement was subsequently reflected in the recommendations detailed in the UK Institute of Acoustics publication A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (UK 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[11, 12, 13] 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.

---

11 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.

12 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.

13 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 8.2 software used to conduct the noise modelling. The software uses these definitions in conjunction with the digital terrain model of the site to evaluate the path between each turbine and receiver pairing, and then subsequently applies the adjustments to each turbine's predicted noise contribution where appropriate.

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

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

> ***Porous ground**, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground G = 1.*

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

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

APPENDIX I TABULATED PREDICTED NOISE LEVEL DATA

Table 22: Predicted noise levels, dB L_{A90} - V162-5.6MW

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
92	12.9	13.5	16.5	19.4	22.1	23.2	23.2
93	12.9	13.5	16.5	19.4	22.1	23.2	23.2
94	13.7	14.3	17.3	20.2	22.9	24.0	24.0
95	13.3	13.9	16.9	19.8	22.5	23.6	23.6
217	14.4	15.0	18.0	20.9	23.6	24.7	24.7
218	14.3	14.9	17.9	20.8	23.5	24.6	24.6
226	13.1	13.7	16.7	19.6	22.3	23.4	23.4
229	15.2	15.8	18.8	21.7	24.4	25.5	25.5
232	14.0	14.6	17.6	20.5	23.2	24.3	24.3
237	14.7	15.3	18.3	21.2	23.9	25.0	25.0
524	13.9	14.5	17.5	20.4	23.1	24.2	24.2
525	14.9	15.5	18.5	21.4	24.1	25.2	25.2
526	16.4	17.0	20.0	22.9	25.6	26.7	26.7
527	16.4	17.0	20.0	22.9	25.6	26.7	26.7
528	16.6	17.2	20.2	23.1	25.8	26.9	26.9
529	16.7	17.3	20.3	23.2	25.9	27.0	27.0
530	15.3	15.9	18.9	21.8	24.5	25.6	25.6
532	13.2	13.8	16.8	19.7	22.4	23.5	23.5
533	16.8	17.4	20.4	23.3	26.0	27.1	27.1
534	16.9	17.5	20.5	23.4	26.1	27.2	27.2
535	17.1	17.7	20.7	23.6	26.3	27.4	27.4
536	16.8	17.4	20.4	23.3	26.0	27.1	27.1
537	17.3	17.9	20.9	23.8	26.5	27.6	27.6
540	16.8	17.4	20.4	23.3	26.0	27.1	27.1
541	16.5	17.1	20.1	23.0	25.7	26.8	26.8
542	17.1	17.7	20.7	23.6	26.3	27.4	27.4
543	17.2	17.8	20.8	23.7	26.4	27.5	27.5
544	17.0	17.6	20.6	23.5	26.2	27.3	27.3
545	17.3	17.9	20.9	23.8	26.5	27.6	27.6
546	17.4	18.0	21.0	23.9	26.6	27.7	27.7

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
547	17.4	18.0	21.0	23.9	26.6	27.7	27.7
548	17.4	18.0	21.0	23.9	26.6	27.7	27.7
549	17.5	18.1	21.1	24.0	26.7	27.8	27.8
550	17.3	17.9	20.9	23.8	26.5	27.6	27.6
551	17.3	17.9	20.9	23.8	26.5	27.6	27.6
552	17.6	18.2	21.2	24.1	26.8	27.9	27.9
564	13.7	14.3	17.3	20.2	22.9	24.0	24.0
565	13.7	14.3	17.3	20.2	22.9	24.0	24.0
566	14.3	14.9	17.9	20.8	23.5	24.6	24.6
567	15.0	15.6	18.6	21.5	24.2	25.3	25.3
568	15.8	16.4	19.4	22.3	25.0	26.1	26.1
569	16.1	16.7	19.7	22.6	25.3	26.4	26.4
570	17.2	17.8	20.8	23.7	26.4	27.5	27.5
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	17.6	18.2	21.2	24.1	26.8	27.9	27.9
574	17.4	18.0	21.0	23.9	26.6	27.7	27.7
575	17.5	18.1	21.1	24.0	26.7	27.8	27.8
576	17.5	18.1	21.1	24.0	26.7	27.8	27.8
577	17.3	17.9	20.9	23.8	26.5	27.6	27.6
578	17.5	18.1	21.1	24.0	26.7	27.8	27.8
579	17.1	17.7	20.7	23.6	26.3	27.4	27.4
580	14.0	14.6	17.6	20.5	23.2	24.3	24.3
582	17.6	18.2	21.2	24.1	26.8	27.9	27.9
583	17.5	18.1	21.1	24.0	26.7	27.8	27.8
584	17.6	18.2	21.2	24.1	26.8	27.9	27.9
585	17.7	18.3	21.3	24.2	26.9	28.0	28.0
586	17.5	18.1	21.1	24.0	26.7	27.8	27.8
587	17.8	18.4	21.4	24.3	27.0	28.1	28.1
588	18.0	18.6	21.6	24.5	27.2	28.3	28.3
589	18.1	18.7	21.7	24.6	27.3	28.4	28.4
590	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
591	18.6	19.2	22.2	25.1	27.8	28.9	28.9
592	18.3	18.9	21.9	24.8	27.5	28.6	28.6
593	19.1	19.7	22.7	25.6	28.3	29.4	29.4
594	19.5	20.1	23.1	26.0	28.7	29.8	29.8
595	19.9	20.5	23.5	26.4	29.1	30.2	30.2
596	20.2	20.8	23.8	26.7	29.4	30.5	30.5
597	20.3	20.9	23.9	26.8	29.5	30.6	30.6
598	21.1	21.7	24.7	27.6	30.3	31.4	31.4
599	21.7	22.3	25.3	28.2	30.9	32.0	32.0
600	22.2	22.8	25.8	28.7	31.4	32.5	32.5
601	22.3	22.9	25.9	28.8	31.5	32.6	32.6
602	23.1	23.7	26.7	29.6	32.3	33.4	33.4
603	22.8	23.4	26.4	29.3	32.0	33.1	33.1
604*	22.7	23.3	26.3	29.2	31.9	33.0	33.0
605	23.5	24.1	27.1	30.0	32.7	33.8	33.8
606	24.8	25.4	28.4	31.3	34.0	35.1	35.1
607	22.3	22.9	25.9	28.8	31.5	32.6	32.6
608	23.8	24.4	27.4	30.3	33.0	34.1	34.1
609	24.8	25.4	28.4	31.3	34.0	35.1	35.1
610	24.3	24.9	27.9	30.8	33.5	34.6	34.6
611	22.4	23.0	26.0	28.9	31.6	32.7	32.7
612	20.3	20.9	23.9	26.8	29.5	30.6	30.6
613	20.6	21.2	24.2	27.1	29.8	30.9	30.9
614	19.2	19.8	22.8	25.7	28.4	29.5	29.5
615	18.9	19.5	22.5	25.4	28.1	29.2	29.2
616	18.6	19.2	22.2	25.1	27.8	28.9	28.9
617	17.6	18.2	21.2	24.1	26.8	27.9	27.9
620	15.1	15.7	18.7	21.6	24.3	25.4	25.4
662	14.1	14.7	17.7	20.6	23.3	24.4	24.4
663	14.2	14.8	17.8	20.7	23.4	24.5	24.5
664	12.7	13.3	16.3	19.2	21.9	23.0	23.0
665	12.7	13.3	16.3	19.2	21.9	23.0	23.0

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
666	13.0	13.6	16.6	19.5	22.2	23.3	23.3
667	13.0	13.6	16.6	19.5	22.2	23.3	23.3
668	12.8	13.4	16.4	19.3	22.0	23.1	23.1
669	12.8	13.4	16.4	19.3	22.0	23.1	23.1
670	13.1	13.7	16.7	19.6	22.3	23.4	23.4
671	13.3	13.9	16.9	19.8	22.5	23.6	23.6
672	13.2	13.8	16.8	19.7	22.4	23.5	23.5
673	12.9	13.5	16.5	19.4	22.1	23.2	23.2
732	17.0	17.6	20.6	23.5	26.2	27.3	27.3
733	18.5	19.1	22.1	25.0	27.7	28.8	28.8
734	18.9	19.5	22.5	25.4	28.1	29.2	29.2
735	19.1	19.7	22.7	25.6	28.3	29.4	29.4
736	16.5	17.1	20.1	23.0	25.7	26.8	26.8
737	16.2	16.8	19.8	22.7	25.4	26.5	26.5
738	16.0	16.6	19.6	22.5	25.2	26.3	26.3
739	16.4	17.0	20.0	22.9	25.6	26.7	26.7
742	16.6	17.2	20.2	23.1	25.8	26.9	26.9
743	17.0	17.6	20.6	23.5	26.2	27.3	27.3
744	17.6	18.2	21.2	24.1	26.8	27.9	27.9
745	17.5	18.1	21.1	24.0	26.7	27.8	27.8
746	17.3	17.9	20.9	23.8	26.5	27.6	27.6
747	17.3	17.9	20.9	23.8	26.5	27.6	27.6
748	16.7	17.3	20.3	23.2	25.9	27.0	27.0
755	18.1	18.7	21.7	24.6	27.3	28.4	28.4
756	18.6	19.2	22.2	25.1	27.8	28.9	28.9
757	17.8	18.4	21.4	24.3	27.0	28.1	28.1
758	18.0	18.6	21.6	24.5	27.2	28.3	28.3
759	17.6	18.2	21.2	24.1	26.8	27.9	27.9
760	17.7	18.3	21.3	24.2	26.9	28.0	28.0
761	17.1	17.7	20.7	23.6	26.3	27.4	27.4
762	16.9	17.5	20.5	23.4	26.1	27.2	27.2
763	17.3	17.9	20.9	23.8	26.5	27.6	27.6

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
764	17.7	18.3	21.3	24.2	26.9	28.0	28.0
765	17.7	18.3	21.3	24.2	26.9	28.0	28.0
766	17.9	18.5	21.5	24.4	27.1	28.2	28.2
767	20.0	20.6	23.6	26.5	29.2	30.3	30.3
779	21.6	22.2	25.2	28.1	30.8	31.9	31.9
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	20.2	20.8	23.8	26.7	29.4	30.5	30.5
785	19.6	20.2	23.2	26.1	28.8	29.9	29.9
786	19.3	19.9	22.9	25.8	28.5	29.6	29.6
787	19.0	19.6	22.6	25.5	28.2	29.3	29.3
788	18.7	19.3	22.3	25.2	27.9	29.0	29.0
789	18.3	18.9	21.9	24.8	27.5	28.6	28.6
790	18.0	18.6	21.6	24.5	27.2	28.3	28.3
791	17.9	18.5	21.5	24.4	27.1	28.2	28.2
792	17.2	17.8	20.8	23.7	26.4	27.5	27.5
793	14.2	14.8	17.8	20.7	23.4	24.5	24.5
794	15.1	15.7	18.7	21.6	24.3	25.4	25.4
795	19.8	20.4	23.4	26.3	29.0	30.1	30.1
796	16.6	17.2	20.2	23.1	25.8	26.9	26.9
797	18.7	19.3	22.3	25.2	27.9	29.0	29.0
798	16.7	17.3	20.3	23.2	25.9	27.0	27.0
799	17.0	17.6	20.6	23.5	26.2	27.3	27.3
800	16.7	17.3	20.3	23.2	25.9	27.0	27.0
801	16.5	17.1	20.1	23.0	25.7	26.8	26.8
802	16.2	16.8	19.8	22.7	25.4	26.5	26.5
803	16.0	16.6	19.6	22.5	25.2	26.3	26.3
804	15.9	16.5	19.5	22.4	25.1	26.2	26.2
805	15.8	16.4	19.4	22.3	25.0	26.1	26.1
806	15.7	16.3	19.3	22.2	24.9	26.0	26.0
807	16.5	17.1	20.1	23.0	25.7	26.8	26.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
808	16.7	17.3	20.3	23.2	25.9	27.0	27.0
809	19.4	20.0	23.0	25.9	28.6	29.7	29.7
810	17.3	17.9	20.9	23.8	26.5	27.6	27.6
811	19.1	19.7	22.7	25.6	28.3	29.4	29.4
817	17.4	18.0	21.0	23.9	26.6	27.7	27.7
818	17.9	18.5	21.5	24.4	27.1	28.2	28.2
819	18.9	19.5	22.5	25.4	28.1	29.2	29.2
820	21.7	22.3	25.3	28.2	30.9	32.0	32.0
821	22.0	22.6	25.6	28.5	31.2	32.3	32.3
822	23.1	23.7	26.7	29.6	32.3	33.4	33.4
823	24.5	25.1	28.1	31.0	33.7	34.8	34.8
824	24.0	24.6	27.6	30.5	33.2	34.3	34.3
825	21.1	21.7	24.7	27.6	30.3	31.4	31.4
826	21.9	22.5	25.5	28.4	31.1	32.2	32.2
827	22.7	23.3	26.3	29.2	31.9	33.0	33.0
828 (S)	24.2	24.8	27.8	30.7	33.4	34.5	34.5
829 (S)	24.1	24.7	27.7	30.6	33.3	34.4	34.4
830	23.6	24.2	27.2	30.1	32.8	33.9	33.9
832	25.0	25.6	28.6	31.5	34.2	35.3	35.3
833	21.4	22.0	25.0	27.9	30.6	31.7	31.7
834	21.2	21.8	24.8	27.7	30.4	31.5	31.5
835	20.9	21.5	24.5	27.4	30.1	31.2	31.2
836	17.0	17.6	20.6	23.5	26.2	27.3	27.3
837	21.6	22.2	25.2	28.1	30.8	31.9	31.9
838	23.9	24.5	27.5	30.4	33.1	34.2	34.2
839	16.7	17.3	20.3	23.2	25.9	27.0	27.0
840	16.0	16.6	19.6	22.5	25.2	26.3	26.3
844	18.8	19.4	22.4	25.3	28.0	29.1	29.1
845	18.7	19.3	22.3	25.2	27.9	29.0	29.0
846	18.8	19.4	22.4	25.3	28.0	29.1	29.1
847	22.7	23.3	26.3	29.2	31.9	33.0	33.0
848	23.5	24.1	27.1	30.0	32.7	33.8	33.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
849	23.0	23.6	26.6	29.5	32.2	33.3	33.3
850	22.7	23.3	26.3	29.2	31.9	33.0	33.0
851	22.3	22.9	25.9	28.8	31.5	32.6	32.6
852	21.7	22.3	25.3	28.2	30.9	32.0	32.0
853	25.0	25.6	28.6	31.5	34.2	35.3	35.3
854	19.0	19.6	22.6	25.5	28.2	29.3	29.3
855	19.1	19.7	22.7	25.6	28.3	29.4	29.4
856	17.8	18.4	21.4	24.3	27.0	28.1	28.1
857	20.7	21.3	24.3	27.2	29.9	31.0	31.0
858	20.1	20.7	23.7	26.6	29.3	30.4	30.4
859	19.7	20.3	23.3	26.2	28.9	30.0	30.0
860	19.2	19.8	22.8	25.7	28.4	29.5	29.5
861	18.5	19.1	22.1	25.0	27.7	28.8	28.8
862	23.1	23.7	26.7	29.6	32.3	33.4	33.4
863	24.1	24.7	27.7	30.6	33.3	34.4	34.4
864	25.4	26.0	29.0	31.9	34.6	35.7	35.7
865	19.9	20.5	23.5	26.4	29.1	30.2	30.2
866	20.4	21.0	24.0	26.9	29.6	30.7	30.7
867	20.6	21.2	24.2	27.1	29.8	30.9	30.9
868	17.0	17.6	20.6	23.5	26.2	27.3	27.3
869	17.2	17.8	20.8	23.7	26.4	27.5	27.5
870	20.8	21.4	24.4	27.3	30.0	31.1	31.1
871	22.8	23.4	26.4	29.3	32.0	33.1	33.1
872	23.4	24.0	27.0	29.9	32.6	33.7	33.7
873	23.5	24.1	27.1	30.0	32.7	33.8	33.8
874	22.0	22.6	25.6	28.5	31.2	32.3	32.3
875	24.4	25.0	28.0	30.9	33.6	34.7	34.7
876	18.0	18.6	21.6	24.5	27.2	28.3	28.3
877	18.7	19.3	22.3	25.2	27.9	29.0	29.0
878	18.0	18.6	21.6	24.5	27.2	28.3	28.3
879	17.6	18.2	21.2	24.1	26.8	27.9	27.9
880	15.6	16.2	19.2	22.1	24.8	25.9	25.9

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
881	15.5	16.1	19.1	22.0	24.7	25.8	25.8
882	16.0	16.6	19.6	22.5	25.2	26.3	26.3
883	16.5	17.1	20.1	23.0	25.7	26.8	26.8
884	15.4	16.0	19.0	21.9	24.6	25.7	25.7
885	14.8	15.4	18.4	21.3	24.0	25.1	25.1
886	15.8	16.4	19.4	22.3	25.0	26.1	26.1
887	15.1	15.7	18.7	21.6	24.3	25.4	25.4
888	15.3	15.9	18.9	21.8	24.5	25.6	25.6
889	15.5	16.1	19.1	22.0	24.7	25.8	25.8
890	15.4	16.0	19.0	21.9	24.6	25.7	25.7
891	16.4	17.0	20.0	22.9	25.6	26.7	26.7
892	18.3	18.9	21.9	24.8	27.5	28.6	28.6
893	20.6	21.2	24.2	27.1	29.8	30.9	30.9
894	20.0	20.6	23.6	26.5	29.2	30.3	30.3
895	13.8	14.4	17.4	20.3	23.0	24.1	24.1
1158	16.9	17.5	20.5	23.4	26.1	27.2	27.2
1159	17.6	18.2	21.2	24.1	26.8	27.9	27.9
1160	19.5	20.1	23.1	26.0	28.7	29.8	29.8
1161	19.1	19.7	22.7	25.6	28.3	29.4	29.4
1162	19.5	20.1	23.1	26.0	28.7	29.8	29.8
1163	20.1	20.7	23.7	26.6	29.3	30.4	30.4
1165	20.3	20.9	23.9	26.8	29.5	30.6	30.6
1166	20.5	21.1	24.1	27.0	29.7	30.8	30.8
1167	20.8	21.4	24.4	27.3	30.0	31.1	31.1
1168	21.3	21.9	24.9	27.8	30.5	31.6	31.6
1169	21.6	22.2	25.2	28.1	30.8	31.9	31.9
1170	23.7	24.3	27.3	30.2	32.9	34.0	34.0
1171	24.1	24.7	27.7	30.6	33.3	34.4	34.4
1172	19.7	20.3	23.3	26.2	28.9	30.0	30.0
1173	18.7	19.3	22.3	25.2	27.9	29.0	29.0
1174	20.8	21.4	24.4	27.3	30.0	31.1	31.1
1175	17.9	18.5	21.5	24.4	27.1	28.2	28.2

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1176	18.6	19.2	22.2	25.1	27.8	28.9	28.9
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	17.6	18.2	21.2	24.1	26.8	27.9	27.9
1180	16.9	17.5	20.5	23.4	26.1	27.2	27.2
1182	16.3	16.9	19.9	22.8	25.5	26.6	26.6
1235	17.2	17.8	20.8	23.7	26.4	27.5	27.5
1255	14.1	14.7	17.7	20.6	23.3	24.4	24.4
1256	14.4	15.0	18.0	20.9	23.6	24.7	24.7
1257	14.6	15.2	18.2	21.1	23.8	24.9	24.9
1258	14.4	15.0	18.0	20.9	23.6	24.7	24.7
1259	14.8	15.4	18.4	21.3	24.0	25.1	25.1
1260	16.0	16.6	19.6	22.5	25.2	26.3	26.3
1261	14.9	15.5	18.5	21.4	24.1	25.2	25.2
1262	14.9	15.5	18.5	21.4	24.1	25.2	25.2
1263	15.1	15.7	18.7	21.6	24.3	25.4	25.4
1264	15.0	15.6	18.6	21.5	24.2	25.3	25.3
1265	15.3	15.9	18.9	21.8	24.5	25.6	25.6
1266	16.0	16.6	19.6	22.5	25.2	26.3	26.3
1267	16.0	16.6	19.6	22.5	25.2	26.3	26.3
1268	16.0	16.6	19.6	22.5	25.2	26.3	26.3
1269	16.8	17.4	20.4	23.3	26.0	27.1	27.1
1270	16.0	16.6	19.6	22.5	25.2	26.3	26.3
1271	16.1	16.7	19.7	22.6	25.3	26.4	26.4
1272	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1273	15.8	16.4	19.4	22.3	25.0	26.1	26.1
1274	15.7	16.3	19.3	22.2	24.9	26.0	26.0
1275	15.4	16.0	19.0	21.9	24.6	25.7	25.7
1276	15.5	16.1	19.1	22.0	24.7	25.8	25.8
1278	15.3	15.9	18.9	21.8	24.5	25.6	25.6
1280	16.3	16.9	19.9	22.8	25.5	26.6	26.6
1281	15.8	16.4	19.4	22.3	25.0	26.1	26.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1293	16.6	17.2	20.2	23.1	25.8	26.9	26.9
1294	15.8	16.4	19.4	22.3	25.0	26.1	26.1
1295	15.4	16.0	19.0	21.9	24.6	25.7	25.7
1296	15.1	15.7	18.7	21.6	24.3	25.4	25.4
1297	15.1	15.7	18.7	21.6	24.3	25.4	25.4
1298	15.9	16.5	19.5	22.4	25.1	26.2	26.2
1299	12.8	13.4	16.4	19.3	22.0	23.1	23.1
1300	13.1	13.7	16.7	19.6	22.3	23.4	23.4
1398	14.3	14.9	17.9	20.8	23.5	24.6	24.6
1415	17.7	18.3	21.3	24.2	26.9	28.0	28.0
1416	18.0	18.6	21.6	24.5	27.2	28.3	28.3
1417	18.2	18.8	21.8	24.7	27.4	28.5	28.5
1418	19.4	20.0	23.0	25.9	28.6	29.7	29.7
1450	19.3	19.9	22.9	25.8	28.5	29.6	29.6
4064	17.1	17.7	20.7	23.6	26.3	27.4	27.4
4066	16.1	16.7	19.7	22.6	25.3	26.4	26.4
4154	16.6	17.2	20.2	23.1	25.8	26.9	26.9
4155	24.6	25.2	28.2	31.1	33.8	34.9	34.9
4183	18.5	19.1	22.1	25.0	27.7	28.8	28.8
4342	13.1	13.7	16.7	19.6	22.3	23.4	23.4
4343	13.3	13.9	16.9	19.8	22.5	23.6	23.6
4354	14.3	14.9	17.9	20.8	23.5	24.6	24.6
4377	15.1	15.7	18.7	21.6	24.3	25.4	25.4
4378*	22.5	23.1	26.1	29.0	31.7	32.8	32.8
4380	18.9	19.5	22.5	25.4	28.1	29.2	29.2
4381	22.8	23.4	26.4	29.3	32.0	33.1	33.1
4495	18.1	18.7	21.7	24.6	27.3	28.4	28.4
4496	19.7	20.3	23.3	26.2	28.9	30.0	30.0
4533	19.3	19.9	22.9	25.8	28.5	29.6	29.6
4534	22.8	23.4	26.4	29.3	32.0	33.1	33.1
4535	17.6	18.2	21.2	24.1	26.8	27.9	27.9
4539	16.8	17.4	20.4	23.3	26.0	27.1	27.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
4540	17.0	17.6	20.6	23.5	26.2	27.3	27.3
4577	16.6	17.2	20.2	23.1	25.8	26.9	26.9
4578	18.8	19.4	22.4	25.3	28.0	29.1	29.1
4579*	19.1	19.7	22.7	25.6	28.3	29.4	29.4
4581	23.1	23.7	26.7	29.6	32.3	33.4	33.4
4582	14.0	14.6	17.6	20.5	23.2	24.3	24.3
4583	16.8	17.4	20.4	23.3	26.0	27.1	27.1
4585	19.4	20.0	23.0	25.9	28.6	29.7	29.7
4587	21.9	22.5	25.5	28.4	31.1	32.2	32.2
4589	21.7	22.3	25.3	28.2	30.9	32.0	32.0

(S) Stakeholder receiver
* Identified as a future dwelling location on a title without an existing dwelling

Table 23: Predicted noise levels, dB L_{A90} – GE 5.5-158

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
92	11.8	12.5	15.6	19.0	21.9	24.0	24.0
93	11.8	12.5	15.6	19.0	21.9	24.0	24.0
94	12.6	13.3	16.4	19.8	22.7	24.8	24.8
95	12.2	12.9	16.0	19.4	22.3	24.4	24.4
217	13.2	13.9	17.0	20.4	23.3	25.4	25.4
218	13.2	13.9	17.0	20.4	23.3	25.4	25.4
226	12.0	12.7	15.8	19.2	22.1	24.2	24.2
229	14.2	14.9	18.0	21.4	24.3	26.4	26.4
232	13.0	13.7	16.8	20.2	23.1	25.2	25.2
237	13.6	14.3	17.4	20.8	23.7	25.8	25.8
524	12.8	13.5	16.6	20.0	22.9	25.0	25.0
525	13.8	14.5	17.6	21.0	23.9	26.0	26.0
526	15.3	16.0	19.1	22.5	25.4	27.5	27.5
527	15.3	16.0	19.1	22.5	25.4	27.5	27.5
528	15.4	16.1	19.2	22.6	25.5	27.6	27.6
529	15.6	16.3	19.4	22.8	25.7	27.8	27.8
530	13.9	14.6	17.7	21.1	24.0	26.1	26.1
532	12.1	12.8	15.9	19.3	22.2	24.3	24.3
533	15.6	16.3	19.4	22.8	25.7	27.8	27.8
534	15.8	16.5	19.6	23.0	25.9	28.0	28.0
535	15.9	16.6	19.7	23.1	26.0	28.1	28.1
536	15.7	16.4	19.5	22.9	25.8	27.9	27.9
537	16.3	17.0	20.1	23.5	26.4	28.5	28.5
540	15.7	16.4	19.5	22.9	25.8	27.9	27.9
541	15.4	16.1	19.2	22.6	25.5	27.6	27.6
542	16.0	16.7	19.8	23.2	26.1	28.2	28.2
543	16.1	16.8	19.9	23.3	26.2	28.3	28.3
544	15.9	16.6	19.7	23.1	26.0	28.1	28.1
545	16.2	16.9	20.0	23.4	26.3	28.4	28.4
546	16.4	17.1	20.2	23.6	26.5	28.6	28.6
547	16.2	16.9	20.0	23.4	26.3	28.4	28.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
548	16.3	17.0	20.1	23.5	26.4	28.5	28.5
549	16.4	17.1	20.2	23.6	26.5	28.6	28.6
550	16.2	16.9	20.0	23.4	26.3	28.4	28.4
551	16.2	16.9	20.0	23.4	26.3	28.4	28.4
552	16.4	17.1	20.2	23.6	26.5	28.6	28.6
564	12.6	13.3	16.4	19.8	22.7	24.8	24.8
565	12.6	13.3	16.4	19.8	22.7	24.8	24.8
566	13.1	13.8	16.9	20.3	23.2	25.3	25.3
567	13.8	14.5	17.6	21.0	23.9	26.0	26.0
568	14.7	15.4	18.5	21.9	24.8	26.9	26.9
569	15.0	15.7	18.8	22.2	25.1	27.2	27.2
570	16.2	16.9	20.0	23.4	26.3	28.4	28.4
571	16.4	17.1	20.2	23.6	26.5	28.6	28.6
572	16.4	17.1	20.2	23.6	26.5	28.6	28.6
573	16.5	17.2	20.3	23.7	26.6	28.7	28.7
574	16.3	17.0	20.1	23.5	26.4	28.5	28.5
575	16.3	17.0	20.1	23.5	26.4	28.5	28.5
576	16.4	17.1	20.2	23.6	26.5	28.6	28.6
577	16.0	16.7	19.8	23.2	26.1	28.2	28.2
578	16.3	17.0	20.1	23.5	26.4	28.5	28.5
579	16.0	16.7	19.8	23.2	26.1	28.2	28.2
580	12.9	13.6	16.7	20.1	23.0	25.1	25.1
582	16.4	17.1	20.2	23.6	26.5	28.6	28.6
583	16.4	17.1	20.2	23.6	26.5	28.6	28.6
584	16.5	17.2	20.3	23.7	26.6	28.7	28.7
585	16.7	17.4	20.5	23.9	26.8	28.9	28.9
586	16.5	17.2	20.3	23.7	26.6	28.7	28.7
587	16.8	17.5	20.6	24.0	26.9	29.0	29.0
588	17.0	17.7	20.8	24.2	27.1	29.2	29.2
589	17.1	17.8	20.9	24.3	27.2	29.3	29.3
590	17.5	18.2	21.3	24.7	27.6	29.7	29.7
591	17.6	18.3	21.4	24.8	27.7	29.8	29.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
592	17.3	18.0	21.1	24.5	27.4	29.5	29.5
593	18.1	18.8	21.9	25.3	28.2	30.3	30.3
594	18.5	19.2	22.3	25.7	28.6	30.7	30.7
595	19.0	19.7	22.8	26.2	29.1	31.2	31.2
596	19.3	20.0	23.1	26.5	29.4	31.5	31.5
597	19.4	20.1	23.2	26.6	29.5	31.6	31.6
598	20.3	21.0	24.1	27.5	30.4	32.5	32.5
599	20.9	21.6	24.7	28.1	31.0	33.1	33.1
600	21.4	22.1	25.2	28.6	31.5	33.6	33.6
601	21.5	22.2	25.3	28.7	31.6	33.7	33.7
602	22.4	23.1	26.2	29.6	32.5	34.6	34.6
603	22.1	22.8	25.9	29.3	32.2	34.3	34.3
604*	22.0	22.7	25.8	29.2	32.1	34.2	34.2
605	22.8	23.5	26.6	30.0	32.9	35.0	35.0
606	24.2	24.9	28.0	31.4	34.3	36.4	36.4
607	21.4	22.1	25.2	28.6	31.5	33.6	33.6
608	23.0	23.7	26.8	30.2	33.1	35.2	35.2
609	24.2	24.9	28.0	31.4	34.3	36.4	36.4
610	23.6	24.3	27.4	30.8	33.7	35.8	35.8
611	21.6	22.3	25.4	28.8	31.7	33.8	33.8
612	19.4	20.1	23.2	26.6	29.5	31.6	31.6
613	19.7	20.4	23.5	26.9	29.8	31.9	31.9
614	18.1	18.8	21.9	25.3	28.2	30.3	30.3
615	17.8	18.5	21.6	25.0	27.9	30.0	30.0
616	17.5	18.2	21.3	24.7	27.6	29.7	29.7
617	16.5	17.2	20.3	23.7	26.6	28.7	28.7
620	14.0	14.7	17.8	21.2	24.1	26.2	26.2
662	13.0	13.7	16.8	20.2	23.1	25.2	25.2
663	13.1	13.8	16.9	20.3	23.2	25.3	25.3
664	11.6	12.3	15.4	18.8	21.7	23.8	23.8
665	11.6	12.3	15.4	18.8	21.7	23.8	23.8
666	11.9	12.6	15.7	19.1	22.0	24.1	24.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
667	12.0	12.7	15.8	19.2	22.1	24.2	24.2
668	11.7	12.4	15.5	18.9	21.8	23.9	23.9
669	11.7	12.4	15.5	18.9	21.8	23.9	23.9
670	12.0	12.7	15.8	19.2	22.1	24.2	24.2
671	12.2	12.9	16.0	19.4	22.3	24.4	24.4
672	12.1	12.8	15.9	19.3	22.2	24.3	24.3
673	11.8	12.5	15.6	19.0	21.9	24.0	24.0
732	15.9	16.6	19.7	23.1	26.0	28.1	28.1
733	17.4	18.1	21.2	24.6	27.5	29.6	29.6
734	17.9	18.6	21.7	25.1	28.0	30.1	30.1
735	18.1	18.8	21.9	25.3	28.2	30.3	30.3
736	15.4	16.1	19.2	22.6	25.5	27.6	27.6
737	15.1	15.8	18.9	22.3	25.2	27.3	27.3
738	14.9	15.6	18.7	22.1	25.0	27.1	27.1
739	15.3	16.0	19.1	22.5	25.4	27.5	27.5
742	15.4	16.1	19.2	22.6	25.5	27.6	27.6
743	15.8	16.5	19.6	23.0	25.9	28.0	28.0
744	16.5	17.2	20.3	23.7	26.6	28.7	28.7
745	16.4	17.1	20.2	23.6	26.5	28.6	28.6
746	16.2	16.9	20.0	23.4	26.3	28.4	28.4
747	16.2	16.9	20.0	23.4	26.3	28.4	28.4
748	15.5	16.2	19.3	22.7	25.6	27.7	27.7
755	17.0	17.7	20.8	24.2	27.1	29.2	29.2
756	17.5	18.2	21.3	24.7	27.6	29.7	29.7
757	16.7	17.4	20.5	23.9	26.8	28.9	28.9
758	16.9	17.6	20.7	24.1	27.0	29.1	29.1
759	16.5	17.2	20.3	23.7	26.6	28.7	28.7
760	16.6	17.3	20.4	23.8	26.7	28.8	28.8
761	16.0	16.7	19.8	23.2	26.1	28.2	28.2
762	15.8	16.5	19.6	23.0	25.9	28.0	28.0
763	16.1	16.8	19.9	23.3	26.2	28.3	28.3
764	16.9	17.6	20.7	24.1	27.0	29.1	29.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
765	16.9	17.6	20.7	24.1	27.0	29.1	29.1
766	17.1	17.8	20.9	24.3	27.2	29.3	29.3
767	19.4	20.1	23.2	26.6	29.5	31.6	31.6
779	20.8	21.5	24.6	28.0	30.9	33.0	33.0
781	20.2	20.9	24.0	27.4	30.3	32.4	32.4
782	19.5	20.2	23.3	26.7	29.6	31.7	31.7
783	21.2	21.9	25.0	28.4	31.3	33.4	33.4
784	19.2	19.9	23.0	26.4	29.3	31.4	31.4
785	18.7	19.4	22.5	25.9	28.8	30.9	30.9
786	18.3	19.0	22.1	25.5	28.4	30.5	30.5
787	18.0	18.7	21.8	25.2	28.1	30.2	30.2
788	17.6	18.3	21.4	24.8	27.7	29.8	29.8
789	17.3	18.0	21.1	24.5	27.4	29.5	29.5
790	16.9	17.6	20.7	24.1	27.0	29.1	29.1
791	16.8	17.5	20.6	24.0	26.9	29.0	29.0
792	16.1	16.8	19.9	23.3	26.2	28.3	28.3
793	13.0	13.7	16.8	20.2	23.1	25.2	25.2
794	13.9	14.6	17.7	21.1	24.0	26.1	26.1
795	19.2	19.9	23.0	26.4	29.3	31.4	31.4
796	15.9	16.6	19.7	23.1	26.0	28.1	28.1
797	18.0	18.7	21.8	25.2	28.1	30.2	30.2
798	15.8	16.5	19.6	23.0	25.9	28.0	28.0
799	16.1	16.8	19.9	23.3	26.2	28.3	28.3
800	15.8	16.5	19.6	23.0	25.9	28.0	28.0
801	15.6	16.3	19.4	22.8	25.7	27.8	27.8
802	15.3	16.0	19.1	22.5	25.4	27.5	27.5
803	15.1	15.8	18.9	22.3	25.2	27.3	27.3
804	15.0	15.7	18.8	22.2	25.1	27.2	27.2
805	14.8	15.5	18.6	22.0	24.9	27.0	27.0
806	14.7	15.4	18.5	21.9	24.8	26.9	26.9
807	15.6	16.3	19.4	22.8	25.7	27.8	27.8
808	15.8	16.5	19.6	23.0	25.9	28.0	28.0

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
809	18.7	19.4	22.5	25.9	28.8	30.9	30.9
810	16.5	17.2	20.3	23.7	26.6	28.7	28.7
811	18.3	19.0	22.1	25.5	28.4	30.5	30.5
817	16.3	17.0	20.1	23.5	26.4	28.5	28.5
818	16.9	17.6	20.7	24.1	27.0	29.1	29.1
819	17.9	18.6	21.7	25.1	28.0	30.1	30.1
820	20.8	21.5	24.6	28.0	30.9	33.0	33.0
821	21.1	21.8	24.9	28.3	31.2	33.3	33.3
822	22.3	23.0	26.1	29.5	32.4	34.5	34.5
823	23.8	24.5	27.6	31.0	33.9	36.0	36.0
824	23.3	24.0	27.1	30.5	33.4	35.5	35.5
825	20.2	20.9	24.0	27.4	30.3	32.4	32.4
826	21.0	21.7	24.8	28.2	31.1	33.2	33.2
827	21.9	22.6	25.7	29.1	32.0	34.1	34.1
828 (S)	23.4	24.1	27.2	30.6	33.5	35.6	35.6
829 (S)	23.3	24.0	27.1	30.5	33.4	35.5	35.5
830	22.8	23.5	26.6	30.0	32.9	35.0	35.0
832	24.3	25.0	28.1	31.5	34.4	36.5	36.5
833	20.4	21.1	24.2	27.6	30.5	32.6	32.6
834	20.2	20.9	24.0	27.4	30.3	32.4	32.4
835	19.9	20.6	23.7	27.1	30.0	32.1	32.1
836	15.9	16.6	19.7	23.1	26.0	28.1	28.1
837	20.6	21.3	24.4	27.8	30.7	32.8	32.8
838	23.1	23.8	26.9	30.3	33.2	35.3	35.3
839	15.5	16.2	19.3	22.7	25.6	27.7	27.7
840	14.8	15.5	18.6	22.0	24.9	27.0	27.0
844	17.8	18.5	21.6	25.0	27.9	30.0	30.0
845	17.7	18.4	21.5	24.9	27.8	29.9	29.9
846	17.7	18.4	21.5	24.9	27.8	29.9	29.9
847	21.9	22.6	25.7	29.1	32.0	34.1	34.1
848	22.6	23.3	26.4	29.8	32.7	34.8	34.8
849	22.1	22.8	25.9	29.3	32.2	34.3	34.3

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
850	21.8	22.5	25.6	29.0	31.9	34.0	34.0
851	21.4	22.1	25.2	28.6	31.5	33.6	33.6
852	20.8	21.5	24.6	28.0	30.9	33.0	33.0
853	24.4	25.1	28.2	31.6	34.5	36.6	36.6
854	17.9	18.6	21.7	25.1	28.0	30.1	30.1
855	18.1	18.8	21.9	25.3	28.2	30.3	30.3
856	16.8	17.5	20.6	24.0	26.9	29.0	29.0
857	19.7	20.4	23.5	26.9	29.8	31.9	31.9
858	19.2	19.9	23.0	26.4	29.3	31.4	31.4
859	18.7	19.4	22.5	25.9	28.8	30.9	30.9
860	18.2	18.9	22.0	25.4	28.3	30.4	30.4
861	17.4	18.1	21.2	24.6	27.5	29.6	29.6
862	22.5	23.2	26.3	29.7	32.6	34.7	34.7
863	23.5	24.2	27.3	30.7	33.6	35.7	35.7
864	24.9	25.6	28.7	32.1	35.0	37.1	37.1
865	19.0	19.7	22.8	26.2	29.1	31.2	31.2
866	19.5	20.2	23.3	26.7	29.6	31.7	31.7
867	19.8	20.5	23.6	27.0	29.9	32.0	32.0
868	16.1	16.8	19.9	23.3	26.2	28.3	28.3
869	16.3	17.0	20.1	23.5	26.4	28.5	28.5
870	20.1	20.8	23.9	27.3	30.2	32.3	32.3
871	22.2	22.9	26.0	29.4	32.3	34.4	34.4
872	22.8	23.5	26.6	30.0	32.9	35.0	35.0
873	22.9	23.6	26.7	30.1	33.0	35.1	35.1
874	21.4	22.1	25.2	28.6	31.5	33.6	33.6
875	23.9	24.6	27.7	31.1	34.0	36.1	36.1
876	17.2	17.9	21.0	24.4	27.3	29.4	29.4
877	17.9	18.6	21.7	25.1	28.0	30.1	30.1
878	17.1	17.8	20.9	24.3	27.2	29.3	29.3
879	16.7	17.4	20.5	23.9	26.8	28.9	28.9
880	14.7	15.4	18.5	21.9	24.8	26.9	26.9
881	14.5	15.2	18.3	21.7	24.6	26.7	26.7

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
882	15.0	15.7	18.8	22.2	25.1	27.2	27.2
883	15.5	16.2	19.3	22.7	25.6	27.7	27.7
884	14.5	15.2	18.3	21.7	24.6	26.7	26.7
885	13.8	14.5	17.6	21.0	23.9	26.0	26.0
886	14.9	15.6	18.7	22.1	25.0	27.1	27.1
887	14.1	14.8	17.9	21.3	24.2	26.3	26.3
888	14.3	15.0	18.1	21.5	24.4	26.5	26.5
889	14.5	15.2	18.3	21.7	24.6	26.7	26.7
890	14.4	15.1	18.2	21.6	24.5	26.6	26.6
891	15.5	16.2	19.3	22.7	25.6	27.7	27.7
892	17.6	18.3	21.4	24.8	27.7	29.8	29.8
893	19.9	20.6	23.7	27.1	30.0	32.1	32.1
894	19.2	19.9	23.0	26.4	29.3	31.4	31.4
895	12.7	13.4	16.5	19.9	22.8	24.9	24.9
1158	15.8	16.5	19.6	23.0	25.9	28.0	28.0
1159	16.6	17.3	20.4	23.8	26.7	28.8	28.8
1160	18.4	19.1	22.2	25.6	28.5	30.6	30.6
1161	18.1	18.8	21.9	25.3	28.2	30.3	30.3
1162	18.4	19.1	22.2	25.6	28.5	30.6	30.6
1163	19.1	19.8	22.9	26.3	29.2	31.3	31.3
1165	19.3	20.0	23.1	26.5	29.4	31.5	31.5
1166	19.6	20.3	23.4	26.8	29.7	31.8	31.8
1167	19.8	20.5	23.6	27.0	29.9	32.0	32.0
1168	20.3	21.0	24.1	27.5	30.4	32.5	32.5
1169	20.7	21.4	24.5	27.9	30.8	32.9	32.9
1170	22.9	23.6	26.7	30.1	33.0	35.1	35.1
1171	23.5	24.2	27.3	30.7	33.6	35.7	35.7
1172	18.7	19.4	22.5	25.9	28.8	30.9	30.9
1173	17.8	18.5	21.6	25.0	27.9	30.0	30.0
1174	19.9	20.6	23.7	27.1	30.0	32.1	32.1
1175	16.9	17.6	20.7	24.1	27.0	29.1	29.1
1176	17.6	18.3	21.4	24.8	27.7	29.8	29.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1177	17.0	17.7	20.8	24.2	27.1	29.2	29.2
1178	16.6	17.3	20.4	23.8	26.7	28.8	28.8
1179	16.5	17.2	20.3	23.7	26.6	28.7	28.7
1180	15.8	16.5	19.6	23.0	25.9	28.0	28.0
1182	15.1	15.8	18.9	22.3	25.2	27.3	27.3
1235	16.1	16.8	19.9	23.3	26.2	28.3	28.3
1255	12.9	13.6	16.7	20.1	23.0	25.1	25.1
1256	13.3	14.0	17.1	20.5	23.4	25.5	25.5
1257	13.5	14.2	17.3	20.7	23.6	25.7	25.7
1258	13.3	14.0	17.1	20.5	23.4	25.5	25.5
1259	13.7	14.4	17.5	20.9	23.8	25.9	25.9
1260	14.9	15.6	18.7	22.1	25.0	27.1	27.1
1261	13.8	14.5	17.6	21.0	23.9	26.0	26.0
1262	13.7	14.4	17.5	20.9	23.8	25.9	25.9
1263	14.0	14.7	17.8	21.2	24.1	26.2	26.2
1264	13.9	14.6	17.7	21.1	24.0	26.1	26.1
1265	14.2	14.9	18.0	21.4	24.3	26.4	26.4
1266	14.9	15.6	18.7	22.1	25.0	27.1	27.1
1267	14.9	15.6	18.7	22.1	25.0	27.1	27.1
1268	14.8	15.5	18.6	22.0	24.9	27.0	27.0
1269	15.9	16.6	19.7	23.1	26.0	28.1	28.1
1270	15.0	15.7	18.8	22.2	25.1	27.2	27.2
1271	15.1	15.8	18.9	22.3	25.2	27.3	27.3
1272	14.5	15.2	18.3	21.7	24.6	26.7	26.7
1273	14.8	15.5	18.6	22.0	24.9	27.0	27.0
1274	14.6	15.3	18.4	21.8	24.7	26.8	26.8
1275	14.3	15.0	18.1	21.5	24.4	26.5	26.5
1276	14.4	15.1	18.2	21.6	24.5	26.6	26.6
1278	14.2	14.9	18.0	21.4	24.3	26.4	26.4
1280	15.3	16.0	19.1	22.5	25.4	27.5	27.5
1281	14.7	15.4	18.5	21.9	24.8	26.9	26.9
1293	15.6	16.3	19.4	22.8	25.7	27.8	27.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1294	14.8	15.5	18.6	22.0	24.9	27.0	27.0
1295	14.4	15.1	18.2	21.6	24.5	26.6	26.6
1296	14.1	14.8	17.9	21.3	24.2	26.3	26.3
1297	14.1	14.8	17.9	21.3	24.2	26.3	26.3
1298	15.0	15.7	18.8	22.2	25.1	27.2	27.2
1299	11.7	12.4	15.5	18.9	21.8	23.9	23.9
1300	12.0	12.7	15.8	19.2	22.1	24.2	24.2
1398	13.1	13.8	16.9	20.3	23.2	25.3	25.3
1415	16.6	17.3	20.4	23.8	26.7	28.8	28.8
1416	16.9	17.6	20.7	24.1	27.0	29.1	29.1
1417	17.1	17.8	20.9	24.3	27.2	29.3	29.3
1418	18.4	19.1	22.2	25.6	28.5	30.6	30.6
1450	18.6	19.3	22.4	25.8	28.7	30.8	30.8
4064	16.0	16.7	19.8	23.2	26.1	28.2	28.2
4066	15.0	15.7	18.8	22.2	25.1	27.2	27.2
4154	15.6	16.3	19.4	22.8	25.7	27.8	27.8
4155	23.9	24.6	27.7	31.1	34.0	36.1	36.1
4183	17.3	18.0	21.1	24.5	27.4	29.5	29.5
4342	12.0	12.7	15.8	19.2	22.1	24.2	24.2
4343	12.2	12.9	16.0	19.4	22.3	24.4	24.4
4354	13.2	13.9	17.0	20.4	23.3	25.4	25.4
4377	14.0	14.7	17.8	21.2	24.1	26.2	26.2
4378*	21.8	22.5	25.6	29.0	31.9	34.0	34.0
4380	17.9	18.6	21.7	25.1	28.0	30.1	30.1
4381	22.0	22.7	25.8	29.2	32.1	34.2	34.2
4495	17.0	17.7	20.8	24.2	27.1	29.2	29.2
4496	18.5	19.2	22.3	25.7	28.6	30.7	30.7
4533	18.3	19.0	22.1	25.5	28.4	30.5	30.5
4534	21.9	22.6	25.7	29.1	32.0	34.1	34.1
4535	16.5	17.2	20.3	23.7	26.6	28.7	28.7
4539	15.7	16.4	19.5	22.9	25.8	27.9	27.9
4540	15.8	16.5	19.6	23.0	25.9	28.0	28.0

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
4577	15.5	16.2	19.3	22.7	25.6	27.7	27.7
4578	17.8	18.5	21.6	25.0	27.9	30.0	30.0
4579*	18.0	18.7	21.8	25.2	28.1	30.2	30.2
4581	22.3	23.0	26.1	29.5	32.4	34.5	34.5
4582	12.8	13.5	16.6	20.0	22.9	25.0	25.0
4583	15.7	16.4	19.5	22.9	25.8	27.9	27.9
4585	18.4	19.1	22.2	25.6	28.5	30.6	30.6
4587	21.0	21.7	24.8	28.2	31.1	33.2	33.2
4589	20.9	21.6	24.7	28.1	31.0	33.1	33.1

(S) Stakeholder receiver
* Identified as a future dwelling location on a title without an existing dwelling

Table 24: Predicted noise levels, dB L_{A90} – SG 6.0-170

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
92	11.1	11.4	16.1	19.9	23.1	23.9	23.9
93	10.9	11.2	15.9	19.7	22.9	23.7	23.7
94	11.7	12.0	16.7	20.5	23.7	24.5	24.5
95	11.3	11.6	16.3	20.1	23.3	24.1	24.1
217	12.4	12.7	17.4	21.2	24.4	25.2	25.2
218	12.3	12.6	17.3	21.1	24.3	25.1	25.1
226	11.2	11.5	16.2	20.0	23.2	24.0	24.0
229	13.3	13.6	18.3	22.1	25.3	26.1	26.1
232	12.1	12.4	17.1	20.9	24.1	24.9	24.9
237	12.7	13.0	17.7	21.5	24.7	25.5	25.5
524	11.9	12.2	16.9	20.7	23.9	24.7	24.7
525	13.0	13.3	18.0	21.8	25.0	25.8	25.8
526	14.5	14.8	19.5	23.3	26.5	27.3	27.3
527	14.4	14.7	19.4	23.2	26.4	27.2	27.2
528	14.6	14.9	19.6	23.4	26.6	27.4	27.4
529	14.8	15.1	19.8	23.6	26.8	27.6	27.6
530	13.3	13.6	18.3	22.1	25.3	26.1	26.1
532	11.2	11.5	16.2	20.0	23.2	24.0	24.0
533	14.8	15.1	19.8	23.6	26.8	27.6	27.6
534	14.9	15.2	19.9	23.7	26.9	27.7	27.7
535	15.1	15.4	20.1	23.9	27.1	27.9	27.9
536	14.8	15.1	19.8	23.6	26.8	27.6	27.6
537	15.3	15.6	20.3	24.1	27.3	28.1	28.1
540	14.8	15.1	19.8	23.6	26.8	27.6	27.6
541	14.5	14.8	19.5	23.3	26.5	27.3	27.3
542	15.1	15.4	20.1	23.9	27.1	27.9	27.9
543	15.2	15.5	20.2	24.0	27.2	28.0	28.0
544	15.0	15.3	20.0	23.8	27.0	27.8	27.8
545	15.3	15.6	20.3	24.1	27.3	28.1	28.1
546	15.4	15.7	20.4	24.2	27.4	28.2	28.2
547	15.3	15.6	20.3	24.1	27.3	28.1	28.1

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
548	15.4	15.7	20.4	24.2	27.4	28.2	28.2
549	15.5	15.8	20.5	24.3	27.5	28.3	28.3
550	15.3	15.6	20.3	24.1	27.3	28.1	28.1
551	15.3	15.6	20.3	24.1	27.3	28.1	28.1
552	15.5	15.8	20.5	24.3	27.5	28.3	28.3
564	11.7	12.0	16.7	20.5	23.7	24.5	24.5
565	11.7	12.0	16.7	20.5	23.7	24.5	24.5
566	12.3	12.6	17.3	21.1	24.3	25.1	25.1
567	13.0	13.3	18.0	21.8	25.0	25.8	25.8
568	13.8	14.1	18.8	22.6	25.8	26.6	26.6
569	14.1	14.4	19.1	22.9	26.1	26.9	26.9
570	15.2	15.5	20.2	24.0	27.2	28.0	28.0
571	15.4	15.7	20.4	24.2	27.4	28.2	28.2
572	15.5	15.8	20.5	24.3	27.5	28.3	28.3
573	15.5	15.8	20.5	24.3	27.5	28.3	28.3
574	15.3	15.6	20.3	24.1	27.3	28.1	28.1
575	15.4	15.7	20.4	24.2	27.4	28.2	28.2
576	15.5	15.8	20.5	24.3	27.5	28.3	28.3
577	15.3	15.6	20.3	24.1	27.3	28.1	28.1
578	15.4	15.7	20.4	24.2	27.4	28.2	28.2
579	15.1	15.4	20.1	23.9	27.1	27.9	27.9
580	12.0	12.3	17.0	20.8	24.0	24.8	24.8
582	15.5	15.8	20.5	24.3	27.5	28.3	28.3
583	15.4	15.7	20.4	24.2	27.4	28.2	28.2
584	15.6	15.9	20.6	24.4	27.6	28.4	28.4
585	15.7	16.0	20.7	24.5	27.7	28.5	28.5
586	15.5	15.8	20.5	24.3	27.5	28.3	28.3
587	15.8	16.1	20.8	24.6	27.8	28.6	28.6
588	16.0	16.3	21.0	24.8	28.0	28.8	28.8
589	16.1	16.4	21.1	24.9	28.1	28.9	28.9
590	16.5	16.8	21.5	25.3	28.5	29.3	29.3
591	16.6	16.9	21.6	25.4	28.6	29.4	29.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
592	16.3	16.6	21.3	25.1	28.3	29.1	29.1
593	17.1	17.4	22.1	25.9	29.1	29.9	29.9
594	17.5	17.8	22.5	26.3	29.5	30.3	30.3
595	17.9	18.2	22.9	26.7	29.9	30.7	30.7
596	18.2	18.5	23.2	27.0	30.2	31.0	31.0
597	18.3	18.6	23.3	27.1	30.3	31.1	31.1
598	19.2	19.5	24.2	28.0	31.2	32.0	32.0
599	19.8	20.1	24.8	28.6	31.8	32.6	32.6
600	20.3	20.6	25.3	29.1	32.3	33.1	33.1
601	20.4	20.7	25.4	29.2	32.4	33.2	33.2
602	21.2	21.5	26.2	30.0	33.2	34.0	34.0
603	20.9	21.2	25.9	29.7	32.9	33.7	33.7
604*	20.8	21.1	25.8	29.6	32.8	33.6	33.6
605	21.6	21.9	26.6	30.4	33.6	34.4	34.4
606	23.0	23.3	28.0	31.8	35.0	35.8	35.8
607	20.3	20.6	25.3	29.1	32.3	33.1	33.1
608	21.8	22.1	26.8	30.6	33.8	34.6	34.6
609	23.0	23.3	28.0	31.8	35.0	35.8	35.8
610	22.4	22.7	27.4	31.2	34.4	35.2	35.2
611	20.5	20.8	25.5	29.3	32.5	33.3	33.3
612	18.3	18.6	23.3	27.1	30.3	31.1	31.1
613	18.6	18.9	23.6	27.4	30.6	31.4	31.4
614	17.2	17.5	22.2	26.0	29.2	30.0	30.0
615	16.8	17.1	21.8	25.6	28.8	29.6	29.6
616	16.6	16.9	21.6	25.4	28.6	29.4	29.4
617	15.6	15.9	20.6	24.4	27.6	28.4	28.4
620	13.1	13.4	18.1	21.9	25.1	25.9	25.9
662	12.2	12.5	17.2	21.0	24.2	25.0	25.0
663	12.3	12.6	17.3	21.1	24.3	25.1	25.1
664	10.8	11.1	15.8	19.6	22.8	23.6	23.6
665	10.8	11.1	15.8	19.6	22.8	23.6	23.6
666	11.1	11.4	16.1	19.9	23.1	23.9	23.9

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
667	11.1	11.4	16.1	19.9	23.1	23.9	23.9
668	10.9	11.2	15.9	19.7	22.9	23.7	23.7
669	10.9	11.2	15.9	19.7	22.9	23.7	23.7
670	11.2	11.5	16.2	20.0	23.2	24.0	24.0
671	11.4	11.7	16.4	20.2	23.4	24.2	24.2
672	11.3	11.6	16.3	20.1	23.3	24.1	24.1
673	11.0	11.3	16.0	19.8	23.0	23.8	23.8
732	15.0	15.3	20.0	23.8	27.0	27.8	27.8
733	16.5	16.8	21.5	25.3	28.5	29.3	29.3
734	16.9	17.2	21.9	25.7	28.9	29.7	29.7
735	17.1	17.4	22.1	25.9	29.1	29.9	29.9
736	14.4	14.7	19.4	23.2	26.4	27.2	27.2
737	14.1	14.4	19.1	22.9	26.1	26.9	26.9
738	14.0	14.3	19.0	22.8	26.0	26.8	26.8
739	14.8	15.1	19.8	23.6	26.8	27.6	27.6
742	14.6	14.9	19.6	23.4	26.6	27.4	27.4
743	14.9	15.2	19.9	23.7	26.9	27.7	27.7
744	15.6	15.9	20.6	24.4	27.6	28.4	28.4
745	15.5	15.8	20.5	24.3	27.5	28.3	28.3
746	15.3	15.6	20.3	24.1	27.3	28.1	28.1
747	15.3	15.6	20.3	24.1	27.3	28.1	28.1
748	14.7	15.0	19.7	23.5	26.7	27.5	27.5
755	16.1	16.4	21.1	24.9	28.1	28.9	28.9
756	16.6	16.9	21.6	25.4	28.6	29.4	29.4
757	15.8	16.1	20.8	24.6	27.8	28.6	28.6
758	15.9	16.2	20.9	24.7	27.9	28.7	28.7
759	15.6	15.9	20.6	24.4	27.6	28.4	28.4
760	15.7	16.0	20.7	24.5	27.7	28.5	28.5
761	15.1	15.4	20.1	23.9	27.1	27.9	27.9
762	14.9	15.2	19.9	23.7	26.9	27.7	27.7
763	15.3	15.6	20.3	24.1	27.3	28.1	28.1
764	15.8	16.1	20.8	24.6	27.8	28.6	28.6

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
765	15.8	16.1	20.8	24.6	27.8	28.6	28.6
766	16.0	16.3	21.0	24.8	28.0	28.8	28.8
767	18.2	18.5	23.2	27.0	30.2	31.0	31.0
779	19.6	19.9	24.6	28.4	31.6	32.4	32.4
781	19.1	19.4	24.1	27.9	31.1	31.9	31.9
782	18.4	18.7	23.4	27.2	30.4	31.2	31.2
783	20.1	20.4	25.1	28.9	32.1	32.9	32.9
784	18.2	18.5	23.2	27.0	30.2	31.0	31.0
785	17.6	17.9	22.6	26.4	29.6	30.4	30.4
786	17.2	17.5	22.2	26.0	29.2	30.0	30.0
787	17.0	17.3	22.0	25.8	29.0	29.8	29.8
788	16.6	16.9	21.6	25.4	28.6	29.4	29.4
789	16.3	16.6	21.3	25.1	28.3	29.1	29.1
790	15.9	16.2	20.9	24.7	27.9	28.7	28.7
791	15.9	16.2	20.9	24.7	27.9	28.7	28.7
792	15.2	15.5	20.2	24.0	27.2	28.0	28.0
793	12.2	12.5	17.2	21.0	24.2	25.0	25.0
794	13.1	13.4	18.1	21.9	25.1	25.9	25.9
795	18.1	18.4	23.1	26.9	30.1	30.9	30.9
796	16.0	16.3	21.0	24.8	28.0	28.8	28.8
797	16.9	17.2	21.9	25.7	28.9	29.7	29.7
798	14.8	15.1	19.8	23.6	26.8	27.6	27.6
799	15.0	15.3	20.0	23.8	27.0	27.8	27.8
800	14.7	15.0	19.7	23.5	26.7	27.5	27.5
801	14.5	14.8	19.5	23.3	26.5	27.3	27.3
802	14.2	14.5	19.2	23.0	26.2	27.0	27.0
803	14.0	14.3	19.0	22.8	26.0	26.8	26.8
804	14.0	14.3	19.0	22.8	26.0	26.8	26.8
805	13.9	14.2	18.9	22.7	25.9	26.7	26.7
806	13.7	14.0	18.7	22.5	25.7	26.5	26.5
807	14.5	14.8	19.5	23.3	26.5	27.3	27.3
808	14.7	15.0	19.7	23.5	26.7	27.5	27.5

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
809	17.6	17.9	22.6	26.4	29.6	30.4	30.4
810	15.4	15.7	20.4	24.2	27.4	28.2	28.2
811	17.2	17.5	22.2	26.0	29.2	30.0	30.0
817	15.4	15.7	20.4	24.2	27.4	28.2	28.2
818	15.9	16.2	20.9	24.7	27.9	28.7	28.7
819	16.9	17.2	21.9	25.7	28.9	29.7	29.7
820	19.7	20.0	24.7	28.5	31.7	32.5	32.5
821	20.0	20.3	25.0	28.8	32.0	32.8	32.8
822	21.1	21.4	26.1	29.9	33.1	33.9	33.9
823	22.7	23.0	27.7	31.5	34.7	35.5	35.5
824	22.1	22.4	27.1	30.9	34.1	34.9	34.9
825	19.1	19.4	24.1	27.9	31.1	31.9	31.9
826	19.9	20.2	24.9	28.7	31.9	32.7	32.7
827	20.7	21.0	25.7	29.5	32.7	33.5	33.5
828	22.2	22.5	27.2	31.0	34.2	35.0	35.0
829	22.1	22.4	27.1	30.9	34.1	34.9	34.9
830	21.7	22.0	26.7	30.5	33.7	34.5	34.5
832	23.1	23.4	28.1	31.9	35.1	35.9	35.9
833	19.4	19.7	24.4	28.2	31.4	32.2	32.2
834	19.2	19.5	24.2	28.0	31.2	32.0	32.0
835	18.9	19.2	23.9	27.7	30.9	31.7	31.7
836	15.0	15.3	20.0	23.8	27.0	27.8	27.8
837	19.6	19.9	24.6	28.4	31.6	32.4	32.4
838	22.0	22.3	27.0	30.8	34.0	34.8	34.8
839	14.7	15.0	19.7	23.5	26.7	27.5	27.5
840	14.0	14.3	19.0	22.8	26.0	26.8	26.8
844	16.8	17.1	21.8	25.6	28.8	29.6	29.6
845	16.7	17.0	21.7	25.5	28.7	29.5	29.5
846	16.7	17.0	21.7	25.5	28.7	29.5	29.5
847	20.8	21.1	25.8	29.6	32.8	33.6	33.6
848	21.5	21.8	26.5	30.3	33.5	34.3	34.3
849	21.0	21.3	26.0	29.8	33.0	33.8	33.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
850	20.7	21.0	25.7	29.5	32.7	33.5	33.5
851	20.3	20.6	25.3	29.1	32.3	33.1	33.1
852	19.7	20.0	24.7	28.5	31.7	32.5	32.5
853	23.2	23.5	28.2	32.0	35.2	36.0	36.0
854	17.0	17.3	22.0	25.8	29.0	29.8	29.8
855	17.1	17.4	22.1	25.9	29.1	29.9	29.9
856	15.8	16.1	20.8	24.6	27.8	28.6	28.6
857	18.7	19.0	23.7	27.5	30.7	31.5	31.5
858	18.1	18.4	23.1	26.9	30.1	30.9	30.9
859	17.7	18.0	22.7	26.5	29.7	30.5	30.5
860	17.2	17.5	22.2	26.0	29.2	30.0	30.0
861	16.5	16.8	21.5	25.3	28.5	29.3	29.3
862	21.3	21.6	26.3	30.1	33.3	34.1	34.1
863	22.4	22.7	27.4	31.2	34.4	35.2	35.2
864	23.7	24.0	28.7	32.5	35.7	36.5	36.5
865	17.9	18.2	22.9	26.7	29.9	30.7	30.7
866	18.5	18.8	23.5	27.3	30.5	31.3	31.3
867	18.7	19.0	23.7	27.5	30.7	31.5	31.5
868	15.0	15.3	20.0	23.8	27.0	27.8	27.8
869	15.2	15.5	20.2	24.0	27.2	28.0	28.0
870	18.9	19.2	23.9	27.7	30.9	31.7	31.7
871	21.1	21.4	26.1	29.9	33.1	33.9	33.9
872	21.7	22.0	26.7	30.5	33.7	34.5	34.5
873	21.7	22.0	26.7	30.5	33.7	34.5	34.5
874	20.2	20.5	25.2	29.0	32.2	33.0	33.0
875	22.7	23.0	27.7	31.5	34.7	35.5	35.5
876	16.1	16.4	21.1	24.9	28.1	28.9	28.9
877	16.9	17.2	21.9	25.7	28.9	29.7	29.7
878	16.0	16.3	21.0	24.8	28.0	28.8	28.8
879	15.6	15.9	20.6	24.4	27.6	28.4	28.4
880	13.7	14.0	18.7	22.5	25.7	26.5	26.5
881	13.5	13.8	18.5	22.3	25.5	26.3	26.3

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
882	14.0	14.3	19.0	22.8	26.0	26.8	26.8
883	14.5	14.8	19.5	23.3	26.5	27.3	27.3
884	13.4	13.7	18.4	22.2	25.4	26.2	26.2
885	12.8	13.1	17.8	21.6	24.8	25.6	25.6
886	13.8	14.1	18.8	22.6	25.8	26.6	26.6
887	13.1	13.4	18.1	21.9	25.1	25.9	25.9
888	13.3	13.6	18.3	22.1	25.3	26.1	26.1
889	13.5	13.8	18.5	22.3	25.5	26.3	26.3
890	13.4	13.7	18.4	22.2	25.4	26.2	26.2
891	14.5	14.8	19.5	23.3	26.5	27.3	27.3
892	16.5	16.8	21.5	25.3	28.5	29.3	29.3
893	18.8	19.1	23.8	27.6	30.8	31.6	31.6
894	18.1	18.4	23.1	26.9	30.1	30.9	30.9
895	12.1	12.4	17.1	20.9	24.1	24.9	24.9
1158	14.8	15.1	19.8	23.6	26.8	27.6	27.6
1159	15.6	15.9	20.6	24.4	27.6	28.4	28.4
1160	17.4	17.7	22.4	26.2	29.4	30.2	30.2
1161	17.1	17.4	22.1	25.9	29.1	29.9	29.9
1162	17.4	17.7	22.4	26.2	29.4	30.2	30.2
1163	18.0	18.3	23.0	26.8	30.0	30.8	30.8
1165	18.3	18.6	23.3	27.1	30.3	31.1	31.1
1166	18.5	18.8	23.5	27.3	30.5	31.3	31.3
1167	18.8	19.1	23.8	27.6	30.8	31.6	31.6
1168	19.3	19.6	24.3	28.1	31.3	32.1	32.1
1169	19.6	19.9	24.6	28.4	31.6	32.4	32.4
1170	21.8	22.1	26.8	30.6	33.8	34.6	34.6
1171	22.3	22.6	27.3	31.1	34.3	35.1	35.1
1172	17.7	18.0	22.7	26.5	29.7	30.5	30.5
1173	16.7	17.0	21.7	25.5	28.7	29.5	29.5
1174	18.8	19.1	23.8	27.6	30.8	31.6	31.6
1175	15.9	16.2	20.9	24.7	27.9	28.7	28.7
1176	16.5	16.8	21.5	25.3	28.5	29.3	29.3

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1177	16.1	16.4	21.1	24.9	28.1	28.9	28.9
1178	15.7	16.0	20.7	24.5	27.7	28.5	28.5
1179	15.5	15.8	20.5	24.3	27.5	28.3	28.3
1180	14.9	15.2	19.9	23.7	26.9	27.7	27.7
1182	14.3	14.6	19.3	23.1	26.3	27.1	27.1
1235	15.2	15.5	20.2	24.0	27.2	28.0	28.0
1255	12.2	12.5	17.2	21.0	24.2	25.0	25.0
1256	12.4	12.7	17.4	21.2	24.4	25.2	25.2
1257	12.6	12.9	17.6	21.4	24.6	25.4	25.4
1258	12.4	12.7	17.4	21.2	24.4	25.2	25.2
1259	12.8	13.1	17.8	21.6	24.8	25.6	25.6
1260	13.9	14.2	18.9	22.7	25.9	26.7	26.7
1261	12.9	13.2	17.9	21.7	24.9	25.7	25.7
1262	12.9	13.2	17.9	21.7	24.9	25.7	25.7
1263	13.1	13.4	18.1	21.9	25.1	25.9	25.9
1264	13.0	13.3	18.0	21.8	25.0	25.8	25.8
1265	13.3	13.6	18.3	22.1	25.3	26.1	26.1
1266	13.9	14.2	18.9	22.7	25.9	26.7	26.7
1267	13.9	14.2	18.9	22.7	25.9	26.7	26.7
1268	14.0	14.3	19.0	22.8	26.0	26.8	26.8
1269	14.8	15.1	19.8	23.6	26.8	27.6	27.6
1270	13.9	14.2	18.9	22.7	25.9	26.7	26.7
1271	14.1	14.4	19.1	22.9	26.1	26.9	26.9
1272	13.5	13.8	18.5	22.3	25.5	26.3	26.3
1273	13.9	14.2	18.9	22.7	25.9	26.7	26.7
1274	13.7	14.0	18.7	22.5	25.7	26.5	26.5
1275	13.4	13.7	18.4	22.2	25.4	26.2	26.2
1276	13.5	13.8	18.5	22.3	25.5	26.3	26.3
1278	13.3	13.6	18.3	22.1	25.3	26.1	26.1
1280	14.3	14.6	19.3	23.1	26.3	27.1	27.1
1281	13.8	14.1	18.8	22.6	25.8	26.6	26.6
1293	14.6	14.9	19.6	23.4	26.6	27.4	27.4

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
1294	13.8	14.1	18.8	22.6	25.8	26.6	26.6
1295	13.8	14.1	18.8	22.6	25.8	26.6	26.6
1296	13.1	13.4	18.1	21.9	25.1	25.9	25.9
1297	13.1	13.4	18.1	21.9	25.1	25.9	25.9
1298	14.0	14.3	19.0	22.8	26.0	26.8	26.8
1299	10.9	11.2	15.9	19.7	22.9	23.7	23.7
1300	11.2	11.5	16.2	20.0	23.2	24.0	24.0
1398	12.3	12.6	17.3	21.1	24.3	25.1	25.1
1415	15.7	16.0	20.7	24.5	27.7	28.5	28.5
1416	16.0	16.3	21.0	24.8	28.0	28.8	28.8
1417	16.1	16.4	21.1	24.9	28.1	28.9	28.9
1418	17.4	17.7	22.4	26.2	29.4	30.2	30.2
1450	17.5	17.8	22.5	26.3	29.5	30.3	30.3
4064	15.1	15.4	20.1	23.9	27.1	27.9	27.9
4066	14.1	14.4	19.1	22.9	26.1	26.9	26.9
4154	14.6	14.9	19.6	23.4	26.6	27.4	27.4
4155	22.8	23.1	27.8	31.6	34.8	35.6	35.6
4183	16.5	16.8	21.5	25.3	28.5	29.3	29.3
4342	11.1	11.4	16.1	19.9	23.1	23.9	23.9
4343	11.3	11.6	16.3	20.1	23.3	24.1	24.1
4354	12.3	12.6	17.3	21.1	24.3	25.1	25.1
4377	13.1	13.4	18.1	21.9	25.1	25.9	25.9
4378*	20.7	21.0	25.7	29.5	32.7	33.5	33.5
4380	16.9	17.2	21.9	25.7	28.9	29.7	29.7
4381	20.9	21.2	25.9	29.7	32.9	33.7	33.7
4495	16.0	16.3	21.0	24.8	28.0	28.8	28.8
4496	17.6	17.9	22.6	26.4	29.6	30.4	30.4
4533	17.3	17.6	22.3	26.1	29.3	30.1	30.1
4534	20.8	21.1	25.8	29.6	32.8	33.6	33.6
4535	15.6	15.9	20.6	24.4	27.6	28.4	28.4
4539	14.8	15.1	19.8	23.6	26.8	27.6	27.6
4540	15.0	15.3	20.0	23.8	27.0	27.8	27.8

Receiver	Hub-height wind speed (m/s)						
	4	5	6	7	8	9	≥10
4577	14.6	14.9	19.6	23.4	26.6	27.4	27.4
4578	16.8	17.1	21.8	25.6	28.8	29.6	29.6
4579*	17.1	17.4	22.1	25.9	29.1	29.9	29.9
4581	21.2	21.5	26.2	30.0	33.2	34.0	34.0
4582	12.0	12.3	17.0	20.8	24.0	24.8	24.8
4583	14.8	15.1	19.8	23.6	26.8	27.6	27.6
4585	17.4	17.7	22.4	26.2	29.4	30.2	30.2
4587	19.9	20.2	24.9	28.7	31.9	32.7	32.7
4589	19.8	20.1	24.8	28.6	31.8	32.6	32.6

(S) Stakeholder receiver
* Identified as a future dwelling location on a title without an existing dwelling

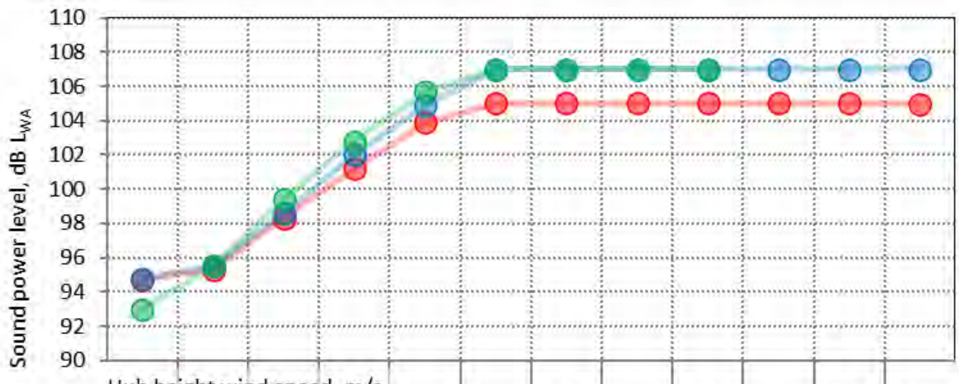
APPENDIX J NZS 6808:2010 DOCUMENTATION

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

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

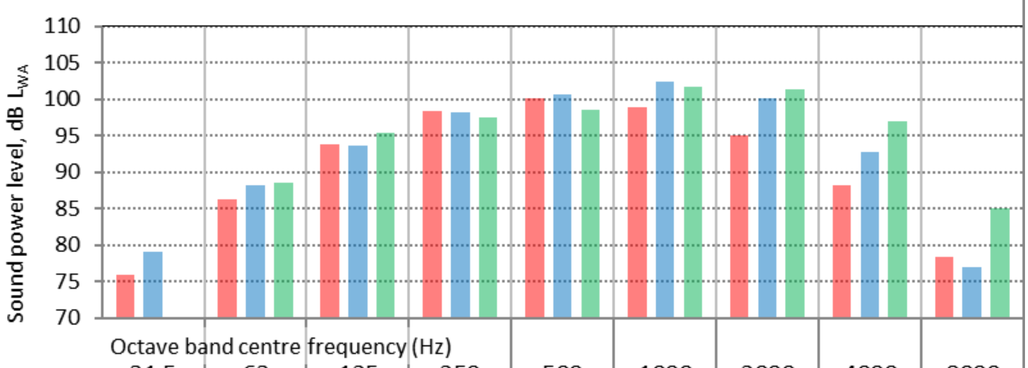
(c) Wind turbine sound power levels, L_{WA} dB (refer to Section 6.3.1)

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



Hub height wind speed, m/s	4	5	6	7	8	9	10	11	12	13	14	15
V162-5.6MW	94.7	95.3	98.3	101.2	103.9	105.0	105.0	105.0	105.0	105.0	105.0	105.0
GE 5.5-158	94.8	95.5	98.6	102.0	104.9	107.0	107.0	107.0	107.0	107.0	107.0	107.0
SG 6.0-170	93.0	95.5	99.4	102.8	105.7	107.0	107.0	107.0	107.0			

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



Octave band centre frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
V162-5.6MW	76.0	86.4	93.8	98.3	100.1	99.0	94.9	88.2	78.5
GE 5.5-158	79.0	88.2	93.6	98.2	100.7	102.3	100.1	92.7	77.0
SG 6.0-170		88.5	95.3	97.5	98.5	101.7	101.4	96.9	85.1

(d) Wind turbine model: See Table 8 of Section 6.2

(e) Turbine hub height: See Table 8 of Section 6.2

(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 v8.2 (See Section 4.0 and Appendix H)

(h) Meteorological conditions assumed:

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

(i) Air absorption parameters:

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

(j) Topography/screening: 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 6.2 and Appendix I.

APPENDIX K CONSTRUCTION EQUIPMENT DATA

It is anticipated that a variety of construction equipment would be used for this project.

Sound power levels for the types of equipment used to construct a wind farm have been determined from guidance and data sources including Australian Standard AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436:2010), and noise level data from previous projects of a similar nature.

Table 25 summarises the noise emissions used to represent key items of plant associated with construction.

Table 25: Construction noise sources sound power data, dB L_{WA}

Noise source	Sound Power Level
Excavator fitted with pneumatic breaker	118
Excavator (100 to 200 kW)	107
Tracked loaders	115
Crane (200 t)	105
Crane (500 t)	110
Crane (1200 t)	115
Delivery Trucks	107
Concrete trucks	108
Dump truck	117
Concrete pump	108
Generator	99
Grader	110
Bulldozer	108

Overall aggregated total sound power levels for key construction tasks have been determined on the basis of a typical schedule of equipment associated with each task. The actual equipment choices and equipment numbers for each task are not presently defined in detail, and therefore the schedule of equipment listed here does not represent a final or definitive list of plant. The equipment schedule has therefore presented solely as an indication of construction noise levels.

The overall total aggregated sound power levels for each of the key construction tasks are detailed in Table 26, and assume that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period.

Table 26: Overall sound power levels of key construction tasks

Construction task	Plant/Equipment	Approximate overall sound power level, dB L_{WA}
Access road construction	2x Excavator (100 to 200kW), 1x Tracked loaders, 2x Dump truck, 1x Grader, 1x Bulldozer	120
Cable trench digging	1x Excavator (100 to 200kW), 1x Dump truck, 1x Generator, 1x Bulldozer	120
Concrete batching plant	1x Concrete trucks, 1x Concrete pump, 1x Batching Plant	115
Site compound construction	1x Excavator (100 to 200kW), 1x Crane (200t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	115
Substation construction	1x Excavator (100 to 200kW), 1x Crane (500t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	115
Temporary site compound construction	1x Excavator (100 to 200kW), 1x Crane (200t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	115
Turbine assembly	2x Crane (200t), 2x Crane (500t), 1x Crane (1200t), 1x Generator	120
Turbine foundations	1x Excavator fitted with pneumatic breaker, 1x Excavator (100 to 200kW), 1x Crane (200t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	120