Chapter 13
Noise and vibration

13.1 Overview

This chapter describes the potential noise and vibration impacts of the construction, operation and decommissioning of the project, and measures that were taken to avoid and minimise these potential adverse impacts. This chapter is based on the findings of the noise and vibration assessment (Appendix E1), prepared by Sonus Pty Ltd.

A verification of the Sonus noise and vibration assessment was undertaken by EnviroRisk Management under Part 8.3 of the *Environment Protection Act 2017* (Appendix E2). An independent peer review of both the noise and vibration assessment and management plan was undertaken by Resonate Consultants (Appendix E3).

The potential impacts of blasting at the temporary on-site quarry were assessed in the blast impact assessment undertaken by Terrock Consulting Engineers (Appendix E4), with the findings summarised in this chapter.

Background noise monitoring was undertaken at 12 dwellings within and around the project site, measured in 10-minute intervals, to determine the baseline conditions and operational noise criteria. The results from the noise monitoring indicate that background noise levels are typically less than 50 dB(A) at all wind speeds, with some monitoring locations recording noise levels between 50–60 dB(A) at wind speeds above 6 metres per second. These noise levels are typical of rural environments. The noise data collected at each monitoring location was correlated with the wind speed at hub height (i.e., 169 metres) for each 10-minute measurement period to determine the noise criteria at the monitoring locations. Additional background noise monitoring is proposed to be conducted prior to construction to assist with identifying the component of noise from the wind farm during compliance monitoring.

To comply with the general environmental duty relating to noise, the approach has been to first avoid or limit potential impacts by creating appropriate separation distances between proposed project infrastructure (such as the quarry, concrete batching plants and the wind turbines) and sensitive receptors (in this case dwellings). Further management controls would then be implemented in accordance with relevant regulations and guidelines prior to and during construction, operation and decommissioning.

During project construction, potential noise- and vibration-generating activities would include works associated with access track construction, civil works, excavation, foundation construction, electrical infrastructure works and turbine erection. A detailed assessment of the noise from these construction activities, based on maximum overall sound power levels, was undertaken as part of the project Construction Noise Assessment (attached to Appendix E1). Potential vibration impacts during construction were assessed to be well below relevant standards for building damage.

Activities that may generate noise and vibration impacts at the project's on-site quarry include large mobile plant (crushers, dozers and trucks), as well as blasting. Noise impacts at the on-site quarry were modelled using the CONCAWE noise model and assessed in accordance with EPA Victoria Publication 1826.4: *Noise limit and assessment protocol* (the Noise Protocol). Vibration impacts from blasting were assessed in the blast impact assessment against the Earth Resources Regulation guideline limits and Australian Standard AS 2187.2-2006 criteria for ground vibration. Noise levels produced from operating the on-site quarry were predicted to be well below the noise criteria without any specific noise treatments. Similarly, predicted noise levels from construction activities are predicted to be considerably less than the relevant criteria.

Noise during operation may result from the wind turbines (from wind turbine generators and the movement of rotor blades), and on-site substation, battery facility and ancillary activities (which include noise-generating equipment such as transformers, inverters and cooling management systems). Noise from wind turbines was modelled in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise*, while noise from the battery facility and on-site substation was determined using the CONCAWE model.

Modelling predicts that noise generated from wind turbines would meet the New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise* at all dwellings of landowners not hosting wind farm infrastructure (i.e., non-stakeholders). Similarly, noise predictions from the on-site substation and battery facility show they would achieve the noise limit, with the adoption of a reduced noise level transformer.

Vibration generated from wind turbines during operation was assessed in accordance with the criteria of the International Standard ISO 10137 – 2007, which is the relevant standard for human annoyance. Modern operating wind farms produce very low levels of ground vibration. Based on measurements at operating wind turbines, the ground vibration from the wind turbines was predicted to be undetectable at the distance dwellings would be from turbines.

The cumulative noise assessment identified that the New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise* would be achieved for all wind speeds at all dwellings between the operating and proposed wind farms. Cumulative noise of other wind farms in the vicinity (i.e., Macarthur, Ryan Corner, Hawkesdale and Woolsthorpe wind farms) were considered in the noise assessment for the project and is further discussed in Chapter 24 – *Cumulative effects*.

13.2 EES objectives and key issues

The EES scoping requirements specify the draft evaluation objective and key issues, outlined in Table 13.1, relevant to noise and vibration that have guided this assessment.

Table 13.1 EES draft evaluation objective and key issues

Draft evaluation objective	
Noise and vibration: *To minimise and manage adverse air quality and noise and vibration effects on residents and local communities as far as practicable during construction, operation and decommissioning having regard to applicable limits, targets or standards.*	
Key issues	Potential for adverse effects on noise and vibration amenity at sensitive receptors during construction, operation and decommissioning (including on-site quarry).

Matters relating to air quality are presented in Chapter 20 – *Air quality* and Appendix L – *Air quality*.

13.3 Legislation, policy and guidelines

Key legislation, policies and guidelines relevant to noise and vibration for the project are summarised in Table 13.2 below and would assist in achieving compliance with the general environmental duty.

Table 13.2 Relevant legislation and guidelines

Legislation, policy and guidelines	Description	Relevance to project
State		
Environment Protection Act 2017	The *Environment Protection Act 2017* and the *Environment Protection Amendment Act 2018* establish the legislative framework for protecting the environment in Victoria. The General Environmental Duty requires that: 'A person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable'.	The project is being developed under the provisions of the new *Environment Protection Act 2017* that relate to the project's general environmental duty and is required to demonstrate it is implementing measures so far as 'reasonably practicable' to minimise the risk of harm to human health and the environment (refer to Chapter 3 – *Legislation and policy framework*). Regulation 131C of the *Environment Protection Amendment (Interim) Regulations 2021* (Wind Farm Regulations) (see below) refers to duties of operators of wind farms and provides that operators must ensure compliance with the noise limits in the relevant standard (for the project, this is NZS6808:2010). The 'note' under s131C stipulates that compliance with section 131C achieves compliance with section 25(1) of the *Environment Protection Act 2017*, being the general environmental duty.
	Environment Protection Regulations 2021	The Environment Protection Regulations 2021 specify the base noise limits for noise emissions in urban and rural areas from commercial, industrial and trade premises. These base noise limits were used to determine the criteria for the assessment of the project's on-site quarry.
	Environment Protection Amendment (Interim) Regulations 2021	The Environment Protection Amendment (Wind Turbine Noise) Regulations 2021 were introduced on 27 July 2021 (under the *Environment Protection Act 2017*) to specify requirements relating to wind turbine noise from wind energy facilities, and outline measures to demonstrate compliance. However, these regulations were revoked on 26 October 2021 and interim regulations introduced (i.e., Environment Protection Amendment (Interim) Regulations 2021). These interim regulations will be effective for 12 months, or until replaced by new regulations. EPA Victoria is the primary regulator for operational wind turbine noise.

Legislation, policy and guidelines	Description	Relevance to project
Planning and Environment Act 1987	The Planning Policy Framework and Particular Provisions of the Moyne Shire Planning Scheme contains clauses relevant to noise and vibration.	A relevant Planning Policy Framework clause is 13.05-1S Noise abatement, with the objective being "*to assist the control of noise effects on sensitive land uses*". Particular provision Clause 52.32 Wind Energy Facility states that noise impacts of wind farm proposals are to be assessed accordance with the New Zealand Standard NZS6808:2010, *Acoustics - Wind Farm Noise*. An application must be accompanied by a pre-construction (predictive) noise assessment report and a report that verifies that the assessment demonstrates the project can comply with the noise limits specified in the New Zealand Standard. These reports are provided in Appendix E1 and E2, respectively.
EPA Victoria (2020d) *Publication 1834: Civil construction, building and demolition guide*	EPA Victoria Publication 1834 outlines controls for civil construction and earthworks to manage risks and obligations under the general environmental duty in relation to air, noise, land and water. This includes general information to assist with managing noise and vibration risks and obligations associated with scheduling works, community consultation, and controls for managing potential noise and vibration impacts.	The Construction Noise Assessment (provided in Appendix E1) was prepared in accordance with EPA Victorian Publication 1834.
EPA Victoria (2021a) *Publication 1826.4: Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*	EPA Victoria Publication 1826.4 (Noise Protocol) provides guidance in determining noise limits for new and existing commercial, industrial and trade premises in Victoria. The noise from wind energy facilities is specifically excluded, with the exception of that associated with substations and transmission infrastructure. The Noise Protocol provides a method to determine noise criteria for utilities in rural areas as well as recommended maximum noise levels for other commercial, industrial and trade premises based on the planning scheme zone of the noise source and noise receiver.	The assessment of noise from the project on-site substation, battery facility and on-site quarry was undertaken in accordance with the Noise Protocol.
EPA Victoria (2021b) *Publication 1996: Noise guidelines: Assessing low frequency noise*	EPA Victoria Publication 1996 provides guidance for determining the risk of "unreasonable noise" from low frequency noise emissions from commercial, industrial and trade premises. "Unreasonable noise" is defined under the *Environment Protection Act 2017* as noise that is unreasonable due to factors such as its volume, intensity or duration, character, or when or where the noise is emitted.	The noise from the on-site substation, battery facility and on-site quarry was assessed against the low frequency noise thresholds specified in EPA Victoria Publication 1996.

Legislation, policy and guidelines	Description	Relevance to project
Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (DELWP, 2021f)	The *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (Policy and Planning Guidelines) provide a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project, and guidance as to how planning permit application requirements might be met. The Policy and Planning Guidelines specify the noise sources which require consideration and the assessment approach required to ensure nearby dwellings are protected.	Wind turbine operational noise has been assessed in accordance with the Policy and Planning Guidelines. The noise criteria adopted under the Policy and Planning Guidelines is outlined in Section 13.6.5.
New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise*	New Zealand Standard 6808:2010 *Acoustics – Wind Farm Noise* (New Zealand Standard) provides methods for predicting, measuring and assessing noise from wind turbines. In accordance with the DELWP (2021f) Policy and Planning Guidelines, a pre-construction (predictive) noise assessment is required in accordance with the New Zealand Standard.	Wind turbine operational noise has been assessed in accordance with the New Zealand Standard. The noise criteria adopted under the New Zealand Standard is outlined in Section 13.6.5.
German Standard DIN 4150, *Structural Vibration – Part 3: Effects of Vibration on Structures*	German Standard DIN 4150 provides guidance when evaluating the effects of short-term vibration on structures.	Assessment of the impact of vibration on structures during construction was undertaken in accordance with the objective criteria of the German Standard DIN 4150.
International Standard ISO 10137:2007 *Bases for design of structures – Serviceability of buildings and walkways against vibrations*	International Standard ISO 10137:2007 provides 'base curves', which represent "*human response to vibration*". The 'base curves' are the most onerous vibration criteria provided by International Standard ISO 10137:2007 and are recommended for 'critical work areas' where even very minor levels of vibration could cause impacts (such as for hospital operating theatres, precision laboratories, etc.).	Assessment of the impact of vibration during operation was undertaken against the criteria specified in International Standard ISO 10137:2007.
Earth Resources Regulation *Guidelines and Codes of Practice: Ground Vibration and Airblast Limits for Blasting in Mines and Quarries*	The Earth Resources Regulation Guidelines provide guideline limits for ground vibration and airblast (overpressure) from quarry blasting. These limits apply at 'sensitive sites', which are defined as *"…any land within 10 metres of a residence, hospital, school, or other premises in which people could reasonably be expected to be free from undue annoyance and nuisance caused by blasting."*	The closest occupied dwelling to the project quarry site is located approximately 1,400 metres south-east of the proposed extraction area. Other dwellings are located more than 3 kilometres from the quarry site, distances at which blasting effects would be imperceptible or negligible.
Australian Standard AS 2187.2-2006: *Explosives - Storage and Use - Use of Explosives*	The Australian Standard AS 2187.2-2006 outlines the compliance requirements for import, export, supply or use of explosives, and the safe use un the mixing, testing initiation and firing of charges.	Criteria from Australian Standard AS 2187.2-2006 were used to determine ground vibration limits for preventing damage to buildings, including wind turbines.
Australian/New Zealand Standard AS/NZS60076.10:2009: *Power transformers – Determination of sound levels*	The Australian/New Zealand Standard AS/NZS60076.10:2009 outlines methods for measuring sound pressure and intensity emitted by power transformers and other associated equipment.	Noise levels assumed for the project transformers were derived from the Australian/New Zealand Standard AS/NZS60076.10:2009.

13.3.1 Working hours

EPA Victoria Publication 1834 specifies normal working hours as:

- Monday to Friday, 7 am to 6 pm
- Saturday, 7 am to 1 pm.

While there is no objective criterion that must be achieved during normal working hours, management measures would be implemented during construction (so far as 'reasonably practicable') to minimise the risk of harm to human health and the environment from construction noise in accordance with the general environmental duty.

Construction activities may also occur of outside these hours, subject to the requirements for work 'outside normal working hours'. For major infrastructure projects, such as energy facilities, EPA Victoria Publication 1834 defines 'outside normal working hours' as:

- Monday to Friday, 6 pm to 10 pm
- Saturday, 1 pm to 10 pm
- Sundays and public holidays, 7 am to 10 pm.

The following types of work may occur at these times, subject to specific requirements and approval from the relevant authority:

- low-noise impact works (quiet or unobtrusive works)
- managed-impact works (where noise emissions are managed through controls outlined in the Construction Noise Assessment)
- unavoidable works (works that cannot be reasonably moved to normal work hours and that pose an unacceptable risk to life or property or a major traffic hazard, and can be justified. Notification would be provided to affected sensitive receivers of the intended work).

Any justified 'low-noise impact works' or 'managed-impact works' must not exceed background noise at residential premises by 10 dB(A) or more for up to 18 months after project commencement, or 5 dB(A) or more after 18 months.

The blast firing times, to be specified in the quarry work plan typically would be restricted to weekdays between 10 am and 4 pm (Attachment II – Preliminary *draft quarry work plan*).

13.3.2 Environmental noise criteria

Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria

The DELWP (2021f) Policy and Planning Guidelines recommend a 45 dB(A) noise limit for stakeholder dwellings. A 'stakeholder dwelling' refers to a dwelling located on the same land as the wind energy facility, or one that has an agreement with the wind energy facility to exceed the noise limit.

The New Zealand Standard is referenced by the Policy and Planning Guidelines and provides further guidance and objective requirements for wind farm operations.

New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise

For wind energy facilities, the New Zealand Standard specifies that any sound levels associated with the facility should not exceed a 40 dB(A) ($L_{A90(10min)}$) noise limit at noise sensitive locations (outdoors) or exceed existing background sound levels by more than 5 dB(A) (whichever is the greater).

In 'high amenity areas' (i.e., areas where a higher degree of amenity protection for the sound environment is required) the noise limit becomes the background noise level plus 5 dB(A), or a level of 35 dB(A) (whichever is the greater). Noise sensitive locations outside the 35 dB(A) ($L_{A90(10\ min)}$) contour do not need to be considered.

All dwellings within the 35 dB(A) contour are located within the Farming Zone. A Victorian Civil and Administrative Tribunal determination and panel report for the Cherry Tree Wind Farm (Cherry Tree Wind Farm Pty Ltd v Mitchell Shire Council, 2013) found that Farming Zones do not promote a higher degree of protection of amenity related to the sound environment. The determination is referenced and supported in the Golden Plains Wind Farm panel report. As such, it is considered that the criteria for 'high amenity areas' do not apply to the project.

The rationale for setting criteria for wind energy facilities is discussed in Section 13.5.2.

Noise Protocol

EPA Victoria Publication 1826.4 (Noise Protocol) provides a method to determine noise criteria for rural areas for earth resources premises (includes quarry sites within the site's approved working area) and utilities (includes noise from substations and battery facilities).

On-site substation and battery facility

The noise from operation of the on-site substation and battery facility, located within the Farming Zone, have been determined in accordance with the Noise Protocol (i.e., noise criteria for utilities) as:

- 45 dB(A) (L_{Aeq}) during the day (7 am to 6 pm)
- 39 dB(A) (L_{Aeq}) during the evening (6 pm to 10 pm Monday to Saturday, and 7 am to 10 pm Sunday)
- 34 dB(A) (L_{Aeq}) during the night (10 pm to 7 am).

Quarry

The most onerous (i.e., lowest) limit under the Noise Protocol is 36 dB(A) (L_{Aeq}). This noise limit has been assigned to the noise from quarry operation and corresponds to the recommended night-time noise level for a noise source that can operate over a 24-hour period (10 pm to 7 am).

13.3.3 Blast vibration limits

The current Earth Resources Regulation blast vibration limits for sensitive sites are:

- ground vibration: 5 millimetres per second for 95% of all blasts and 10 millimetres per second for all blasting
- airblast (overpressure): 115 dBL for 95% of all blasts and 120 dBL for all blasting.

The lower 95% limits are considered the control limit for all blasting. These ground vibration and airblast limits are based on human comfort considerations and are below levels where cosmetic damage to residential type buildings is known to occur.

Noise assessment terminology

A-weighting: frequency adjustment representing the response of the human ear, devised to attempt to take into consideration that human response (or sensitivity) to sound is not consistent across all frequencies**.**

Airblast (overpressure): a sub-audible, low frequency (1-20 Hertz) change of air pressure that radiates from blast sites.

dB $L_{A90(10mins)}$ (A-frequency-weighted L_{90} centile level): used in the New Zealand Standard to assess noise generated by wind energy facilities. It refers to a sound level measurement being the average decibel that, over a 10-minute interval period, was equalled or exceeded 90% of the time.

dB(A): A-weighted noise level measured in decibels (i.e., unit for expressing sound intensity).

dB(G): G-weighted noise level measured in decibels.

dBL: Airblast (overpressure) is measured as decibels linear (dBL), which is associated with sound pressure levels. This a separate measure to the audible component of a blast, which uses dBA and measures noise levels that affect hearing.

G-weighting: frequency adjustment (standardisation) to determine annoyance caused by noise in the infrasound range (i.e., frequencies less than 20 Hertz).

L_{Aeq}: the A-weighted equivalent continuous noise level. It is the energy-average of noise levels of a continuous steady sound occurring over a measurement period.

Noise criteria: refers to the noise values set to avoid potential noise impacts for most people, most of the time.

Noise limit: the maximum effective noise level permitted in a noise sensitive area, as determined in accordance with the EPA Victoria Noise Protocol. Effective noise level is determined (for noise from commercial, industrial and trade premises) as a 30-minute equivalent sound pressure level $L_{Aeq,30min}$ adjusted for duration, noise character and measurement position (where relevant).

Noise sensitive locations: defined by the New Zealand Standard as areas "*associated with a habitable space or education space in a building not on a wind farm site*". This includes:

- any part of land zoned predominantly for residential use
- residential uses including land uses listed in the accommodation group at Clause 73.04-1 of the Moyne Planning Scheme
- education and childcare uses listed in the education centre group at Clauses 73.04-4 of the Moyne Planning Scheme.

Noise sensitive residential use: as defined by the Victoria Planning Provision, this refers to a community care accommodation, dependent person's unit, dwelling, residential aged care facility, residential village, retirement village or rooming house.

Sound power level: how much noise a source produces (expressed as dB(A)), irrespective of distance or the environment.

13.4 Method

The noise and vibration assessment used a combination of background noise monitoring and modelling of the potential noise impacts from the construction, operation and decommissioning of the project. These assessment methods are outlined below.

13.4.1 Background noise monitoring

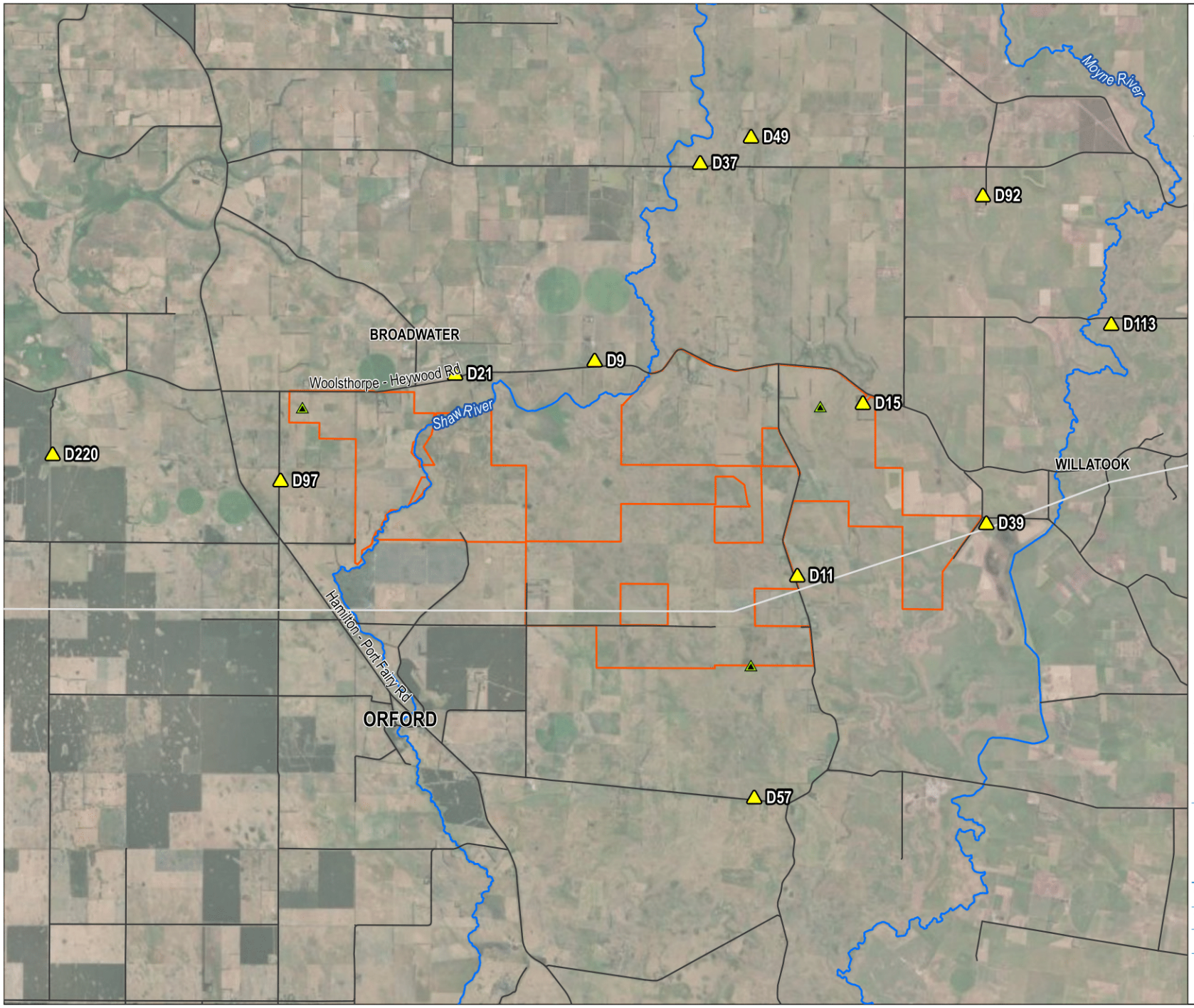
Background noise monitoring is required to characterise the background noise levels at various wind speeds and establish a 'normal' level of noise, which can then be used as the baseline conditions to assess the potential impact of the project construction and operation on the existing noise environment. Background noise monitoring using noise monitoring equipment (referred to as noise loggers) was conducted at 12 sites in accordance with the New Zealand Standard near the project site. An example noise logger is shown in Figure 13.1. This monitoring occurred early in the project development, between 30 September and 10 November 2010, at locations as shown in Figure 13.2. These locations for were selected based on preliminary predictions of the project noise. Preference was given to residential locations with the highest predicted noise levels that were not landowners hosting wind farm infrastructure (i.e., non-stakeholder dwellings), subject to permission being granted by the landowner to place a noise logger on their property.

Figure 13.1 Noise logger

The noise loggers were positioned to best represent the background noise level at the dwellings. That is, they were located at a similar distance as the dwelling from sources that provide background noise (e.g., significant trees) and away from fixed noise sources (e.g., domestic pumps or air conditioning units). The background noise level was measured in 10-minute intervals.

During noise monitoring, wind speed was measured in 10-minute intervals with a meteorological mast located within the project site (Figure 13.2). This wind speed data was extrapolated to a height of 169 metres (i.e., the highest hub height without exceeding a tip height of 250 metres). Rainfall and wind speed were also measured at the noise logger locations. These measurements were used to eliminate periods where the noise levels may have been influenced by weather directly onto the microphone, such as from rainfall or the pressure of wind on the microphone, which may increase the recorded noise level.

Additional background noise monitoring is proposed to be conducted prior to construction to assist with identifying the component of noise from the wind farm during compliance monitoring.



LEGEND

- Noise monitoring location
- Met mast location
- Watercourse
- Road
- 500kV Moorabool-Heywood transmission line
- Willatook Wind Farm boundary

SOURCE:
Willatook Wind Farm boundary and monitoring locations from Wind Prospect.
Roads, transmission line and watercourses from Vicmap.
Imagery from ArcGIS Online (various capture dates).

N

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SCALE 1:115,000
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PROJECTION: **GDA 1994 MGA Zone 54**

WIND PROSPECT

WILLATOOK WIND FARM

FIGURE 13.2

Background noise monitoring locations

DATE: 02.02.22 PROJECT: 754-MELEN287657 FILE: 287657_02_F024_GIS DOC REFERENCE: 287657_02_FIGS_CAPRX_V01

13.4.2 Predicted noise

Construction phase

The equipment and activities would vary depending on the stage of construction. The noise levels from typical construction activities, which would occur at each wind turbine site and concrete batching facility location, have been predicted as a typical worst-case scenario for the various stages of construction (i.e., highest noise level using CONCAWE model Category 6 whereby receivers are down wind of noise sources and light to no cloud cover exists prior to sunrise or after sunset). These predictions were made based on activities previously measured at other wind farms and based on sound power levels outlined in Appendix E1 – *Noise and vibration*. The predictions provide an indication of the construction noise level that can be expected at dwellings near wind turbine and concrete batching plant locations.

For the assessment of construction noise, a background noise level of 30 dB(A) was used to determine a reference level for construction activity. This noise level is the average of the background noise levels measured at the 12 noise monitoring sites during the quietest time (i.e., night time). As per EPA Victoria Publication 1834, noise levels from weekend or evening works are not to exceed the background noise by 10 dB(A) or more for up to 18 months at dwellings. As such, this results in a reference level of 40 dB(A) for any works during these times (i.e., outside normal working hours).

While this chapter has assessed noise impacts in relation to the relevant noise criteria and guidelines, it is acknowledged that noise levels below the criteria limits have the potential to cause annoyance. Concerns raised by the community and an assessment of potential social amenity impacts relating to noise from the project construction and operation are discussed further in Chapter 17 – *Socio-economic*.

An assessment of potential vibration impacts to structures during construction was undertaken in accordance with German Standard DIN 4150. Based on the separation distances between the construction activities and the nearest dwellings, vibration from construction activities is unlikely to be detectable to humans and therefore would achieve criteria associated with residential amenity.

Operational phase

Wind turbines

Noise from the wind turbines was modelled within the SoundPLAN 8.2 noise modelling software using the CONCAWE and ISO 9613 noise models. Both methods were used so that the most conservative (i.e., most onerous) noise prediction model could be used to place wind turbines, with some stakeholders having shown an interest in both modelling methods.

Modelling of the project operational wind turbine noise for each of the dwellings in the vicinity was based on 59 Vestas V162 wind turbines with a hub height of 149 metres and tip height of approximately 230 metres. Although increasing a source height can sometimes result in higher noise levels (because of less absorption of sound waves by the ground surface), increasing the tip height to the proposed maximum (169 metre hub height and 250 metre tip height) does not result in higher noise predictions. This is because the ground attenuation[1] near the noise source is already removed by the 230-metre height and as such, there is a negligible change from increasing the height to 250 metres.

Sound power level data for the proposed wind turbine is summarised in Appendix E1 – *Noise and vibration*.

Vibration from wind turbine operation was assessed against International Standard ISO 10137:2007 and based on previous measurements of ground vibration for Challicum Hills Wind Farm, located east of Ararat in western Victoria.

Sound power level data for the proposed transformers and battery facility are summarised in Appendix E1 – *Noise and vibration*.

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[1] Ground attenuation is results from acoustic energy losses the occur as a result of sound being reflected by the ground surface.

Noise models

Both CONCAWE and ISO 9613 noise models are internationally accepted noise models, which consider:

- the sound power level and position of the noise sources
- the separation between the noise sources and receivers
- the topography between the noise sources and receivers
- the hardness of the ground
- atmospheric absorption at different frequencies
- meteorological conditions.

CONCAWE

The CONCAWE noise model is widely accepted for predicting noise levels for wind farms and does not require adjustments to ensure accurate predictions.

The CONCAWE system has six categories for meteorological conditions, with Category 6 representing conditions which are most favourable to noise transmission over a distance (i.e., they result in the highest noise levels being transmitted from an activity, such as operating wind turbines). Category 6 corresponds to a night with no clouds and wind, with all dwellings being downwind of the wind turbines.

ISO 9613

The ISO 9613 noise model is widely accepted and recommended by the UK Institute of Acoustics for the prediction of wind farm noise levels. The model does however require adjustments to be made to ensure accurate results for wind farm assessments.

This model is a downwind noise model, meaning it does not have the option of other weather categories like the CONCAWE model.

On-site substation and battery facility

Noise from the project on-site substation and battery facility was predicted based on the CONCAWE noise model.

For the on-site substation, noise was modelled based on a total transformer capacity of 520 megavolt-ampere and considered noise associated with the existing Macarthur Wind Farm substation and Tarrone Terminal Station.

Noise from the battery facility was modelled based on 126 Tesla 'Megapacks' with a capacity of 200 megawatts/400 megawatt hours and assumed unit fan operating speeds (based on manufacturer information) of 60% during the day and evening, and at 40% at night. This corresponds to times when the temperature is less than 40°C and therefore considered a conservative assessment.

Quarry

The noise modelling for the quarry site was undertaken using the CONCAWE noise model and included consideration of noise sources (operating continuously during quarry operating hours) from excavators, bulldozers, delivery trucks, generators and crushers.

Ground vibration and airblast (overpressure) from blasting activity was assessed in the blast impact assessment, completed by Terrock Consulting Engineers (Appendix E4) in accordance with Earth Resources Regulation's (2021) *Guidelines and Codes of Practice; Ground Vibration and Airblast Limits for Blasting in Mines and Quarries* (which defines blast vibration limits for sensitive sites) and Australian Standard AS2187.2-2006 (which defines ground vibration limits for preventing vibration damage to buildings).

Sound power level data for the quarry activities/equipment are summarised in Appendix E1 – *Noise and vibration*.

13.4.3 Cumulative noise assessment

The greatest potential for **cumulative noise impacts** to exceed the noise criterion is where the noise from one wind farm at a dwelling only marginally achieves the noise criterion. In this situation, the contribution from a second wind farm may then cause a higher cumulative noise level, increasing the total noise level above the noise criterion.

The cumulative impact of the nearby Ryan Corner, Hawkesdale and Woolsthorpe Wind Farms (all more than 7 kilometres from the closest project wind turbine) on the compliance of the project was not quantitatively assessed.

The Macarthur Wind Farm is the closest operating or approved wind farm to the project, situated approximately 7 kilometres north of the closest project wind turbine. To demonstrate compliance with the noise criteria, noise levels at dwellings between this operating wind farm and the project have been considered in the noise and vibration assessment (Appendix E1).

The cumulative noise assessment was based on Vestas 'V112-3.0' wind turbines for the Macarthur Wind Farm, with a hub height of 84 metres above ground level.

Predictions were made for high wind speeds using both the ISO 9613 and CONCAWE noise models for sensitive receptors downwind of both wind farms. This is a conservative modelling approach as it considers the highest noise levels from both the project and Macarthur Wind Farm turbines.

13.5 Existing conditions

13.5.1 Sensitive receptors

There are 29 stakeholder dwellings (6 defined as dilapidated) and 141 non-stakeholder dwellings (that are not dilapidated) within about 6 kilometres metres of proposed project wind turbine locations.

For all dwellings not hosting wind farm infrastructure, there is a separation distance of 1,500 metres or more from any proposed wind turbine location, and 1,200 metres or more from any temporary concrete batching plant.

The quarry site is considered remote, with a single occupied dwelling located about 1,400 metres south-east of the proposed extraction area. Other dwellings in the area are located more than 3 kilometres from the quarry site.

13.5.2 Background noise modelling results

The background noise data collected at each monitoring location was correlated with the wind speed at a hub height of 169 metres for each 10-minute measurement period. Example plots of noise correlations with wind speeds are provided in Figure 13.3 and Figure 13.4 below for background noise monitoring locations D9 and D97, respectively. In these plots, the black line represents the least squares regression line that that fits the points as closely as possible. The red line represents the operational noise criteria that could apply to that dwelling, being 40 dB(A) ($L_{A90(10min)}$) or background sound level plus 5 dB(A) ($L_{A90(10min)}$), whichever is greater.

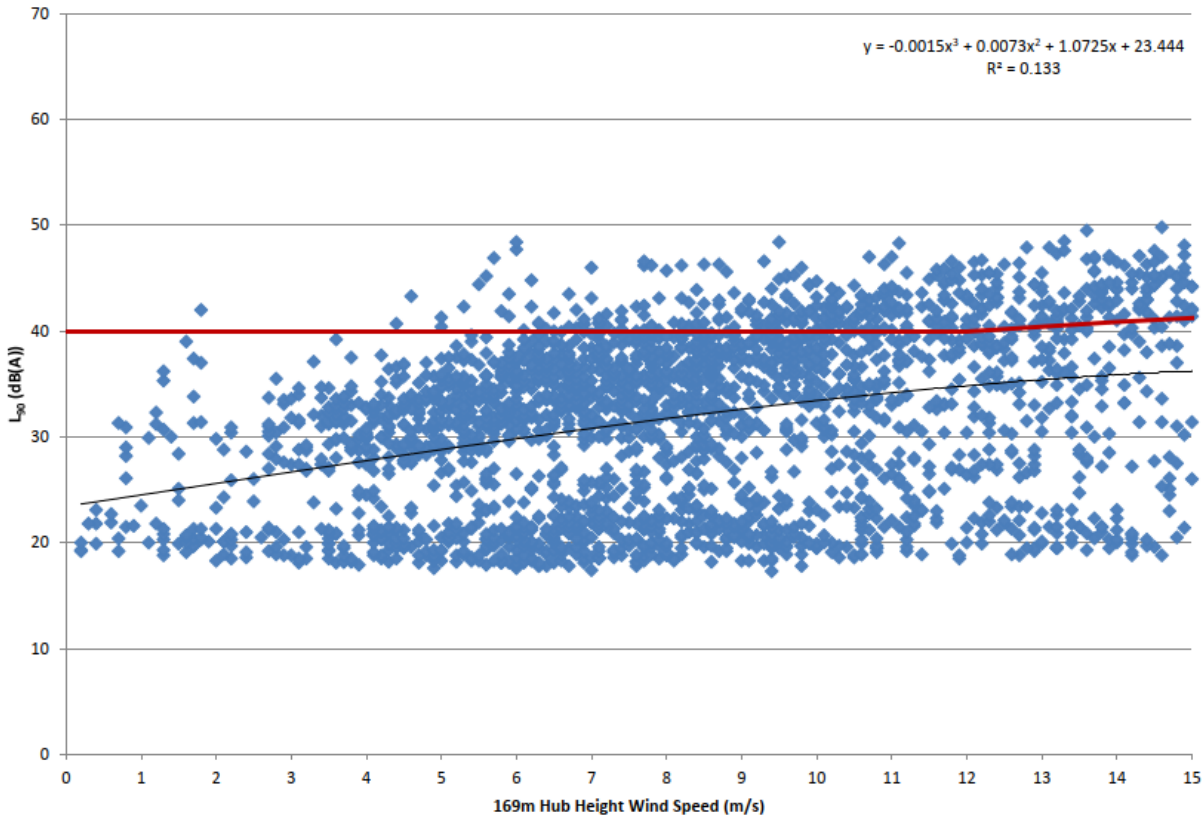


Figure 13.3 **Background noise correlations with wind speed (metres per second) for background noise monitoring location D9 (*source: Appendix E1 – Noise and vibration*)**

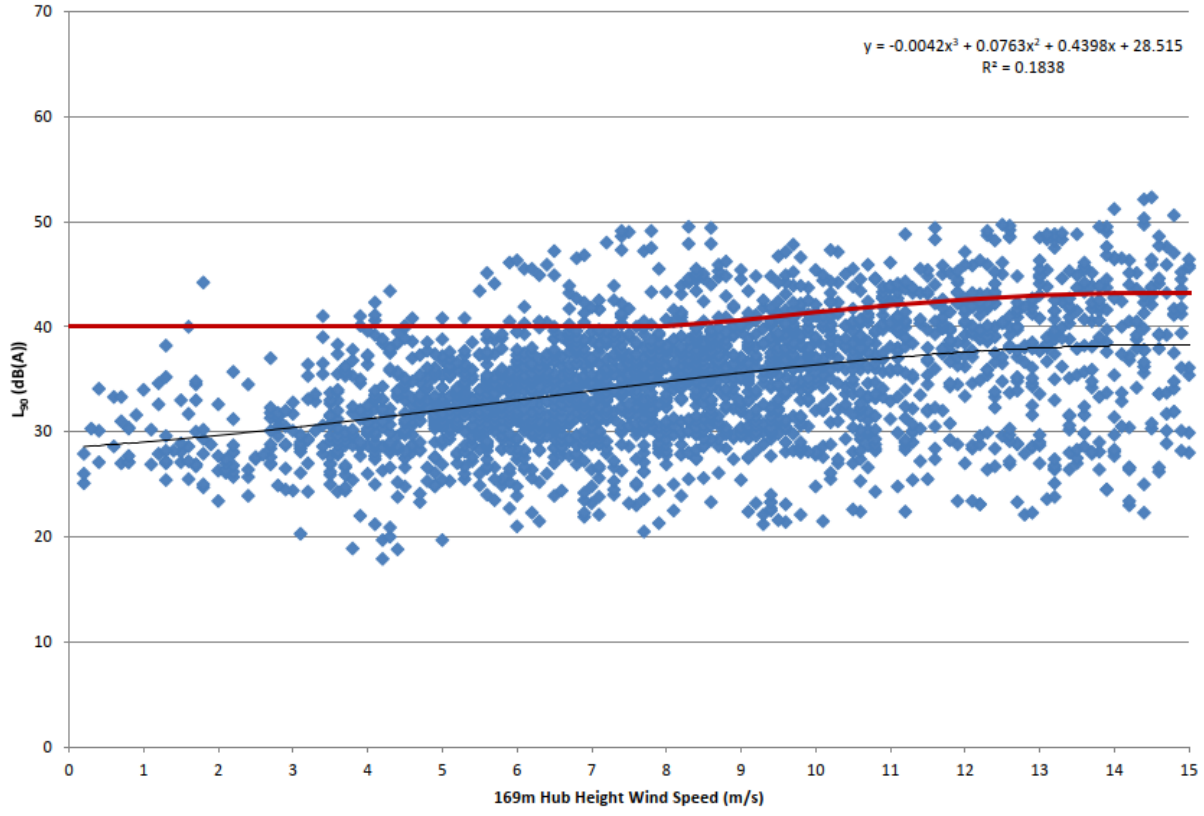


Figure 13.4 **Background noise correlations with wind speed (metres per second) for background noise monitoring location D97 (*source: Appendix E1 – Noise and vibration*)**

Locations were selected as representative dwellings based on preliminary predictions of the wind farm noise, with preference given to residential locations with the highest predicted noise levels and without commercial agreements.

The measured background noise levels would not have resulted in a significant increase to a baseline criterion of 40 dB(A) ($L_{A90(10min)}$) if a background sound level plus 5 dB(A) ($L_{A90(10min)}$) were to be used. Since wind turbine noise is not predicted to exceed 39 dB(A) ($L_{A90(10min)}$) at any non-stakeholder dwelling (see Section 13.6.4), the project can (and would) commit to a baseline criteria of 40 dB(A) ($L_{A90(10min)}$). There would be no increase in the criteria for stakeholder dwellings, where a baseline criteria of 45 dB(A) applies.

13.5.3 Cumulative noise

There are three approved wind farms and one operating wind farm within 10 kilometres of the project site. The location of these wind farms in relation to the project site is presented in Chapter 24 – *Cumulative effects*.

13.6 Impact assessment

13.6.1 Impact pathways

The *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (DELWP, 2021f) state that:

> *The impact of the noise depends on the sensitivity of the surrounding land uses, existing background noise levels, topography and wind speed and direction, power output from the turbines and any special auditory characteristics present.*

Key activities that have the potential to cause noise and vibration impacts from the construction, operation and decommissioning of the project are:

- works associated with wind turbine and concrete batching construction, including civil works, excavation, foundation construction and turbine erection. These require processes such as heavy vehicle movements, crushing and screening, possible concrete batching, loaders, excavators, generators, cranes and rock breaking
- works associated with the on-site quarry. This work would involve the use of transformers, inverters, cooling management systems and large mobile plant (crushers, dozers and trucks), as well as blasting
- wind turbine operation. This includes noise and vibration from wind turbine generators and movement of rotor blades
- on-site substation, battery facility and ancillary activities, which include noise-generating equipment such as transformers, inverters and cooling management systems.

13.6.2 Design mitigation

The project's design has been refined to maximise separation distances between noise-producing infrastructure and dwellings, and to minimise noise from construction works and operational activities.

The quarry has been located as far away from occupied dwellings as possible, while still being able to provide enough aggregate at sufficient quality. The closest occupied dwelling, owned by a project stakeholder, is 1,400 metres from the quarry boundary.

The three temporary concrete batch plants have been located to provide convenient access to all wind turbines, with consideration of setback distances from dwellings. The closest stakeholder dwelling (sensitive receptor) to a proposed concrete batch plant is approximately 1,200 metres. The closest non-stakeholder dwelling is approximately 1,800 metres to a proposed concrete batch plant.

There have been concerns raised by the community regarding potential noise impacts associated with the project and the nearby Macarthur Wind Farm operating at the same time. The project has been designed with a maximum operational sound level of 40 dB(A) from wind turbines measured at neighbouring dwellings, inclusive of any noise contributions from the Macarthur Wind Farm.

13.6.3 Management controls

Wind farm projects often undergo a degree of micro-siting of infrastructure (including wind turbines) during detailed design, and so preparation of a 'pre-construction noise assessment' will be required for the final project layout and equipment selection. Wind turbine noise predictions for the final layout will be included in that assessment, which would ensure that the noise criteria are achieved at all non-stakeholder dwellings under all wind speeds prior to construction commencing.

Management measures, outlined in Table 13.3, are recommended to minimise potential noise and vibration impacts and include community consultation, scheduling of works, and engineered noise reduction measures for plant and equipment.

Table 13.3 Noise and vibration management measures

Activity	Management measures	Number
Construction		
All construction activity noise (including the quarry)	**Noise and Vibration Management Plan** All construction activities will be managed and occur in accordance with the Noise and Vibration Management Plan, which would be developed and endorsed by the responsible authority prior to the commencement of construction. The Noise and Vibration Management Plan would: • address the effects of construction noise and vibration associated with project activities • outline the proposed construction program and how the proposed management controls are compliant with the requirements defined by EPA Victoria Publication 1834 • outline all unavoidable works, low-noise impact and managed-impact works that may occur outside normal working hours • outline the proposed scheduling of any out of hours works to minimise noise and vibration impacts • be generally in accordance with the recommendations contained within the Construction Noise Assessment prepared by Sonus (April 2022). Should the noise level from any of the project aspects exceed the requirements detailed in the Environmental Noise Assessment report, the operating times would be restricted to the standard hours if appropriate noise criteria cannot be achieved, and the work cannot be justified to be unavoidable. As part of the Noise and Vibration Management Plan, a suitably qualified and independent Health, Safety, and Environment (HSE) professional would be appointed to pre-approve unavoidable night work activities (occurring between 10:00pm and 7:00am). Options to reduce the noise level may also include installing aftermarket mufflers to mobile equipment and use of portable acoustic screens around loud activities (such as grinders of impact drivers). The construction manager would be required (via conditions of contract) to ensure that these and any other practical noise reduction measures are undertaken prior to the commencement of construction. A Noise and Vibration Management Plan has been prepared and forms part of this EES. The plan would be updated prior to construction to account for the final layout.	NV01

Activity	Management measures	Number

	Community consultation
	The following community consultation would occur with nearby residents prior to construction activity being undertaken:
	• engage community to keep them informed, for example meetings with community
	• notify the community before and during construction communicating information such as:
	  – dates and times (start and finish) when noise will be generated
	  – why the noise is necessary
	  – type of noise
	  – measures to minimise noise volume
	  – measures to minimise disturbance
	  – contact details for information
	• install and maintain a site information board at the front of the project site with contact details, hours of operations, after hours emergency contact details, and regular information updates
	• maintain a process for managing complaints (see NV04)
	• offer alternative accommodation where there is sustained noise impact (such as ongoing sleep disturbance over many nights) or where residents may have underlying health conditions that could be adversely impacted
	• relocate affected residents if noise levels cannot be reduced sufficiently for the agreed period of construction activity.
		NV02

	Noise monitoring Conduct noise monitoring whenever a new construction activity is occurring outside of normal working hours, if blasting is required, and if other earthmoving construction activities are required within 100 metres of a dwelling (with the permission of the dwelling owner). This would include: • measurement of background noise levels at the closest dwelling before construction works occur or at a location representative of the closest dwelling • measurement of noise level from construction works at the closest dwelling (or at a location representative of the closest dwelling) during the night under conditions that are conducive to noise propagation towards the measurement location • measurement of noise level at an intermediate location and extrapolated using a recognised noise model if a measured level cannot be satisfactorily achieved at the closest dwelling (or at a location representative of the closest dwelling). In the event that the measured noise level exceeds the relevant criteria in EPA Victoria Publication 1834, further mitigation measures would be implemented to reduce the risk of harm so far as reasonably practicable, and the testing repeated to confirm compliance with the criteria.	NV03

Activity	Management measures	Number
	Noise complaints response procedure The noise complaints response process, to be developed prior to construction, would identify any feasible and reasonable measures that may further reduce impacts following a complaint, and to provide feedback to the community on the above process within a reasonable timeframe. The complaints response process would include the following noise elements: • provision of a contact person for dealing with any complaints • establishment of a complaints handling procedure that: – assesses whether the issue can be resolved easily and take immediate action if possible – if not, ensures that the appropriate consultation has been undertaken for the activity – ensures the on-site inspections of the Noise and Vibration Management Plan have been carried out regularly for the activity – assesses the construction site and activities to determine whether there is any reason to believe the noise exposure of dwellings is higher than anticipated – undertakes monitoring of noise levels where this cannot be confirmed and the complaint relates to out of hours activity, with the aim of establishing if the exposure of receivers is higher than anticipated by the Noise and Vibration Management Plan – takes remedial action with the assistance of an acoustic engineer if any of the above cannot be confirmed.	NV04
	Concrete batching plant The design and operation of the temporary concrete batching plants would be in accordance with the control measures outlined in EPA Victoria Publication 1806 *Reducing risk in the premixed concrete industry* to minimise industrial noise emissions and prevent harm to nearby sensitive receptors.	NV05
Blasting	**Blast Management Plan** Control measures for mitigating the risks and impacts posed by blasting would be contained in the Blast Management Plan. The Blast Management Plan, to be prepared by the proponent and approved by the responsible authority prior to the commencement of construction, would outline the procedures and controls required to conduct blasting operations safely and achieve compliance with the relevant standards and thresholds. A noise monitoring regime would be implemented when blasting is required to ensure compliance with relevant blasting criteria. Should the noise level from any of the project aspects exceed the requirements detailed in the blasting report, the size of the charge mass would be reduced.	NV06
Quarry noise	**Quarry work plan** All quarry operations would be undertaken in accordance with the Work Authority. Prior to construction, the draft quarry work plan (provided in Attachment II) would be finalised and submitted to Earth Resources Regulation (Department of Jobs, Precincts and Regions) for approval, as required under the *Mineral Resources (Sustainable Development) Act 1990*.	NV07

Activity	Management measures	Number
Operation		
Wind turbine noise	**Pre-construction noise assessment** Prior to the commencement of construction, a pre-construction noise assessment would be completed and approved by the responsible authority. This assessment would be undertaken to assess the final project layout and equipment selection to ensure that the noise criteria are achieved at all non-stakeholder dwellings under all wind speeds prior to construction commencing. The pre-construction noise assessment would be verified in accordance with the requirements of the New Zealand Standard by an EPA Victoria accredited auditor.	NV08
	Post-construction noise assessment A post-construction noise assessment would be undertaken in accordance with the New Zealand Standard and regulations under the *Environment Protection Act 2017* to demonstrate that the project is compliant. This assessment would be provided to the responsible authority for endorsement.	NV09
	Additional noise monitoring would be undertaken at intervals required by the *Environment Protection Act 2017* (currently every five years as specified in the Environment Protection Amendment (Interim) Regulations 2021).	NV10
	Operational noise management plan A noise management plan including complaints management would be prepared and implemented, as required by the *Environment Protection Act 2017* (as specified in the Environment Protection Amendment (Interim) Regulations 2021). Should the noise level from wind turbine operation exceed the requirements detailed in the planning permit, a wind turbine curtailment regime under specific wind speeds and directions will be implemented.	NV11
	Annual statement An annual statement would be prepared detailing the actions undertaken to ensure compliance, as required by the *Environment Protection Act 2017* (as specified in the Environment Protection Amendment (Interim) Regulations 2021).	NV12
On-site substation and battery facility noise	**Substation and battery noise reduction** Adopt 'reduced' sound power level transformer as specified in the Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers – Determination of sound levels*.	NV13
	Should the noise level from the substation and battery exceed the requirements detailed in the Environmental Noise Assessment report, a barrier between the noise sources (transformers and containerised batteries) and the closest residences would be designed to reduce the noise levels or reductions would be achieved through fitting attenuators to the inlet and outlet of the containerised battery storage units.	NV14

Activity	Management measures	Number
Decommissioning		
Wind turbine noise and vibration	**Decommissioning noise and vibration management plan** Prior to decommissioning, a decommission noise and vibration management plan would be prepared and submitted to the responsible authority for endorsement. This plan would include: • an assessment of the potential impacts of decommissioning noise and vibration from project activities • outline the proposed decommissioning program and how the proposed management controls are compliant with the requirements defined by EPA Victoria Publication 1834 • outline all unavoidable works, low-noise impact and managed-impact works that may occur outside normal working hours • outline the proposed scheduling of any out of hours works to minimise noise and vibration impacts.	NV15

13.6.4 Residual effects

Construction noise

Wind farm construction noise

The predicted noise levels from construction of wind turbines, the substation and battery, and operation of the concrete batching plants at the closest dwellings are predicted to be less than the reference levels outlined within EPA Victoria's Publication 1834: *Civil construction, building and demolition guide*. Further detail on the predicted noise levels from these activities are provided in Section 4.2 – *Prediction model* and Section 4.3 – *Noise levels* of the Construction Noise Assessment attached to Appendix E1.

The reference level of 40 dB(A) for weekend or evening works (outside normal working hours) is achieved for all proposed activities associated with the construction of wind turbines, substation and battery, and concrete batching plants, based on the separation distances from the closest non-stakeholder dwellings. The loudest wind farm construction activities at a distance of 1,500 metres are predicted to be associated with the preparation of the nacelle and hub for installation (35 dB(A)), with both requiring the use of hand tools and a crane. Noise from the substation and battery construction is predicted to be up to 40 dB(A) at a distance of 890 metres, which is the distance to the nearest dwelling. Noise from concrete batching activities at 1,200 metres is predicted to be up to 37 dB(A).

At stakeholder dwellings, which are closer to construction activities, higher noise levels would be experienced. The noise level at the closest occupied stakeholder dwelling, an addition of 7 dB(A) can be applied to the predicted levels for turbine sites, 2 dB(A) for the substation and battery site, and 3 dB(A) for the concrete batching plant sites. At times, some construction activities are predicted to be marginally above the "outside of normal working hours" reference level of 40 dB(A). The higher noise levels are generally accepted given that the dwellings are associated with the project and its outcomes.

The "night time" reference level (30 dB(A)) is only achieved for one proposed construction activity at the closest non-stakeholder dwelling, however works are not proposed to occur at night unless they are unavoidable and are approved by the responsible authority. In reality, noise levels would likely be less than those predicted as a result of topography and barriers at the construction site.

There are no objective criteria for work which occurs during normal working hours. Therefore, the noise levels from wind farm construction activities predicted in the Construction Noise Assessment will comply with the requirements of EPA Publication 1834 where reasonable and practical noise reduction measures are implemented in Section 13.6.3.

Quarry noise

Noise sources and activities at the quarry site would include excavators, crushers, generator and pumps, and delivery trucks.

Predicted noise levels for the quarry and the closest sensitive receptors are shown in Figure 13.5. The highest predicted noise level at any residence in the vicinity of the quarry is at D375, which is a stakeholder dwelling. Without any specific treatment of the site, noise levels at this residence are predicted to be 31 dB(A). Even where a penalty is considered warranted, the noise criterion of 36 dB(A) during the night period would still be achieved, noting that the quarry would not operate at night.

Should the noise level from activity at the quarry be measured to be higher than that predicted, a contingency may be to restrict the operating hours to periods where the criteria are higher (day and evening).

Noise generated from the construction of the substation and battery combined with noise from the quarry are not predicted to have a cumulative impact due to the distances between these components and the closest sensitive receptors.

Low frequency noise levels from the quarry site are also predicted to achieve the requirements of EPA Victoria Publication 1996. Comparison of predicted quarry noise against the Noise Protocol and EPA Victoria Publication 1996 is expected to demonstrate requirements of the general environmental duty.

Blasting of basalt rock would occur at the quarry site, however audible noise levels from blasting are not currently subject to regulation. Airblast (overpressure) from blasting, which is regulated, is below the threshold of human hearing and has been considered in the following construction vibration section.

Construction vibration

It is expected that the main sources of vibration would be from the operation of earth moving equipment and blasting at the quarry site, as well as during the construction of the wind turbine foundations. The level of vibration will depend on the energy input of the equipment, as well as the local ground conditions.

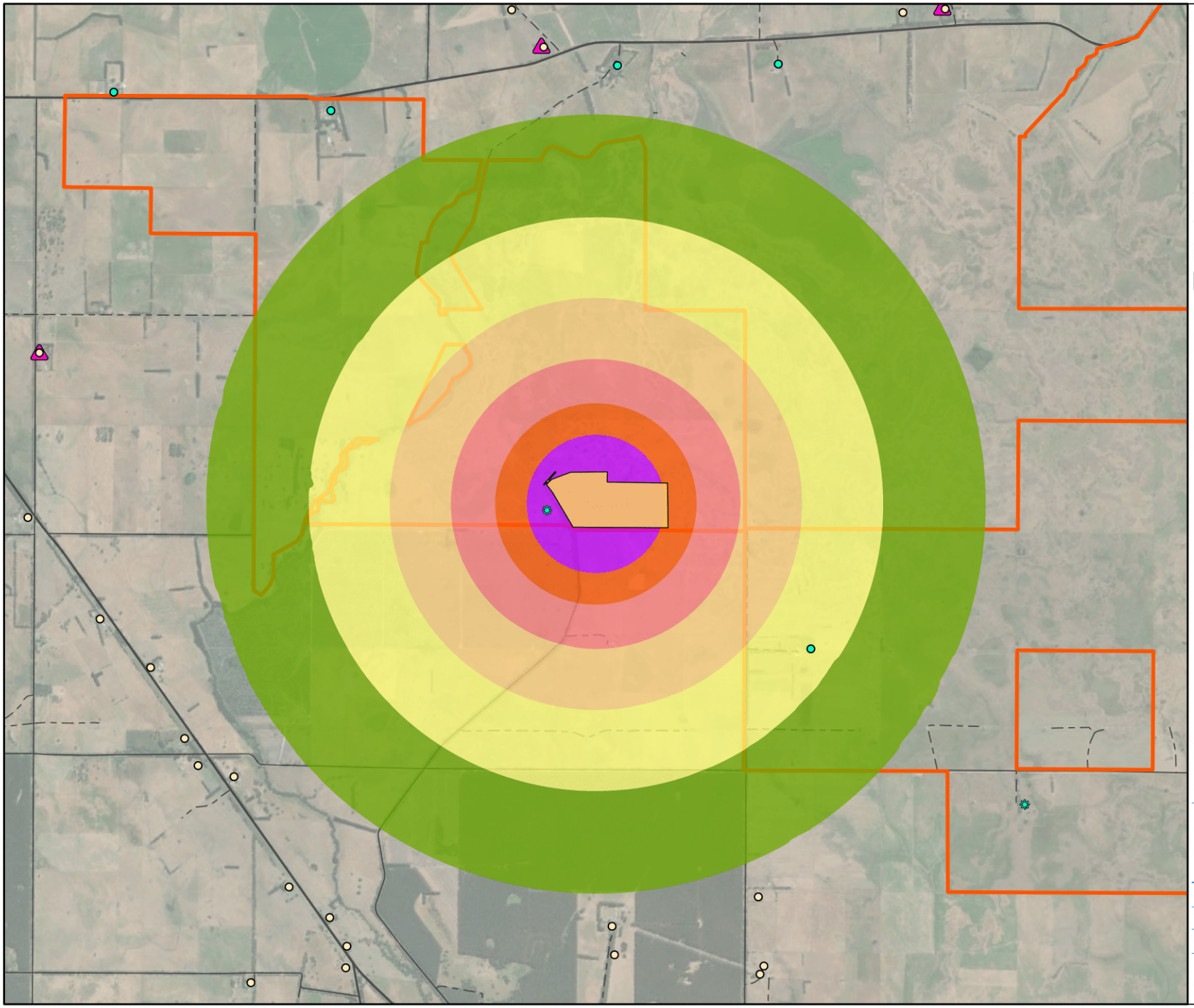
Vibration from earth moving activities is unlikely to be detectable to humans at a distance of 100 metres. As the nearest dwellings are significantly more than 100 metres from these construction activities, vibration impacts are expected to be negligible.

Quarry vibration

Blasting at the quarry would likely occur no more than twice per month, with the quarry operation proposed for around two years. Blasting effects would have short durations of 2–5 seconds per event and would be limited to business hours.

For the closest dwelling to the extraction area (about 1,400 metres), the maximum ground vibration level from the closest standard blast is predicted to be 0.31–0.63 millimetres per second. These levels are around one-tenth of the Earth Resources Regulation limit of 5 millimetres per second and around 3% of the threshold for cosmetic damage contained within Australian Standard AS2187.2. Blasting would result in minimal blast vibration effects with low level perceptible effects anticipated at the closest dwelling.

The potential impact to buildings and other infrastructure from blasting (e.g., wind turbines) is also low due to the relatively high ground vibration limits that normally apply (e.g., 100 millimetres per second for unoccupied structures of reinforced concrete or steel construction (AS2187.2–2006 *Dangerous Good (Explosives) Regulations 2011*)). The separation distances between the quarry extraction area and wind turbine locations and other structures would also limit the potential vibration impact.



LEGEND

- Noise monitoring location
- Non-involved stakeholder dwelling
- Involved stakeholder dwelling
- Dilapidated dwelling
- Major road
- Local road
- Track
- Willatook Wind Farm boundary
- Quarry area

Noise level (db(A))

- >= 25
- >= 30
- >= 35
- >= 40
- >= 45
- >= 50

SOURCE:
Willatook Wind Farm boundary from Wind Prospect (2021).
Watercourses from Vicmap (2021).
RAP boundaries from Wind Prospect.
Imagery from ArcGIS Online (various capture dates).

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PROJECTION: **GDA 1994 MGA Zone 54**

WIND PROSPECT

WILLATOOK WIND FARM

FIGURE 13.5

Predicted noise levels (dB(A)) from the on-site quarry

DATE: 05.05.22 PROJECT: 754-MELEN287657 FILE: 287657_02_F063_GIS DOC REFERENCE: 287657_02_FIGS_G.APRX_V02

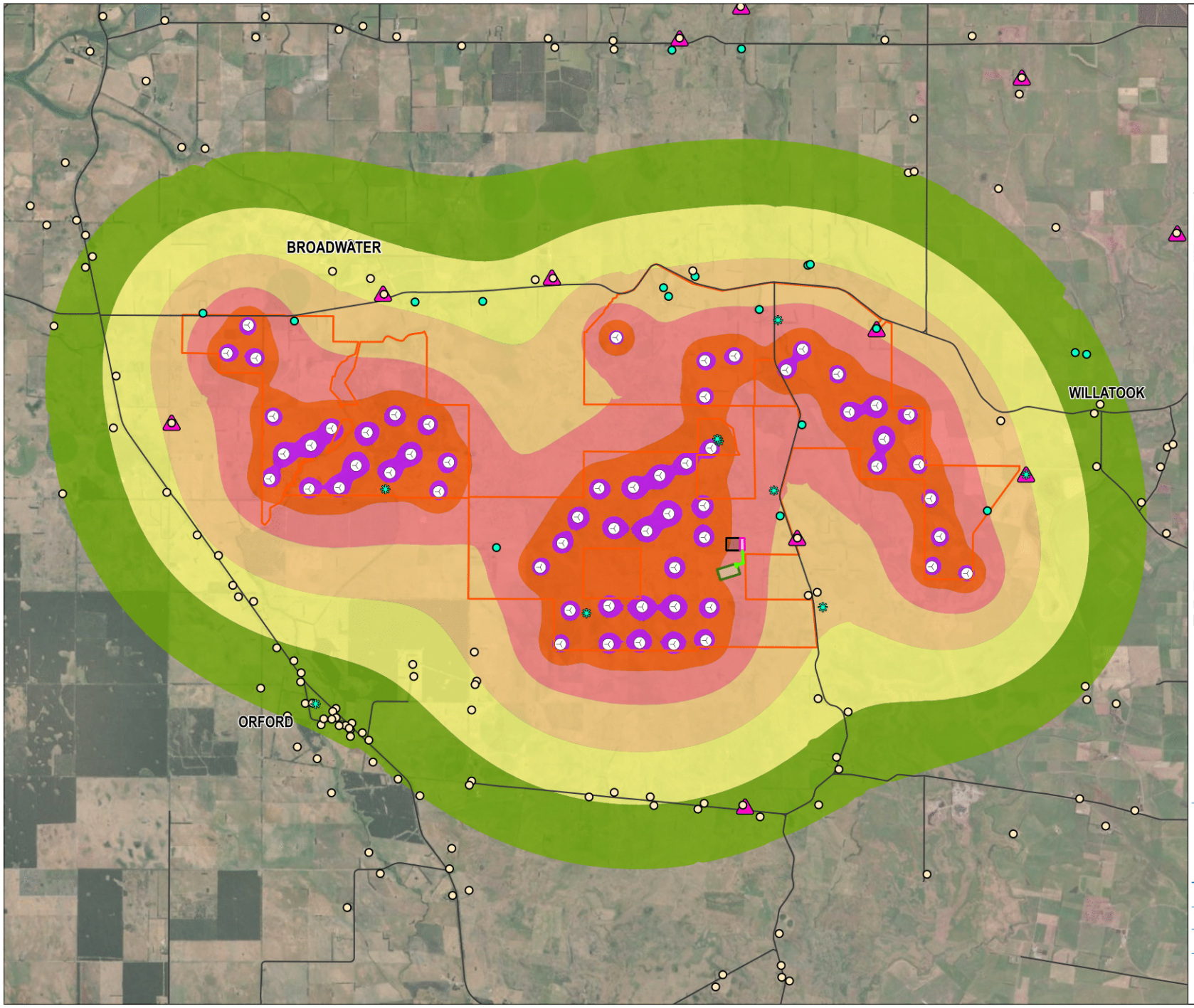
Operational noise

Wind turbine noise

The noise level at stakeholder and non-stakeholder residences is provided in the Environmental Noise Assessment report (Appendix E1) in tabulated form for wind turbine operation. Both CONCAWE and ISO 9613 models predict that the wind turbine operational noise complies with the New Zealand Standard at all non-stakeholder dwellings (i.e., the predicted noise level is no more than 39 dB(A)), thereby achieving the noise criteria of 40 dB(A). The highest predicted noise level at a stakeholder dwelling is 43 dB(A), which achieves the 45 dB(A) criterion of the Policy and Planning Guidelines.

The results for both models are shown in the noise prediction contours for the highest predicted noise level wind speed (11 metres per second) (see Figure 13.6 (CONCAWE) and Figure 13.7 (ISO 9613)).

Predictions for the final layout and turbine selection would be included in a pre-construction noise assessment (NV08), which would indicate if the noise criteria can be achieved at all dwellings at all wind speeds. Compliance monitoring would be undertaken during operation to ensure the noise criteria are achieved at dwellings. If any noise exceedances are identified, modifications (such as operation of wind turbines in noise reduced modes under specific wind conditions) would be required.



LEGEND

- Noise monitoring location
- Turbine location
- Non-involved stakeholder dwelling
- Involved stakeholder dwelling
- Dilapidated dwelling
- Major road
- Willatook Wind Farm boundary
- Substation 33kV/220kV
- Battery energy storage system
- Transmission line and grid connection infrastructure
- Tarrone Terminal Station

Noise level (db(A))

- >= 25
- >= 30
- >= 35
- >= 40
- >= 45
- >= 50

Noise (dBA) modelled using Vestas V162 model at a wind speed of 11m/s at a hub height of 149 meters.

SOURCE:
Willatook Wind Farm boundary, dwellings, noise contours and noise monitoring locations from Wind Prospect.
Roads and watercourses from Vicmap.
Imagery from ArcGIS Online (various capture dates).

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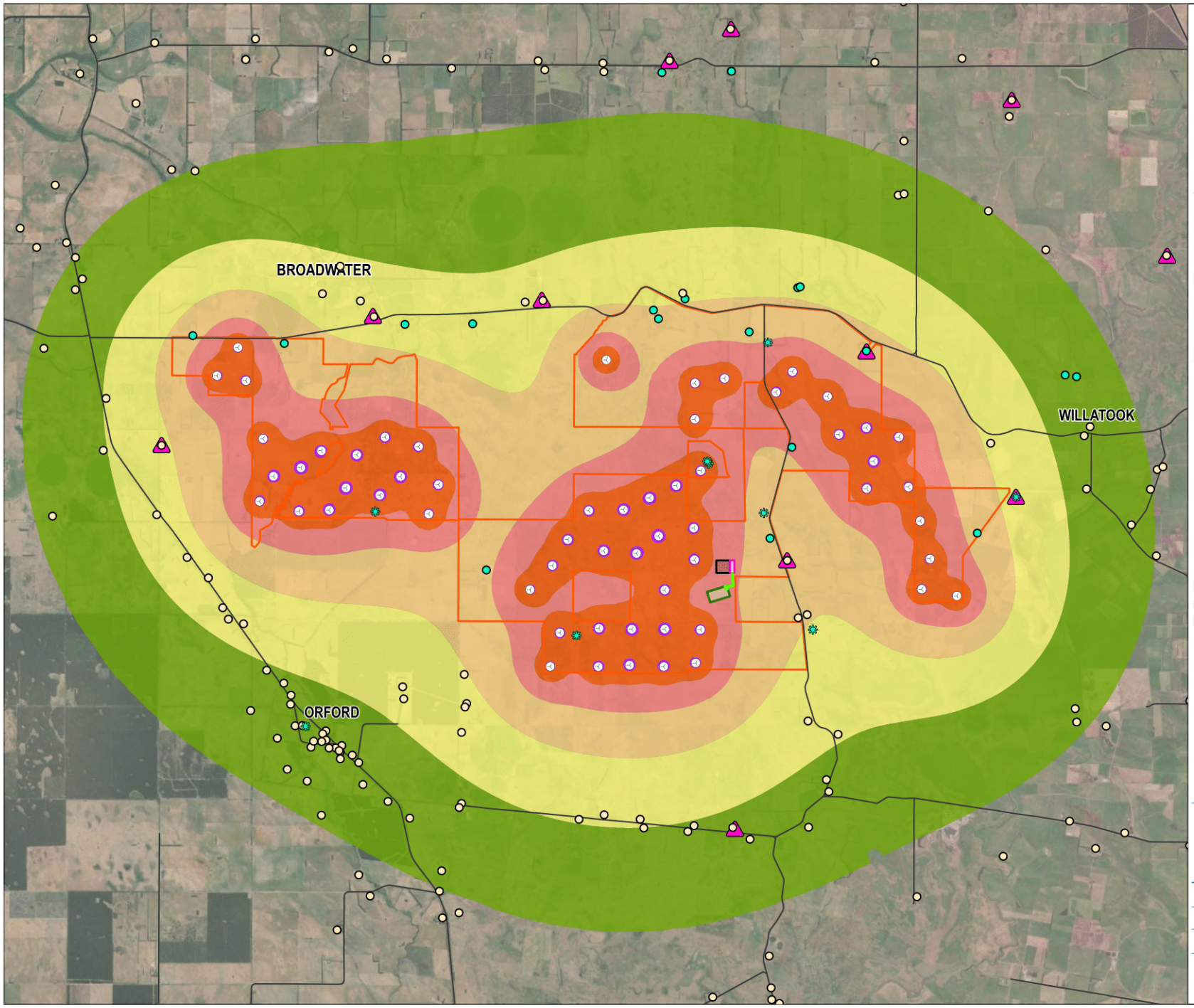
WIND PROSPECT

WILLATOOK WIND FARM

FIGURE 13.6

CONCAWE prediction model noise contours

DATE: 24.02.22 PROJECT: 754-MELEN287657 FILE: 287657_02_F043_GIS DOC REFERENCE: 287657_02_FIGS_D_APRX_V02



LEGEND

- Noise monitoring location
- Turbine location
- Non-involved stakeholder dwelling
- Involved stakeholder dwelling
- Dilapidated dwelling
- Major road
- Willatook Wind Farm boundary
- Substation 33kV/220kV
- Battery energy storage system
- Transmission line and grid connection infrastructure
- Tarrone Terminal Station

Noise level (dB(A))

- >= 25
- >= 30
- >= 35
- >= 40
- >= 45
- >= 50

Noise (dBA) modelled using Vestas V162 model at a wind speed of 11m/s at a hub height of 149 meters.

SOURCE:
Willatook Wind Farm boundary and noise contours from Wind Prospect.
Roads and watercourses from Vicmap.
Imagery from ArcGIS Online (various capture dates).

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PROJECTION: **GDA 1994 MGA Zone 54**

WIND PROSPECT

WILLATOOK WIND FARM

FIGURE 13.7

ISO 9613 prediction model noise contours

DATE: 24.02.22 PROJECT: 754-MELEN287657 FILE: 287657_02_F042_GIS DOC REFERENCE: 287657_02_FIGS_D.APRX_V01

On-site substation and battery facility noise

The noise level at stakeholder residences is provided in the Environmental Noise Assessment report (Appendix E1) the grid noise maps for the substation and battery facility.

The highest predicted noise level at residences in the vicinity of the substation/battery facility is at dwelling D8, which is a stakeholder dwelling. Without treatment of the site, noise levels at this residence are predicted to be 38 dB(A) during the day/evening period and 36 dB(A) during the night (inclusive of a 2 dB(A) penalty for potential tonality). With the inclusion of the treatment recommended in the report, being a "reduced noise level transformer", the noise levels are reduced to 36 dB(A) and 34 dB(A) respectively.

When considering the cumulative noise levels, which include operation of the approved, but not constructed, gas-fired power station and the existing Tarrone Terminal Station, the predictions increase to 36 dB(A) during the night and 37 dB(A) during the day/evening period. No penalties are applied to the cumulative predictions given the likelihood that the combination of sources would result in tonality from transformers being masked.

Based on the predicted noise levels above, the criteria would be achieved in all instances, with the exception of during the night period with the gas fired power station operating.

Should the power station proceed to construction, the Willatook substation/battery facility can be further treated to ensure the night time criterion is achieved. If necessary, a barrier will be designed to reduce the noise levels from the transformers and containerised batteries such that the cumulative noise level is reduced to 34 dB(A) during the night period.

There is the potential for the noise from transformers to be tonal in character. When the noise has this character then an adjustment is required if the noise is just detectable or prominent, as defined in the Noise Protocol.

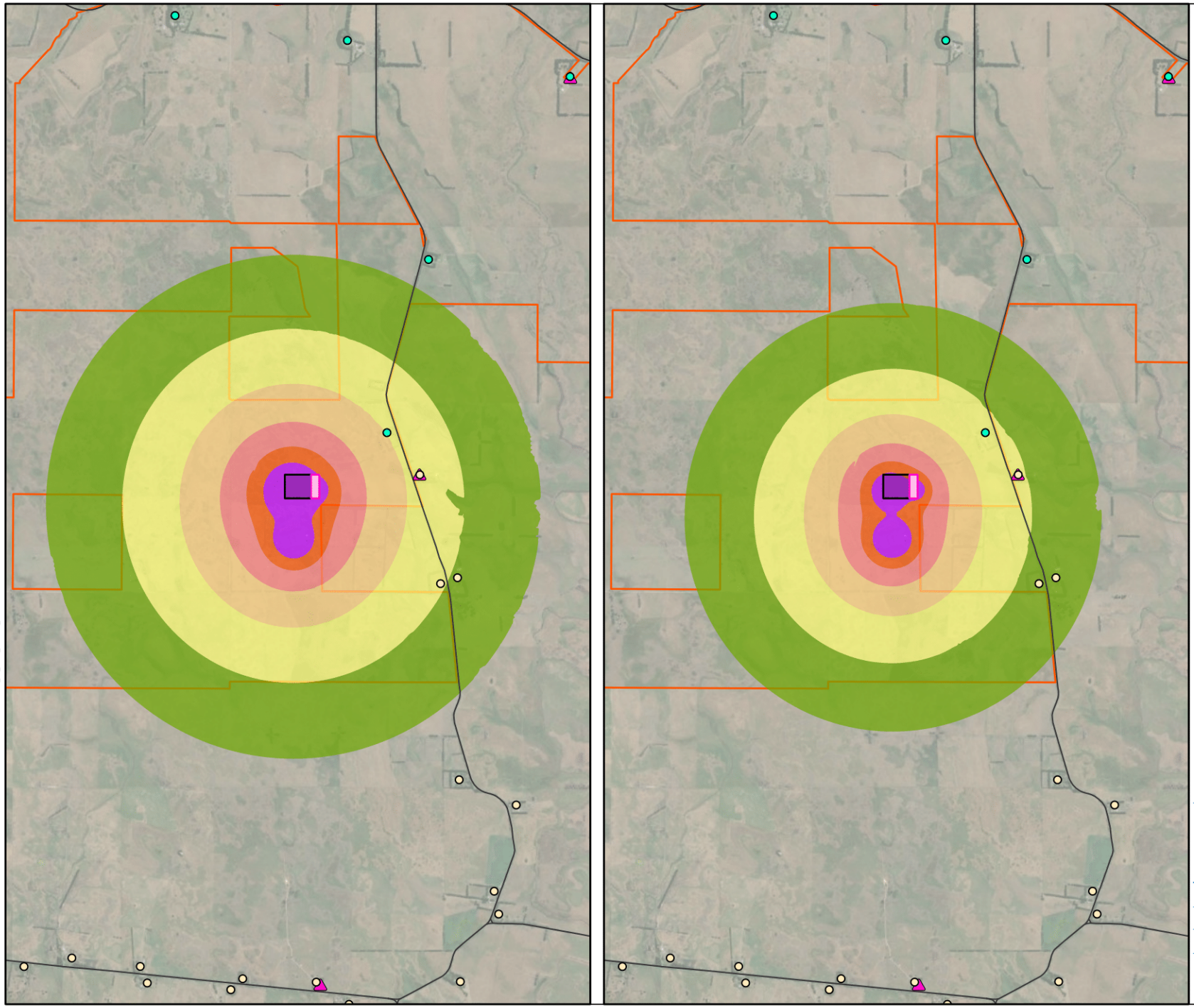
Given the distance from the sensitive receptors (all dwellings in the case of the project), any tone from transformers may be just detectable. In this situation and in accordance with the Noise Protocol, a 2 dB(A) adjustment (increase) would be applied for the noise tonal character, increasing the predicted noise levels to 37 dB(A) during the day and evening periods, and 35 dB(A) during the night. Where an adjustment applies, there is the potential for the 34 dB(A) night time noise criteria to be exceeded. In addition to "standard" substation transformer noise levels, the Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers – Determination of sound levels* also defines a "reduced" sound power level. The project would ensure that the sound power level of the transformer would be no more than the specified reduced sound power level. With the adoption of a reduced sound power level for the transformer and a 2 dB(A) adjustment, the noise level at the closest dwelling is predicted to be 35 dB(A) during the day and evening and 33 dB(A) during the night (Figure 13.8).

Noise character can be described as:

- **Tonal:** noise typically associated with a particular frequency (pure tone) and can often be more annoying. Tonal noise can be generated by rotating equipment (e.g., fan blades).
- **Impulse:** sharp, brief increases in noise volume. Impulse noise can be generated by voltage spikes in equipment.
- **Intermittency:** noise that starts and stops.

Factoring in these measures, the noise from the on-site substation and battery facility would achieve the Noise Protocol criteria. Compliance with the Noise Protocol is expected to assist with meeting the general environmental duty.

Low frequency noise levels from the on-site substation and battery facility at all dwellings are predicted to achieve the EPA Victoria Publication 1996 outdoor threshold and would not be deemed "unreasonable noise" under the *Environment Protection Act 2017*.



LEGEND

- Non-involved stakeholder dwelling
- Involved stakeholder dwelling
- Noise monitoring location
- Major road
- Substation 33kV/220kV
- Battery energy storage system
- Willatook Wind Farm boundary

Noise level (dB(A))

- >= 25
- >= 30
- >= 35
- >= 40
- >= 45
- >= 50

SOURCE:
Willatook Wind Farm boundary and noise level measurements from Wind Prospect.
Imagery from ArcGIS Online (various capture dates).

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PROJECTION: **GDA 94 MGA Zone 54**

WIND PROSPECT

WILLATOOK WIND FARM

FIGURE 13.8

Predicted ancillary infrastructure noise contours using a reduced noise level transformer for day (left) and night (right)

DATE: 12.05.22 PROJECT: 754-MELEN287657 FILE: 287657_01_FI53 DOC REFERENCE: 287657_02_FIGS_F_APRX_V02

Other potential noise issues

Infrasound

The aerodynamic noise from rotating turbine blades produces energy in the infrasound range. However, a large range of measurements from various studies of infrasound noise emissions from modern turbines indicates that at distances of 200 metres, infrasound is around 25 dB below the recognised perception threshold of 85 dB(G) (Appendix E1 – *Noise and vibration*). The level of infrasound further reduces at greater distances from the turbines. As such, infrasound at all dwellings is expected to be even lower as the distances between wind turbines and dwellings is significantly more than 200 metres.

Infrasound is generally defined as noise at frequencies less than 20 Hertz. Non-audible perception of infrasound through vibrations felt in various parts of the body can occur at levels well above the threshold of hearing.

Natural sources of infrasound include wind and breaking waves, and manufactured sources include industrial processes, vehicle movements and air conditioning and ventilation systems.

As measured levels of infrasound from wind farms are well below the threshold of perception, being no higher than levels measured at other locations where people live, work and sleep, infrasound from wind farms is not required to be assessed in contemporary standards and guidelines used by Australian and International authorities.

Low frequency noise

The predicted low frequency noise levels within the Environmental Noise Report (Appendix E1) are significantly below the threshold levels under EPA Publication 1996.

Tarrone gas-fired power station and existing substation

The Tarrone gas-fired power station (located at the Landers Lane/Riordans Road intersection in the south-east portion of the project site) was approved in 2012, however it has not been developed. An existing substation, associated with the Macarthur Wind Farm, is also located at this site. The noise and vibration assessment considered the combined noise level from the operation of the proposed gas-fired power station, existing substation, and the project on-site substation and battery facility.

Based on the modelled combined (cumulative) noise levels from these noise sources, the noise criteria for utilities (i.e., 34 dB(A) during the night time, 45 dB(A) during the day and 39 dB(A) during the evening) would be achieved at the non-stakeholder dwellings closest to the proposed gas-fired power station.

Operational vibration

Modern wind farms produce very low levels of ground vibration. Based on previous ground vibration measurements at Challicum Hills Wind Farm and the recommendation of International Standard ISO 10137:2007 for ‘critical working areas’, ground vibration from the wind turbines would be undetectable at nearby dwellings.

Cumulative noise

There are four wind farms within 15 kilometres of the project site that are either in operation or have already received planning approval. Based on the distance between the project and these wind farms no cumulative noise impacts are not predicted. Cumulative impacts (including noise) are discussed in Chapter 24 – *Cumulative effects*.

Decommissioning noise

Decommissioning activities would be expected to be similar in terms of noise generated by some construction activities, including involvement of large equipment (cranes, excavators and graders) and the transport of large project components from the site (e.g., wind turbine towers and blades).

The decommissioning process is anticipated to take at approximately six months, but like the construction phase, activities would be concentrated at a few discrete locations in any given week. A decommission noise and vibration management plan would be prepared and submitted to the responsible authority for endorsement that would provide a detailed assessment of decommissioning noise and vibration from project activities, and proposed measures to minimise potential impacts.

Monitoring and contingency

Should the development proceed, compliance monitoring would be undertaken for each aspect of the project. This would include the operation of turbines, the substation/battery facility and construction activities (including temporary quarry and blasting). Should the noise level from any of the project aspects exceed the requirements detailed in the Environmental Noise Assessment report (Appendix E1) or blasting report (Appendix E4), contingency measures will be implemented as described in Table 13.3).

13.6.5 Assessment summary

A summary of the assessment findings against the relevant noise and vibration criteria, and how the project construction and operation activities achieve these criteria with the implementation of management controls (outlined in Section 13.6.3), is provided in Table 13.4.

Table 13.4 Assessment summary against relevant noise criteria

Activity	Relevant noise criteria/ limit/guidelines	Impact summary	Assessment against criteria
Construction			
Wind turbine, substation and battery, and concrete batching plant noise	Weekend or evening works reference level (outside normal working hours): 40 dB(A) Night time reference level: 30 dB(A)	The separation distance from non-stakeholder dwellings and wind turbines is more than 1,500 metres. The separation distance from non-stakeholder dwellings and the substation and battery is 890 metres. The closest non-stakeholder dwelling to a proposed temporary concrete batching location is about 1,800 metres.	Noise levels are predicted to be lower than the criteria for all wind turbine, substation and battery, and concrete batching plant construction activities during normal working hours. Works are not proposed to occur at night. However, some low-noise, managed-impact or unavoidable works may occur (as defined in EPA Victoria's Publication 1834: *Civil construction, building and demolition guide*. Notification would be provided to affected stakeholders of the intended work.
Quarry noise	36 dB(A) (daytime)	Quarry activity noise levels are predicted to be less than 25 dB(A) at the closest non-stakeholder dwelling.	Noise levels are predicted to be lower than the criteria for all quarry activities.
Earth moving equipment and blasting vibration	Criteria contained within German Standard DIN 4150 for earth moving equipment Earth Resources Regulation ground vibration: 5 millimetres per second for 95% of all blasts (for sensitive sites) Australian Standard AS2187.2-2006 (buildings)	At 100 metres, vibration from earth moving activities is unlikely to be detectable to humans. Blasting would result in minimal blast vibration effects at the closest dwelling. The potential impact of blasting to the wind farm and other infrastructure is low.	Vibration levels are predicted to be lower than the criteria for activities associated with earth moving equipment and blasting.

Activity	Relevant noise criteria/ limit/guidelines	Impact summary	Assessment against criteria
Operation			
Wind turbine noise	Non-stakeholder dwellings: 40 dB(A) Stakeholder dwellings: 45 dB(A)	Both noise models predict the noise level for non-stakeholder dwellings is less than 40 dB(A)). The highest predicted noise level at a stakeholder dwelling is 43 dB(A).	Noise levels from wind turbine operation are predicted to be lower than the criteria.
On-site substation and battery facility	Day noise limit: 45 dB(A) Evening noise limit: 39 dB(A) Night noise limit: 34 dB(A)	The highest noise level at any non-stakeholder dwelling is predicted to be 35 dB(A) during the day and evening, and 33 dB(A) at the night. If the noise tone from transformers is just detectable a 2 dB(A) adjustment (increase) would be applied.	Noise levels for the operation of the on-site substation and battery facility are predicted to be lower than the day, evening and night noise criteria. Where an adjustment applies for noise tonal character, there is the potential for the night time noise criteria to be exceeded. However, with the inclusion of limiting the sound power level to the 'reduced' option and a 2 dB(A) adjustment made, the noise level at the closest dwelling is predicted to be 35 dB(A) during the day and evening and 33 dB(A) during the night. Factoring in these measures, the noise from the on-site substation and battery facility would achieve the Noise Protocol criteria.
Wind turbine vibration	International Standard ISO 10137:2007	Ground vibration from the wind turbines would be undetectable at nearby dwellings.	Vibration levels from wind turbine operation are predicted to be lower than the criteria**.**
Cumulative impacts	40 dB(A)	Modelling predictions indicate that noise levels at high wind speeds at dwellings between the project and Macarthur wind farms not hosting wind farm infrastructure would be less than 40 dB(A).	Noise levels are predicted to be lower than the criteria for cumulative impacts.

13.7 Independent peer review

The independent peer review (by Resonate) of the noise and vibration assessment concluded that these reports demonstrate that the project is expected to be able to operate in compliance with appropriate noise and vibration criteria, subject to the incorporation of appropriate noise and vibration management measures during construction and operation. This would include:

- implementation of the Noise and Vibration Management Plan during the construction phase
- an updated Pre-Construction Noise Assessment once the final turbine type, layout and ancillary infrastructure is confirmed. The Pre-Construction Noise Assessment would need to demonstrate that the final design is capable of complying with the applicable noise limits
- post-construction noise monitoring to be carried out for both wind turbine and ancillary infrastructure noise.

13.8 Conclusions

The noise and vibration assessment was undertaken for the project construction and operation phases in accordance with:

- the general environmental duty under the *Environment Protection Act 2017*
- the Environment Protection Amendment (Interim) Regulations 2021
- EPA Victoria Publication 1834: Civil construction, building and demolition guide
- German Standard DIN for the impact of vibration on structures during construction
- Earth Resources Regulation blast vibration limits
- DELWP's Policy and Planning Guidelines and New Zealand Standard for the impact of wind turbine operational noise
- EPA Victoria Publication 1826.4 (Noise Protocol) for the impact of the on-site substation, battery facility and quarry operational noise
- International Standard ISO 10137:2007 for the impact of vibration (human annoyance) during operation.

A detailed assessment of noise and vibration from construction activities was undertaken as part of the Construction Noise Assessment (Appendix E1), which outlines measures to be incorporated into work plans to minimise potential noise and vibration impacts to comply with the requirements of EPA Victoria Publication 1834. As the quarry would operate for the duration of the construction period, noise impacts from quarry activities have been assessed against the noise objective criteria of EPA Victoria's Noise Protocol. Blasting impacts at the quarry site were assessed to be well within the acceptable limits. Similarly, predicted noise levels from construction activities are predicted to be considerably less than the relevant criteria.

Noise modelling predicts that the project noise criteria of 40 dB(A) for the operation of the wind turbines would be achieved at all non-stakeholder dwellings. Similarly, noise predictions from the on-site substation and battery energy facility are predicted achieve the relevant noise criteria.

To meet the general environmental duty of the *Environment Protection Act 2017*, the project has sought to avoid harm to human health and the environment (so far as reasonably practicable) from noise and vibration during project construction, operation and decommissioning. Noise and vibration predictions indicate that all project construction and operation activities would achieve the relevant noise and vibration criteria. To further eliminate or reduce the risk of harm (as required by the general environmental duty), management measures would be implemented such as noise monitoring, community consultation, scheduling of works, and engineered noise reduction measures for plant and equipment (e.g., specified 'reduced' noise level for the on-site substation and battery facility transformer). Contingency measures would be implemented should noise monitoring show that criteria are being exceeded.

A 'pre-construction noise assessment' is required for the final project layout and equipment selection to ensure that the operational noise criteria are achieved at all non-stakeholder dwellings under all wind speeds prior to construction commencing.