Appendix 10

NOISE AND VIBRATION ASSESSMENT

MARSHALL DAY Acoustics

MALLEE WIND FARM
NOISE AND VIBRATION ASSESSMENT

Rp 002 20220306 | 24 September 2024

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EXECUTIVE SUMMARY

Spark Renewables Pty Limited (Spark Renewables) proposes to develop the Mallee Wind Farm (the Project) to provide a reliable and affordable source of energy for the people of New South Wales (NSW) and contribute to reducing greenhouse gas emissions associated with energy generation.

The Project is located approximately 16 km northeast of Buronga in the Murray region of southwestern NSW within the Wentworth local government area (LGA) and 17 km northeast of Mildura, Victoria (VIC). It will include the installation, operation, maintenance and decommissioning of up to 76 wind turbine generators (WTG), a single grid scale 100 MW/200 MW battery energy storage system (BESS), ancillary infrastructure and temporary facilities associated with construction of the Project. The Project design incorporates up to 76 WTGs, with a maximum blade-tip height of 280 m above ground level, and an installed capacity of up to 402 MW. Marshall Day Acoustics Pty Ltd (MDA) has been engaged to prepare this noise and vibration assessment to support the Environmental Impact Statement (EIS) for the Project.

This report presents the results of an assessment of operational noise and construction noise and vibration for the proposed Project, undertaken in accordance with the applicable Planning Secretary's Environmental Assessment Requirements (SEARs) (SSD-53293710), dated 17 February 2023, and the Supplementary SEARS dated 28 June 2023.

METHOD

For the purposes of this assessment, one candidate WTG model has been nominated by Spark Renewables comprising the one noise modelling scenario that has been documented within this assessment.

To provide for a precautionary assessment, the capacity of the candidate WTG is greater than the WTG capacity intended for use by the Project, in the context of the current project design and layout.

Operational noise from the WTGs has been assessed in accordance with the DPE (Department of Planning and Environment) *NSW Wind Energy: Noise Assessment Bulletin* (NSW Noise Assessment Bulletin) 2016, as required by SSD-53293710.

The NSW Noise Assessment Bulletin specifies that the assessment of WTG noise is to be conducted in accordance with the SA EPA (Environment Protection Authority) *Wind farms environmental noise guidelines* (SA Guidelines 2009), dated July 2009, subject to a set of supplementary procedures that are specific to NSW.

Background noise monitoring is typically conducted for wind farm projects, to establish background adjusted noise limits. However, the Project provides a comparatively unique development environment in which:

- There are no 'nearby' receivers – the minimum distance between a WTG and receiver is greater than 10 km.
- Predicted noise levels at receivers, as detailed later in the report, are below the base noise limit by a minimum margin of 13.7 dB.

On this basis background noise levels have not been measured for the Project, with the noise assessment documented herein considering the base noise limit only. This is the most stringent approach described by the NSW Noise Assessment Bulletin and provides a conservative assessment.

Manufacturer specification data provided by Spark Renewables for the candidate WTG model has been used as the basis for the assessment. These specifications provide noise emission data in accordance with the international standard referenced in the NSW Noise Assessment Bulletin. [1] The noise emission data is consistent with the range of values expected for comparable types of multi megawatt WTG models that may be considered for the Project.

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

The noise emission data has been used with international standard ISO 9613-2 to predict the level of noise expected to occur at neighbouring receivers. [2] The ISO 9613-2 standard has been applied based on well-established input choices and adjustments, considering research and international guidance that is specific to wind farm noise assessment. ISO 9613-2 is nominated as being an acceptable noise prediction method in the SA Guidelines 2009.

ASSESSMENT OVERVIEW

The results of the noise modelling for the Project demonstrate that the predicted noise levels for the proposed WTG layout are below the base noise limit determined in accordance with the NSW Noise Assessment Bulletin at all neighbouring non-associated receivers.

To assess compliance with the applicable noise limit, the NSW Noise Assessment Bulletin also requires consideration of potential adjustments to the predicted WTG noise levels for special noise characteristics, comprising tonality and low frequency. Analysis of the noise emission frequency data for the proposed WTG model indicates that the noise from the Project is not expected to be characterised by tonality. This is supported by evidence of operational wind farms in Australia which indicates that the occurrence of tonality at receivers is atypical.

Indicative unconstrained noise modelling also demonstrates the Project is predicted to result in noise levels below 60 dB L_{Ceq} at all assessed non-associated receivers (the threshold defined by the NSW Noise Assessment Bulletin for the presence of low frequency noise).

Accordingly, adjustments for special noise characteristics are not warranted and have therefore not been applied to the predicted noise levels.

The assessment has also considered operational noise from the proposed ancillary infrastructure, including substations and BESS. The predicted noise levels have been assessed in accordance with the NSW EPA (Environment Protection Authority) *Noise Policy for Industry* (NPfI) 2017. The assessment demonstrates that ancillary infrastructure noise is predicted to be below the most stringent night-time project noise trigger level of 35 dB $L_{Aeq,\ 10\ min}$.

A preliminary construction noise and vibration assessment has been conducted, accounting for typical equipment items and work practices. Details of the relevant NSW guidelines is also provided alongside preliminary noise management recommendations. The assessment was undertaken in accordance with the DECC (Department of Environment and Climate Change) *Interim Construction Noise Guideline* (ICNG) 2009 and the DEC (Department of Environment and Conservation) *Assessing Vibration: A Technical Guideline* (AVTG) 2006. The assessment confirmed that construction noise and vibration can be appropriately managed using standard good practice measures.

An assessment of traffic noise associated with construction activities has been conducted in accordance with the DECCW (Department of Environment, Climate Change and Water) *Road Noise Policy* (RNP) 2011. The assessment established setback distances for local and freeway/arterial/sub-arterial roads within which applicable traffic noise criteria may be exceeded.

No associated or non-associated receivers identified by Spark Renewables are located within the setback distances. However, some unidentified receivers may be located within the setback distances for transport routes further from the Project, particularly at the Silver City Highway/Arumpo Road intersection. These receivers should be consulted prior to and during construction activities to manage impacts and considered in more detail as part of a future Construction Noise and Vibration Management Plan (CNVMP), per the following section.

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

RECOMMENDATIONS

The findings of the operational noise assessment demonstrate that the Project can be designed and operated to comply with NSW requirements for both WTG noise and ancillary infrastructure, including the BESS. It is recommended that the predicted noise levels for all components of the operational noise assessment are updated for the final Project configuration and equipment selections, in order to verify compliance with the applicable noise criteria prior to the commencement of construction.

Consistent with the NSW Noise Assessment Bulletin, compliance is also recommended to be verified by post-construction noise compliance monitoring. The compliance testing procedures should be documented in a compliance test plan. Given the size of the Project, the compliance testing regime to be documented in a future noise compliance test plan is recommended to include provisions for early onsite noise emission testing of the WTGs to verify consistency with the design validation modelling.

Measures for the management of construction noise and vibration would be implemented via a CNVMP to be prepared at a later stage of the Project when a construction contractor has been selected and specialised construction planning for the site has been developed. This would comprise a detailed noise and vibration assessment, as well as Project specific noise mitigating work practices and physical noise controls (where required). Construction traffic noise impacts should also be reviewed in the context of the finalised construction planning, particularly for receivers close to the Silver City Highway/Arumpo Road intersection.

MARSHALL DAY Acoustics

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1.0 INTRODUCTION

Spark Renewables Pty Limited (Spark Renewables) proposes to develop the Mallee Wind Farm (the Project) to provide a reliable and affordable source of energy for the people of New South Wales (NSW) and contribute to reducing greenhouse gas emissions associated with energy generation.

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Assessments required by the SEARs and the relevant sections of reporting are summarised below:

- assessment of WTG noise in accordance with the DPE (Department of Planning and Environment) *NSW Wind Energy: Noise Assessment Bulletin* (NSW Noise Assessment Bulletin) 2016 (refer to Section 6.0)
- assessment of the noise generated by ancillary infrastructure in accordance with the NSW EPA (Environment Protection Authority) *Noise Policy for Industry* (NPfI) 2017 (refer to Section 7.0)
- assessment of construction noise under the DECC (Department of Environment and Climate Change) *Interim Construction Noise Guideline* (ICNG) 2009 (refer to Section 11.0)
- assessment of traffic noise under the DECCW (Department of Environment, Climate Change and Water) *Road Noise Policy* (RNP) 2011 (refer to Section 12.0)
- an assessment of vibration under the DEC (Department of Environment and Conservation) *Assessing Vibration: A Technical Guideline* (AVTG) 2006 (refer to Section 11.4)
- assessment of the noise impacts on amenity/recreational use of the Mallee Cliffs National Park (including walking tracks, campgrounds and lookouts) comparing comparable noise amenity levels in the NPfI (refer to Section 8.0)
- assessment of the cumulative noise impacts (considering other developments in the area) (refer to Section 9.0)

The noise assessment presented in this report is based on:

- Operational noise limits determined in accordance with applicable regulatory documentation
- Predicted WTG noise levels, based on the proposed Project layout and a candidate WTG model
- Predicted noise levels from the ancillary infrastructure, based on noise emission data provided by Spark Renewables (and in some cases sourced from MDA's noise database)

No blasting is proposed for the Project, and hence, consideration of blasting impacts has not been provided in this report.

A glossary of terminology is provided in Appendix A with general information regarding the description of sound provided in Appendix B.

2.0 PROJECT OVERVIEW

2.1 Project location and context

The Project is located in the Murray region of southwestern NSW, within the South West Renewable Energy Zone (South West REZ). The Project is situated within the Wentworth Shire LGA. The Project is located approximately 16 km northeast of Buronga, NSW, 17 km northeast of Mildura, VIC and 40 km east of Wentworth, NSW. Smaller localities of Mallee, Red Cliffs and Trentham Cliffs are located to the south and southwest of the Project.

The Project Area encompasses approximately 57,330 ha of predominantly cropping and grazing land and adjoins the Mallee Cliffs National Park, which is located directly south and southeast. The Project Area is zoned primarily as RU1 Primary Production with some portions of C2 Environmental Conservation zoned land within the Project Area under the Wentworth Local Environment Plan 2011. There is no C2 zoned land within the Disturbance Footprint and no Project infrastructure will be sited within C2 land.

2.2 Key project features

The Project will include the installation, operation, maintenance and decommissioning of up to 76 WTGs, a BESS facility, ancillary infrastructure and temporary facilities associated with construction of the Project. The current design incorporates WTGs with a maximum blade-tip height of 280 m above ground level with an installed capacity of up to 402 MW.

The key components of the Project include:

- Up to 76 (3 blade) WTGs, with a maximum blade-tip height of 280 m above ground.
- A single grid-scale 100 MW/200 MWh BESS.
- Permanent ancillary infrastructure including internal roads, hardstands, main and collector substations, switchyards, operations and maintenance facilities, underground and overhead electricity transmission lines and poles, telecommunications facilities and utility services, permanent meteorological masts and water storage tanks.
- Temporary facilities used for the construction, repowering and/or decommissioning of the Project, including but not limited to the temporary workforce accommodation, site offices, amenities, construction compounds and laydown areas (including stockpiling and materials storage areas), concrete or asphalt batching plants, minor ‘work front’ construction access roads, environmental management and monitoring and signage and temporary meteorological masts.
- Off-site road works, involving upgrades to the proposed local transport route and establishment of site access points.

The coordinates of the WTGs are presented in tabular format in Appendix C.

A Project layout plan illustrating the WTG layout, approximate ancillary infrastructure locations, and noise sensitive receivers is provided in Figure 1.

The topography of the Project and surrounding area is depicted in the elevation map provided in Appendix D.

2.3 Receivers

Throughout this report, the term receiver is used to identify any dwelling identified by Spark Renewables in the vicinity of the proposed Project.

A total of 7 receivers have been identified by Spark Renewables within 12 km of a Project WTG and are considered in this noise assessment. Typically, MDA would assess noise to receivers within 5 km. This is a nominal distance commonly referenced on account of being significantly greater than the separation distance required to achieve compliance with the lowest possible noise limit prescribed in the NSW Noise Assessment Bulletin. As there are no receivers located within 5 km of the Project, this has been increased to 12 km to provide greater context to the noise modelling results.

For the purposes of noise assessment, receivers are separated into two distinct categories, based on the requirements of the NSW Noise Assessment Bulletin, SA Guideines 2009 and preliminary guidance in the Draft Wind Energy Guideline: [3]

Associated

- A residence on privately-owned land in respect of which the owner has reached an agreement with the applicant in relation to the development and management of noise impacts

Non-associated

- A residence on privately-owned land in respect of which the owner has not reached an agreement with the applicant in relation to the development; or
- A residence on privately-owned land in respect of which the owner has reached an agreement with the applicant in relation to the development, but the agreement does not include management of noise impacts

Agreements established between an applicant and landholders/owners can comprise two general types:

Host agreements

- Where applicants enter into agreements with 'host' landholders who are willing to have project infrastructure located on their land; or

Impact agreements

- Where agreements are negotiated between the applicant and neighbours of the development when the development may significantly impact the neighbour or their land. The agreement aims to manage and mitigate these impacts.

Where an agreement of either type, specifically addressing noise, is in place between an applicant and a landholder, the affected residence is taken to be associated with the development for the purpose of the assessment.

Where an agreement is not in place between an applicant and a landholder/s, the affected residence is categorised as non-associated.

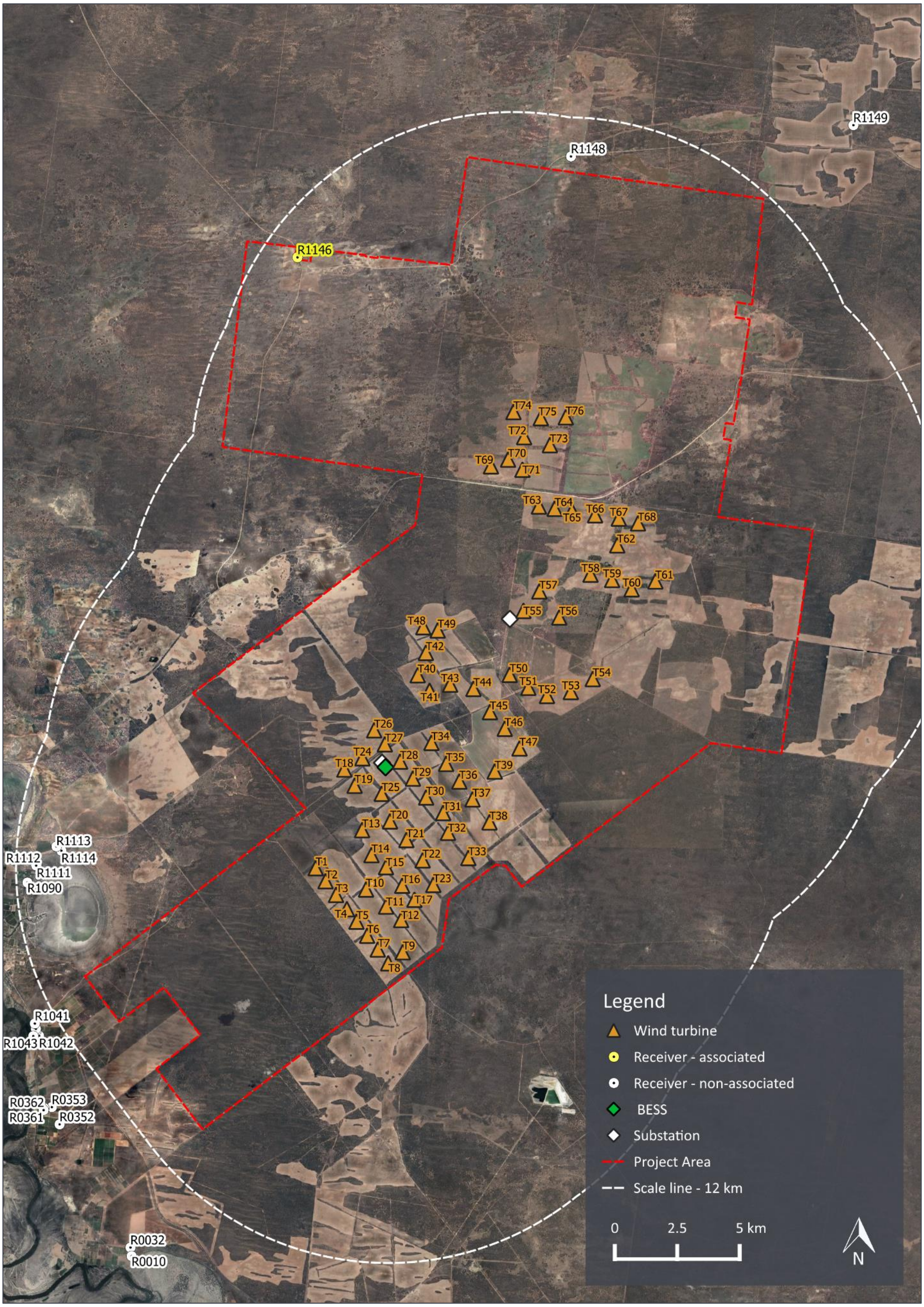
Of the 7 identified receivers, one receiver, R1146, is subject to a host agreement with Spark Renewables, with provisions included to address noise impacts. Based on the above, this receiver is categorised as associated for the purposes of noise assessment. The remaining 6 receivers, in not having either host or impact agreements, are categorised as non-associated.

A high-level review of satellite imagery in the vicinity of the site was conducted by MDA, for the purposes of confirming the receiver dataset, with no residual dwellings identified.

The coordinates of the receivers identified within 12 km of the Project WTGs are tabulated in Appendix E.

[3] NSW DPE (Department of Planning and Environment) *Draft Wind Energy Guideline - Guidance for state significant wind energy development* November 2023

Figure 1: Project layout



3.0 NEW SOUTH WALES POLICY & GUIDELINES

Based on the requirements specified in the Project SEARs (SSD-53293710), the following publications are relevant to the assessment of operational and construction noise from proposed wind farm developments in NSW:

- DPE (Department of Planning and Environment) *NSW Wind Energy: Noise Assessment Bulletin* (NSW Noise Assessment Bulletin) 2016
- EPA (Environment Protection Authority) *Noise Policy for Industry* (NPfI) 2017
- DECC (Department of Environment and Climate Change) *Interim Construction Noise Guideline* (ICNG) 2009
- DECCW (Department of Environment, Climate Change and Water) *Road Noise Policy* (RNP) 2011
- DEC (Department of Environment and Conservation) *Assessing Vibration: A Technical Guideline* (AVTG) 2006

Details of the guidance and noise criteria provided by these publications are provided in the following sections.

3.1 NSW Noise Assessment Bulletin

The NSW Noise Assessment Bulletin provides proponents of wind energy projects and the community with advice about how noise impacts are assessed for large-scale wind energy development projects that are a State significant development. The stated objective of the NSW Noise Assessment Bulletin is to ensure that the noise impacts of wind energy projects are appropriately identified, mitigated, and managed.

The NSW Noise Assessment Bulletin specifies that the assessment of WTG noise is to be conducted in accordance with the SA Guidelines 2009, subject to a set of supplementary procedures that are specific to NSW. The variations relate to:

- *Noise limits:* selection of a lower base noise limit in all areas of NSW, in recognition that the regional areas of NSW with high quality wind resources are more populated than the equivalent regions in South Australia.
- *Special noise characteristics:* definition of additional procedures and establishing low frequency as an assessable characteristic.
- *Noise monitoring:* definition of additional technical procedures, including the use of alternative/intermediate noise monitoring locations for compliance monitoring.

The elements of the NSW Noise Assessment Bulletin that are applicable to the current planning stage assessment are described in further detail below.

3.1.1 Noise limits

In relation to noise limits, the variation defined in the NSW Noise Assessment Bulletin sets the base criterion at a value of 35 dB for all projects, in lieu of the 35 to 40 dB base criterion range defined in the SA Guidelines 2009. The criteria in the NSW Noise Assessment Bulletin are subsequently defined as follows:

> *The predicted equivalent noise level ($L_{Aeq,10\,minute}$)*, adjusted for tonality and low frequency noise in accordance with these guidelines, should not exceed 35 dB(A) or the background noise ($L_{A90(10\,minute)}$) by more than 5 dB(A), whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the wind turbine generator and each integer wind speed in between.*
>
> ** Determined in accordance with SA 2009, Section 4.*

The NSW Noise Assessment Bulletin notes the following in relation to the types of receivers where the noise limits apply:

> *The criteria in this Bulletin have been developed to address potential noise impacts on the amenity of residents and other relevant receivers in the vicinity of a proposed wind energy project. Wind energy proponents commonly negotiate agreements with private land owners where applicable noise limits may not be achievable at relevant receiver locations. A negotiated agreement will be considered as part of the assessment of a wind energy project, as will the requirements of SA 2009 and this Bulletin. The proponent's EIS should clearly identify the expected noise levels at all receiver locations including host properties to ensure that affected persons are appropriately informed regarding the development proposal.*

Accordingly, the NSW Noise Assessment Bulletin noise limits only apply to non-associated receivers. Associated receivers are discussed in Section 3.1.4.

3.1.2 Tonality

Sounds which have unusually high levels of energy in a relatively narrow band of frequencies may be referred to as being tonal. Audible tonal sounds from WTGs are generally related to rotational equipment in the WTG nacelle and can have a specific pitch dependent on the speed of rotation. This can cause the noise to be more annoying or noticeable. These tonal characteristics (as defined below) typically do not occur in well designed and well-maintained WTGs.

The SA Guidelines 2009 requires that development applications for wind energy projects report the following:

> *To help determine whether there is tonality, the method and results of testing (such as in accordance with IEC 61400−11) carried out on the proposed wind turbine model to determine the presence of tonality should also be specified in the development application.*

Section 4 of the SA Guidelines 2009 further requires checks to be made during post completion compliance assessments.

Under the NSW Noise Assessment Bulletin, in addition to the above requirements, tonality is also assessed using the method described in Annex D of ISO 1996-2:2007 *Acoustics - Description, measurement and assessment of environmental noise – Determination of environmental noise levels* (ISO 1996-2:2007) for the assessment of tonality.

Tonality is defined as when the level of a one-third octave band (with the descriptor in accordance with the SA Guidelines 2009), exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is in the range 500 Hz to 10,000 Hz
- 8 dB or more if the centre frequency of the band containing the tone is in the range 160 Hz to 400 Hz, and/or
- 15 dB or more if the centre frequency of the band containing the tone is in the range 25 Hz to 125 Hz.

If tonality is found to be a repeated characteristic of the candidate WTG, 5 dB is to be added to the predicted or measured WTG noise levels. Note that 5 dB is the maximum penalty that may be applied for special noise characteristics, irrespective of whether one or more characteristics are present.

3.1.3 Low frequency noise

Low frequency noise is present in all types of environmental noise and is particularly difficult to measure in the presence of wind due to the increased level of background noise. The NSW Noise Assessment Bulletin indicates that low frequency noise is typically not a significant feature of modern WTG noise when it complies with the A-weighted noise limits.

In NSW, contemporary approvals include the following requirement for low frequency noise:

> *The presence of excessive low frequency noise that is a repeated characteristic* [i.e. noise from the wind farm that is repeatedly greater than 60 dB(C)] will incur a 5 dB(A) penalty, to be added to the measured noise level for the wind farm, unless a detailed low frequency noise assessment to the satisfaction of the Secretary demonstrates compliance with the proposed criteria for the assessment of low frequency noise disturbance (UK Department for Environment, Food and Rural Affairs (DEFRA, 2005)) for a steady state noise source.*
>
> ** The descriptor shall be in accordance with SA 2009, Section 4*

In the unlikely event that excessive low frequency noise is found to be a repeated characteristic of the WTG noise, 5 dB is to be added to the predicted or measured WTG noise levels. An assessment of C-weighted WTG noise levels must be undertaken against the 60 dB L_{Ceq} criterion at non-associated receivers in the vicinity of the Project. Note that 5 dB is the maximum penalty that may be applied for special noise characteristics, irrespective of whether one or more characteristics are present.

3.1.4 Associated receivers

The NSW Noise Assessment Bulletin also requires noise levels to be predicted for associated receivers, i.e. host properties and receivers where a noise agreement is in place with Spark Renewables.

The SA Guidelines 2009 provides guidance with respect to acceptable levels for *financial stakeholders,* presenting a base reference level of 45 dB $L_{Aeq,\ 10\ min}$ for associated receivers, in order to provide context to the predicted noise levels for these locations.

Comparisons between the predicted noise levels and the 45 dB reference level are provided for informative purposes only. Noise levels at associated receivers will ultimately need to be managed in accordance with the commercial agreements established between Spark Renewables and the landowners.

3.2 Noise Policy for Industry

The NPfI is the applicable guideline for assessing operational noise associated with the proposed ancillary infrastructure i.e. BESS and substations.

The NPfI provides a method for determining project noise trigger levels that are used for assessing the potential impact of noise from industry at existing receivers. Specifically, the project noise trigger levels provide a benchmark or objective for assessing a proposal or site. The NPfI states that the project noise trigger levels are not intended for use as mandatory requirements, but represent the levels that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response; for example, further investigation of mitigation measures.

The project noise trigger levels are derived from an analysis of the background noise environment and zoning information, accounting for amenity-based criteria and, in the case of residential receivers, intrusiveness criteria. The project noise trigger levels are defined as the minimum of the amenity criteria and the intrusiveness criteria.

Assessments are conducted in terms of $L_{Aeq,\ 15\ min}$, as opposed to the $L_{Aeq,\ 10\ min}$ used for WTG noise assessments.

Additional criteria are defined for assessing the potential for sleep disturbance from noise sources that are characterised by transient events which result in brief periods of increased noise levels. The additional criteria are applicable during the night-time period only.

The following subsections describe the amenity and intrusiveness noise levels used to determine the project noise trigger levels. Further details on the derivation of appropriate project noise trigger levels for the assessment of operational noise levels from ancillary infrastructure are provided in Section 7.1.

3.2.1 Amenity noise levels

The amenity noise assessment is designed to prevent industrial noise continually increasing above an acceptable level. The NPfI provides recommended amenity noise levels based on receiver categories and typical planning zones.

The recommended amenity noise levels outlined in the NPfI have been selected on the basis of studies that relate industrial noise to annoyance in communities and have been subjectively scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban, and urban communities for residential receivers. They are based on protecting the majority of the community (90 %) from being highly annoyed by industrial noise.

The amenity levels defined in the NPfI relate to total industry noise levels. The project amenity noise levels for an individual industry are set at a level 5 dB below the recommended amenity levels to provide a margin for cumulative industry noise.

3.2.2 Intrusiveness noise levels

The intrusiveness noise assessment is applicable to residential receivers and is based on knowledge of the background noise level at the receiver. The background noise levels are referred to as the rating background noise level (RBL) in the NPfI.

The intrusiveness noise level is the RBL at the nearest noise sensitive location plus 5 dB. Therefore, the noise emissions from the premises are considered to be intrusive if the source noise level ($L_{Aeq,\ 15\ min}$) is greater than the background noise level (L_{A90}) plus 5 dB.

3.2.3 Mallee Cliffs National Park

Mallee Cliffs National Park (MCNP) is located to the east and southeast of the Project. The closest point of the MCNP boundary is approximately 800 m from the nearest WTG.

The SEARs issued for the Project requires the noise assessment to:

assess the noise impacts on amenity/recreational use of the Mallee Cliffs National Park (including walking tracks, campgrounds and lookouts) considering comparable noise amenity levels in the NSW Noise Policy for Industry (EPA, 2017);

The NPfI specifically states:

The policy does not apply to:

…

- *wind farms*

…

Other government policies, guidelines and legislation typically cover these noise sources.

Notwithstanding the above, the NPfI has been referred due to instruction of the SEARs.

The NPfI provides amenity noise levels for different receiver types, including areas specifically reserved for passive recreation, e.g. national parks, providing a prescriptive recommended amenity noise level of 50 dB L_{Aeq}. The recommended amenity noise level is independent of background noise level and applies when the park is in use.

3.3 Interim Construction Noise Guideline

The ICNG aims to provide a clear understanding of ways to identify and minimise noise from construction works through applying all 'feasible' and 'reasonable' work practices to control noise impacts. The guideline identifies sensitive land uses and recommends construction hours, provides quantitative and qualitative assessment methods, and subsequently advises on appropriate work practices.

The ICNG recommended standard construction hours detailed in Table 1.

Table 1: ICNG recommended standard hours of work

Work type	Recommended standard hours of work	
Normal construction	Monday to Friday	0700 to 1800 hrs
	Saturday	0800 to 1300 hrs
	No work on Sundays or public holidays	

In relation to residential receivers considered in this assessment, and based on the recommended standard hours, the ICNG provides two primary management levels for consideration in the assessment of noise at residential receivers:

- The noise affected management level ($L_{Aeq\ 15\ min}$) is the NPfI's rating background noise level +10 dB
- The highly noise affected management level is prescriptively set at 75 dB $L_{Aeq,\ 15\ min}$.

Where noise from construction works is above the noise affected management level, all feasible and reasonable work practices should be applied. Where the noise from construction works is above highly noise affected management level, restrictions to the hours of construction may be required.

The ICNG also defines the following 5 categories of works that might be undertaken outside the recommended standard hours:

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

The ICNG defines additional assessment and reporting requirements that apply if out of hours work is proposed, including justification of the need to work during these periods, including additional management levels for ground borne noise from construction vibration.

Construction works associated with the Project are only expected to occur during standard working hours. On this basis assessment of out of hours works is not included in this report. The only exceptions are for potentially unavoidable works or low-noise managed-works. Unavoidable works outside of standard hours may comprise the delivery of oversized WTG components at times selected to minimise traffic disruption associated with intersection closures, and potentially WTG installation activities that are sensitive to weather conditions, e.g. installation of rotors or concrete pouring during summer.

3.4 Assessing Vibration: A Technical Guideline

The Project SEARs stipulate that vibration related to construction and operation of the proposed Project should be assessed in accordance with the AVTG.

The AVTG presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. Preferred and maximum vibration values outlined in the AVTG are taken from British Standard 6472:1992 *Evaluation of human exposure to vibration in buildings (1-80 Hz)* (BS 6472).

The AVTG identifies three vibration categories:

- *Continuous vibration* – Examples: Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery)
- *Impulsive vibration* – Examples: Infrequent activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading
- *Intermittent vibration* – Examples: Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Similar to other policy and guideline documentation, the AVTG allows for assessment at various receiver types.

3.4.1 Intermittent vibration

The vibration characteristics of most construction activities, e.g. excavation and pilling, are considered to be intermittent. Intermittent vibration can be defined as interrupted periods of continuous vibration, e.g. heavy truck pass-bys or rock breaking, or continuous periods of impulsive vibration, e.g. impact pile driving.

Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels occur over a shorter time period. Hence, for intermittent vibration, human disturbance vibration levels are assessed on the basis of the vibration dose value (VDV), based on the level and the duration of the vibration events. Vibration criteria applicable to residential receivers for intermittent vibration sources are summarised in Table 2.

Table 2: Preferred and maximum vibration levels for human disturbance limits, VDV [1]

Assessment period [2]	Preferred value	Maximum value
Daytime	0.20	0.40
Night-time	0.13	0.26

1 These values are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

2 Daytime is 0700 hrs to 2200 hrs and night-time is 2200 hrs to 0700 hrs

3.4.2 Continuous and impulsive vibration

Vibration criteria applicable to the residential receivers in the vicinity of the Project for continuous and impulsive vibration sources, are summarised in Table 3.

Table 3: Preferred and maximum vibration levels for human disturbance limits, m/s [1]

Vibration type	Assessment period [2]	Preferred values		Maximum values	
		Z axis	X and Y axes	Z axis	X and Y axes
Continuous vibration	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0,014	0.010
Impulsive vibration	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

1 The preferred and maximum values are weighted RMS acceleration values. These values are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

2 Daytime is 0700 hrs to 2200 hrs and night-time is 2200 hrs to 0700 hrs

3.5 Road Noise Policy

The Project SEARs indicate that additional traffic on public roads due to construction and operation of the Project must be assessed against the requirements of the RNP and relevant application notes.

The RNP provides noise level criteria for increased traffic flow as a result of a land-use development with the potential to create additional traffic, as detailed in Table 4.

Table 4: Road traffic noise assessment criteria for residential land uses

Type of development	Day (0700-2200 hrs)	Night (2200-0700 hrs)
Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 dB $L_{Aeq, 15 hr}$ (external)	55 dB $L_{Aeq, 9 hr}$ (external)
Existing residences affected by additional traffic on existing local roads generated by land use developments	55 dB $L_{Aeq, 1 hr}$ (external)	50 dB $L_{Aeq, 1 hr}$ (external)

Additionally, the RNP requires that the relative increase in noise levels at residential receivers not exceed 12 dB for land use developments with the potential to generate additional traffic on existing freeways, arterial or sub-arterial roads. The relative increase criterion does not apply for local roads.

The RNP notes that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

Where night-time construction traffic is likely to occur, an assessment of sleep disturbance is appropriate. The RNP provides guidance on this matter:

- Maximum internal noise levels below 50–55 dB L_{Amax} are unlikely to awaken people from sleep
- One or two noise events per night, with maximum internal noise levels of 65–70 dB L_{Amax}, are not likely to affect health and wellbeing significantly.

Based on the assumption that an open window provides 10 dB attenuation (which would be typical of a facade with partially open windows), noise levels below 60 - 65 dB L_{Amax} outside an open bedroom window would be unlikely to cause awakening reactions.

Furthermore, one or two events with a noise level of 75 - 80 dB L_{Amax} outside an open bedroom window would be unlikely to affect health and well-being significantly.

4.0 NOISE PREDICTION METHOD

4.1 Operational noise

Operational Project noise levels are predicted using:

- Noise emission data for the WTGs and ancillary infrastructure equipment
- A 3D digital model of the Project 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 9613-2:1996). The prediction method is consistent with the guidance provided by the SA Guidelines 2009, as referenced in the NSW Noise Assessment Bulletin, 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 WTG and ancillary infrastructure noise levels. For example, for both types of sources, equivalent ground and atmospheric conditions are used for the calculations. However, when applied to WTG noise, additional and specific input choices apply, as detailed below.

Key elements of the noise prediction method are summarised in Table 5. Further discussion of the method and the calculation choices is provided in Appendix F.

Table 5: Noise prediction elements

Detail	Description
Software	Proprietary noise modelling software SoundPLANnoise version 9.0
Method	International Standard ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (ISO 9613-2:1996). 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* (UK Institute of Acoustics guidance). The adjustments are applied within the SoundPLANnoise 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 F.
Source characterisation	Each source of operational noise is modelled as a point source of sound. The total sound of the component of the Project being modelled, i.e. the WTGs or the related infrastructure, is then calculated on the basis of simultaneous operation of all elements, e.g. all WTGs, and summing the contribution of each. To model the WTG components of the Project, the following specific procedures are noted: • Calculations of WTG 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 WTG. • Calculations of terrain related screening are made on the basis of the point source being located at the maximum tip height of each WTG. Further discussion of terrain screening effects is provided below.
Terrain data	Digital terrain map with a cell size of 5 m throughout the Project and surrounds, provided by Umwelt, on behalf of Spark Renewables.

Detail	Description
Terrain effects (WTG-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 F. *Valley effects*: +3 dB is applied to the calculated noise level of a WTG when a significant valley exists between the WTG and calculation point. A significant valley is determined to exist when the actual mean sound propagation height between the WTG 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 WTG 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 WTG and receivers are tabled in Appendix C and Appendix E, respectively. The topography of the Project is depicted in the elevation map provided in Appendix D.
Ground conditions	Ground factor of G = 0.5 on the basis of the UK Institute of Acoustics guidance and research outlined in Appendix F. The ground around the Project 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 80 % These represent conditions which result in relatively low levels of atmospheric sound absorption and are chosen on the basis of the UK Institute of Acoustics guidance and SA Guidelines 2009. The calculations are based on sound speed profiles which increase the propagation of sound from each WTG to each receiver, whether as a result of thermal inversions or wind directed toward each calculation point. [4] The primary consideration for wind farm noise assessment is wind speed and direction. The noise level at each calculation point is assessed on the basis of being simultaneously downwind of every WTG at the Project. Other wind directions in which part or the entire wind farm is upwind of the receiver will result in lower noise levels. In some cases, it is not physically possible for a receiver to be simultaneously downwind of each WTG and the approach is therefore conservative in these instances.
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. The magnitude of these differences is comparable and therefore balance each other out to provide similar predicted noise levels. This approach has been shown to be valid for predicting noise levels of wind farms expected to be measured using the L_{A90} parameter (per the NSW Noise Assessment Bulletin).

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

4.2 Construction noise

Predicted noise levels have been calculated in general accordance with the method detailed in Australian Standard 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436). This method enables the prediction of noise levels for sound propagation over hard or soft ground but does not provide the ability to calculate predicted noise levels for mixed ground cover with varied soil conditions.

The standard also notes that caution must be applied when considering predicted noise levels at distances beyond 100 m. For these reasons, predicted noise levels have been determined as the arithmetic average of the hard and soft ground prediction methods.

This approach is broadly consistent with the equivalent prediction procedure in British Standard 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites: Noise* (BS 5228), as referenced in AS 2436, and provides a margin of caution with respect to ground conditions for the typical magnitude of separating distances between construction activities and neighbouring sensitive receivers.

5.0 EXISTING NOISE ENVIRONMENT

5.1 Policy

5.1.1 NSW Noise Assessment Bulletin

Background noise monitoring is typically conducted for wind farm projects, to establish background adjusted noise limits. Background noise monitoring can also be useful to demonstrate post-construction compliance of a project, as the influence of background noise can be removed from measured noise levels at receivers near WTGs, in line with methods set out in the SA Guidelines 2009. The NSW Noise Assessment Bulletin refers to the SA Guidelines 2009 on this matter, as well as several others.

The first step in assessing background noise levels involves determining whether background noise measurements are warranted. For this purpose, Section 3.1 of the SA Guidelines 2009 provides the following guidance:

> *Background noise measurements should be carried out at locations that are relevant for assessing the impact of wind turbine noise on nearby premises (relevant receivers).*
>
> *Relevant receiver locations are premises:*
>
> *- where someone resides or has development approval to build a residential dwelling;*
>
> *- where the predicted noise level exceeds the base noise level for the area [35 or 40 dB(A)] for wind speeds up to the speed of the rated power;*
>
> *- that are representative of the worst-case situation when considering the range of premises, e.g. a house located among a group of nearby houses within a residential zone.*

In applying the above to the Project it is clear that:

- There are no 'nearby' receivers – the minimum distance between a WTG and receiver is greater than 10 km.
- Predicted noise levels at receivers, as set out in Section 6.0 are below the base noise limit (35 dB $L_{Aeq,\,10\,min}$) by a minimum margin of 13.7 dB.

Given the large separating distances between WTGs and receivers, and significant margin of compliance, it is expected that measurement of background noise levels:

- Has no technical merit for the purpose of deriving adjusted noise limits at receivers, as noise levels from WTGs are predicted to be significantly below the base noise limit.
- Has little technical merit for the purpose of demonstrating post-construction compliance of the Project, as it is highly unlikely that noise from the wind farm will be directly measurable at any of the receivers - the combined noise level measurement will be wholly dominated by the background noise level, "masking" the WTG noise.

On this basis background noise levels have not been measured for the Project, with the noise assessment documented herein considering the base noise limit only.

The NSW Noise Assessment Bulletin and the SA Guidelines 2009 recognise that alternative methods of demonstrating compliance may be required in situations where WTG noise at a receiver location is fully or partially masked. Alternative methods described in the NSW Noise Assessment Bulletin may include:

> *…alternative or intermediate locations between the wind energy project and the relevant receiver where the signal-to-noise ratio is much higher, and for which there are well established theoretical and empirical relationships to the relevant receivers.*

Additionally the SA Guideline 2009 states:

> *The EPA recognises that there will be natural variations in background noise throughout the year, with different prevailing wind directions, foliage on trees, atmospheric conditions and possibly with changes to local conditions such as buildings, trees or topography that may affect compliance with the criteria.*
>
> *Where this may be the case, the onus of responsibility to prove this resides with the developer or current operator of the wind farm.*
>
> *A range of alternative compliance checking procedures can remove the influence of background noise to accurately determine the wind farm noise in isolation.*

For the purposes of demonstrating compliance, intermediate locations, or sound power testing would permit WTG noise from the Project to be evaluated at receivers without relying on pre-construction background noise levels.

The above pragmatic approach is expected to satisfy the requirements of the NSW Noise Assessment Bulletin, allowing prediction of WTG noise at receivers using an empirical propagation method based on sound power levels set out by manufacturer specification, or measured from the Project. Additionally, the approach would eliminate the influence of background noise and the seasonal variance recognised in the SA Guidelines 2009, allowing noise from the wind farm to be determined in isolation of such factors.

5.1.2 Noise Policy for Industry and Interim Construction Noise Guideline

Project noise trigger levels and noise management levels applicable to ancillary infrastructure noise and construction noise assessment also consider background noise levels, in principle.

Contrary to the descriptor used for background noise assessment under the NSW Noise Assessment Bulletin, background noise levels in the NPfI and ICNG, referred to as rating background noise levels, are assessed in terms of $L_{A90,\ 15\ min}$.

Measurement procedures for determining rating background noise levels are set out in Fact Sheet B *Measurement procedures for determining background noise* of the NPfI. Background noise data developed for an NPfI assessment is also suitable for use as part of an assessment under the ICNG.

5.2 Background noise levels

As set out in Section 5.1.1, background noise levels have not been measured for the Project.

The following sub-sections set out the basis for deriving noise limits under the respective policy documents, in the absence of measured background noise levels.

5.2.1 NSW Noise Assessment Bulletin

Assessment at non-associated receivers has been conducted considering the base noise limit, 35 dB $L_{Aeq,\ 10\ min}$, in the NSW Noise Assessment Bulletin. This represents the most stringent noise limits that can be applied under the policy.

5.2.2 Noise Policy for Industry and Interim Construction Noise Guideline

The NPfI recognises that very low background noise levels, particularly at night, can present challenges with the derivation of reasonable assessment criteria. Table 2.1 of the NPfI provides minimum assumed rating background noise levels which are summarised in Table 6.

These minimum levels are used for derivation of the NPfI project noise trigger levels in Section 7.1 and ICNG management levels in Section 11.0.

Table 6: Minimum assumed rating background noise levels for NPfI and ICNG, dB L_{A90}

Time of day	Minimum assumed RBL
Day	35
Evening	30
Night	30

Time of day is defined as:

Day	0700- 1800 hrs Monday to Saturday and 0800 - 1800 hrs Sundays and public holidays
Evening	1800 - 2200 hrs Monday to Sunday and public holidays
Night	the remaining periods

6.0 WTG OPERATIONAL NOISE ASSESSMENT

The model of WTG ultimately selected for the Project would be determined based on a range of design requirements.

Accordingly, to provide an assessment at this stage of the Project, it is necessary to consider a "*candidate WTG*" model that is representative of the size and type of WTG being considered. The purpose of a candidate WTG model 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 WTGs being considered for the Project.

To provide for a precautionary assessment, Spark Renewables has considered a candidate WTG model as detailed in Table 7. The capacity of this candidate WTG is greater than and does not reflect the WTG capacity intended for use by the Project, in the context of the current project design and layout.

The candidate WTG model is a variable speed WTG, with the speed of rotation and the amount of power generated by the WTG being regulated by control systems that vary the pitch of the WTG blades (the angular orientation of the blade relative to its axis).

Table 7: Candidate WTG model specifications

Item	Detail
Make	Vestas
Model	V162-6.0
Rated power, MW	6.0
Rotor diameter, m	162
Modelled hub height, m	199
Equivalent tip height, m	280
Operating mode	PO6000-0S
Serrated trailing edge	No
Highest sound power, dB L_{WA}	108.1

Unless specified otherwise, this assessment has been based on all WTGs using unconstrained generation modes, i.e. no sound optimised operating modes, and without blade serrations.

A range of sound optimised modes are also available reducing the maximum power output and sound power levels.

6.1 WTG noise emissions

6.1.1 Sound power levels

The noise emissions of a WTG 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 WTG and is distinct from the sound *pressure* level which depends on a range of factors such as the distance from the WTG.

Sound power level data for the candidate WTG model, including sound frequency characteristics, has been sourced from the following document:

- *0095-3732_V02 - V162-6_0MW Third Octaves* dated 22 May 2023

Based on the data sourced from the above specification, the noise modelling conducted for this assessment involved the conversion of third octave band levels to octave band levels 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 8.

Table 8: Sound power levels per hub height wind speed, dB L_{WA}

Operating mode	Hub height wind speed, m/s						
	4	**5**	**6**	**7**	**8**	**9**	**≥10 [2]**
PO6000-0S [1]	97.9	98.1	100.0	103.0	105.8	107.9	108.1

1 Other sound optimised modes are also available (but have not been considered for this assessment)

2 Overall sound power levels in the manufacturer provided noise datasheet for wind speeds between 10 – 20 m/s are equal to 108.1 dB L_{WA} but exhibit increasing levels of low-frequency content as the hub-height wind speeds increase.

The reference octave band values used as the basis for this assessment are presented in Table 9 and were adjusted to the overall A-weighted noise levels detailed in Table 8.

Table 9: Octave band sound power levels, dB L_{WA}

	Octave band centre frequency, Hz									
Operating mode	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Total**
PO6000-0S [1]	79.2	91.4	98.9	103.2	103.1	99.9	94.9	87.0	76.1	108.1

1 Based on one-third octave band levels at 20 m/s, being the highest overall A-weighted sound power level detailed in Table 8 manufacturer provided noise datasheet (considering low frequency content)

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

A review of available sound power data for a range of WTG models has shown that there is no clear relationship between WTG size or power output and the noise emission characteristics of a given WTG model. In practice, the overall noise emissions of a WTG are dependent on a range of factors, including the WTG size and power output, and other important factors such as the blade design and rotational speed of the WTG.

Therefore, while WTG sizes and power ratings of contemporary WTGs have increased, the noise emissions of the WTGs are comparable to, or lower than, previous generations of WTGs as a result of design improvements (notably, measures to reduce the speed of rotation of the WTGs, and enhanced blade design features such as serrations for noise control).

6.1.2 Tonality

Information concerning potential tonality is often limited at the planning stage of a Project, and narrow band test data for tonality (in the form of IEC 61400-11 tonality data, as referenced in the SA Guidelines 2009) is presently unavailable for the candidate WTG model. However, the occurrence of tonality in the noise of contemporary multi-megawatt WTG 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.

Further, the third octave band data detailed in the manufacturer's specification has been assessed against the additional tonality test prescribed in the NSW Noise Assessment Bulletin (detailed in Section 3.1.2). This test did not indicate the presence of tonality at any of the available hub height wind speeds.

On this basis, adjustments for tonality have not been applied to the predicted noise levels presented in this assessment. Notwithstanding this, the potential for tonality would be subject to further review and controls, i.e. contractual performance specifications, during the WTG procurement stage of the Project, following approval of the Project, and again following the construction of the Project.

6.1.3 Low frequency noise

The NSW Noise Assessment Bulletin prescribes a criterion for the application of low frequency noise penalty adjustments, based on C-weighted noise levels. However, there is no established or verified engineering method for the prediction of C-weighted noise levels associated with the operation of WTGs.

For the purposes of this report, a risk assessment approach has been adopted using a simplified prediction method to estimate C-weighted noise levels. Details of the assessment are provided in Appendix G.

The risk assessment indicates calculated low frequency noise levels are below the applicable thresholds for the application of penalties at all non-associated receivers. On the above basis, adjustments for low frequency noise have not been applied to the predicted noise levels presented in this assessment.

The effects of WTG noise on health and amenity are discussed in Appendix H.

6.2 Predicted noise levels

This section of the report presents the predicted A-weighted WTG noise levels at surrounding receivers, and an assessment of compliance with the applicable noise limits.

Sound levels in environmental assessment work are typically reported to the nearest integer to reflect the practical use of measurement and prediction data. However, in the case of wind farm layout design, significant layout modifications may only give rise to fractional changes in the predicted noise level. This is a result of the relatively large number of sources influencing the total predicted noise level, as well as the typical separating distances between the WTG 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. For this reason, noise levels presented in this section are reported to one decimal place.

The predicted noise levels are for conditions when the WTG's noise emissions have reached their highest level (corresponding with hub height wind speeds of 20 m/s for the candidate WTG model) and the wind is directed from the Project to each receiver. The predicted noise levels include + 1 dB allowance to account for WTG sound power level measurement uncertainty, as described in Section 6.1.1.

6.2.1 Associated receiver

Only one associated receiver has been identified by Spark Renewables within 12 km of a Project WTG and is considered in this noise assessment.

The predicted noise level at the associated receiver is presented in Table 10 for informative purposes only.

Table 10: Highest predicted noise level at the associated receiver

Receiver	Distance to nearest turbine, m	Predicted noise level, dB $L_{Aeq\ 10\ min}$
R1146	10,640	19.6

It can be seen from Table 10 that the predicted WTG noise level from the proposed Project is below the reference level of 45 dB $L_{Aeq\ 10\ min}$ with a minimum compliance margin of 25.4 dB.

6.2.2 Non-associated receivers

The base noise limit applicable to the Project at all other receivers i.e. classified as non-associated for noise assessment purposes, is 35 dB $L_{Aeq\ 10\ min}$ as detailed in Section 3.1.1.

The highest predicted noise levels at all non-associated receivers within 12 km of a WTG are shown in Table 11.

Table 11: Highest predicted noise level at non-associated receivers within 12 km of a WTG

Receiver	Distance to nearest turbine, m	Predicted noise level, dB $L_{Aeq,\ 10\ min}$
R1090	11,560	20.1
R1111	11,170	20.5
R1112	11,200	20.4
R1113	10,420	21.1
R1114	10,210	21.3
R1148	10,440	18.6

It can be seen from Table 11 that the predicted WTG noise levels from the proposed Project are below the NSW Noise Assessment Bulletin base noise limit of 35 dB $L_{Aeq,\ 10\ min}$ at all non-associated receivers by a minimum margin of 13.7 dB.

Predicted noise contours for the candidate WTG model identified in Section 6.1.1 are shown in Figure 2.

Predicted noise levels for each integer wind speed at all receivers located within 12 km from a WTG are tabulated in Appendix I.

The above findings support that the Project can be designed and operated to comply with the operational noise requirements of the NSW Noise Assessment Bulletin.

Figure 2: Highest predicted noise level contours

Figure 3: Highest predicted noise level contours - zoomed

7.0 ANCILLARY INFRASTRUCTURE OPERATIONAL NOISE ASSESSMENT

7.1 Project noise trigger levels

For the purposes of this planning assessment, all receivers have been considered to be Rural in nature, as defined in Table 2.2 of the NPfI. On this basis, and considering the minimum assumed rating background levels detailed in Section 5.2.2 , the project noise trigger levels that are relevant for assessment of ancillary infrastructure are summarised in Table 12.

Table 12: NPfI project noise trigger levels, dB $L_{Aeq,\ 15\ min}$

Time of day	Project noise trigger level
Day	40
Evening	35
Night	35

As the ancillary infrastructure is proposed to be able to operate at any time of day, the most stringent night-time noise level of 35 dB $L_{Aeq,\ 15\ min}$ will be the controlling factor for compliance.

The noise sources associated with the ancillary infrastructure typically give rise to steady noise levels and are not typically characterised by brief momentary increases in noise levels. Accordingly, the additional procedures defined in the NPfI for assessing potential sleep disturbance from brief elevated noise levels associated with transient noise sources are not relevant. The assessment is therefore solely based on noise levels of the equipment assessed in terms of the $L_{Aeq\ 15\ min}$ descriptor, which is adopted by the NPfI for the assessment of average noise energy over a 15-minute period.

7.2 Infrastructure noise sources

Based on information provided by Spark Renewables, permanent noise generating ancillary infrastructure that is proposed to be developed as part of the Project is limited to:

- a single grid-scale 100 MW/200 MWh BESS
- two collector substations.

Other permanent ancillary infrastructure proposed as part of the Project e.g. switchyard and O & M facility, do not typically include significant sources of noise and are not considered further.

The approximate coordinates of the ancillary infrastructure noise sources are shown in Table 13.

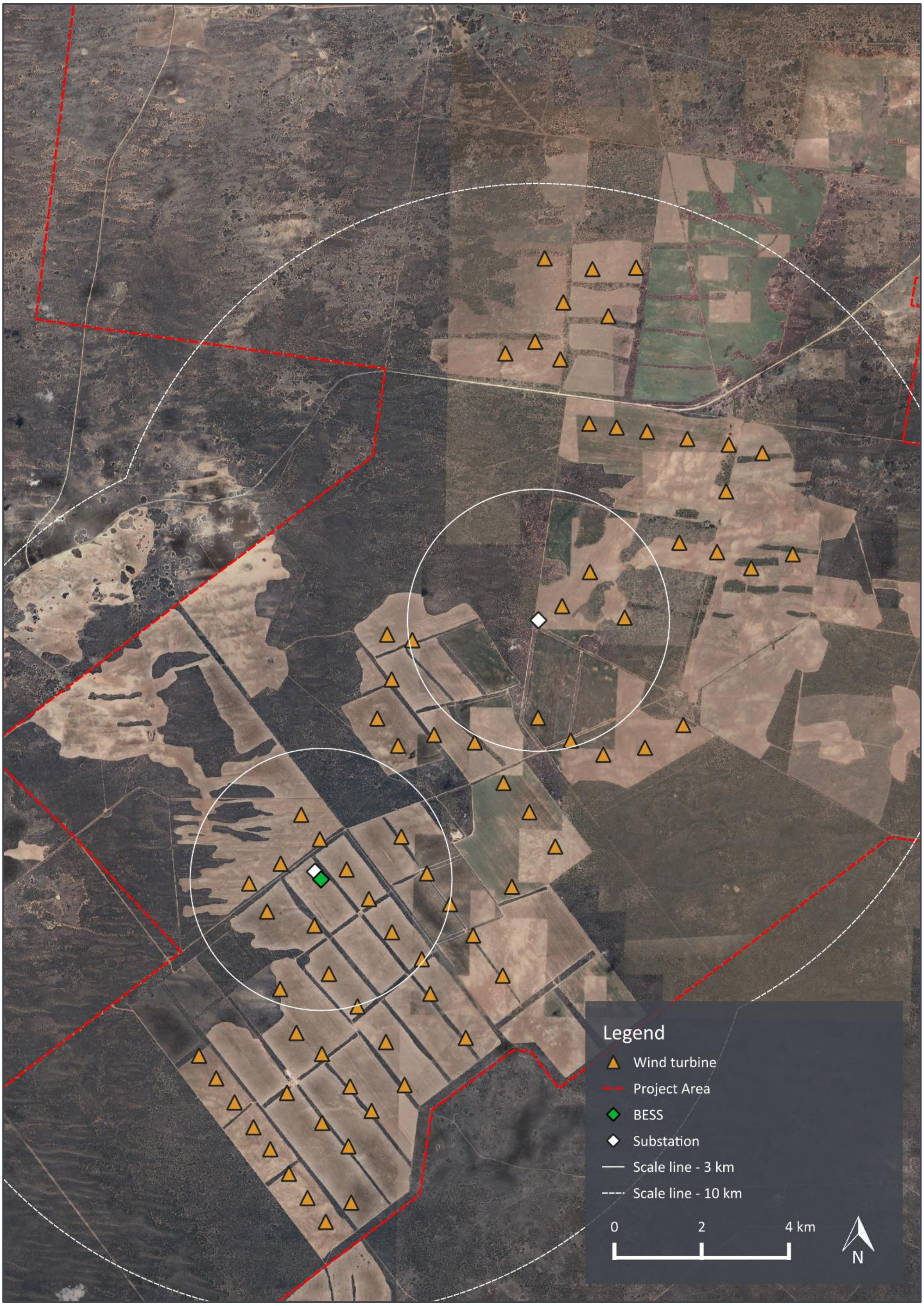
Table 13: Approximate ancillary infrastructure coordinates – GDA 2020 MGA zone 54

Item	Easting, m	Northing, m
BESS [1]	628,963	6,224,343
Collector substation 1 [1]	628,824	6,224,521
Collector substation 2 [1]	633,944	6,230,278

1 Represents the centroid of the proposed BESS/substation boundary

The approximate location of each assessed ancillary infrastructure location within the context of the broader Project is shown in Figure 4.

Figure 4: Ancillary infrastructure noise source overview



7.2.1 BESS

At this stage of the Project, a detailed BESS design has not been established, however for the purposes of the noise assessment a design concept has been developed by Spark Renewables. This concept comprises a layout of combined inverter/transformer and battery modules, indicating the number and discrete position of each equipment item at the proposed BESS location shown in Figure 4.

To provide a precautionary assessment, the design concept created for the purposes of noise assessment corresponds with a BESS capacity marginally above that intended to be developed as part of the Project. This precautionary approach is taken to demonstrate the viability of achieving compliance with the applicable noise limits when incorporating worst-case assumptions with respect to BESS sizing. The capacity of the modelled BESS, being 300 MW/600 MWh, is greater than the actual BESS capacity intended for use by the Project, which is 100 MW/200 MWh.

A summary of the relevant information provided to MDA by Spark Renewables is shown in Table 14.

Table 14: BESS equipment details

Equipment item	Quantity
Combined inverter/transformer	88
Battery unit	352

7.2.2 Substations

Noise sources associated with the operation of substations that are relevant for consideration within an environmental noise assessment are typically limited to high-voltage (HV) transformers.

Information provided to MDA by Spark Renewables regarding the HV transformers at the substation included:

- Spatial data indicating the boundary of each substation (used to derive the positions shown in Figure 4).
- Specification details including power rating (MVA) and quantity.

The relevant specifications of the HV transformers at each substation, as provided to MDA by Spark Renewables, are shown in Table 15.

Table 15: Substation HV transformer specification

Location	Power rating, MVA	Quantity
Collector substation 1	300	2
Collector substation 2	300	2

7.3 Sound power level data

Sound power levels for individual ancillary infrastructure equipment items, as used in the noise model, are detailed in Table 16. Data is provided as un-weighted (linear) octave band spectra and A-weighted overall sound power level.

In some cases, noise data associated with the specific equipment selections nominated by Spark Renewables did not provide sufficient information to be suitable for noise modelling. On this basis MDA has adopted noise data associated with similar equipment items, taken from MDA manufacturer noise database, where required.

In order to provide a continued conservative approach to assessment, noise levels associated with the upper range of sound power levels demonstrated by equipment currently available on the market has been adopted. Based on MDA's review the adopted noise data is greater in magnitude i.e. 'louder', than that proposed by Spark Renewables, for those specific equipment items.

Table 16: Sound power levels for ancillary infrastructure equipment items, dB L_W

Item	Octave band centre frequency, Hz							
	63	125	250	500	1000	2000	4000	L_{WA}
BESS								
Combined inverter/transformer	101	100	103	96	95	91	88	100
Battery unit	86	86	96	89	84	81	76	92
Collector substations								
HV transformer (300 MVA)	103	105	100	100	94	89	84	101

Additional information with respect to the source of the data is provided in Table 17.

Table 17: Ancillary infrastructure sound power level data description

Item	Description
BESS	
Combined inverter/transformer	Manufacturer third octave band sound power levels measured in accordance with ISO 3744:2010 have been provided to MDA by Spark Renewables. Due to commercial sensitivities the specific inverter manufacturer and model is not detailed in this report but has been confirmed by the Proponent to be representative of the specification required for the Project.
Battery unit	Manufacturer third octave band sound power levels measured in accordance with ISO 3744:2010 associated with a containerised battery system have been sourced from MDA library data. Due to commercial sensitivities the specific battery unit manufacturer and model is not detailed in this report but has been confirmed by the Proponent to be representative of the specification required for the Project.
Collector substations	
HV transformer	At this stage of the Project, specific details of the transformer makes and models are yet to be finalised. Based on information provided by Spark Renewables, MDA understands that the HV transformers proposed for the Project are expected to be rated at 300 MVA. In the absence of measured sound power level data for a specific transformer model, reference has been made to the standard maximum method for estimating overall transformer sound power levels for a given power rating described in AS 60076-10:2009. [5] Spectral data for each transformer was then estimated by applying Bies & Hansen corrections from Table 11.27, (Location 1a for outdoor transformer noise) to the determined overall sound power level. [6]

7.4 Noise modelling method

All equipment items are modelled as omnidirectional point sources of noise with associated octave band sound power level noise emissions, except for the HV transformers located at each of the collector substations. As discrete positions for each transformer have not been provided, a cumulative point source has been used to represent the noise emissions of the two HV transformers at each substation location.

The noise modelling method adopted for ancillary infrastructure noise predictions is equivalent to that documented in Section 4.1, with the exception of the UK Institute of Acoustics guidance modifications which have only been applied to WTG noise predictions.

[5] *Australian Standard AS 60076-10:2009 Power transformers – Part 10: Determination of sound levels (AS 60076-10:2009)*

[6] *Bies, D. H. & Hansen, C. H. (2009). Engineering noise control: theory and practice (Fourth edition.). p. 601*

7.5 Predicted noise levels

Noise levels resulting from the operation of the ancillary infrastructure have been predicted at all receivers referenced in Appendix E.

The results of these predictions are shown in Table 18.

Table 18: Predicted ancillary infrastructure noise levels at receivers within 12 km, dB $L_{Aeq, 15 min}$

Receiver	BESS	Substation	Cumulative [1]
All receivers	< 10	< 10	< 10

1 BESS and substation noise levels combined

The predicted noise levels at all receivers are more than 25 dB below the night-time project noise trigger level of 35 dB $L_{Aeq 15min}$ as set out in Section 7.1, being the most stringent noise limit applicable under the NPfI.

7.6 Tonality

Fact Sheet C of the NPfI sets out corrections for annoying characteristics, including tonality, that must be applied where the characteristics are evident at receiver locations.

While noise data associated with BESS and substation equipment considered as part of this assessment exhibits tonality at source, the likelihood of tonality being audible or measurable at receivers is essentially nil, given the very low predicted noise indicated in Table 18.

On this basis, a modifying correction factor for tonality is not applicable to the ancillary infrastructure assessment and has not been applied to the predicted noise levels.

7.7 Discussion

The results shown in Table 18 demonstrate that predicted noise levels are below the 35 dB $L_{Aeq, 15 min}$ night-time project noise trigger level at all receivers, by a margin of 25 dB or more.

Noise from the ancillary infrastructure is therefore predicted to be significantly below the most stringent applicable noise level criterion.

Given the magnitude of the indicated margin, and the general adoption of upper range source noise levels for equipment items, the Project is likely to afford significant flexibility with respect to Project design and equipment procurement during detailed design and tender.

8.0 MALLEE CLIFFS NATIONAL PARK OPERATIONAL NOISE ASSESSMENT

Information provided on the NSW National Parks and Wildlife Service (NPWS) website states:

> *Mallee Cliffs National Park is managed to protect the sand plain and sand dune land systems and ecological communities. Emphasis is placed on the value of Mallee Cliffs National Park as a wildlife conservation area.*
>
> *A policy of restricted public access for education purposes is maintained to assist in meeting conservation objectives. The park is used for educational activities by schools and colleges. Research activities which are relevant to the management of the Park and compatible with conservation objectives are encouraged.*

In addition to the above MDA has reviewed the MCNP mapping published by NPWS. [7]

The mapping indicates that no walking tracks, campgrounds, lookouts, attractions and activities, facilities or other recreational uses are present in the park. On this basis it could be interpreted that the recommended amenity noise level set out in the NPfI, and referred to in the SEARs, do not apply to MCNP.

To provide complete due diligence, predicted WTG noise levels and ancillary infrastructure noise levels have been reviewed in the context of the MCNP boundary.

WTG predicted operational noise contours are provided in Figure 5 in the context of the MCNP boundary. WTG noise levels are in the order of 40 dB L_{Aeq} at the boundary, below the recommended amenity noise level of 50 dB L_{Aeq}.

Ancillary infrastructure predicted operational noise contours are provided in Figure 6 in the context of the MCNP boundary. The 35 dB L_{Aeq} noise contour for ancillary infrastructure operational noise is approximately 3.8 km away from the MCNP boundary, meaning noise levels at the boundary will be significantly less.

On this basis predicted noise levels from WTGs and ancillary infrastructure associated with the Project are significantly below the recommended amenity noise level of 50 dB L_{Aeq}, should it be interpreted to apply. Further assessment of the potential impacts of noise to fauna within MCNP is outlined within the BDAR and EIS.

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7 https://www.nationalparks.nsw.gov.au/-/media/npws/maps/pdfs/parks/mallee-cliffs-national-park/mallee-cliffs-national-park-map.pdf

Figure 5: WTG predicted operational noise contours in relation to MCNP

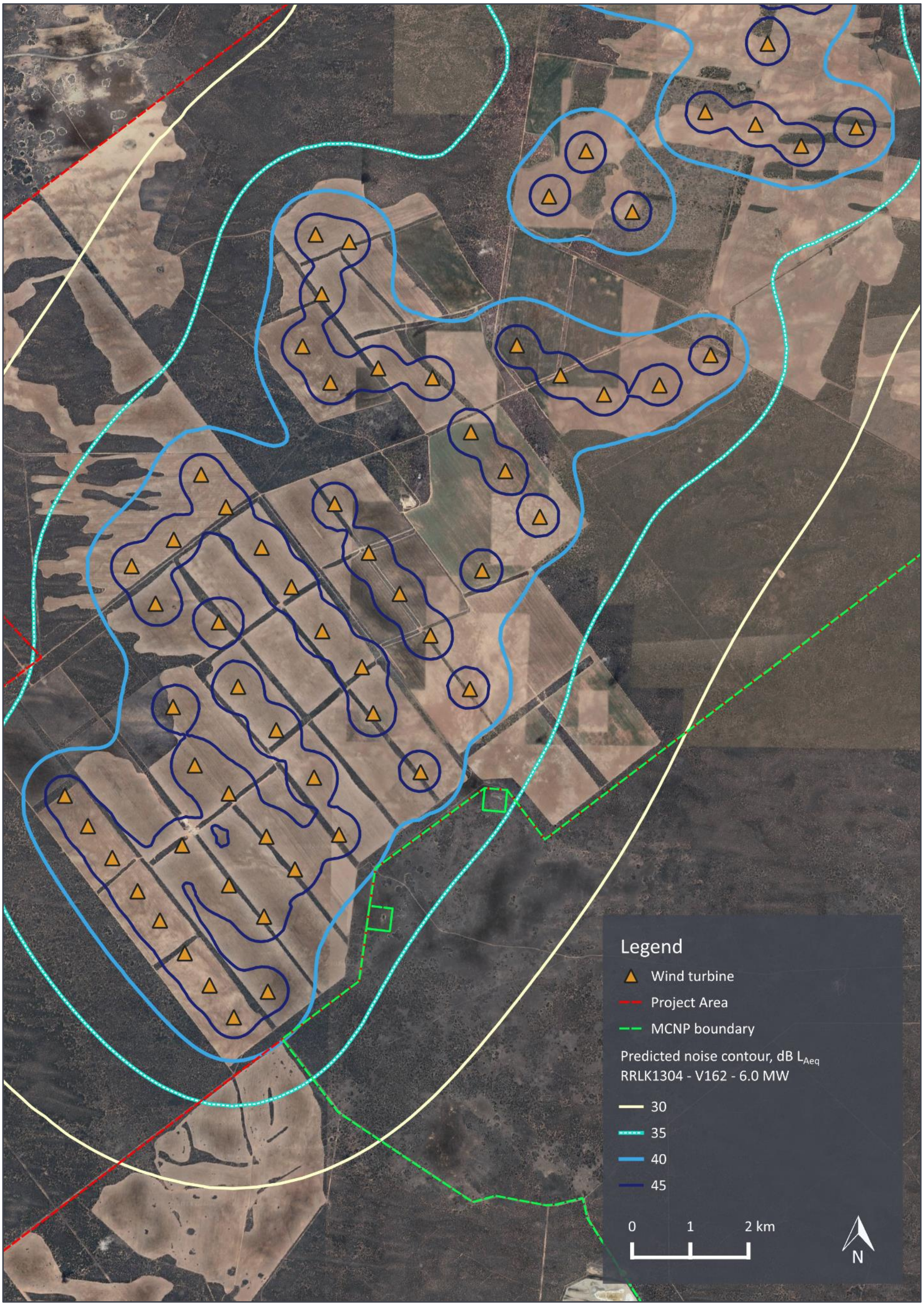
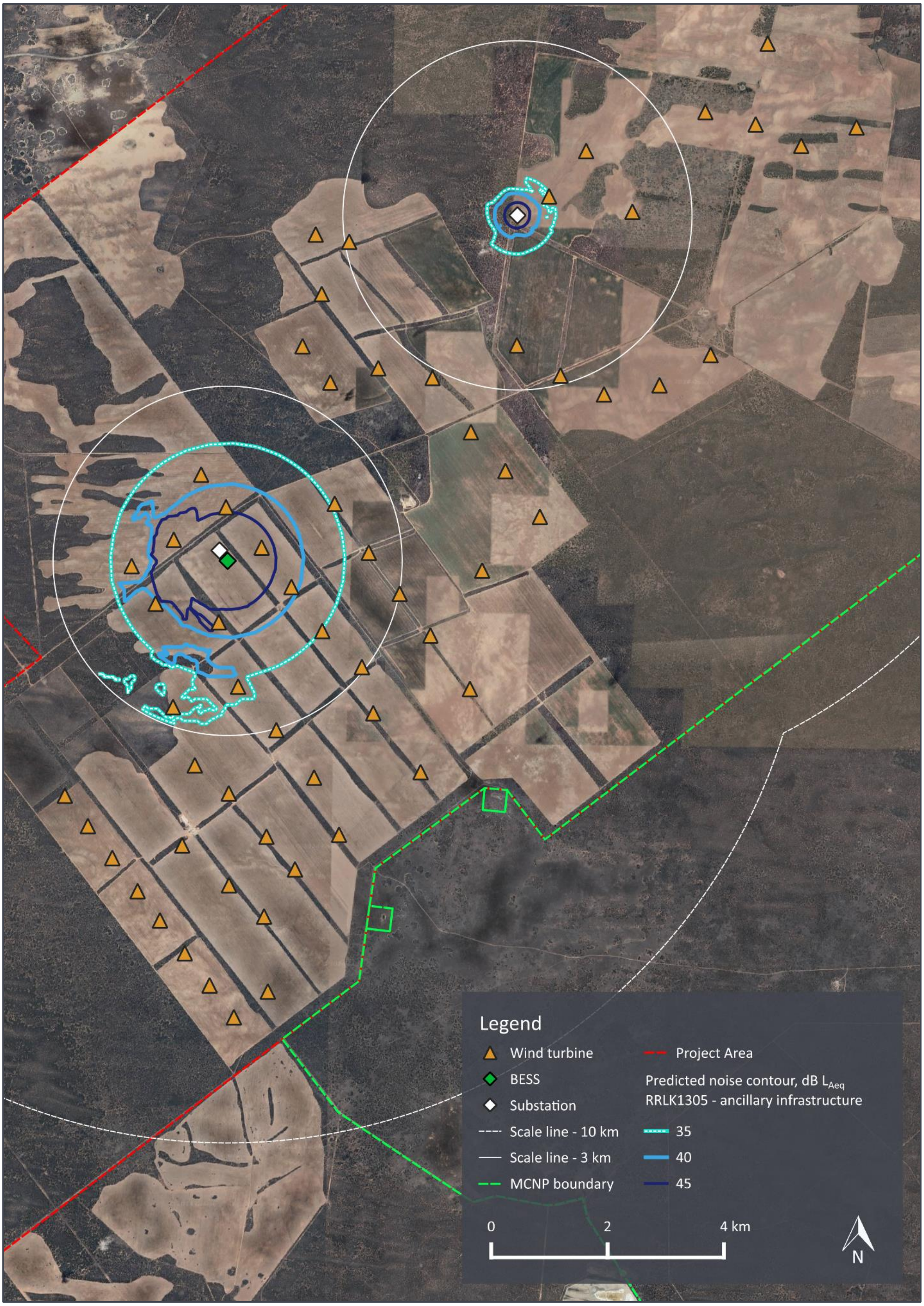


Figure 6: Ancillary infrastructure predicted operational noise contours in relation to MCNP



9.0 CUMULATIVE OPERATIONAL NOISE ASSESSMENT

The SEARs issued for the Project requires an:

assessment of the cumulative noise impacts (considering other developments in the area).

Based on information provided to MDA by Spark Renewables, the other developments in the area of the Project are shown in Table 19.

Table 19: Other developments in the vicinity of the Project

Project name	SSD ID	Distance to Project
Lake Victoria Wind Farm	SSD-71630724	71 km west
Koorakee Energy Park	SSD-70640221	40 km southeast
Euston Wind Farm	SSD-62466963	30 km southeast
Buronga Landfill Expansion	SSD-10096818	14 km west of the nearest WTG
Project EnergyConnect (NSW – Eastern Section)	SSI-9172452	11 km south of the Project
Gol Gol Battery Energy Storage System	SSD-70893706	9 km to the northwest between WTG to BESS substation
Gol Gol Wind Farm	SSD-70849709	Same Project Boundary to the western side of the Project Area 8.3 km to the northwest WTG to WTG
Mallee Solar Farm	SSD-69576706	Overlapping Project Boundary and 3.7 km between Disturbance Footprint
Euston Mineral Sands Project	SSD-53674728	Overlapping within the Disturbance Footprint
Gol Gol Solar Farm	SSD-70916707	Same Project Boundary to the western side of the Project Area 3.3 km to the northwest to the nearest piece of Project Infrastructure

Cumulative WTG operational noise and cumulative ancillary infrastructure operational noise are discussed in the following sections.

9.1 Cumulative WTG operational noise

Of the other developments described in Table 19, only Lake Victoria Wind Farm, Koorakee Energy Park, Euston Wind Farm and Gol Gol Wind Farm contain WTGs.

In relation to other wind farm developments, the NSW Noise Assessment Bulletin does not make specific recommendations concerning cumulative noise. The SA Guidelines 2009 do however refer to cumulative noise, noting that the criteria have been specified to allow for other potential development, and that any noise criteria which are set relative to background noise levels should not include the influence of other wind farms.

While neither document explicitly states a requirement to assess the combined noise levels of multiple wind farm projects, nor do they define criteria which directly applies to cumulative noise, an assessment of cumulative WTG noise considering the Project and other relevant developments is provided herein.

Lake Victoria Wind Farm, Koorakee Energy Park and Euston Wind Farm are located 71 km, 40 km and 30 km away, respectively. Noise at this distance is not relevant for consideration in the context of cumulative noise assessment.

Gol Gol Wind Farm (GGWF) shares the western Project Boundary and is therefore sufficiently proximate to be relevant for consideration.

The method for cumulative assessment involves:

- identifying any receivers common to the Project and GGWF
- establishing the noise level contribution from each project
- establishing an expected cumulative predicted noise level.

This is done through review of publicly available documentation for GGWF, in particular the predicted noise contours. [8]

Figure 7 provides an overlay of predicted noise contours associated with GGWF and the Project.

This indicates the following:

- R1146 (an associated receiver for the Project) is approximately 11 km from the 35 dB noise contour associated with GGWF and approximately 9 km from the 35 dB noise contour associated with the Project.
- R1114 is approximately 7 km from the 35 dB noise contour associated with GGWF and approximately 9 km from the 35 dB noise contour associated with the Project.

On this basis cumulative predicted noise level at both receivers, considering GGWF and the Project, is below the base noise limit of 35 dB $L_{Aeq,\ 15\ min,}$ with neither wind farm development affecting the compliance outcome of the other.

9.2 Cumulative ancillary infrastructure operational noise

The most stringent noise limit that can be applied under the NPfI is 35 dB $L_{Aeq,\ 15\ min}$, as adopted by the ancillary infrastructure noise assessment documented herein.

On the assumption that each of the developments identified in Table 19 comply with their obligations under the NPfI, noise from the Project would need to be below 20 dB $L_{Aeq,\ 15\ min}$ to ensure compliance for all projects is maintained individually and cumulatively, based on standard log summation laws.

Predicted noise levels associated with Project ancillary infrastructure are below 10 dB $L_{Aeq,\ 15\ min}$ at all receivers, as shown in Table 18 of Section 7.5.

This is significantly below the 20 dB $L_{Aeq,\ 15\ min}$ threshold described above. On this basis cumulative ancillary infrastructure operational noise will be below the NPfI noise limits at all receivers.

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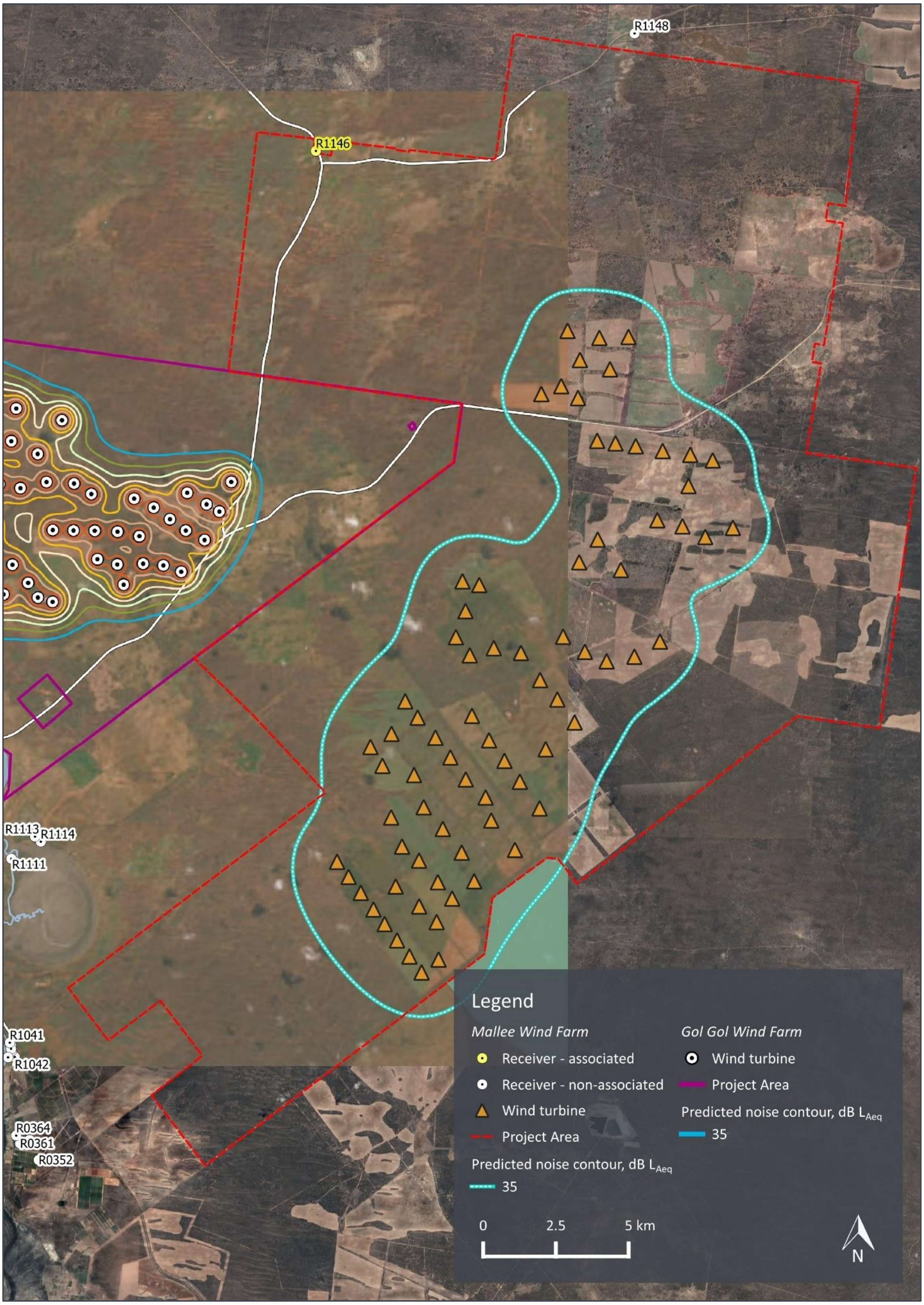
[8] *Squadron Energy - Gol Gol Wind Farm Scoping Report* dated May 2024

Figure 7: Overlay of GGWF predicted noise contours (refer to GGWF Scoping Report noise assessment for further details) with Project predicted noise contours (refer to Figure 2 and Figure 3)



10.0 RECOMMENDED OPERATIONAL NOISE MANAGEMENT MEASURES

In order to ensure that operational noise from the Project is appropriately managed during subsequent stages of the development, the following is recommended:

- The predicted operational WTG noise levels should be updated prior to construction with final layout and sound power levels of the final WTG selected for the Project to verify compliance with the criteria in accordance with the NSW Noise Assessment Bulletin.
- The predicted operational ancillary infrastructure noise levels should be updated prior to construction with the final design and sound power levels of the final equipment selection to verify compliance with the criteria in accordance with the NPfI.
- An operational noise management plan should be prepared prior to commencement of operations which identifies how compliance with the Project's operational noise limits will be demonstrated, including details of testing procedures and reporting time frames following commencing operation of the Project.
- Following construction, compliance monitoring should be conducted to satisfy the NSW Noise Assessment Bulletin including evaluation of special noise characteristics.

In addressing the SEARs and assessing operational WTG noise in accordance with the NSW Noise Assessment Bulletin, it is expected that the Project will satisfy the applicable noise limits.

Further given the magnitude of the indicated compliance margin it is not expected that noise control measures are likely to be required for the Project, even under extraordinary conditions.

Notwithstanding this, consideration should be given to available contingency strategies to reduce noise levels, in the unlikely event they are required.

The following summarises the two key measures available to reduce the noise:

- *Procurement contract*

  The procurement contract for the supply of WTG to the Project will typically include specifications concerning the allowable total noise emissions from the WTG, and the permissible characteristics of the WTG.

  In the event that WTG emissions are found to exceed the contracted values, the supplier will be required to implement measures to reduce the noise to the contracted value. This can include measures to rectify manufacturing defects or appropriate control settings.

- *Noise reduction management strategy*

  Modern wind farms include control systems which enable the operation of the WTG to be varied according to environmental constraints. Specifically, variable pitch WTGs as proposed for this Project include control functions which enable the noise emissions of the WTGs to be selectively controlled; by adjusting the pitch of blade, the noise emissions of the WTG can be reduced.

In addition, where required, the WTGs can be selectively shut down under relevant wind speeds and directions. These types of control measures can be used separately, or in combination, to achieve noise reductions for predetermined wind speed ranges and directions.

11.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

11.1 Overview

The 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.

As per the SEARs, construction noise is to be assessed in accordance with the ICNG (see Section 3.3) and construction vibration in accordance with the AVTG (see Section 3.4).

Off-site noise generating activities considered within this assessment are limited to heavy vehicle movements to and from the site. These have been addressed separately in the traffic noise assessment, documented in Section 12.0.

On-site works include a range of activities such as construction of access tracks, transmission infrastructure, WTG foundations and erection of the WTGs.

Construction of a wind farm mostly occurs at relatively large separating distances from receivers, with most of the work typically limited to standard working hours.

The only exceptions are for potentially unavoidable works or low-noise managed-works. Unavoidable works outside of standard hours may comprise the delivery of oversized WTG components at times selected to minimise traffic disruption associated with intersection closures, and potentially WTG installation activities that are sensitive to weather conditions, e.g. installation of rotors or concrete pouring during summer.

Should these works be required, an out of hours construction noise and vibration assessment should be conducted during the detailed design stage.

Should these works be required, authorisation from the relevant authority, expected to be the Planning Secretary or DPHI, should be sought, based on justification provided by Spark Renewables or its contractors. Supporting information for the justification may include evidence of consultation with potentially affected non-associated residents, details of reasonable and feasible noise mitigation measures which are to be implemented, or an assessment of out of hours construction noise and vibration impacts.

As per the ICNG, noise associated with the construction of a wind farm may require the adoption of reasonable and feasible general management measures and considerate working practices. These measures are normally documented and agreed in a Construction Noise and Vibration Management Plan (CNVMP) for inclusion in a broader Environmental Management Plan (EMP), which is typically prepared for review and approval by the responsible authority prior to commencing any construction works.

The following sections provide general information regarding the types of activities that are expected to be associated with the construction of the Project, and reference data that should be considered as part of the preparation of a future CNVMP for the Project.

11.2 Construction activities

Construction of a wind farm project typically involves key stages such as:

- concrete batching
- infrastructure construction (substations, masts, transmission, BESS)
- road upgrades
- site establishment (internal roads, hardstands, compounds)
- WTG assembly
- WTG foundation construction.

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

The types of equipment associated at different stages of construction typically include excavation plant, pneumatic equipment and lifting equipment.

Appendix J provides a construction site layout denoting key work areas.

Appendix K details typical major equipment items associated with the above construction stages, alongside noise levels developed on the basis of reference data from AS 2436 and previous project experience. These are conceptual assumptions provided by Spark Renewables and provide an approximation of potential construction equipment and processes. Project specific equipment and processes will be determined once a main contractor is appointed.

As shown in Appendix K, typical construction plant sound power levels range from approximately 100 to 120 dB L_{WA} per equipment item.

Based on the groupings of major plant items during key construction tasks, the total aggregated noise emissions for the proposed works stages typically ranges from 115 to 130 dB L_{WA}. These predictions are based on the assumption that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period thus providing a conservative approach that is unlikely to occur in practice.

11.3 Construction noise assessment

Noise levels associated with each of the main construction tasks have been predicted at the nearest noise sensitive receivers to provide an indication of the upper range of noise levels.

Given that the precise equipment selections and methods of working would be determined during the future development of a CNVMP, and that the noise associated with construction plant and activity varies significantly, the predicted noise levels are provided in the following sections as an indicative range of levels which may occur in practice.

The predicted noise level ranges for each of the main construction tasks are provided in Table 20 and Table 21 for non-associated and associated receivers, respectively.

Table 20: Indicative range of construction noise predictions at non-associated receivers, dB $L_{Aeq, 15 min}$

Construction phase	Nearest receiver (distance, m)	Predicted level range	Noise affected management level	Exceedance	Highly noise affected management level	Exceedance
Concrete batching	R1148 (13,450)	15-20	45	-	75	-
Infrastructure (substations, masts, transmission, BESS)	R1114 (5,650)	40-45	45	-	75	-
Road upgrades	R1114 (10,200)	20-25	45	-	75	-
Site establishment (internal roads, hardstands, compounds)	R1114 (10,200)	25-30	45	-	75	-
Turbine assembly	R1114 (5,700)	30-35	45	-	75	-
Turbine foundations	R1114 (5,800)	30-35	45	-	75	-

Table 21: Indicative range of construction noise predictions at the associated receivers, dB $L_{Aeq, 15 min}$

Construction phase	Nearest receiver (distance, m)	Predicted level range	Noise affected management level	Exceedance	Highly noise affected management level	Exceedance
Concrete batching	R1146 (12,900)	15-20	45	-	75	-
Infrastructure (substations, masts, transmission, BESS)	R1146 (9,500)	35-40	45	-	75	-
Road upgrades	R1146 (10,600)	20-25	45	-	75	-
Site establishment (internal roads, hardstands, compounds)	R1146 (10,600)	25-30	45	-	75	-
Turbine assembly	R1146 (9,550)	25-30	45	-	75	-
Turbine foundations	R1146 (12,300)	20-25	45	-	75	-

The following can be seen from the construction noise predictions shown in Table 20 and Table 21:

- Construction noise levels are predicted to be below the noise affected management levels at the associated receiver and all non-associated receivers during all assessed construction tasks.
- Construction noise levels are predicted to be below the highly noise affected management levels at the associated receiver and all non-associated receivers during all assessed construction tasks.

11.3.1 Discussion – General

The majority of construction activities considered within this assessment typically occur nearby to the proposed WTG and related infrastructure locations. These works are therefore subject to larger setback distances to receivers than would be expected for the construction of access tracks. As a result, construction noise levels associated with these activities are predicted to be lower.

It is noted that, depending on environmental factors such as the background noise level and wind direction, construction noise associated with more distant works could still be audible at surrounding receivers. In particular, given the low background noise levels that typically occur in rural environments at low wind speeds, it is possible that construction noise could be higher than the background noise level in some instances.

The ICNG indicates:

> *The noise affected level represents the point above which there may be some community reaction to noise.*
>
> - *Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.*
> - *The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.*

The predicted noise levels summarised in Table 20 and Table 21 demonstrate that no exceedances of either the noise affected or highly noise affected management levels are predicted to occur during any of the assessed construction tasks. This is due to the significant separation distances between the work areas and the receiver locations.

Although the results of the current assessment indicate that the likelihood of exceedances of the relevant criteria during the construction of the Project is low, care should still be taken to minimise noise where feasible. Specific evaluation of noise associated with Project specific construction work processes and equipment will be required once a main contractor is appointed. This should be done to provide a more representative assessment of construction noise than the conceptual assumptions detailed in this report to verify the continued compliance of the Project.

11.4 Construction vibration assessment

The prediction of vibration propagation through the ground is convoluted and complex, and depends on several factors including damping, reflection, and impedance in-ground conditions. A detailed vibration propagation assessment is considered to be a site-specific assessment and often requires a combination of baseline vibration assessment, empirical measurement of equipment and analytical methods. Assessment of this nature is outside of the scope of a planning stage vibration risk assessment.

The AVTG provides guidance with respect to the assessment of human comfort due to vibration from construction works. This guideline provides distinguishes intermittent, impulsive, and continuous vibration sources, which can be generated by construction activities. For the purposes of this planning risk assessment only residential receivers are considered.

11.4.1 Intermittent vibration

The AVTG indicates that intermittent vibration should be assessed in terms of the vibration dose value (VDV). These values for intermittent construction activities are highly specific to site conditions, equipment selections and operational durations. As such, calculation of VDV levels is not typical or practical at the planning stage but will need to be considered as part of a later detailed vibration assessment.

The AVTG recommends that best management practices in all cases should be to reduce values as far as practicable, and a comprehensive community consultation program should be developed.

11.4.2 Continuous vibration

Vibration due to some construction operations can be considered continuous depending on the duration and nature of the works. Since the guide values for continuous vibration are independent of exposure duration, indicative safe working distances can be developed. Section 7.1 of the NSW RMS *Construction Noise & Vibration Guideline* (CNVG) sets out minimum working distances from sensitive receivers for typical items of vibration intensive plant. The minimum distances, reproduced in Table 22 are quoted for effects relating to human comfort.

Table 22: Recommended minimum working distances for human response limits for vibration intensive plant

Plant item	Rating/description	Minimum working distance, m
Vibratory roller	< 50 kN (typically 1-2 tonnes)	15 to 20
	< 100 kN (typically 2-4 tonnes)	20
	< 200 kN (typically 4-6 tonnes)	40
	< 300 kN (typically 7-13 tonnes)	100
	> 300 kN (typically 13-18 tonnes)	100
	> 300 kN (> 18 tonnes)	100
Small hydraulic hammer	300 kg – 5 to 12 t excavator	7
Medium hydraulic hammer	900 kg – 12 to 18 t excavator	23
Large hydraulic hammer	1600 kg – 18 to 34 t excavator	73
Vibratory pile driver	Sheet piles	20
Pile boring	≤ 800 mm	4
Jackhammer	Handheld	2

Note: Reproduced from Table 2 of Section 7.1 of the CNVG

The CNVG notes that the minimum working distances for human comfort relate to continuous vibration and are indicative. In practice, appropriate minimum working distances will vary depending on the particular item of plant and local geotechnical conditions. The CNVG further notes that for most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, likely equating to greater minimum working distances.

11.5 Decommissioning

Similar construction activities to those detailed in Section 11.2 are expected to be required during the decommissioning of the Project. Decommissioning activities are likely to be less intensive than during construction and occur over a shorter duration. On this basis no further assessment has been conducted.

11.6 Construction noise and vibration recommendations

At this stage of the Project, only a preliminary, conceptual assessment of construction noise and vibration impact risk is feasible. Once a more detailed schedule of equipment and plant items, construction method and work areas are known, a detailed CNVMP should be prepared.

Any future CNVMP should include site and process specific noise management work practices designed to mitigate the impact of construction noise activities, including traffic noise.

The ICNG provides extensive details and guidance with respect to noise mitigation including:

- universal work practices
- consultation and notification
- plant and equipment
- on-site controls
- work scheduling
- transmission path and at-receiver considerations.

All of the above items should be considered as part of the future CNVMP.

Generally, it is likely to be feasible for a majority of works to be restricted to normal working hours, i.e. the ICNG recommended standard construction hours detailed in Section 3.3. This will assist in limiting noisy activities to times of the day when intrusive impacts or adverse reactions may be less likely.

In some cases, construction works may be required to occur outside of these hours. Such activities are typically related to public infrastructure i.e. timing oversized deliveries to avoid hazardous traffic conditions or weather windows, i.e. aspects of WTG assembly which must occur in still wind conditions for safety reasons.

Where out of hours works are proposed, the ICNG advises:

- *A strong justification would typically be required for works outside the recommended standard hours.*
- *The proponent should apply all feasible and reasonable work practices to meet the noise affected level.*
- *Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.*

General experience of wind farm developments has indicated that construction noise tends to represent a limited risk factor. This is particularly the case for the Project where significant separation distances (multiple kilometres) are present between work areas and receivers. With reasonable and feasible work practices implemented it is expected that noise associated with the construction and decommissioning of the Project can be acceptably managed.

12.0 TRAFFIC NOISE ASSESSMENT

Noise criteria for the assessment of traffic associated with the construction and operation of the Project are detailed in Section 3.5.

Traffic generation during the operation of the Project is limited, with construction stage traffic likely to comprise the significant majority of traffic movements associated with the Project. On this basis, operational traffic on public roads is not considered further in this report as it is likely to be very low and have negligible noise impacts.

Based on information provided by Umwelt, on behalf of Spark Renewables noise impacts related to construction traffic along the Silver City Highway (north and south of Arumpo Road) and from the Silver City Highway/Arumpo Road intersection to the proposed site access point on Arumpo Road have been assessed.

Traffic noise along the broader OSOM Transport Route and remainder of the Local Transport Route has not been considered further in this report. [9] On the basis that the Project will target the use of existing major roads and designated heavy vehicle routes, existing traffic flows would be expected to be greater than any increase arising from construction of the Project. Therefore increases in noise levels experienced by receivers near these major roads are likely to be negligible.

The base traffic flows and estimated construction traffic flows along Silver City Highway and Arumpo Road have been provided to MDA by Umwelt in correspondence dated 7 August 2024.

Based on the definitions in the RNP, Silver City Highway is considered to be a freeway/arterial/sub-arterial road, and Arumpo Road is a local road. The assessment has therefore been based on the relevant RNP criteria for each road category.

Project traffic data has been produced by Access Traffic Consulting as part of the Project traffic assessment and is summarised in Table 23.

Table 23: Construction traffic and base traffic flows on public roads – vehicles (% heavy vehicles)

Road category	Existing traffic		Future: existing + construction traffic	
	Day [1]	Night [1]	Day [1]	Night [1]
Local roads [2]				
Arumpo Road (East of Silver City Highway)	37 (5%)	95 (24%)	137 (1%)	195 (12%)
Arumpo Road (East of Project EnergyConnect Camp)	18 (5%)	6 (24%)	118 (1%)	106 (12%)
Freeways/arterial/sub-arterial roads [3] [4]				
Silver City Highway (North of Arumpo Road)	2044 (14%)	375 (14%)	2174 (14%)	403 (14%)
Silver City Highway (South of Arumpo Road)	2996 (17%)	496 (16%)	3346 (18%)	631 (14%)

1. Day is 0700 - 2200 hrs; Night is 2200 - 0700 hrs
2. Day & Night: Peak 1 hr AADT (Annual Average Daily Traffic)/Heavy vehicle (%)
3. Day: Total 15 hr AADT/Heavy vehicle (%)
4. Night: Total 9 hr AADT/Heavy vehicle (%)

9 Local Transport Route and OSOM Transport Route are defined in the EIS

12.1 Screening assessment

In considering feasible and reasonable mitigation measures, the RNP states that an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. On this basis, to assess noise impacts from construction traffic, an initial screening test is undertaken in the following section to evaluate whether existing road traffic noise levels would increase beyond this threshold.

Where the predicted traffic noise increase is 2 dB or less, no further assessment is conducted, as impacts will be barely perceptible. However, where the road traffic noise levels are predicted to increase by more than 2 dB as a result of additional traffic, consideration is given to the actual noise levels associated with the construction traffic and whether or not these levels comply with the road traffic noise criteria detailed in Table 4 of Section 3.5.

A 2 dB increase in relative traffic noise level is approximately equal to a 60 % increase in traffic flow.

The relative traffic flow increases on the Local Transport Route that are estimated to occur during the construction of the Project are shown in Table 24.

Table 24: Relative increase to traffic flow on public roads

Road category	Relative increase	
	Day	Night
Local roads		
Arumpo Road (East of Silver City Highway)	270%	105%
Arumpo Road (East of Project EnergyConnect Camp)	556%	1667%
Freeways/arterial/sub-arterial roads		
Silver City Highway (North of Arumpo Road)	6%	7%
Silver City Highway (South of Arumpo Road)	12%	27%

Based on the data in Table 24, the relative traffic noise level increase due to the proposed construction activities is predicted to be:

- Below the 2 dB threshold on all freeway/arterial/sub-considered within the assessment.
- Above the 2 dB threshold on all local roads considered within the assessment.

On this basis, the detailed assessment documented herein has only considered construction traffic noise along Arumpo Road.

The location of each of the assessed sections of Arumpo Road in relation to the Project Area is shown in Figure 8.

Figure 8: Arumpo Road in relation to the Project Area

12.2 Construction traffic predictions

Based on the information provided in Table 23, it is noted that both the existing traffic volumes and those associated with the construction of the Project are generally low in absolute levels, particularly when considering traffic flows during the night on local roads. The Calculation of Road Traffic Noise (CoRTN) prediction method, preferred by Transport for NSW and the EPA, is not typically applied where traffic flows are less than 50 vehicles per hour. A correction factor for low traffic volumes, applicable when considering traffic flows lower than 200 vehicles per hour, has been applied where relevant, in accordance with CoRTN.

From the traffic data in Table 23, traffic noise levels have been predicted in the vicinity of Arumpo Road using the following method and assumptions:

- Traffic speed set to 100 km/h.
- Road assessed as a local road as defined in the RNP.
- Predicted noise levels include an additional +2.5 dB correction for facade reflection as required by the RNP.
- $L_{Aeq, 1h}$ levels are calculated as CoRTN $L_{A10(1hr)}$ - 3 dB, per RMS practice (noting that this research was conducted by the RMS which has now been absorbed into TfNSW).
- Grass or cultivated fields assumed between the road and receivers.

Modifying corrections for Australian conditions (e.g. per Australian Road Research Board report ARR 121 dated 1983) or for road surface conditions have not been applied as applicable data for the road surfaces in question is not available.

The additional vehicle flows during construction, particularly on roads carrying very little existing traffic at night, may result in a noticeable increase for some residents. However, the total vehicle flows are still low (less than 200 vehicles per hour during the night in all cases) in an absolute sense. It is also noted that the assessments presented for local roads are based on the peak 1 hr traffic data, which is considered to be a worst-case scenario.

Table 25 shows a summary of the minimum setback distance from Arumpo Road, beyond which compliance with the RNP criteria is predicted to be achieved during the day and night periods.

Table 25: Minimum setback distance for RNP compliance

	Minimum setback distance for compliance, m		
Road	**Day**	**Night**	**Receivers within setback zone**
Local roads			
Arumpo Road (East of Silver City Highway)	45	120	7 [1]
Arumpo Road (East of Project EnergyConnect Camp)	40	80	None

1. See discussion below.

No receivers identified in Appendix E reside within the predicted setback zones for RNP compliance, however, the receiver dataset provided by Umwelt/Spark Renewables does not identify receivers in the vicinity of some sections of Arumpo Road, as they are more than 12 km from a Project WTG.

Notably, review of aerial imagery along the first 3 km of the Arumpo Road (East of Silver City Highway) road section indicates that there may be several receivers located within the setback zones, particularly near to the Silver City Highway intersection. All of these receivers appear to be located outside the 45 m daytime setback zone, but within the 120 m night-time setback zone.

Many of the premises appear to be commercial in nature with a limited number of apparent dwellings. These receivers are identified graphically in Figure 9, and should be included in the CNVMP, where relevant.

Notwithstanding the prediction results, the increase in traffic noise from the already low existing volumes may result in a noticeable increase in noise during some periods of construction. Noise mitigation options are generally limited for local roads, with community consultation and regular communication being the most effective and practical means of minimising adverse impacts.

It is recommended that residents residing nearby to the Silver City Highway/Arumpo Road intersection be included in consultation prior to, and during, construction.

Alternative practical methods for minimising noise impact may include limiting construction traffic speed for the affected stretches of Arumpo Road following the Silver City Highway intersection. Reducing construction traffic speeds would reduce the minimum setback distances and potential for adverse noise impacts to these receivers.

12.3 Sleep disturbance due to construction traffic

The majority of construction traffic movements are generally expected to occur during the day period only. However, during some construction stages, oversize/over mass vehicles (OSOM) may be required for the delivery of larger items. Movements on local roads during the night period are more likely to be associated with the OSOM deliveries during a particular phase of the construction works.

Based on the traffic sleep disturbance criteria established in Section 3.5, an external noise level screening threshold of 65 dB L_{Amax} is established to assess the potential for sleep disturbance due to construction traffic during the periods of OSOM delivery. A maximum external noise level of 65 dB L_{Amax} or higher, is predicted at receivers within 40 m of the OSOM vehicle movements.

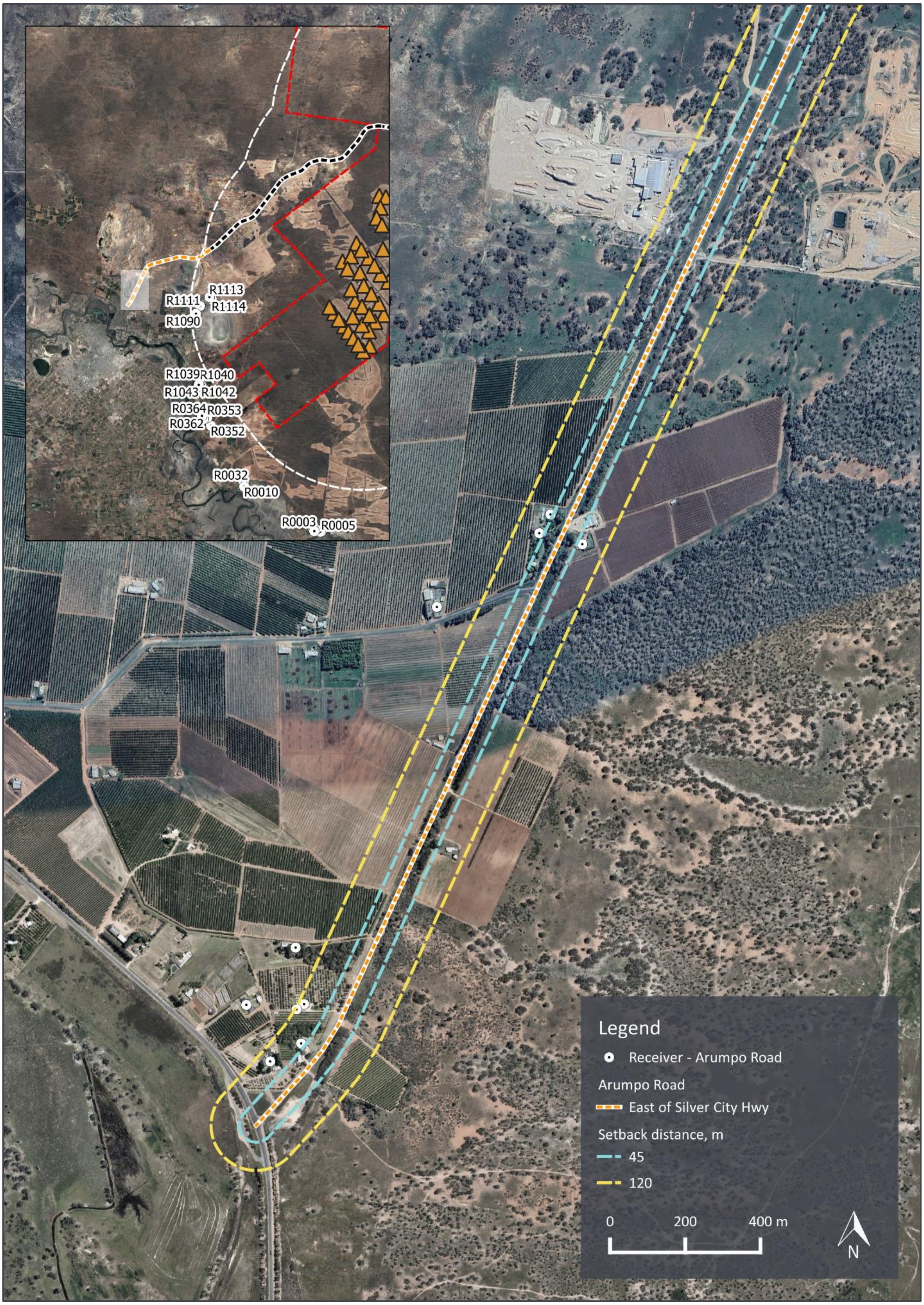
The OSOM Transport Route would be used for OSOM deliveries where required. On this basis, the sleep disturbance assessment has considered the potential for noise impacts resulting from OSOM deliveries along Arumpo Road.

As discussed in Section 12.2, the provided receiver dataset does not identify receivers nearby to the Silver City Highway/Arumpo Road intersection. Review of aerial imagery indicates that there may be receivers located within 40 m of the first 3 km of Arumpo Road. Care must be taken where OSOM deliveries are required to pass through this section of road during the night period.

Where OSOM deliveries must be carried out during night periods, reasonable and feasible noise mitigations should be considered. Potential mitigation could include:

- Reducing the maximum number of movements to once or twice each night.
- Planning for times when there is a clear change in the noise environment.

Figure 9: Receivers adjacent to Silver City Highway/Arumpo Road intersection



13.0 CONCLUSIONS

Marshall Day Acoustics Pty Ltd (MDA) has been engaged to prepare this noise and vibration assessment to support the Environmental Impact Statement (EIS) for the Project.

Operational noise from the WTGs has been assessed in accordance with the NSW Noise Assessment Bulletin, as required by the applicable SEARs and Supplementary SEARs (SSD-53293710), dated 17 February 2023, and 28 June 2023 respectively. The NSW Noise Assessment Bulletin specifies that the assessment of WTG noise is to be conducted in accordance with the SA Guidelines 2009 subject to a set of supplementary procedures that are specific to NSW.

Given the large separating distances between WTGs and receivers, and significant margin of compliance indicated in the current assessment, background noise levels have not been measured. Assessment at non-associated receivers has therefore been conducted considering the base noise limit, 35 dB $L_{Aeq,\,10\,min}$, in the NSW Noise Assessment Bulletin. This represents the most stringent noise limits that can be applied under the policy.

For the purposes of this assessment, one candidate WTG model has been nominated by Spark Renewables comprising the one noise modelling scenario that has been documented within this assessment.

To provide for a precautionary assessment, the capacity of the candidate WTG is greater than the WTG capacity intended for use by the Project, in the context of the current project design and layout.

Noise emission data representing the candidate WTG model has been used with international standard ISO 9613-2 to predict the level of noise expected to occur at neighbouring receivers.

The results of the noise modelling for the Project demonstrate that the predicted noise levels for the proposed WTG layout are below the base noise limit determined in accordance with the NSW Noise Assessment Bulletin at all neighbouring non-associated receivers by a minimum margin of 13.7 dB, including consideration of tonality and special noise characteristics.

The assessment has also considered operational noise from the proposed permanent noise generating ancillary infrastructure, specifically substations and BESS. Predicted noise levels are more than 25 dB below the most stringent night-time project noise trigger level of 35 dB L_{Aeq}, derived in accordance with the NPfI.

A preliminary construction noise and vibration assessment has been conducted, accounting for typical equipment items and work practices, as well as details of the relevant NSW guidelines and preliminary noise management recommendations. The assessment was undertaken in accordance with the ICNG and AVTG. The assessment confirmed that construction noise and vibration can be appropriately managed using standard good practice measures.

An assessment of traffic noise associated with construction traffic movements on local and freeway/arterial/sub-arterial roads has been conducted in accordance with the RNP. The assessment established setback distances for both road types within which applicable traffic noise criteria may be exceeded.

No associated or non-associated receivers identified by Spark Renewables are located within the setback distances. However, some unidentified receivers may be located within the setback distances for transport routes further from the Project, particularly at the Silver City Highway/Arumpo Road intersection. These receivers should be consulted prior to and during construction activities to manage impacts and considered in more detail as part of a future CNVMP.

Potential noise impacts from WTG noise and ancillary infrastructure noise have been assessed considering amenity noise levels for passive recreation receivers set out in the NPfI. Predicted noise levels from WTGs and ancillary infrastructure associated with the Project are significantly below the recommended amenity noise level of 50 dB L_{Aeq}.

Cumulative WTG and ancillary infrastructure noise impacts have been assessed considering a significant number of nearby developments. It is concluded that adverse impacts are unlikely.

The findings of the operational noise assessment therefore demonstrates that the Project is capable of being designed and operated to comply with SEARs requirements for both WTG noise and ancillary infrastructure noise. It is recommended that the predicted noise levels for all components of the operational noise assessment be updated for the final Project configuration and equipment selections, in order to verify compliance with the applicable noise criteria prior to the commencement of construction.

Consistent with the NSW Noise Assessment Bulletin, compliance is also recommended to be verified by post-construction noise compliance monitoring. The compliance testing procedures should be documented in a compliance test plan. Given the size of the Project, the compliance testing regime to be documented in a future noise compliance test plan is recommended to include provisions for early onsite noise emission testing of the WTGs to verify consistency with the design validation modelling.

Measures for the management of construction noise and vibration would be implemented via a CNVMP to be prepared at a later stage of the Project when a construction contractor has been selected and specialised construction planning for the site has been developed. This would comprise a detailed noise and vibration assessment, as well as Project specific noise mitigating work practices and physical noise controls (where required). Construction traffic noise impacts should also be reviewed in the context of the finalised construction planning, particularly for receivers close to the Silver City Highway/Arumpo Road intersection.

Overall, the construction, operational and decommissioning of the Project can be designed and executed such that associated noise is capable of complying with the requirements of the Project SEARs and Supplementary SEARs (SSD-53293710).

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}
A-weighted average noise level	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.	$L_{Aeq\,(t)}$
A-weighted maximum noise level	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.	L_{Amax}
C-weighting	The process by which noise levels are corrected to account for non-linear frequency response of the human ear at high noise levels (typically greater than 100 decibels).	See discussion below this table
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.	-
Peak Particle Velocity	The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment	PPV
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, unless included in a direct quote of external documentation.

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; and
- 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 26 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 26: Atmospheric pressure versus sound pressure – example values of pressure

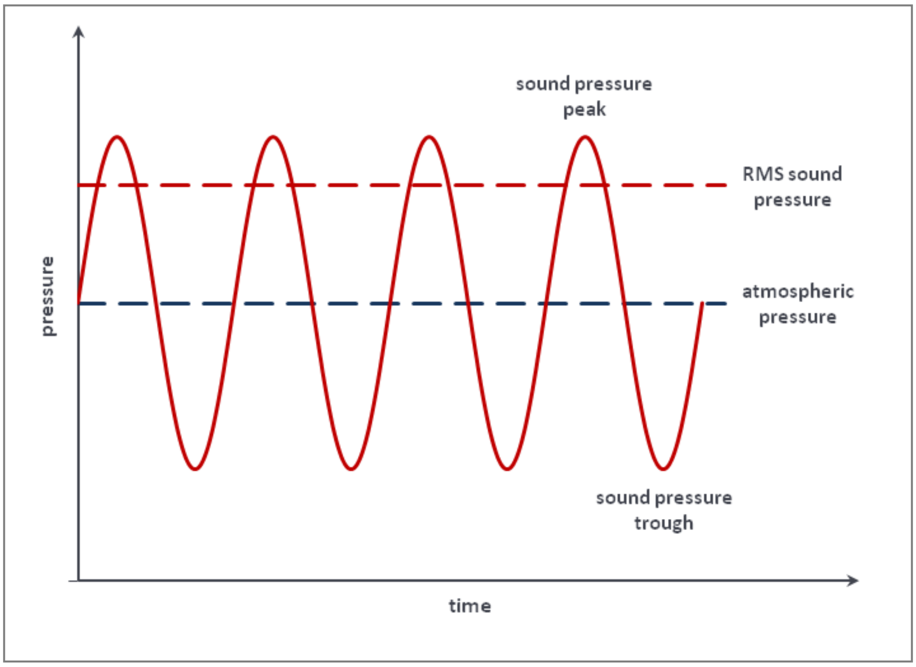
Example	Pascals	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002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

The pressure values in Table 26 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 10 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 10: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

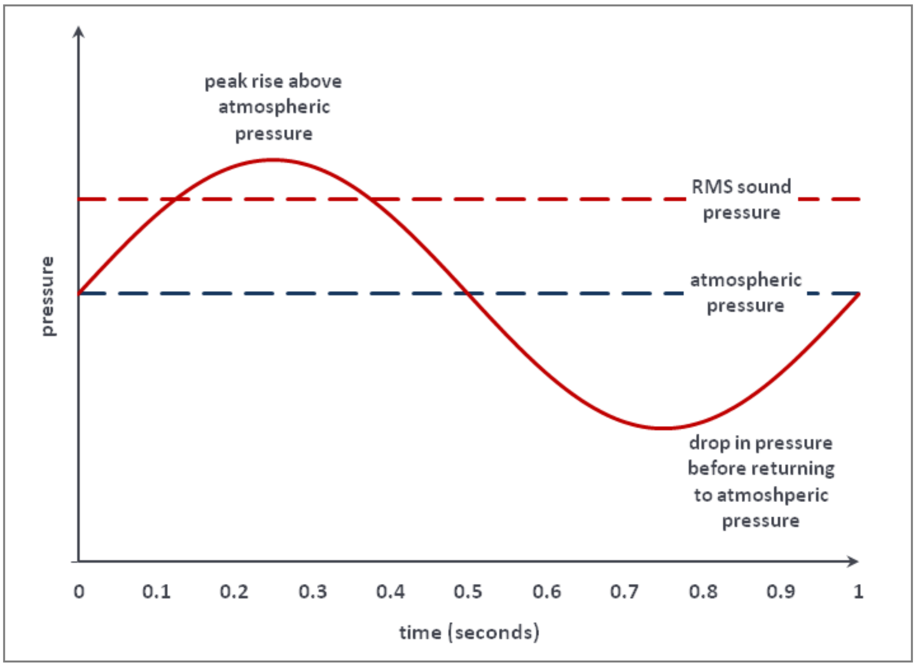
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period. The rate of change in pressure is an important feature that determines whether it can be perceived as a sound by the human ear.

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 11 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.

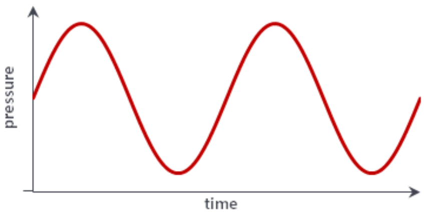
Figure 11: Illustration of a pressure fluctuation with a frequency of 1 Hz



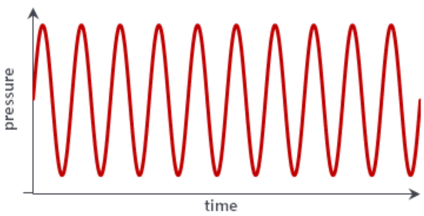
The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone 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 12 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 12: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

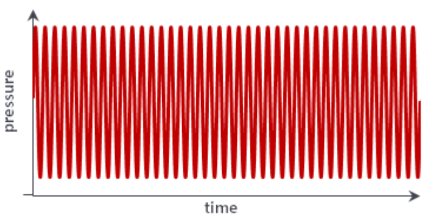
Low frequency sounds: 20 to 200 Hz



Mid-frequency sounds: 200 to 800 Hz



High frequency sounds: greater than 800 Hz



B2.3 Sound pressure and frequency variations

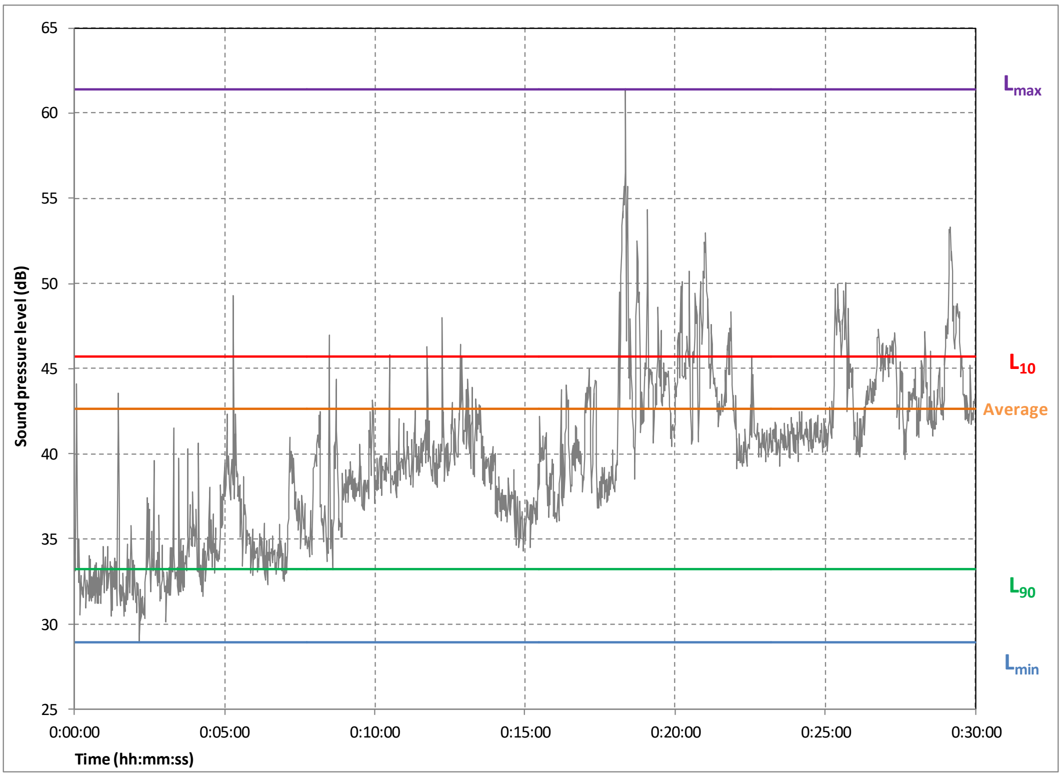
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

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 13 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 13: 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; and
- 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 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 27 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 27: 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 28 provides some examples of how changes in sound pressure levels, for a sound with the same character, can be perceived.

Table 28: 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 28 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.

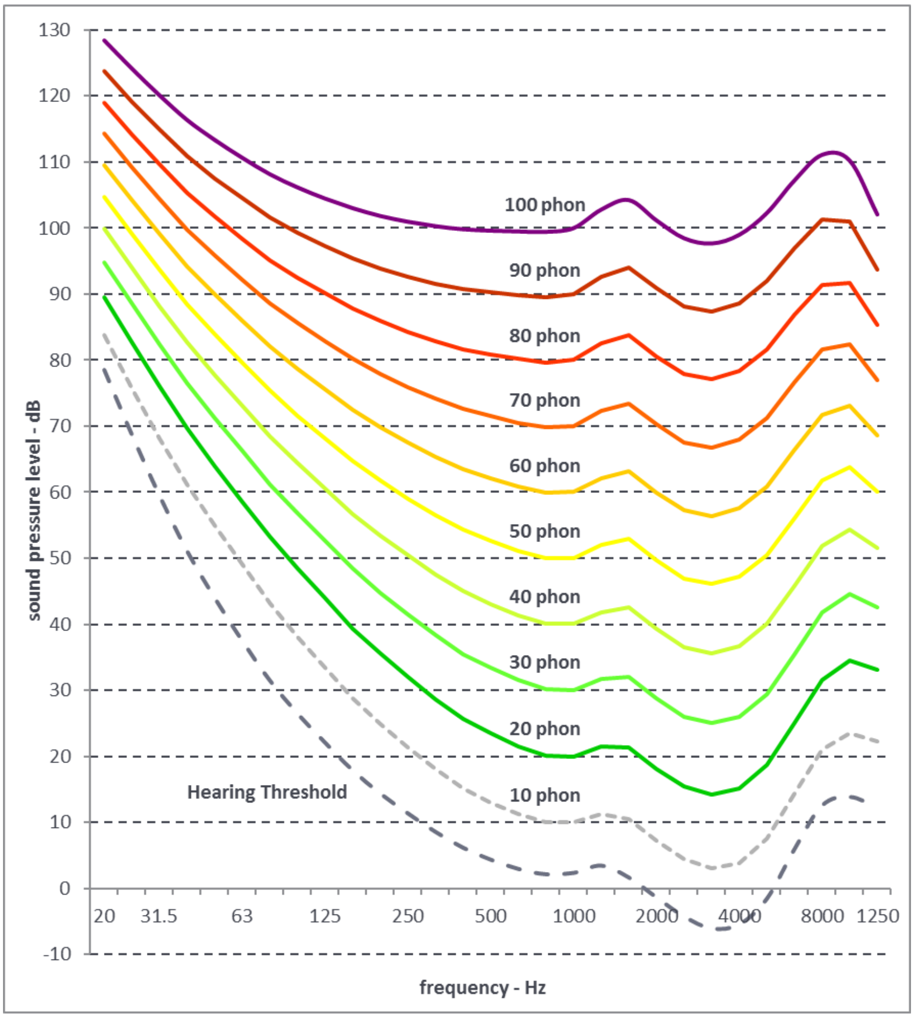
B3.2 Sound frequency and loudness

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 14. 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 standard[10] 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 14 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 14: Equal loudness contours for pure tone sounds



The noise curves in Figure 14 demonstrate that human hearing is most sensitive at frequencies from 500 to 4,000 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; and
- 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 WTG COORDINATES

Table 29 sets out the coordinates of the proposed WTG layout based on the Project layout dated 4 September 2024 as supplied by Umwelt/Spark Renewables.

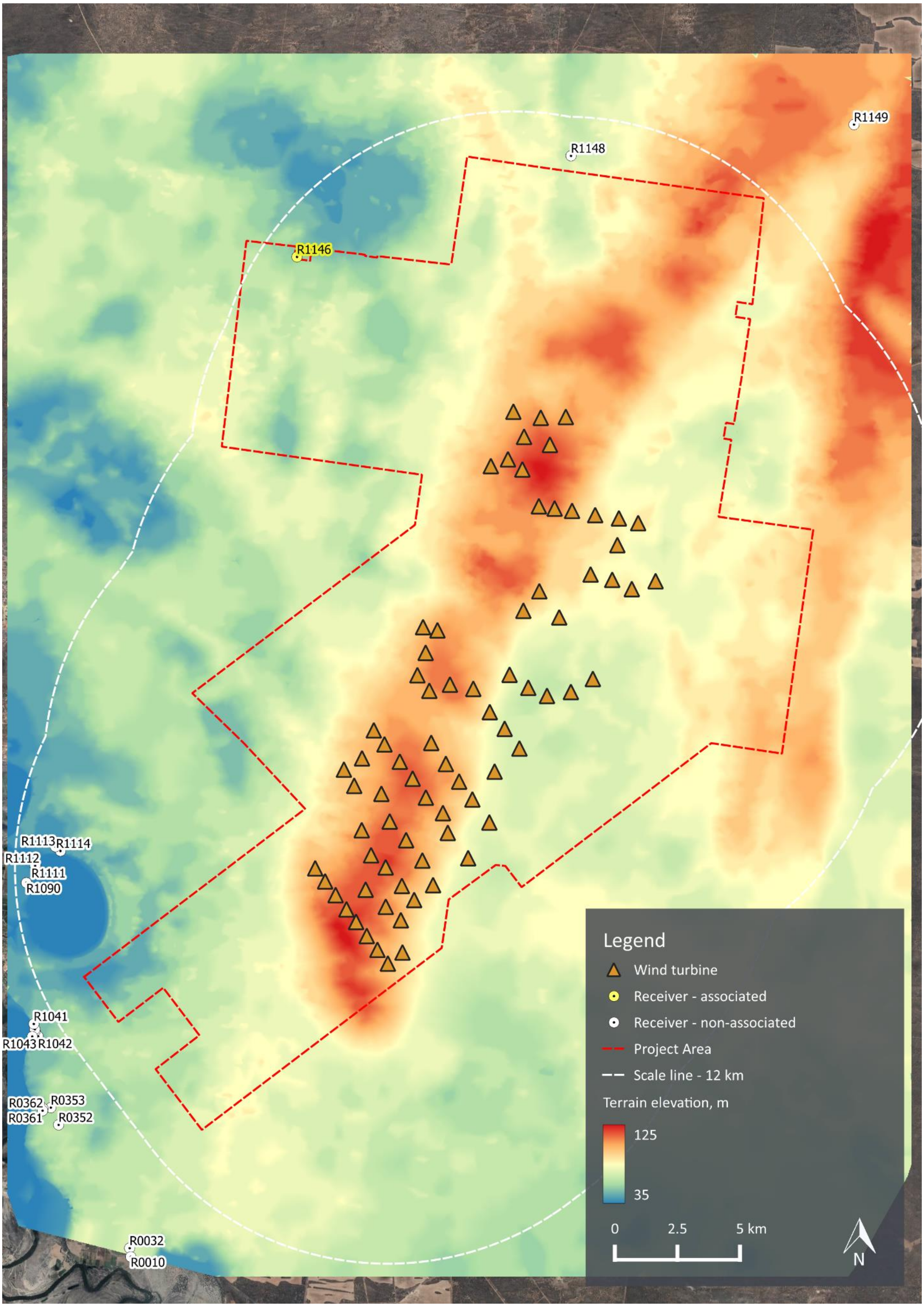
Table 29: Proposed WTG coordinates – GDA2020 MGA zone 54

WTG ID	Easting, m	Northing, m	Terrain elevation, m
T1	626,166	6,220,309	100
T2	626,562	6,219,788	105
T3	626,982	6,219,239	111
T4	627,416	6,218,668	117
T5	627,801	6,218,166	118
T6	628,227	6,217,605	97
T7	628,654	6,217,050	113
T8	629,071	6,216,502	118
T9	629,655	6,216,944	92
T10	628,182	6,219,456	115
T11	628,987	6,218,771	110
T12	629,589	6,218,233	99
T13	628,025	6,221,832	103
T14	628,399	6,220,830	113
T15	628,983	6,220,349	118
T16	629,631	6,219,604	103
T17	630,121	6,219,043	91
T18	627,314	6,224,254	90
T19	627,726	6,223,608	99
T20	629,143	6,222,182	113
T21	629,800	6,221,435	109
T22	630,450	6,220,621	101
T23	630,877	6,219,637	88
T24	628,037	6,224,706	97
T25	628,812	6,223,288	105
T26	628,508	6,225,824	97
T27	628,936	6,225,264	104
T28	629,548	6,224,573	111
T29	630,060	6,223,894	115
T30	630,590	6,223,137	111

WTG ID	Easting, m	Northing, m	Terrain elevation, m
T31	631,271	6,222,518	101
T32	631,466	6,221,726	94
T33	632,280	6,220,715	76
T34	630,804	6,225,324	102
T35	631,389	6,224,483	101
T36	631,920	6,223,778	100
T37	632,449	6,223,062	84
T38	633,128	6,222,141	75
T39	633,337	6,224,176	75
T40	630,251	6,228,029	103
T41	630,728	6,227,407	104
T42	630,581	6,228,925	103
T43	631,552	6,227,652	110
T44	632,485	6,227,485	102
T45	633,144	6,226,553	81
T46	633,738	6,225,888	71
T47	634,330	6,225,099	70
T48	630,477	6,229,950	95
T49	631,053	6,229,824	104
T50	633,935	6,228,047	76
T51	634,684	6,227,527	70
T52	635,432	6,227,202	70
T53	636,386	6,227,359	70
T54	637,265	6,227,879	70
T55	634,487	6,230,605	90
T56	635,920	6,230,340	80
T57	635,125	6,231,384	95
T58	637,174	6,232,054	83
T59	638,038	6,231,841	81
T60	638,822	6,231,473	83
T61	639,772	6,231,789	79
T62	638,245	6,233,229	83
T63	635,107	6,234,780	109

WTG ID	Easting, m	Northing, m	Terrain elevation, m
T64	635,736	6,234,694	110
T65	636,434	6,234,598	96
T66	637,357	6,234,430	85
T67	638,306	6,234,299	80
T68	639,076	6,234,107	85
T69	633,187	6,236,388	102
T70	633,871	6,236,658	111
T71	634,447	6,236,253	117
T72	634,515	6,237,559	110
T73	635,548	6,237,241	117
T74	634,088	6,238,563	100
T75	635,182	6,238,321	105
T76	636,184	6,238,353	104

APPENDIX D SITE TOPOGRAPHY



APPENDIX E RECEIVER COORDINATES

Table 30 sets out the 7 receivers identified by Spark Renewables that are located within 12 km of the proposed WTGs and have been considered within the noise assessment.

This includes one associated receiver where a noise agreement has been formalised between the landowners and Spark Renewables.

Data has been supplied by Spark Renewables on 25 July 2024.

Table 30: Receivers within 12 km of a Project WTG – GDA2020 MGA zone 54

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Nearest WTG	Distance to the nearest WTG, m
Associated receiver					
R1146	625,438	6,244,749	55	T74	10,636
Non-associated receivers					
R1090	614,621	6,219,728	40	T1	11,561
R1111	614,997	6,220,406	35	T1	11,171
R1112	614,971	6,220,410	35	T1	11,198
R1113	615,782	6,221,174	40	T1	10,422
R1114	615,984	6,220,999	44	T1	10,208
R1148	636,393	6,248,789	66	T76	10,440

APPENDIX F NOISE PREDICTION MODEL

In Australia, WTG noise predictions are typically calculated using ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (ISO 9613-2:1996) with a set of conservative assumptions tailored to wind farm assessment, as detailed in 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).

A revised version of the standard, ISO 9613-2:2024[11], was published earlier in 2024 based on broadly equivalent procedures to ISO 9613-2:1996, subject to refinements, clarifications, and supplementary advice for different types of sources. Notably, ISO 9613-2:2024 introduces an informative annex on WTG noise modelling to reflect the recommendations of the UK Institute of Acoustics guidance.

At the date of preparing this report, the revised standard has not yet been implemented in commonly used proprietary noise modelling software options. However, the core elements of the two versions (particularly with respect to wind farm noise modelling), are similar, and proprietary software options already implement the UK Institute of Acoustics guidance with respect to ISO 9613-2:1996.

On this basis ISO 9613-2:1996 continues to be used and referenced in Australia and 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 MDA and direct reference to the standard in the South Australia EPA W*ind farms environmental noise guidelines*, NZS 6808:2010 *Acoustics – Wind farm noise* and AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators.*

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 WTGs, 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 ISO 9613-2:1996, the noise emissions of each WTG 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; and
- 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.

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11 ISO 9613-2:2024 *Acoustics — Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors*

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

Wind farm noise propagation has been the subject of considerable research in recent years. These studies have provided support for the reliability of engineering methods such as ISO 9613-2:1996 when a certain set of input parameters are chosen in combination. 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 WTGs 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 9613-2:1996 and the choice of G = 0.5 as an appropriate ground characterisation, the following references are noted:

- A factor of G = 0.5 is frequently applied in Australia for general environmental noise modelling purposes as a way of accounting for the potential mix of ground porosity which may occur in regions of dry/compacted soils or in regions where persistent damp conditions may be relevant
- NZS 6808:2010 refers to ISO 9613-2:1996 as an appropriate prediction method 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 9613-2:1996 model provided a robust representation of upper noise levels which may occur in practice and provided a closer agreement between predicted and measured noise levels than alternative standards such as CONCAWE and ENM. Specifically, the report indicated the ISO 9613-2:1996 method generally tends to marginally over predict noise levels expected in practice
- The UK Institute of Acoustics journal dated March/April 2009 published a joint agreement between practitioners in the field of wind farm noise assessment (the UK IOA 2009 joint agreement), including consultants routinely employed on behalf of both developers and community opposition groups, and indicated the ISO 9613-2:1996 method as the appropriate standard and specifically designated G = 0.5 as the appropriate ground characterisation. This agreement was subsequently reflected in the recommendations detailed in the UK Institute of Acoustics guidance. It is noted that these publications refer to predictions made at receiver heights of 4 m. Predictions in Australia are generally based on a lower prediction height of 1.5 m which tends to result in higher ground attenuation for a given ground factor, however conversely, predictions in Australia do not generally incorporate a -2 dB factor (as applied in the UK) to represent the relationship between L_{Aeq} and L_{A90} noise levels. The result is that these differences tend to balance out to a comparable approach and thus supports the use of G = 0.5 in the context of Australian prediction methods.

A range of measurement and prediction studies[12, 13, 14] for wind farms in which MDA staff have been associated in have provided further support for the use of ISO 9613-2:1996 and G = 0.5 as an appropriate representation of typical upper noise levels expected to occur in practice.

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12 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.

13 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.

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

The findings of these studies demonstrate the suitability of ISO 9613-2:1996 method to predict the propagation of WTG 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.

In addition to the choice of ground factor referred to above, adjustments to ISO 9613-2:1996 for screening and valleys effects are applied based on recommendations of the Joule Report, UK IOA 2009 joint agreement and the UK Institute of Acoustics guidance. The following adjustments are applied to the calculations:

- Screening effects as a result of terrain are limited to 2 dB;
- Screening effects are assessed based on each WTG being represented by a single noise source located at the maximum tip height of the WTG rotor; and
- An adjustment of 3 dB is added to the predicted noise contribution of a WTG if the terrain between the WTG 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 WTG calculation procedure of the SoundPLANnoise 9.0 software used to conduct the noise modelling. The software uses these definitions in conjunction with the digital terrain model of the Project and surrounds to evaluate the path between each WTG and receiver pairing, and then subsequently applies the adjustments to each WTG's predicted noise contribution where appropriate.

APPENDIX G C-WEIGHTING ASSESSMENT RESULTS

G1 Introduction

Presented below are details of the risk assessment carried out for the purpose of gauging whether penalties for low frequency, as detailed in the NSW Noise Assessment Bulletin, are applicable.

G2 Assessment requirement

The following excerpt concerning C-weighted WTG noise have been reproduced from NSW Noise Assessment Bulletin.

> ***Low Frequency Noise***
>
> *The presence of excessive low frequency noise (a special noise characteristic) [ie noise from the wind farm that is repeatedly greater than 65 dBC during day time or 60 dBC during the night-time at any relevant receiver] will incur a 5 dB(A) penalty, to be added to the measured noise level for the wind farm, unless a detailed internal low frequency noise assessment demonstrates compliance with the proposed criteria for the assessment of low frequency noise disturbance (UK Department for Environment, Food and Rural Affairs (DEFRA, 2005) for a steady noise source.*

G3 Prediction method

As stated in Section 6.1.3, there is not a commonly used, practical method to accurately predict WTG low frequency noise levels at receiver locations.

In this case, the C-weighted noise levels at receiver locations have been estimated using a simplified approach based on the same noise modelling methods as described above for A-weighted levels, but with the ground absorption parameter set to G = 0 (hard ground) to account for the increased influence of ground reflections at low frequencies.

C-weighted noise levels have been predicted for the worst-case wind speed as specified in Section 6.1.1.

G4 Results

Table 31 presents the results of the preliminary C-weighted noise predictions for all non-associated receivers located within 12 km of a Project WTG.

The results show that the predicted low frequency noise levels are below the applicable threshold of 60 dB $L_{Ceq,\ 10\ min}$ for the application of penalties at all non-associated receivers.

Table 31: Predicted C-weighted noise levels, dB $L_{Ceq,\ 10\ min}$

Receiver	Predicted noise level dB $L_{Ceq,\ 10\ min}$
R1090	47.3
R1111	47.6
R1112	47.5
R1113	48.0
R1114	48.1
R1148	45.7

APPENDIX H EFFECTS OF WTG NOISE

In terms of the effect of WTG noise, one of the most important consideration is how the sound is perceived. However, judging whether or not a sound is noisy is highly subjective, and depends on many factors including the setting where the sound is heard, the character of the sound, and factors that influence how an individual perceives the sound.

In recognition of the rural settings where wind farms are usually built, wind farms are required to adhere to strict noise controls. Wind farm policies in Australia are among the most stringent international standards and set limits using a combination of a base (or fixed value) limit and an allowable margin above the background.

H1 Health and amenity

Sound is an important feature of the environment in which we live; it provides information about our surroundings and is a key influence on our overall perception of amenity and environmental quality. Sound is therefore an environmental quality that must be considered as part of any proposal to develop new infrastructure that could influence the sound environment of neighbouring communities.

Excessive or unwanted sound is commonly referred to as noise and can have a range of effects on people, depending on a range of physical and contextual factors. The *Guidelines for Community Noise* 1999 prepared by the World Health Organisation (WHO) provides a health-based framework of guideline limits and values to address the broad definition of health given as:

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

This broad definition means that effects ranging from community annoyance, sleep disturbance and speech interference, through to direct physiological impacts such as hearing damage, are all identified as potential health considerations. An important aspect of this range of considerations is that some effects will be highly dependent on the listener's perception and attitude to the noise in question, such as annoyance, while other effects are primarily related to the level of sound and the direct physiological risks these may represent, such as hearing damage.

Environmental noise policies, including those applied to wind farms, establish objective noise criteria to address these health considerations. In particular, environmental noise policies define criteria which are chosen to prevent direct physiological risks of sound and minimise as far as practically possible adverse health considerations such as annoyance and sleep disturbance.

Practically minimising the risks of noise effects related to annoyance and sleep disturbance requires the potential range of responses to sound to be considered. In this respect, it is important to note that individual attitudes and reactions to sound are highly variable and will depend on a complex set of acoustic and non-acoustic factors. These include the level and character of the sound in question, the time of day the sound occurs, the regularity of the sound, the environment in which the sound is heard, the individuals hearing acuity, and an individual's personal opinion and perception of the sound source or development in question. The latter will in turn depend on other complicating factors such as visual impressions of the source in question and the perceived community benefit, or otherwise, of the source in question.

Due to the complexity and range of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Further, it is usually not feasible or practical to design new development or infrastructure to inaudible noise levels. As a result, minimising the risks of noise effects involves setting criteria which prevents the majority of people from being disturbed. This requires regulatory authorities to strike a balance between amenity and development, setting noise limits which are as stringent as can be practically achieved without preventing new development.

This type of approach to noise policy was outlined by the Victorian Department of Health in their 2013 publication on wind farm sound and health which states:

> *Noise standards are used not only for environmental noise (such as wind farms and traffic noise) but also for industry and even household appliances.*
>
> *Noise standards are set to protect the majority of people from annoyance. The wide individual variation in response to noise makes it unrealistic to set standards that will protect everyone from annoyance. A minority of people may still experience annoyance even at sound levels that meet the standard. This is the case not only for wind farms, but for all sources of noise.*

The subject of health effects related to operational wind farms in Australia has been extensively considered by the Commonwealth Government's National Health and Medical Research Council (NHMRC) and the Australian Medical Association; in particular, the NHMRC has undertaken and coordinated a systematic review of evidence related to wind farms and health. The research reviews[15] and public statements[16, 17] produced by these peak health bodies support that, as with any audible sound, wind farm noise can represent a potential source of annoyance or sleep disturbance for some individuals. Their findings did however indicate that there was no reliable evidence to support a relationship between wind farm noise and direct adverse effects on human health.

In July 2012, Health Canada undertook a large-scale epidemiology study in response to community health concerns expressed in relation to WTGs. The following conclusions[18] were made from this research.

> *The following were not found to be associated with* [Wind Turbine Noise] *exposure:*
>
> - *self-reported sleep (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);*
> - *self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and*
> - *self-reported perceived stress and quality of life.*
>
> *While some individuals reported some of the health conditions above, the prevalence was not found to change in relation to* [Wind Turbine Noise] *levels.*
>
> [...]
>
> *The following was found to be statistically associated with increasing levels of* [Wind Turbine Noise]*:*
>
> - *annoyance towards several wind turbine features (i.e. noise, shadow flicker, blinking lights, vibrations, and visual impacts).*

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15 *Systematic review of the human health effects of wind farms*, 2013, Adelaide University, commissioned by the NMRC

16 NHMRC Information Paper: *Evidence on Wind Farms and Human Health*, February 2015, National Health and Medical Research Council

17 AMA Position Statement: *Wind Farms and Health*, 2014, Australian Medical Association

18 https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html

In 2018, the World Health Organization released the *Environmental Noise Guidelines for the European Region*[19] which concluded:

> *In accordance with the prioritization process, the GDG set a guideline exposure level of 45.0 dB L_{den} for average exposure, based on the relevant increase of the absolute %HA. The GDG stressed that there might be an increased risk for annoyance below this noise exposure level, but it could not state whether there was an increased risk for the other health outcomes below this level owing to a lack of evidence. As the evidence on the adverse effects of wind turbine noise was rated low quality, the GDG made the recommendation conditional.*
>
> [...]
>
> *Based on the low quantity and heterogeneous nature of the evidence, the GDG was not able to formulate a recommendation addressing sleep disturbance due to wind turbine noise at night time.*

As detailed in the MDA paper *WHO Environmental Noise Guidelines for the European Region: conditional recommendation for wind turbine noise in the context of Australian regulations*[20], achieving compliance with NZS 6808 corresponds to noise levels that are consistent with the recommendations of the 2018 WHO European Noise Guidelines.

These findings lend support to the suitability of the wind farm noise controls applied in New South Wales, which are intended to provide reasonable protection of health and amenity at noise sensitive locations.

Further discussions of specific noise considerations related low-frequency sound and infrasound are provided in the following section.

H2 Low frequency noise, infrasound, and ground vibration

The limits adopted for the assessment of operational noise from wind farms represent relatively low levels which have been specified in recognition of the quieter rural environments in which wind farms are normally located.

However, consistent with noise policies applied to other forms of development, the criteria are not intended to restrict wind farm noise to inaudible levels. Accordingly, a wind farm which achieves compliance with the criteria may still be audible at surrounding receivers on some occasions; this will depend on a range of factors such as the time of day, the speed and direction of the wind, the proximity to WTGs, the extent of vegetation around the dwelling, and the degree to which the dwelling is sheltered from prevailing wind conditions. Irrespective of the relatively low levels which operational wind farm noise is restricted to, an individual's judgement of the audible noise from a wind farm is highly subjective and will be influenced by a range of contextual factors.

The subject of wind farm noise and its characteristics has attracted considerable attention. Specific attention has been directed to alleged matters relating to low frequency sound as well as infrasound and vibration. Low frequency sounds are generally regarded as sounds above 20 Hz and extending upwards into the range of 100-200 Hz. The definition of infrasound often varies in different jurisdictions but is generally accepted to refer to frequencies of sound which lie below 20 Hz. While 20 Hz is commonly cited as the lower bound of audibility, frequencies below 20 Hz can still be audible, provided that the level of the sound is sufficiently high to exceed the threshold of audibility at those frequencies.

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19 https://www.euro.who.int/en/health-topics/environment-and-health/noise/environmental-noise-guidelines-for-the-european-region

20 http://tinyurl.com/WTN2019-Delaire

In common with many other sources of noise, WTGs emit infrasound, low frequency sound and ground vibrations. However, what is often overlooked is that these types of sound and vibration are a feature of the everyday environment in which we live and arise from a wide range of natural sources such as the wind and the ocean to man-made sources such as domestic appliances, transportation and agricultural equipment. The important point in relation to WTGs is that the levels of these types of emissions are low and therefore, in many cases, cannot generally be reliably measured amidst normal background levels.

The NSW Noise Assessment Bulletin states the following concerning infrasound:

> *there is currently no consistent evidence supporting a link between wind energy projects and adverse health outcomes in humans relating to infrasound.*

These types of emissions have been the subject of considerable misrepresentation in media commentary. Notably, the work of Dr Geoff Leventhall, a prominent UK consultant in the field of acoustics and vibration, and researcher in the field of low frequency noise is often cited in some documents which continue to claim concerns about infrasound and low frequency noise from WTGs. However, Dr Leventhall has regularly made clear statements to assert that there is no significant infrasound from current designs of WTGs and very little low frequency sound, neither of which are anywhere near the sorts of levels which would represent a direct health risk for neighbouring residents of modern wind farms. An example of such publication, co-authored by Dr Leventhall, was published in the UK Institute of Acoustics Bulletin in March 2009[21]. This publication was prepared as an agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed by local councils and community groups campaigning against wind farm developments. The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern.

On the subject of infrasound and low frequency noise, the article notes:

> *Infrasound is the term generally used to describe sound at frequencies below 20Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles. Sounds at frequencies from about 20Hz to 200Hz are conventionally referred to as low frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view.*
>
> *A Portuguese group has been researching 'Vibro-acoustic Disease' (VAD) for about 25 years. Their research initially focussed on aircraft technicians who were exposed to very high overall noise levels, typically over 120dB. A range of health problems has been described for the technicians, which the researchers linked to high levels of low frequency noise exposure. However other research has not confirmed this. Wind farms expose people to sound pressure levels orders of magnitude less than the noise levels to which the aircraft technicians were exposed. The Portuguese VAD group has not produced evidence to support their new hypothesis that infrasound and low frequency noise from wind turbines causes similar health effects to those experienced by the aircraft technicians.*

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21 Institute of Acoustics Bulletin – Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall, McKenzie - *Prediction and Assessment of Wind Turbine Noise* –March 2009

Another example of the misrepresentations made in relation to the environmental effects of WTGs centred around work carried out by Keele University in the UK on ground vibration. Professor Peter Styles and his team at Keele University undertook a study of the effects of WTGs on the seismic detection array at Eskdalemuir, Scotland. The results of this work were widely misinterpreted and resulted in a statement[22] from Professor Styles:

> *We are writing to clarify some misconceptions [...] about wind farm noise. Whilst it is technically correct that 'vibrations can be picked up as far away as 10km', to give the impression that they can be felt at this distance is highly misleading. The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect. The Dunlaw study was designed to measure effects of extremely low level vibration on one of the quietest sites (Eskdalemuir) in the world, and one which houses one of the most sensitive seismic installations in the world. Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health. It is, however, an issue for the Eskdalemuir seismic array, as it can detect this level of vibration. It is designed to detect explosions and earthquakes of a low magnitude from all over the world. The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health.*

More recent measurements[23, 24] have demonstrated that infrasound and low frequency sound produced by regularly encountered natural and man-made sources, such as the infrasound produced by the wind or distant traffic, is comparable to that of modern WTGs, noting that:

> *Infrasound levels in the rural environment appear to be controlled by localised wind conditions. During low wind periods, levels as low as 40dB(G) were measured at locations both near to and away from wind turbines. At higher wind speeds, infrasound levels of 50 to 70dB(G) were common at both wind farm and non-wind farm sites.*
>
> *Organised shutdowns of the wind farms adjacent to [sic: measurement locations] indicate that there did not appear to be any noticeable contribution from the wind farm to the G-weighted infrasound level measured at either house. This suggests that wind turbines are not a significant source of infrasound at houses located approximately 1.5 kilometres away from wind farm sites*

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22 *Keele University Rejects Renewable Energy Foundation's Low Frequency Noise Research Claims*

23 Sonus report for Pacific Hydro - *Infrasound measurements from wind farms and other sources* – November 2010 See http://www.pacifichydro.com.au/media/192017/infrasound_report.pdf

24 Evans, T., Cooper, J. & Lenchine, V., *Infrasound levels near wind farms and in other environments*, South Australian Environment Protection Authority, Adelaide, 2013 - See https://www.epa.sa.gov.au/files/477912_infrasound.pdf

In 2010, the UK Health Protection Agency published a report[25] on the health effects of exposure to ultrasound and infrasound. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

> *Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *[...]*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects.*

Also, a recent State Government of Victorian Department of Health document[26] concludes the following in relation to infrasound from wind farms:

> *Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents.*

These studies all indicate that infrasound levels from the proposed Project are anticipated to be comparable with existing ambient levels.

In February 2015, the National Health and Medical Research Council (NHMRC) released an information paper[27] addressing human health effects of wind farms which includes consideration of noise.

From well over 4,000 articles which were identified during the NHMRC review, only thirteen (13) studies across Europe, North America and Australia satisfied a set of pre-specified eligibility criteria for detailed review and therefore form the basis of the report, which concludes:

> *Examining whether wind farm emissions may affect human health is complex, as both the character of the emissions and individual perceptions of them are highly variable. After careful consideration and deliberation of the body of evidence, NHMRC concludes that there is currently no consistent evidence that wind farms cause adverse health effects in humans. Given the poor quality of current direct evidence and the concern expressed by some members of the community, high quality research into possible health effects of wind farms, particularly within 1,500 metres (m), is warranted.*

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25 Health Protection Agency UK – *Health Effects of Exposure to Ultrasound and Infrasound – Report of the independent Advisory Group on Non-ionising Radiation* - 2010

26 Public Statement: Wind Turbines and Health - July 2010

27 *Information Paper - Evidence on Wind Farms and Human Health*, February 2015

The NSW *Noise Assessment Bulletin* issued in December 2016 refers to this advice and states the following in its section on Noise and Health:

> *High levels of noise are associated with adverse health outcomes. To examine this potential relationship the National Health and Medical Research Council (NHMRC) undertook a comprehensive assessment of the scientific evidence on wind farms and human health. In 2015, the NHMRC concluded that "there is no direct evidence that exposure to wind turbine noise affects physical or mental health", and there is currently no consistent evidence supporting a link between wind energy projects and adverse health outcomes in humans relating to infrasound. More specifically, they stated that, "while exposure to environmental noise is associated with health effects, these effects occur at much higher levels of noise than are likely to be perceived by people living in close proximity to wind farms in Australia".*

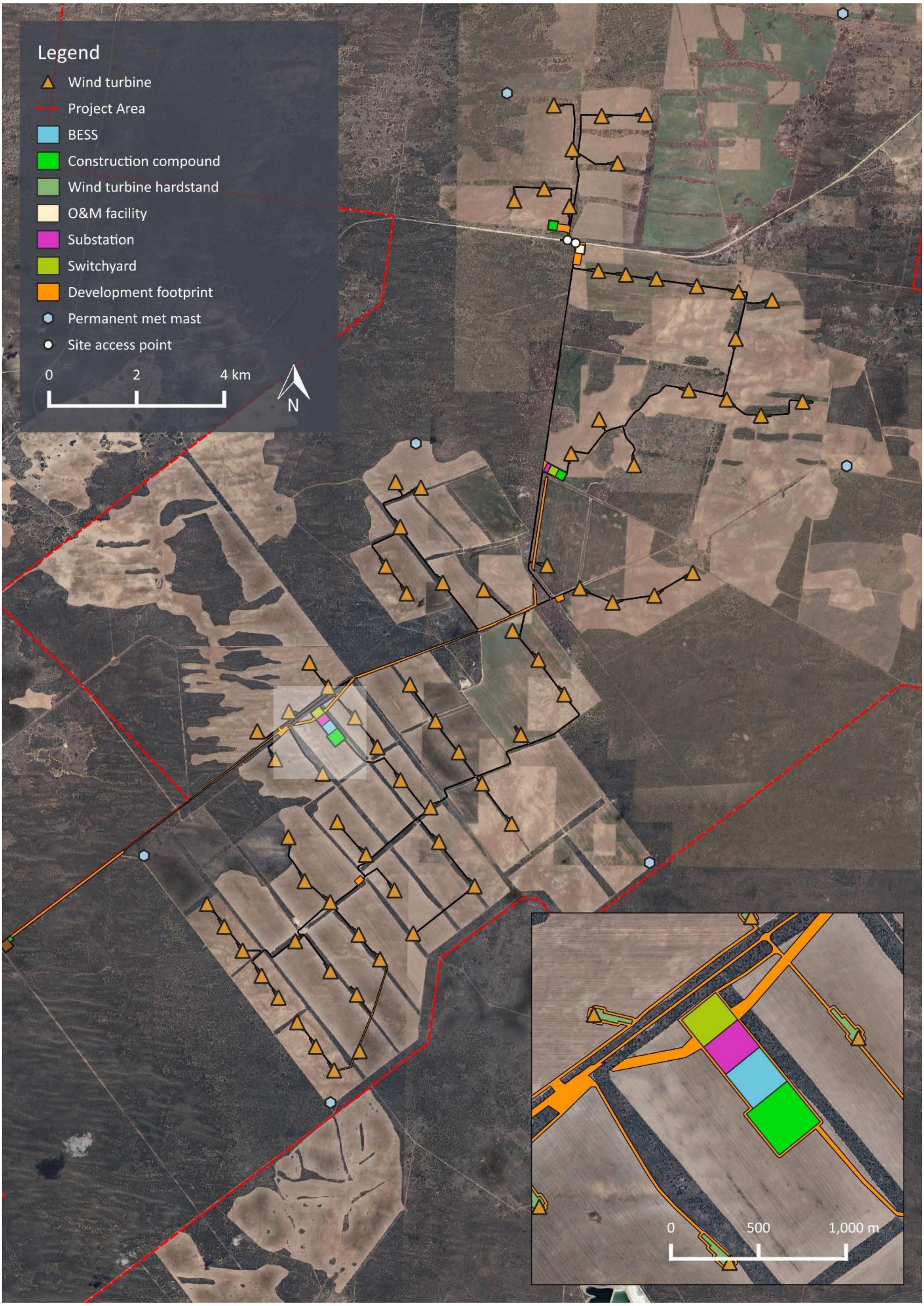
These studies all indicate that infrasound levels are anticipated to be comparable with existing ambient levels and, as such, are not expected to represent an impact from the proposed wind farm. Similarly, vibration levels from WTGs are well below perception thresholds, and low frequency levels are typically low.

APPENDIX I TABULATED PREDICTED NOISE LEVELS

Table 32: Predicted noise levels, dB $L_{Aeq,\ 10\ min}$ for all receivers within 12 km of a WTG

Receiver	Hub-height wind speed, m/s																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Associated receivers																	
R1146	9.4	9.6	11.5	14.5	17.3	19.4	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
Non-associated receivers																	
R1090	9.9	10.1	12.0	15.0	17.8	19.9	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
R1111	10.3	10.5	12.4	15.4	18.2	20.3	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
R1112	10.2	10.4	12.3	15.3	18.1	20.2	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4
R1113	10.9	11.1	13.0	16.0	18.8	20.9	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1
R1114	11.1	11.3	13.2	16.2	19.0	21.1	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
R1148	8.4	8.6	10.5	13.5	16.3	18.4	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6

APPENDIX J CONSTRUCTION LAYOUT PLAN



APPENDIX K CONSTRUCTION EQUIPMENT, WORK STAGES AND ACOUSTIC DATA

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), and noise level data from previous projects of a similar nature.

Table 33 summarises the noise emissions used to represent key items of plant associated with construction.

Table 33: Construction noise sources sound power level data, dB L_{WA}

Noise source	Sound power level
Asphalt rotomill	111
Backhoe	104
Bulldozer	108
Compressor (silenced)	101
Concrete pump truck	108
Concrete truck	108
Crane (1200 t)	115
Crane (500 t)	110
Dump truck	117
Excavator	107
Forklift	106
Front end loader	113
Generator	99
Grader	110
Hand tools (electric)	102
Machine mounted pneumatic drill	116
Piling (vibratory)	125
Roller (vibratory)	108
Truck (water cart)	107

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 is therefore presented solely as an indication of typical construction noise levels.

The overall total aggregated sound power levels for each of the key construction tasks are detailed in Table 34. These have been developed based on the assumption that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period.

Table 34: Overall sound power levels of key construction tasks, dB L_{WA}

Construction task	Plant/Equipment	Approximate overall sound power level
Concrete batching	1 x Compressor (silenced) 1 x Concrete truck 2 x Front end loader 1 x Generator	115
Infrastructure (substations, masts, transmission, BESS)	1 x Concrete truck 1 x Crane (500 t) 2 x Front end loader 1 x Generator 10 x Hand tools (electric) 1 x Machine mounted pneumatic drill 2 x Piling (vibratory)	130
Road upgrades	1 x Asphalt rotomill 3 x Backhoe 1 x Dump truck 2 x Front end loader 2 x Grader 2 x Roller (vibratory) 1 x Truck (water cart)	120
Site establishment (internal roads, hardstands, compounds)	3 x Backhoe 3 x Bulldozer 1 x Dump truck 2 x Excavator 3 x Forklift 2 x Front end loader 2 x Grader 5 x Roller (vibratory) 2 x Truck (water cart)	125
WTG assembly	1 x Compressor (silenced) 2 x Crane (1200 t) 1 x Generator 1 x Machine mounted pneumatic drill	120
WTG foundations	1 x Concrete pump truck, 2 x Concrete truck 2 x Crane (1200 t) 1 x Excavator 2 x Front end loader	120

APPENDIX L NSW NOISE ASSESSMENT BULLETIN – INFORMATION REQUIREMENTS

The NSW Noise Assessment Bulletin specifies the minimum information to be provided in a noise report accompanying an EIS. The requirements and the location within this report where the requirement is addressed, are summarised in Table 35.

Table 35: NSW Noise Assessment Bulletin – information requirements

Information requirement	Location of relevant content
• *the model used to predict the wind energy project noise levels and input assumptions and factors used in the model, noting that noise management mode or sector management (i.e. stopping individual wind turbines or combinations, or operating in low noise mode, during identified meteorological conditions) should not be used in the primary modelling or predicting of noise levels. Any modelling and predictions which incorporate noise management mode or sector management must be reported separately;*	Section 4.1/Appendix F
• *background noise measurement locations including time and duration of the background noise monitoring program;*	See Section 5.0
• *wind speed monitoring locations within the Project area, heights above ground and graphical correlation plot of hub height wind speed versus background noise level data;*	See Section 5.0
• *a summary of the environmental noise criteria for the Project at each integer wind speed based on the above correlation;*	See Section 5.0
• *make and model of the representative wind turbine(s) along with the positions of the wind turbines;*	Figure 1/Section 6.1/Appendix C
• *predicted noise levels at the closest non-associated dwellings to the wind energy project at each integer wind speed;*	Section 6.2/Appendix A
• *a comparison of the predicted noise levels against the criterion at each integer wind speed for the closest non-associated dwellings to the wind energy project; and*	Section 6.2
• *modifications or operating strategy that would be employed to address any unforeseen non-compliances. The error margins of the noise model used should be considered in developing such modifications or strategies.*	Section 8.0