Noise Assessment

Quirindi 1B Solar Farm
Quirindi, NSW

Prepared for: ITP Development Pty Ltd
January 2024
MAC180781-24RP1V1

Muller Acoustic Consulting

Document Information

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Quirindi, NSW

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by ITP Development Pty Ltd (ITP) to prepare a Noise Assessment (NA) for the proposed Quirindi 1B Solar Farm and Battery Energy Storage System (BESS) near Quirindi, NSW (the project). This report presents the methodology and findings of the NA for the construction and operation of the project.

1.1 Purpose and Objectives

A NA is required as part of the environmental assessment to be submitted to Liverpool Plains Shire Council as part of the Development Application (DA). The purpose of the NA is to quantify potential environmental noise emissions associated with the construction and operation of the project. Where impacts are identified, the assessment includes recommendations for potential noise mitigation and management measures.

1.2 Scope of the Assessment

The NA includes the following key tasks:

- review construction and operating activities to identify key noise generating plant, equipment, machinery or activities proposed to be undertaken as part of the project;
- identify the closest and/or potentially most affected receivers situated within the area of influence to the project;
- determine project-specific construction Noise Management Levels (NMLs), and operational noise criteria;
- undertake 3D noise modelling to predict levels that may occur as a result of the construction and operation of the project at the closest and/or potentially most affected receivers;
- provide a comparison of predicted noise levels against relevant construction and operational criteria;
- assess the potential noise impacts associated with construction and operational aspects of the project;
- assess the potential noise impacts associated with road traffic noise during construction; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where criteria may be exceeded.

The assessment has been undertaken in accordance with the following documents:

- NSW Department of Environment and Climate Change (DECCW) – NSW Interim Construction Noise Guideline (ICNG), July 2009;
- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- NSW Department of Environment, Climate Change and Water (DECCW) – NSW Road Noise Policy (RNP), March 2011;
- Standards Australia AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures; and
- International Standard ISO 9613:1996 - Acoustics - Attenuation of sound during propagation outdoors.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

2 Project Description

2.1 Background

ITP propose to construct and operate a 5-Megawatt (MW AC) solar farm and BESS using Photovoltaic (PV) technology at Borah Creek Road, approximately 5km northeast of Quirindi, NSW.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north aligned PV modules on mounting structures of 1.3m to 1.5m in height. Approximately 10,750 PV panels will be installed using a single axis tracking system, tilting along the east - west axis. The PV mounting structure would comprise steel posts driven into the ground using a small pile driver. Additional support structures would be attached to the piles, which would then support the PV panels.

Where cabling of each PV array/module to inverters is required to be underground, earthworks will primarily involve trenching. Other minor earthworks would be completed for the preparation of the site and in most cases a concrete slab would be required to support the ancillary infrastructure, BESS foundations and associated cabling connections. Most of the infrastructure would be prefabricated off-site, delivered and assembled on-site. Construction activities associated with the BESS would involve the placement of a shipping container at the appropriate location (by crane or crane truck) and is a negligible noise source/event.

It is anticipated that the solar farm would be constructed in stages, with construction of two to three stages occurring at any one time over a three-month period during standard construction hours.

All vehicles would access the project site from Quirindi via Borah Creek Road and Porters Lane to a dedicated access track during construction and operational phases.

During construction, traffic generated by the project would include employee and delivery vehicles. During the peak construction period, the traffic volume is expected to be up to a maximum of four (4) heavy vehicles (semi-trailers or B-doubles) per hour and up to 40 light vehicles for worker transport per day.

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels installed in rows running north to south. The PV modules will be on a single axis tracker system which will follow the sun and move in an east to west direction. Electrical cabling would be attached beneath the modules and would connect the individual PV modules to each other. The BESS and Inverters will be located centrally and connected by underground cables. The project will be contained solely within the site as shown in Figure 1.

The project would operate 24 hours a day, 7 days a week, with no permanent staff on site. During operation, the PV panels would generate electricity which would be fed into the power grid via the adjacent existing powerline with excess solar energy from the PV system being stored in the BESS for night-time usage.

Key noise emissions from the operation of the project are associated with the inverter and transformer(s). The BESS typically consists of a lithium-ion battery rack in a shipping container fitted with relevant switches and controllers. As this equipment generates heat, a Heating Ventilation and Air Conditioning (HVAC) system is required to provide cooling and is the primary noise source associated with the BESS. The HVAC system consists of an air conditioner, heat exchanger and ventilation fans. It is noted that emissions from these sources are anticipated to be acoustically insignificant compared to ambient background noise levels at assessed receivers.

When required, maintenance activities will occur during standard working hours (except for emergencies) and are expected to include:

- panel cleaning;
- repairs or replacement of infrastructure, as required; and
- land management including mowing to control vegetation as required.

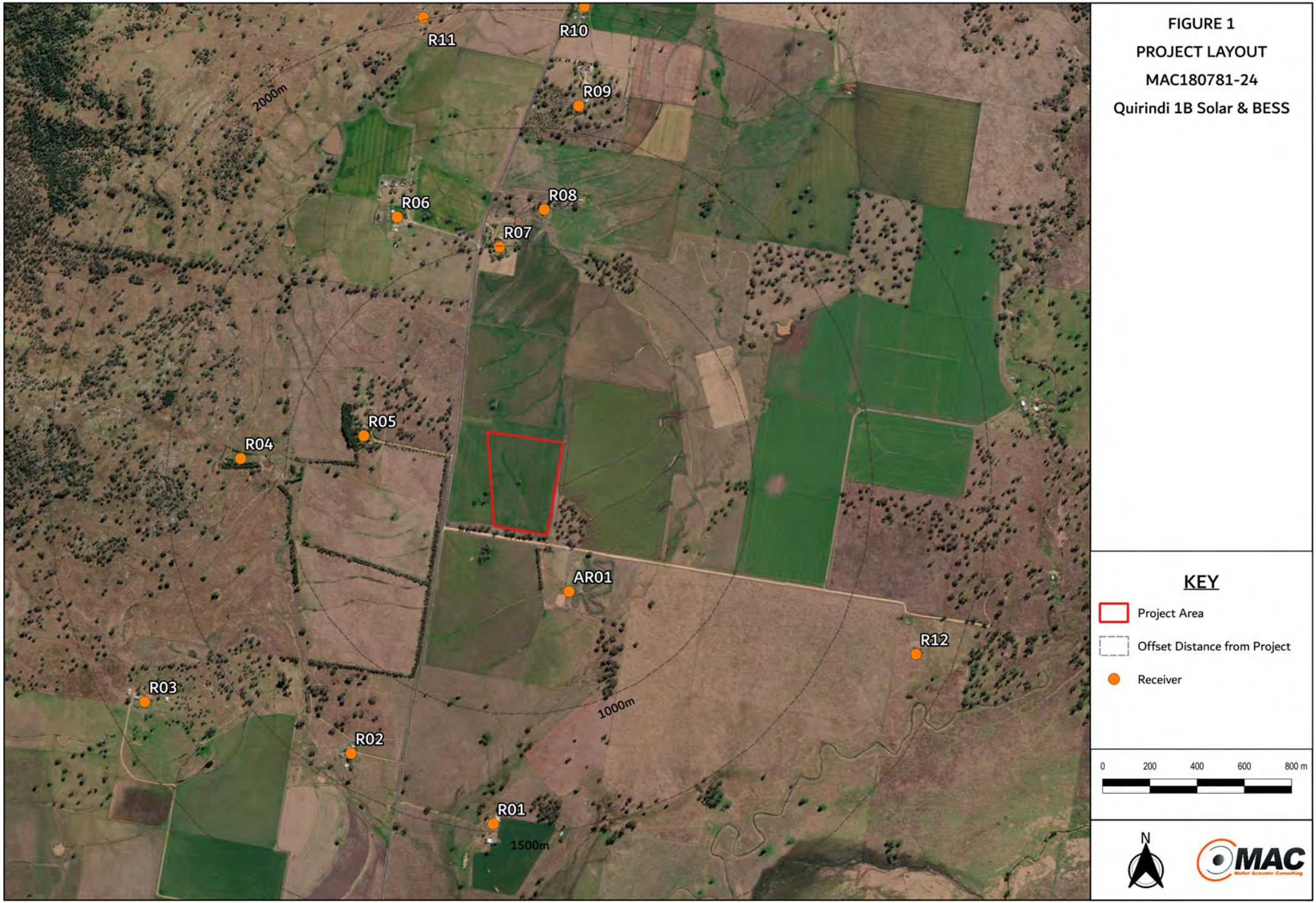
Typical noise sources associated with maintenance activities would include light vehicle movements on site and maintenance of equipment.

2.4 Receiver Review

Using aerial photography, geospatial information and other project design information, MAC has identified the following potentially sensitive receivers that may be affected by noise from operation or construction activities and project related road traffic. **Table 1** presents a summary of receiver identification, type, address and coordinates. These are reproduced visually in **Figure 1**.

Table 1 Receiver Locations

Receiver	Description	Receiver Type	Coordinates (GDA94/MGA56)	
			Easting	Northing
R01	382 Borah Creek Road	Rural Residential	282603	6515163
R02	395 Borah Creek Road	Rural Residential	282001	6515461
R03	247 Borah Creek Road	Rural Residential	281128	6515680
R04	531 Borah Creek Road	Rural Residential	281534	6516710
R05	531 Borah Creek Road	Rural Residential	282056	6516806
R06	619 Borah Creek Road	Rural Residential	282197	6517733
R07	630 Borah Creek Road	Rural Residential	282630	6517607
R08	683 Borah Creek Road	Rural Residential	282820	6517765
R09	684 Borah Creek Road	Rural Residential	282966	6518205
R10	734 Borah Creek Road	Rural Residential	282990	6518625
R11	723 Borah Creek Road	Rural Residential	282308	6518578
R12	94 Gamble Street	Rural Residential	284394	6515881
AR01	Quirindi Motorcycle Club	Active Recreation	282925	6516147


R11
R10
R09
2000m
R06
R08
R07
R05
R04
AR01
R12
R03
1000m
R02
R01
1500m
FIGURE 1
PROJECT LAYOUT
MAC180781-24
Quirindi 1B Solar & BESS
KEY
Project Area
Offset Distance from Project
Receiver
0
200
400
600
800 m
N
MAC
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3 Noise Policy and Guidelines

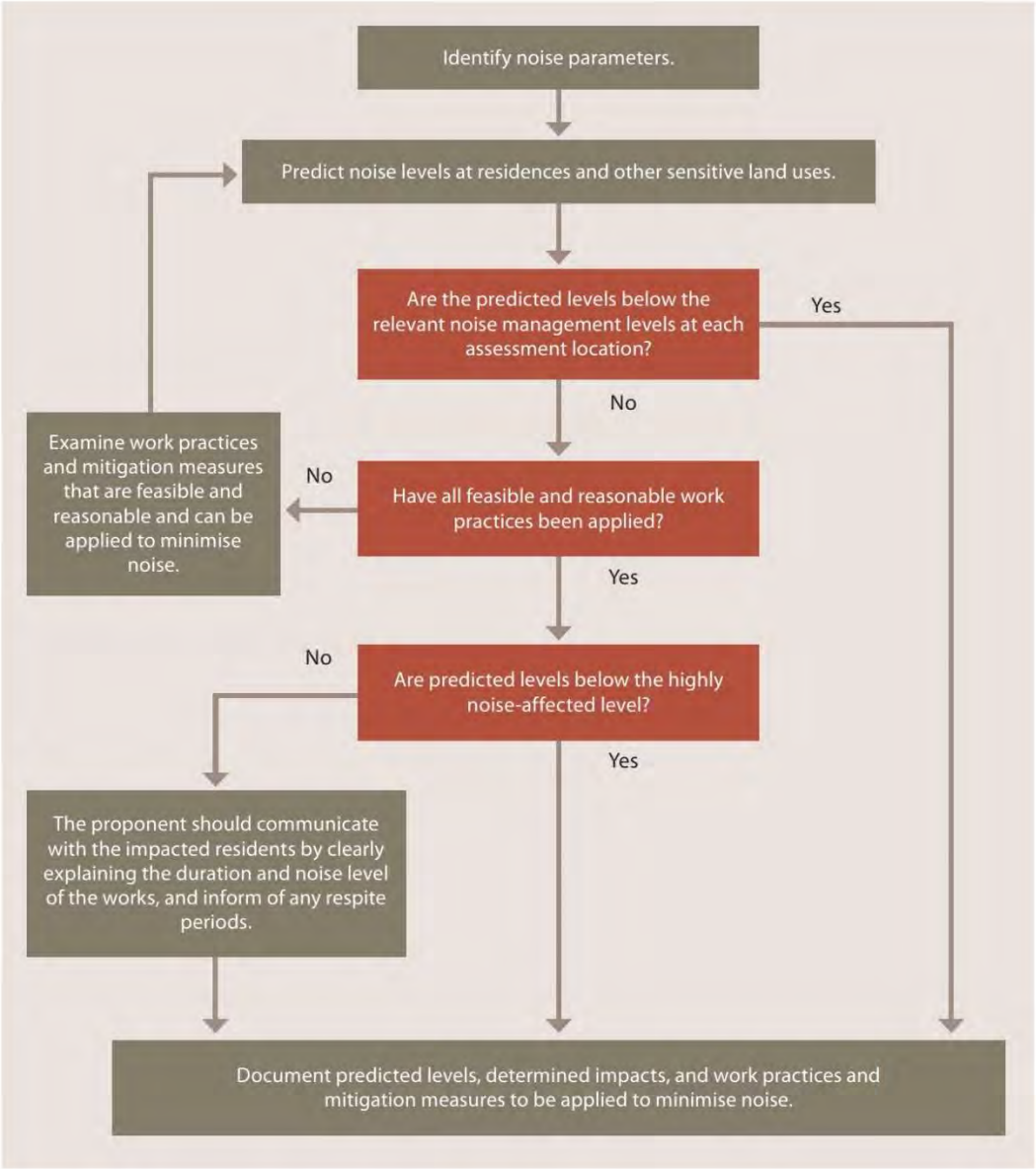
3.1 Interim Construction Noise Guideline

The ICNG sets out procedures to identify and address the impacts of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment. The ICNG provides two methodologies for the assessment of construction noise emissions:

- quantitative, which is suited to major construction projects with typical durations of more than three weeks; and
- qualitative, which is suited to short term infrastructure maintenance (< three weeks).

The qualitative assessment methodology is a more simplified approach that relies on noise management strategies. This study has adopted a quantitative assessment approach which is summarised in **Figure 2.** The quantitative approach includes identification of potentially affected receivers, derivation of the construction noise management levels, quantification of potential noise impact at receivers via predictive modelling and, provides management and mitigation recommendations.

Figure 2 Quantitative Assessment Processes for Assessing and Managing Construction Noise



Source: Department of Environment and Climate Change, 2009.

3.1.1 Standard Hours for Construction

Table 2 summaries the ICNG recommended standard hours for construction works.

Table 2 Recommended Standard Hours for Construction

Daytime	Construction Hours
Monday to Friday	7am to 6pm
Saturdays	8am to 1pm
Sundays or Public Holidays	No construction

These recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

Construction activities are anticipated to be undertaken during standard construction hours.

3.1.2 Out of Hours Construction

Works conducted outside of recommended standard hours are considered out of hours work (OOH). The ICNG suggests that any request to vary the hours of construction activities as identified above shall be:

- considered on a case by case basis or activity-specific basis;
- accompanied by details of the nature and need for activities to be undertaken during the varied construction hours;
- accompanied by written evidence that activities undertaken during the varied construction hours are strongly justified;
- appropriate consultation with potentially affected receivers and notification of the relevant regulatory authorities has occurred; and
- all practicable and reasonable mitigation measures will be put in place.

3.1.3 Construction Noise Management Levels

Section 4 of the ICNG (DECC, 2009) details the quantitative assessment method involving predicting noise levels and comparing them with the Noise Management Level (NML) and are important indicators of the potential level of construction noise impact. **Table 3** reproduces the ICNG Noise Management Level (NML) for residential receivers. The NML is determined by adding 10dB (standard hours) or 5dB (OOH) to the Rating Background Level (RBL) for each specific assessment period.

Table 3 Noise Management Levels

Time of Day	Management Level LAeq(15min)[1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) 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 work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB	A strong justification would typically be required for work 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 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction noise management levels for noise assessment purposes and is the median of the ABL's.

3.1.4 Construction Sleep Disturbance

Section 4.3 of the ICNG (DECC, 2009) states that a sleep disturbance assessment is required where construction activities are planned to occur for more than two consecutive nights. Given that construction activities are anticipated to occur during standard construction hours, sleep disturbance has not been considered in this assessment.

3.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing noise criteria for consents and licenses enabling the EPA to regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997.

The objectives of the NPI are to:

- provide noise criteria that is used to assess the change in both short term and long-term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified; and
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, considering the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels (criteria), above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTL, assessing impacts and the need for noise mitigation and management measures.

4. Consider residual noise impacts - that is, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.

5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.

6. Monitor and report environmental noise levels from the development.

3.2.1 Project Noise Trigger Levels (PNTL)

The policy sets out the procedure to determine the PNTLs relevant to an industrial development. The PNTL is the lower (ie, the more stringent) of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

3.2.2 Rating Background Level (RBL)

The Rating Background Level (RBL) is a determined parameter from noise monitoring and is used for assessment purposes. As per the NPI, the RBL is an overall single figure background level representing each assessment period (day, evening and night) over the noise monitoring period.

For low noise environments, such as rural environments, minimum assumed RBLs apply within the NPI and can be adopted in lieu of completing background noise measurements. This is considered the most conservative method for establishing noise criteria for a project. These result in minimum intrusiveness noise levels as follows:

- Minimum Day RBL = 35dBA;
- Minimum Evening RBL = 30dBA; and
- Minimum Night RBL = 30dBA.

Due to the rural nature of the locality, the PINLs for the Project have been determined based on the minimum RBL+5dBA.

3.2.3 Project Intrusiveness Noise Level (PINL)

The PINL ($LA_{eq(15min)}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. Hence, when assessing intrusiveness, background noise levels need to be measured.

3.2.4 Project Amenity Noise Level (PANL)

The PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended Amenity Noise Levels specified in Table 2.2 (of the NPI). The NPI defines two categories of Amenity Noise Levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area; and
- **Project Amenity Noise Level (PANL)** – is the recommended level for a receiver area, specifically focusing the project being assessed.

Additionally, Section 2.4 of the NPI states: "to ensure that industrial noise levels (existing plus new) remain within the recommended Amenity Noise Levels for an area, a PANL applies for each new source of industrial noise as follows":

PANL for new industrial developments = recommended **ANL** minus 5dBA.

The following exceptions apply when deriving the PANL:

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

Where relevant this assessment has considered influences of traffic with respect to ANLs (ie areas where existing traffic noise levels are 10dB greater than the recommended ANL).

The recommended Amenity Noise Levels as per Table 2.2 of the NPI are reproduced in **Table 4**.

Table 4 Amenity Noise Levels

Receiver Type	Noise Amenity Area	Time of day	Recommended Amenity Noise Level dB LAeq(period)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks.	See column 4	See column 4	5dB above the recommended Amenity Noise Level for a residence for the relevant noise amenity area and time of day
School Classroom	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)
Hospital ward			
- internal	All	Noisiest 1-hour	35
- external	All	Noisiest 1-hour	50
Place of worship - internal	All	When in use	40
Passive Recreation	All	When in use	50
Active Recreation	All	When in use	55
Commercial premises	All	When in use	65
Industrial	All	When in use	70

Notes: The recommended Amenity Noise Levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7 of the NPI.

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

3.2.5 Maximum Noise Assessment Trigger Levels

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

Where night-time noise levels from a development/premises at a residential location exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq(15min)}$ 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- L_{Amax} 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

3.3 Road Noise Policy

The road traffic noise criteria are provided in the Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011. The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in **Section 4.5**.

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4 Noise Assessment Criteria

Background noise monitoring has not been conducted for this project and hence, the minimum assumed Rating Background Levels (RBL) of 35dBA for the daytime period and 30dBA for the evening and night-time periods have been adopted in accordance with NPI methodology.

4.1 Construction Noise

The relevant NMLs for standard construction hours are presented in **Table 5**.

Table 5 Construction Noise Management Levels

Receiver Type	Assessment Period[1]	Adopted RBL dB LA_{90}	NML dB $LA_{eq(15min)}$
Urban Residential	Standard Hours	35	45 (RBL+10dBA)
Suburban Residential	Standard Hours	35	45 (RBL+10dBA)
Rural Residential	Standard Hours	35	45 (RBL+10dBA)
Educational	When in use	N/A	45 (internal) 55 (external)[2]
Hospital Wards	When in use	N/A	45 (internal) 55 (external)[2]
Place of Worship	When in use	N/A	45 (internal) 55 (external)[2]
Active Recreation Areas	When in use	N/A	65 (external)
Passive Recreation Areas	When in use	N/A	60 (external)
Industrial Premises	When in use	N/A	75 (external)
Community Centres	When in use	N/A	Refer to AS2107 for maximum internal levels and specific use
Commercial Premises	When in use	N/A	70 (external)

Note 1: See **Table 2** for Standard Recommended Hours for Construction.

Note 2: External level based on 10dB with windows open for adequate ventilation (ICNG).

4.2 Construction Vibration

Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: A Technical Guideline* (the guideline) provides guidance on determining effects of vibration on buildings occupants. The guideline does not address vibration induced damage to structures, blast induced vibration effects or structure borne noise effects.

The Construction Noise & Vibration Strategy (CNVS, V4.1 Transport for NSW, 2019) sets out safe working distances to achieve the human response criteria for vibration. The key vibration generating source proposed to be used is small pile driver used to drive the piles into the ground on which the PV mounting structures are mounted and vibratory roller for road construction. The CNVS sets a safe working distance of 50m for a hammer piling rig and 100m for a large vibratory roller to achieve the residential human response criteria for continuous vibration. Therefore, as the nearest non project related receivers to the project are greater than 100m from the project boundary, human exposure to vibration is anticipated to be minimal. Furthermore, where the human response criteria are satisfied, the structural or cosmetic criteria for sensitive receivers will be achieved. Therefore, vibration impacts are not considered to be a significant issue and have not been considered further in this assessment.

4.3 Operational Noise

4.3.1 Project Intrusiveness Noise Levels

The PINLs for the project are presented in **Table 6** and have been determined based on the RBLs +5dBA.

Table 6 Project Intrusiveness Noise Levels

Receiver	Period[1]	Adopted RBL dB LA90(period)	PINL dB LAeq(15min)
All Residential Receivers	Day	35	40
	Evening	30	35
	Night	30	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.3.2 Project Amenity Noise Levels

The PANL for residential receivers and other receiver types (ie non-residential) potentially affected by the project are presented in **Table 7.**

Table 7 Amenity Noise Levels and Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	Recommended ANL dB $LA_{eq(period)}$	ANL dB $LA_{eq(period)}$[2]	PANL dB $LA_{eq(15min)}$[3]
Residential	Rural	Day	50	50	53
		Evening	45	45	48
		Night	40	40	43
Residential	Suburban	Day	55	55	58
		Evening	45	45	48
		Night	40	40	43
Residential	Urban	Day	60	60	63
		Evening	50	50	53
		Night	45	45	48
Hotels Motels	Rural/Urban/ Suburban	Day	ANL +5dB	ANL +5dB	ANL +5dB
		Evening	ANL +5dB	ANL +5dB	ANL +5dB
		Night	ANL +5dB	ANL +5dB	ANL +5dB
Educational		When in use	35 (internal 1 hr)	30 (internal 1 hr)	33 (internal 1 hr) 43 (external 1 hr)[4]
Hospital Wards		When in use	35 (internal 1 hr) 50 (external 1 hr)	30 (internal 1 hr) 45 (external 1 hr)	33 (internal 1 hr) 48 (external 1 hr)
Place of worship		When in use	40 (internal)	35 (internal 1 hr)	38 (internal 1 hr) 48 (external 1 hr)[4]
Passive Recreation		When in use	50	50	53
Active Recreation		When in use	55	55	58
Commercial		When in use	65	65	68
Industrial		When in use	70	70	73
Industrial Interface		When in use	ANL +5dB	ANL +5dB	ANL +5dB

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.
Note 2: Project Amenity Noise Level equals the Amenity Noise Level as there is no other industry in the area.
Note 3: Includes a +3dB adjustment to the amenity period level to convert to a 15-minute assessment period as per Section 2.2 of the NPI.
Note 4: External level based on 10dB loss through partially open window.

4.3.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINLs or the PANLs. **Table 8** presents the derivation of the PNTLs in accordance with the methodologies outlined in the NPI. For this assessment the night-time PNTL of 35dB $L_{Aeq(15min)}$ is the limiting criteria for residential receivers.

Table 8 Project Noise Trigger Levels

Catchment	Assessment Period[1]	PINL dB $L_{Aeq(15min)}$	PANL dB $L_{Aeq(15min)}$	PNTL dB $L_{Aeq(15min)}$
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Industrial	When in use	--	68	68

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.4 Maximum Noise Assessment Trigger Levels

The maximum noise trigger levels shown in **Table 9** are based on night-time RBLs and trigger levels as per Section 2.5 of the NPI. The trigger levels will be applied to transient noise events that have the potential to cause sleep disturbance.

Table 9 Maximum Noise Trigger Level

Residential Receivers	
52dB L_{Amax} or RBL + 15dB	
Trigger	52
RBL 30+15dB	45
Highest	**52**

Note: Monday to Saturday; Night 10pm to 7am. On Sundays and Public Holidays Night 10pm to 8am.
Note: NPI identifies that maximum of the two values is to be adopted which is shown in bold font.

4.5 Road Traffic Noise

It is acknowledged that the functional classification of roads connecting to arterial roads such as major highways are 'Collector Roads' in accordance with the Roads and Maritime Noise Criteria Guideline (April 2015). However, the Road Noise Policy does not provide separate noise criteria for Collector Roads but applies the sub-arterial category to all roads that are not classified as local roads and hence, the 'sub arterial road' category has been adopted for collector roads.

The relevant road traffic noise criteria are provided in the RNP and are presented in **Table 10** for residential receivers.

Table 10 Road Traffic Noise Assessment Criteria

Road category	Type of project/development	Assessment Criteria – dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeways/arterial/ sub-arterial Roads	Existing residences affected by additional traffic on freeways/arterial/sub-arterial roads generated by land use developments	60dB LAeq(15hr)	55dB LAeq(9hr)
Local roads	Existing residences affected by additional traffic on local roads generated by land use developments	55dB LAeq(1hr)	50dB LAeq(1hr)
School Classrooms	Proposed road projects and traffic generating developments	40dB LAeq(1hr) (internal) when in use	N/A
Hospital Wards		35dB LAeq(1hr) (internal)	35dB LAeq(1hr) (internal)
Places of Worship		40dB LAeq(1hr) (internal)	40dB LAeq(1hr) (internal)
Open Space (active use)		60dB LAeq(1hr)	N/A
Open Space (passive use)		55dB LAeq(1hr)	N/A
Isolated residences in commercial or industrial zones		Refer to AS2107 for internal levels	
Mixed Use development		Each component to be considered separately	
Childcare Facilities		Sleeping rooms 35dB LAeq(1hr) (internal) Indoor play areas 40dB LAeq(1hr) (internal) Outdoor play areas 55dB LAeq(1hr) (external)	

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dBA, which is generally accepted as the threshold of perceptibility to a change in noise level.

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5 Modelling Methodology

A computer model using DGMR (iNoise, Version 2024) noise modelling software was used to quantify noise emissions from the project. iNoise is an intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. Where relevant, modifying factors in accordance with Fact Sheet C of the NPI have been applied to calculations.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation' including corrections for meteorological conditions using CONCAWE[1]. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

5.1 Construction Assessment Methodology

Construction activities are proposed to be progressive (trenching, piling and assembly) and will occur at several locations simultaneously. Noise emissions were modelled for the following four scenarios:

- earthworks for internal roads and compound construction including the stripping of topsoil and unsuitable soil and the placement and compaction of road base for internal roads;
- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels.

[1] Report no. 4/18, "the propagation of noise from petroleum and petrochemical complexes to neighbouring communities", Prepared by C.J. Manning, M.Sc., M.I.O.A. Acoustic Technology Limited (Ref.AT 931), CONCAWE, Den Haag May 1981

It is envisaged that all four construction scenarios have the potential to occur simultaneously at up to two (2) key locations across the site. Noise emission data and assumptions used in this assessment are summarised in **Table 11**. All significant noise generating construction activities will be limited to standard construction hours. Where low intensity construction activities are required to be undertaken outside standard construction hours, such as cabling, minor assembly, use of hand tools etc, they will be managed such that they are not audible at any residential receivers.

Table 11 Construction Equipment Sound Power Levels, Lw dBA (re 10^{-12} Watts)

Noise Source/Item	Utilisation %	Quantity	Lw/Item	Total Lw
Trenching & Earthworks				
Backhoe	80	1	104	103
Light vehicle	25	2	76	73
Total – Trenching & Earthworks				**103**
Piling				
Piling Rig (hydraulic)	80	1	113	112
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Total – Piling				**113**
Assembly				
Mobile Crane/HIAB	75	1	104	103
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Hand tools/Power tools	50	1	102	99
Welder	50	1	105	102
Total – Assembly				**109**
Transport (on site)				
Heavy vehicle	40	1	104	101
Tele-handler	50	1	106	103
Total – Transport				**105**

5.2 Operational Assessment Methodology

For this assessment, noise predictions were modelled for a typical worst-case operational scenario over a 15-minute assessment period based on the assumptions and Sound Power Levels in **Table 12.** Plant noise emission data used in modelling for this assessment were obtained from manufacturers data or the MAC database. Where relevant, modifying factors in accordance with Section 3.3 and Fact Sheet C of the NPI have been applied to calculations.

Table 12 Operational Equipment Sound Power Levels, Lw dBA (re 10^{-12} Watts)

Noise Source/Item	Activity	Quantity	Lw/Item	Total Lw
PV Panel Tracking Motor[1]	All tracking motors in operation 1 minute per 15-minute period	154	78	83
3.4MW Inverter[2]	Constant	2	91	94
5MVA Transformer[2]	Constant	2	80	83
BESS HVAC System[3]	Intermittent	2	88	91

Note 1: Tracking motor is situated underneath the PV panel, -5dB attenuation applied to account for shielding provided by the panel.

Note 2: Modifying factor penalty of +5dB added for low frequency and +5dB added for tonality.

Note 3: Modifying factor penalty of +5dB added for intermittent operation and +5dB added for low frequency.

5.2.1 Meteorological Analysis

Noise emissions can be influenced by prevailing weather conditions. Light stable winds (<3m/s) and temperature inversions have the potential to increase noise at a receiver.

Fact Sheet D of the NPI provides two options when considering meteorological effects:

- adopt the noise enhancing conditions for all assessment periods without an assessment of how often the conditions occur – a conservative approach that considers a source to receiver winds for all receivers and F class temperature inversions with wind speeds up to 2m/s at night; or
- determine the significance of noise enhancing conditions. This requires assessing the significance of temperature inversions (F and G Class stability categories) for the night-time period and the significance of light winds up to 3m/s for all assessment periods during stability categories other than E, F or G.

Standard meteorological conditions and noise-enhancing meteorological conditions as defined in Table D1of the NPI are reproduced in **Table 13**.

Table 13 Standard and Noise-Enhancing Meteorological Conditions

Meteorological Conditions	Meteorological Parameters
Standard Meteorological Conditions	Day/evening/night: stability categories A–D with wind speed up to 0.5m/s at 10m AGL.
Noise Enhancing Meteorological Conditions	Daytime/evening: stability categories A–D with light winds (up to 3 m/s at 10m AGL). Night-time: stability categories A–D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10 m AGL.

A detailed analysis of the significance of noise enhancing conditions has not been undertaken and hence, the (worst case) NPI noise enhancing meteorological conditions have been applied to the noise modelling assessment and are presented in **Table 14**.

Table 14 Modelled Meteorological Parameters

Assessment Condition[1]	Temperature	Wind Speed[2]/ Direction	Relative Humidity	Stability Class[2]
Day	20°C	3m/s all directions	50%	D
Evening	10°C	3m/s all directions	50%	D
Night	10°C	2m/s all directions	50%	F

Note 1: Day 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening 6pm to 10pm; Night - the remaining periods.

Note 2: Implemented using CONCAWE meteorological corrections.

5.3 Road Traffic Noise Assessment Methodology

Due to the low traffic volume generated by the project over a typical day during the construction phase, road traffic noise has been calculated using the Traffic Noise Model (TNM) by the United States Department of Transport, Federal Highway Administration Low Volume Calculation Tool at an offset distance of 15m for receivers along the transport route using the parameters presented in **Table 15.**

Table 15 Road Traffic Noise Modelling Parameters

Noise Source/Item	Lw dBA re 10^{-12} W	Movements/hr	Speed, km/h	Source Height, m[1]
Heavy Vehicle (rigid, semi-trailer or b-double)	104	8	50	1.5
Light Vehicle	96	20	50	0.75

Note 1: Height above ground level.

6 Noise Assessment Results

6.1 Construction Noise Assessment

Noise levels were predicted to all identified receivers at 1.5m above ground level based on typical construction activities during standard construction hours. **Table 16** summarises the predicted noise level range and maximum predicted noise level for each of the construction scenarios (trenching, piling and assembly) at identified receivers.

Table 16 Predicted Construction Noise Levels

Receiver	Description/Address	Predicted Noise Level Range dB $LA_{eq(15min)}$[1]	Highest Predicted Noise Level dB $LA_{eq(15min)}$	NML Standard Hours dB $LA_{eq(15min)}$	Compliance Achieved
R01	382 Borah Creek Road	24 - 35	35	45	✓
R02	395 Borah Creek Road	23 - 33	33	45	✓
R03	247 Borah Creek Road	20 - 32	32	45	✓
R04	531 Borah Creek Road	23 - 35	35	45	✓
R05	531 Borah Creek Road	32 - 45	45	45	✓
R06	619 Borah Creek Road	26 - 35	35	45	✓
R07	630 Borah Creek Road	32 - 42	42	45	✓
R08	683 Borah Creek Road	27 - 38	38	45	✓
R09	684 Borah Creek Road	25 - 35	35	45	✓
R10	734 Borah Creek Road	19 - 29	29	45	✓
R11	723 Borah Creek Road	19 - 29	29	45	✓
R12	94 Gamble Street	20 - 30	30	45	✓
AR01	Quirindi Motorcycle Club	38 – 50	50	65	✓

Note 1: Noise levels from construction activities vary due to their position across the project site with respect to surrounding receivers.

Noise levels are expected to satisfy the NMLs at all identified receivers standard construction hours.

6.2 Operational Noise Assessment

Noise levels from operations during the night-time period during noise enhancing meteorological conditions were predicted all identified receivers at 1.5m above ground level for all operational sources and are presented in **Table 17**. Noise levels are expected to satisfy the PNTLs at all receivers.

Table 17 Predicted Operational Noise Levels – Night-Time, Noise Enhancing Conditions

Receiver	Description/Address	Predicted Noise Level dB LAeq(15min)	PNTL dB LAeq(15min) Day/Eve/Night[1]	Compliance Achieved
R01	382 Borah Creek Road	<30	40/35/35	✓
R02	395 Borah Creek Road	<30	40/35/35	✓
R03	247 Borah Creek Road	<30	40/35/35	✓
R04	531 Borah Creek Road	<30	40/35/35	✓
R05	531 Borah Creek Road	<30	40/35/35	✓
R06	619 Borah Creek Road	<30	40/35/35	✓
R07	630 Borah Creek Road	<30	40/35/35	✓
R08	683 Borah Creek Road	<30	40/35/35	✓
R09	684 Borah Creek Road	<30	40/35/35	✓
R10	734 Borah Creek Road	<30	40/35/35	✓
R11	723 Borah Creek Road	<30	40/35/35	✓
R12	94 Gamble Street	<30	40/35/35	✓
AR01	Quirindi Motorcycle Club	<30	40/35/35	✓

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

6.3 Maximum Noise Level Assessment

A detailed maximum noise level assessment is not required as predicted noise levels for night-time operations do not exceed the maximum noise trigger levels of 40dB LAeq(15min) and there are no operational noise sources that generate significant maximum noise events.

6.4 Road Traffic Noise Assessment

During construction, traffic generated by the project include employee/subcontractor and delivery vehicles. The traffic volume over a typical day for standard construction hours is expected to be up to a maximum of four heavy vehicles (semi-trailers or B-doubles) per hour and up to 40 light vehicles for worker transport per day.

The transport route for all vehicles to the project site from Quirindi would be via Borah Creek Road and Porters Lane to the site access road. Therefore, it has been assumed that the closest residential receivers along the transport route are 15m from the road to represent a potential worst case assessment scenario.

Predicted noise levels from project related construction traffic has been calculated using the methodology described in Section 5.3 and the parameters presented in Table 15. The results presented in Table 18 show the calculated noise levels as $LA_{eq(1hr)}$ for local roads and $LA_{eq(15hr)}$ for arterial/sub arterial roads to align with RNP categories and assessment periods.

Table 18 Predicted Construction Road Traffic Noise Levels

Road Type/Name	Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Compliance Achieved
Arterial, Sub Arterial and Collector Roads Borah Creek Road	15m	45dB LAeq(15hr)	60dB LAeq(15hr)	✓
Local Roads Porters Lane	15m	48dB LAeq(1hr)	55dB LAeq(1hr)	✓

Results demonstrate that project construction traffic noise levels would comply with the relevant RNP criteria.

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7 Discussion and Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Assessment for a proposed Solar Farm with Battery Energy Storage System near Quirindi, NSW.

The results of the Noise Assessment demonstrate that noise emissions from the project would satisfy construction NMLs at all receiver locations.

The results of the Noise Assessment demonstrate that emissions from the project would satisfy the operational PNTLs at all identified receivers.

Furthermore, sleep disturbance is not anticipated, as there are no operational noise sources that generate significant maximum noise events and noise emissions from the project are predicted to satisfy the EPA maximum noise level criteria.

Road noise emissions associated with the project are anticipated to satisfy the relevant RNP criteria at all receivers along the proposed transportation route.

A qualitative assessment of potential vibration impacts has been completed. Due to the nature of the works proposed and distances to potential vibration sensitive receivers, vibration impacts from the project would be negligible.

Based on the Noise Assessment results, the project satisfies the relevant requirements of the Interim Construction Noise Guideline, Noise Policy for Industry and the Road Noise Policy and supports the Development Application.

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Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in **Table A1**.

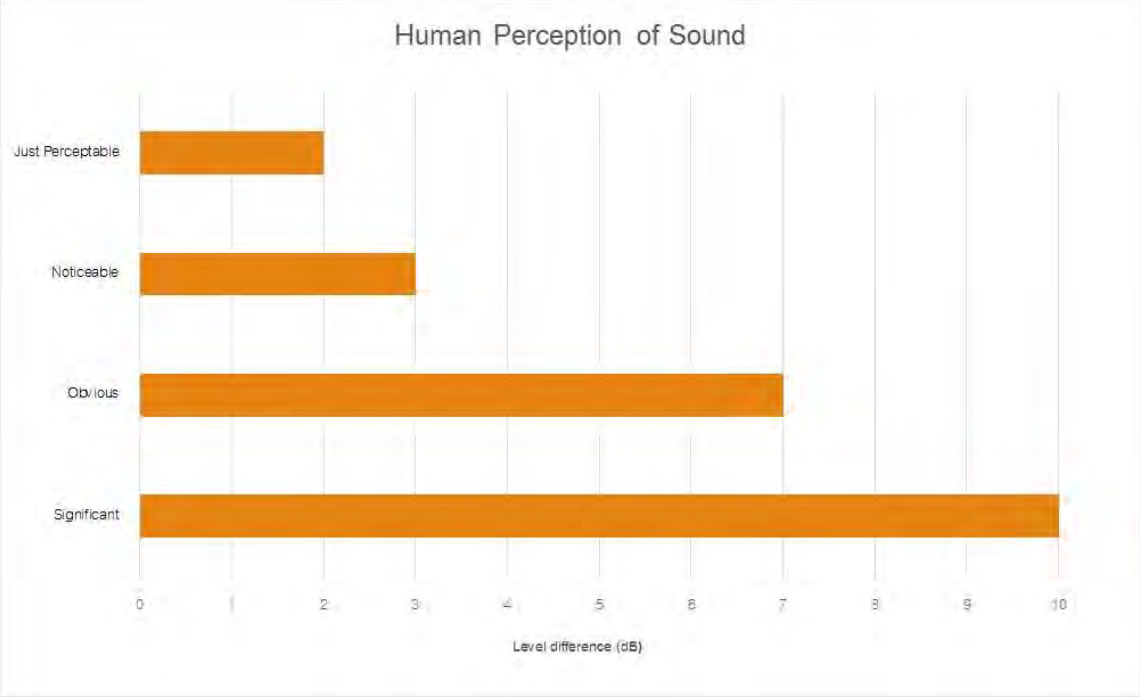
Table A1 Glossary of Acoustical Terms

Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The total noise associated with a given environment. Typically, a composite of sounds from all sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to sound.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is usually represented by the LA90 descriptor
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Z-weighted or decibels Linear (unweighted).
Extraneous Noise	Sound resulting from activities that are not typical of the area.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A sound level which is exceeded 10% of the time.
LA90	Commonly referred to as the background noise, this is the level exceeded 90% of the time.
LAeq	Represents the average noise energy or equivalent sound pressure level over a given period.
LAmax	The maximum sound pressure level received at the microphone during a measuring interval.
Masking	The phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.
RBL	The Rating Background Level (RBL) as defined in the NPI, is an overall single figure representing the background level for each assessment period over the whole monitoring period. The RBL, as defined is the median of ABL values over the whole monitoring period.
Sound power level (Lw or SWL)	This is a measure of the total power radiated by a source in the form of sound and is given by 10.log10 (W/Wo). Where W is the sound power in watts to the reference level of 10^{-12} watts.
Sound pressure level (Lp or SPL)	the level of sound pressure; as measured at a distance by a standard sound level meter. This differs from Lw in that it is the sound level at a receiver position as opposed to the sound 'intensity' of the source.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Pressure Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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