Noise Assessment

Petersons Solar Farm
Armidale, NSW.

Prepared for: ITP Development Pty Ltd
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MAC180781-06RP1

Muller Acoustic Consulting

Document Information

NOISE ASSESSMENT

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by ITP Development Pty Ltd (ITP) to complete a Noise Assessment (NA) for the proposed Petersons Solar Farm near Armidale, 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 Statement of Environmental Effects (SEE) to be submitted to Armidale District 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;
- establish existing noise levels to 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 NMLs and operational criteria;
- assess the potential noise impacts associated with construction and operational aspects of the project; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where NMLs or operational criteria may be exceeded.

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

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2 Project Description

2.1 Background

ITP propose to construct and operate a 5 Megawatt (MW) solar farm using photovoltaic (PV) technology at 347 Dangarsleigh Road, Armidale, NSW. The site is on the Dangarsleigh Road approximately 4km south east of Armidale, NSW.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north facing PV modules (approximately 2m x 1m) on mounting structures up to approximately 2.5m in height. An estimated 16,000 PV panels will be installed using a single axis tracking system, tilted +/- 60° along the north-south axis. The PV mounting structure would comprise steel posts driven up to approximately 1.5m below ground using a small pile driver. Additional support structures would be attached to the piles, which would then support the PV panels.

Earthworks will primarily involve trenching which is required for cabling of each PV array/module to inverters and a substation. 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. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

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

All vehicles would access the project via the Dangarsleigh Road during construction and operational phases.

During construction, traffic generated by the project would include employee and delivery vehicles. During the peak construction period, the daily traffic volume is expected to be up to four heavy vehicles (semi-trailers or b-doubles) per hour and 20 light commercial vehicles or equivalent mini buses for worker transport during the morning and afternoon peaks.

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels installed in rows running north to south. Each row of PV modules will rotate to track the sun across the sky from east to west each day. There is approximately 6m spacing between each row. The hub height of each tracker is 1.5m with the peak of the modules reaching a height of 2.5m when the array is fully tilted.

Electrical cabling would be attached beneath the modules and would connect the individual PV modules to each other. Inverters will be located centrally to groups of PV panels and connected to each other by underground cables. The PV modules will be on a single axis tracker system which will follow the sun and move in an east to west direction.

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 substation. Key noise emissions from the operation of the project are associated with the inverter and transformer(s). 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 Potentially Sensitive Receivers

Using aerial photography, geospatial information and other project 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 address and coordinates. These are reproduced graphically in **Figure 1.**

Table 1 Noise Sensitive Receivers

ID	Description/Address	Coordinates (MGA 56)	
		Easting	Northing
R01	130 Roseneath Lane	373359	6620071
R02	80 Roseneath Lane	372827	6620130
R02A	130 Roseneath Lane	372754	6620156
R03	40 Roseneath Lane	372562	6620227
R04	36 Roseneath Lane	372422	6620245
R05	18 Roseneath Lane	372322	6620268
R05A	18 Roseneath Lane	372279	6620266
R06	21 Roseneath Lane	372260	6620328
R06A	21 Roseneath Lane	372272	6620349
R07	23-27 Roseneath Lane	372424	6620426
R08	55-57 Dangarsleigh Road	372262	6620464
R09	43-53 Dangarsleigh Road	372318	6620626
R10	48-56 Dangarsleigh Road	371958	6620673
R11	58-62 Dangarsleigh Road	371986	6620547
R12	64-74 Dangarsleigh Road	372019	6620285
R13	2 Old Gostwyck Road	371953	6620119
R14	11 Old Gostwyck Road	371947	6620018
R15	22 Springhill Lane	371715	6620521
R16	14 Springhill Lane	371696	6620453
R17	40 Sutherland Avenue	371541	6620286
R18	19 Sutherland Avenue	371609	6620082
R19	17 Sutherland Avenue	371734	6620103
R20	11 Sutherland Avenue	371743	6620061
R21	56 Old Gostwyck Road	371632	6619881
R22	205 Dangarsleigh Road	372083	6619911
R23	240 Dangarsleigh Road	372121	6619643
R24	25 Simmons Road	372563	6619177
R25	28 Simmons Road	372256	6619171
R26	276 Dangarsleigh Road	372117	6619232
R27	68 Simmons Road	372103	6619005
R28	46 Simmons Road	372375	6619014

Table 1 Noise Sensitive Receivers			
ID	Description/Address	Coordinates (MGA 56)	
		Easting	Northing
R29	2 Durham Road	372543	6618989
R30	1 Durham Road	372589	6618967
R31	3 Durham Road	372636	6618939
R32	4 Durham Road	372519	6618943
R33	18 Durham Road	372504	6618739
R34	25 Durham Road	372642	6618697
R35	13 Red Hill Way	372762	6618688
R36	347 Dangarsleigh Road	372837	6618734
R37	24 Durham Road	372534	6618652
R38	30 Durham Road	372547	6618598
R39	29 Durham Road	372614	6618560
R40	88 Simmons Road	372366	6618541
R41	87 Old Gostwyck Road	371629	6619379
R42	71 Old Gostwyck Road	371657	6619471
R43	69 Old Gostwyck Road	371713	6619604
R44	345 Dangarsleigh Road (Petersons Winery & Guesthouse)	373629	6618980
R45	85 Lucas Lane	374221	6619148
R46	55 Lucas Lane	374473	6619041
R47	39 Lucas Lane	374622	6619246
R48	8 Lucas Lane	374565	6619625
R49	264 Long Swamp Road	374345	6619834
R50	267 Long Swamp Road	374417	6619924
R51	15 Gainsborough Lane	373177	6618231
R52	29 Gainsborough Lane	373273	6618237
R53	31 Gainsborough Lane	373391	6618221
I1	Industrial Area	373305	6620514

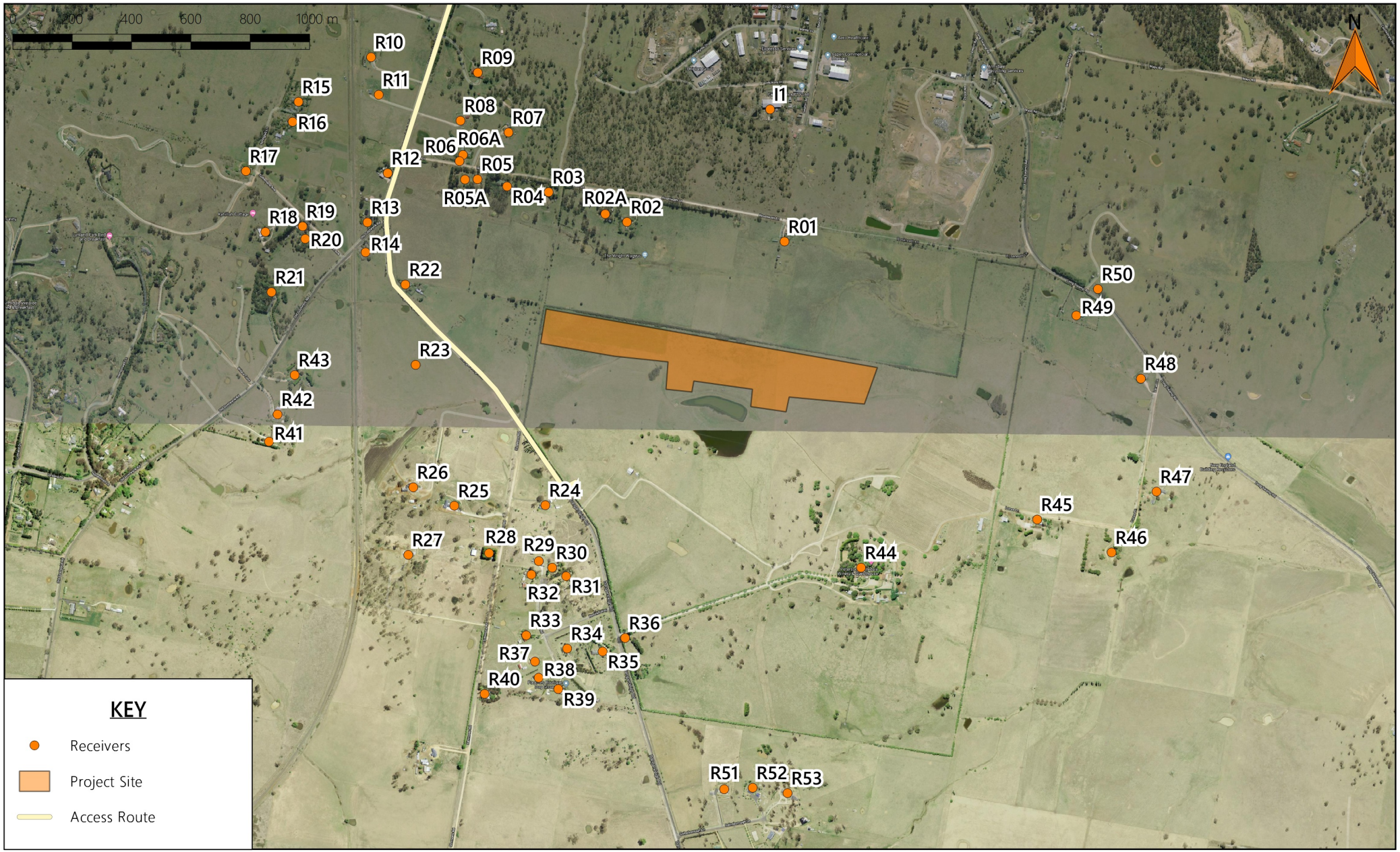

FIGURE 1

PROJECT LAYOUT

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3 Noise Policy and Guidelines

This Noise Assessment has been conducted in accordance with the following key policy and guidelines:

- NSW Department of Environment and Climate Change, NSW Interim Construction Noise Guideline (ICNG), 2009;
- Environment Protection Authority's (EPA's), Noise Policy for Industry (NPI), 2017; and
- NSW Department of Environment, Climate Change and Water (DECCW), NSW Road Noise Policy (RNP), 2011.

The assessment has also considered and applied the following additional policy, guidelines and standards where relevant:

- Australian Standard AS 2436–2010 (R2016) (AS 2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance sites;
- Australian Standard AS 1055:2018 – Description and Measurement of Environmental Noise;
- Australian Standard AS /NZS IEC 61672.1–2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring; and
- Australian Standard AS IEC 60942-2004 (AS 60942) – Electroacoustics – Sound Calibrators.

3.1 Interim Construction Noise Guideline

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by the EPA under the POEO Act (1997), include construction, maintenance and renewal activities carried out by a public authority, such as road upgrades as described in Schedule 1 of the POEO Act.

The ICNG sets out procedures to identify and address the impact 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; or
- Qualitative, which is suited to short term infrastructure maintenance (for projects with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest relevant receivers. The qualitative assessment methodology is a more simplified approach that relies more on noise management strategies. This study has adopted a quantitative assessment approach.

The quantitative approach includes identification of potentially affected receivers, description of activities involved in the project, derivation of the construction noise management levels, quantification of potential noise impact at receivers and, provides management and mitigation recommendations. **Table 2** summarises the ICNG recommended standard hours for construction.

Table 2 Recommended Standard Hours for Construction

Period	Preferred Construction Hours
Day (Standard construction hours)	Monday to Friday - 7am to 6pm Saturdays - 8am to 1pm Sundays or Public Holidays - No construction

The 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. Work conducted outside of standard hours are considered out of hours work (OOH). OOH periods are divided into two categories representing evening and night periods and cover the hours listed below:

Period 1 (evening/low risk period): Monday to Friday – 6pm to 10pm, Saturdays – 1pm to 6pm, Sundays – 8am to 6pm.

Period 2 (night/medium to high risk period): Monday to Friday – 10pm to 7am, Saturdays/Sundays – 6pm to 7am (8am on Sunday mornings).

There are no out of hours work proposed for this project.

3.1.1 Construction Noise Management Levels

Section 4 of the ICNG 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** provides the ICNG recommended $LA_{eq(15min)}$ NMLs and how they are to be applied.

Table 3 Noise Management Levels

Time of Day	Management Level $LA_{eq(15min)}$[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 $LA_{eq(15min)}$ 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.
Commercial	70dBA	Offices, retail outlets
Hospital	45dBA (internal) 55dBA (external)	Assuming 10dB loss through open window

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.

3.1.2 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 operational noise criteria for development consents and/or licenses where the EPA 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 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 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 during operation, including:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels, 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 PNTLs, assessing impacts and the need for noise mitigation and management measures.

4. Consider residual noise impacts, 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

The policy sets out the procedure to determine the PNTLs for an industrial development. The PNTL is the lower (ie, the more stringent) value 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 Project Intrusiveness Noise Level

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. When assessing intrusiveness, background noise levels needs to be measured, from which RBLs are determined.

3.2.3 Project Amenity Noise Level

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) and are reproduced in **Table 4**. 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.

- **Project Amenity Noise Levels (PANL)** – is the recommended levels for a receiver area, specifically focusing the project being assessed.

Notwithstanding, where the PANL is applicable and can be satisfied, the assessment of cumulative industrial noise is not required.

Table 4 Amenity Criteria			
Receiver Type	Noise Amenity Area	Time of day	Recommended amenity noise level dB L_{Aeq}
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	5dBA above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom – internal	All	Noisiest 1-hour period when in use	35
Hospital ward - internal - external	All	 Noisiest 1 hour Noisiest 1 hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5dBA to recommended noise amenity area

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.

Time of day is defined as follows: (These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

- 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.

In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40dB LAeq(1hr).

3.2.4 Maximum Noise Level Assessment

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:

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

a detailed maximum noise level event assessment should be undertaken.

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.

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4 Assessment Criteria

Background noise monitoring has not been conducted for this project and hence, the minimum applicable 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 Management Levels

Noise Management Levels (NMLs) for construction activities at all residential receivers are 45dB $LA_{eq(15min)}$ (RBL +10dB). Construction activities are planned for standard hours, however the relevant NML standard construction hours and out of hours periods are summarised in **Table 5**.

Table 5 Construction Noise Management Levels

Location	Assessment Period[1]	RBL, dBA	NML dB $LA_{eq(15min)}$
All Residential Receivers	Day (Standard Hours)	35	45 (RBL+10dBA)
	Evening (OOH Period 1)	30	35 (RBL+5dBA)
	Night (OOH Period 2)	30	35 (RBL+5dBA)
Commercial	When in Use	N/A	70
Hospital	When in Use	N/A	55
Industrial	When in Use	N/A	70

Note 1: See table 2 for Recommended Standard Hours for Construction.

4.2 Operational Noise Criteria

4.2.1 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 LA_{90}	PINL dB $LA_{eq(15min)}$
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.

4.2.2 Project Amenity Noise Levels

The PANLs for receivers potentially affected by the project are presented in **Table 7.**

Table 7 Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	Recommended ANL dB $LA_{eq(period)}$[2]	PANL dB $LA_{eq(period)}$[3]	PANL dB $LA_{eq(15min)}$[4]
Residential	Rural	Day	50	50	53
		Evening	45	45	48
		Night	40	40	43
Industrial		When In Use	70	70	73

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: Recommended amenity noise levels as per Table 2.2 of the NPI.

Note 3: Project Amenity Noise Level equals the amenity noise level as there is no other industry in the area.

Note 4: Includes a +3dB adjustment to the amenity period level to convert to a fifteen-minute assessment period as per Section 2.2 of the NPI.

4.2.3 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 $LA_{eq(15min)}$ is the limiting criteria for residential receivers.

Table 8 Project Noise Trigger Levels

Catchment	Assessment Period[1]	PINL dB $LA_{eq(15min)}$	PANL dB $LA_{eq(15min)}$	PNTL dB $LA_{eq(15min)}$
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Industrial	When In Use	N/A	73	73

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.

4.2.4 Maximum Noise Level Screening Criterion

The maximum noise level screening criterion shown in **Table 9** is based on night time RBLs and trigger values as per Section 2.5 of the NPI.

Table 9 Maximum Noise Assessment Trigger Levels

Residential Receivers			
$L_{Aeq(15min)}$		L_{Amax}	
40dB $L_{Aeq(15min)}$ or RBL + 5dB		52dB L_{Amax} or RBL + 15dB	
Trigger	40	Trigger	52
RBL +5dB	35	RBL +15dB	45
Highest	**40**	**Highest**	**52**

Note: As per Section 2.5 of the NPI, the highest of the two criteria are adopted as the screening criteria.

4.3 Road Traffic Noise Criteria

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 for Residential Land Uses

Road category	Road Name	Type of Project/Development	Assessment Criteria - dBA	
			Day (7am to 10pm)	Night (10pm to 7am)
Local Roads	Dangarsleigh Road	Existing residences affected by additional traffic on existing local roads generated by land use developments	55dBA LAeq(1hr) external	50dBA LAeq(1hr) external

Note: For road noise assessments, the day period is from 7am to 10pm (ie there is no evening assessment period as there is with operational noise). Night is from 10pm to 7am.

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 2dB, 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 was developed to quantify project noise emissions to neighbouring receivers for typical construction activities and operations. DGMR's iNoise (Version 2019.1) noise modelling software was used to assess potential noise impacts associated with the project. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. Additionally, the model uses relevant noise source data, ground type, shielding such as barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. Plant and equipment were modelled at various locations and heights, representative of realistic construction and operational conditions for assessed scenarios.

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'.

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

It is envisaged that all four construction scenarios have the potential to occur simultaneously at up to two 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} W				
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

5.2.1 Operational Noise Modelling Scenarios

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 D of the NPI have been applied to calculations.

Table 12 Operational Equipment Sound Power Levels, Lw dBA re 10^{-12} W				
Noise Source/Item	Activity	Quantity	Lw/Item	Total Lw
PV Panel Tracking Motor[1, 2]	All tracking motors in operation 1 minute per 15-minute period	300-400	78	87
2.5MW Inverter[2]	Constant	4	81	97
5MVA Transformer[2]	Constant	2	77	90

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.

5.2.2 Meteorological Analysis

Noise emissions from industry can be significantly 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.

Given that a detailed analysis of the significance of noise enhancing conditions has not been undertaken the meteorological conditions adopted in the noise modelling assessment are summarised in **Table 13**.

Table 13 Modelled Site Specific Meteorological Parameters				
Assessment Condition[1]	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
Day - Calm	20°C	3m/s all directions	50%	D
Evening - Calm	10°C	3m/s all directions	50%	D
Night - Calm	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.

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6 Results

6.1 Construction Noise Results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities during noise enhancing meteorological conditions. Table 14 summarises the maximum predicted noise level from each of the construction scenarios (trenching, piling and assembly) at identified residential receivers.

Table 14 Predicted Construction Noise Levels

Receiver ID	Description/Address	Predicted Noise Level Range dB $L_{Aeq(15min)}$[1]	Highest Predicted Noise Level dB $L_{Aeq(15min)}$	NML Standard Hours dB $L_{Aeq(15min)}$	Compliance Achieved
R01	130 Roseneath Lane	34-51	**51**	45	No
R02	80 Roseneath Lane	34-52	**52**	45	No
R02A	130 Roseneath Lane	33-51	**51**	45	No
R03	40 Roseneath Lane	31-49	**49**	45	No
R04	36 Roseneath Lane	29-48	**48**	45	No
R05	18 Roseneath Lane	28-46	**46**	45	No
R05A	18 Roseneath Lane	28-46	**46**	45	No
R06	21 Roseneath Lane	27-45	45	45	Yes
R06A	21 Roseneath Lane	27-45	45	45	Yes
R07	23-27 Roseneath Lane	27-45	45	45	Yes
R08	55-57 Dangarsleigh Road	22-40	40	45	Yes
R09	43-53 Dangarsleigh Road	21-39	39	45	Yes
R10	48-56 Dangarsleigh Road	18-36	36	45	Yes
R11	58-62 Dangarsleigh Road	19-37	37	45	Yes
R12	64-74 Dangarsleigh Road	21-40	40	45	Yes
R13	2 Old Gostwyck Road	25-43	43	45	Yes
R14	11 Old Gostwyck Road	26-44	44	45	Yes
R15	22 Springhill Lane	21-38	38	45	Yes
R16	14 Springhill Lane	22-39	39	45	Yes
R17	40 Sutherland Avenue	21-38	38	45	Yes
R18	19 Sutherland Avenue	22-40	40	45	Yes
R19	17 Sutherland Avenue	23-41	41	45	Yes
R20	11 Sutherland Avenue	23-41	41	45	Yes
R21	56 Old Gostwyck Road	23-40	40	45	Yes
R22	205 Dangarsleigh Road	28-47	**47**	45	No
R23	240 Dangarsleigh Road	28-47	**47**	45	No

Table 14 Predicted Construction Noise Levels					
Receiver ID	Description/Address	Predicted Noise Level Range dB $L_{Aeq(15min)}$[1]	Highest Predicted Noise Level dB $L_{Aeq(15min)}$	NML Standard Hours dB $L_{Aeq(15min)}$	Compliance Achieved
R24	25 Simmons Road	29-47	**47**	45	No
R25	28 Simmons Road	27-45	45	45	Yes
R26	276 Dangarsleigh Road	26-44	44	45	Yes
R27	68 Simmons Road	21-39	39	45	Yes
R28	46 Simmons Road	26-44	44	45	Yes
R29	2 Durham Road	24-43	43	45	Yes
R30	1 Durham Road	24-42	42	45	Yes
R31	3 Durham Road	24-42	42	45	Yes
R32	4 Durham Road	23-41	41	45	Yes
R33	18 Durham Road	21-39	39	45	Yes
R34	25 Durham Road	22-40	40	45	Yes
R35	13 Red Hill Way	22-40	40	45	Yes
R36	347 Dangarsleigh Road	22-40	40	45	Yes
R37	24 Durham Road	21-39	39	45	Yes
R38	30 Durham Road	21-39	39	45	Yes
R39	29 Durham Road	21-39	39	45	Yes
R40	88 Simmons Road	19-37	37	45	Yes
R41	87 Old Gostwyck Road	19-37	37	45	Yes
R42	71 Old Gostwyck Road	23-40	40	45	Yes
R43	69 Old Gostwyck Road	24-41	41	45	Yes
R44	345 Dangarsleigh Road	26-44	44	45	Yes
R45	85 Lucas Lane	22-40	40	45	Yes
R46	55 Lucas Lane	18-36	36	45	Yes
R47	39 Lucas Lane	18-36	36	45	Yes
R48	8 Lucas Lane	22-40	40	45	Yes
R49	264 Long Swamp Road	25-43	43	45	Yes
R50	267 Long Swamp Road	24-41	41	45	Yes
R51	15 Gainsborough Lane	18-36	36	45	Yes
R52	29 Gainsborough Lane	18-36	36	45	Yes
R53	31 Gainsborough Lane	18-35	35	45	Yes
I1	Industrial Area	28-45	45	73	Yes

Note 1: Noise levels from construction activities vary due to their location across the project site.

Noise levels at ten receivers are expected to exceed the NMLs when works are nearest to those locations. The exceedance would be temporary, and of short duration and is due to piling activities.

6.2 Operational Noise Results

Noise levels were predicted at each assessed receptor assuming receiver heights of 1.5m above ground level during worst case noise enhancing meteorological conditions. Table 15 summarises the predicted operational noise levels which are demonstrated to comply with the PNTLs at all residential receivers.

Table 15 Predicted Operational Noise Levels

Receiver ID	Description/Address	Predicted Noise Level dB $LA_{eq(15min)}$	Limiting Night PNTL dB $LA_{eq(15min)}$	Compliance Achieved
R01	130 Roseneath Lane	<30	35	Yes
R02	80 Roseneath Lane	<30	35	Yes
R02A	130 Roseneath Lane	<30	35	Yes
R03	40 Roseneath Lane	<30	35	Yes
R04	36 Roseneath Lane	<30	35	Yes
R05	18 Roseneath Lane	<30	35	Yes
R05A	18 Roseneath Lane	<30	35	Yes
R06	21 Roseneath Lane	<30	35	Yes
R06A	21 Roseneath Lane	<30	35	Yes
R07	23-27 Roseneath Lane	<30	35	Yes
R08	55-57 Dangarsleigh Road	<30	35	Yes
R09	43-53 Dangarsleigh Road	<30	35	Yes
R10	48-56 Dangarsleigh Road	<30	35	Yes
R11	58-62 Dangarsleigh Road	<30	35	Yes
R12	64-74 Dangarsleigh Road	<30	35	Yes
R13	2 Old Gostwyck Road	<30	35	Yes
R14	11 Old Gostwyck Road	<30	35	Yes
R15	22 Springhill Lane	<30	35	Yes
R16	14 Springhill Lane	<30	35	Yes
R17	40 Sutherland Avenue	<30	35	Yes
R18	19 Sutherland Avenue	<30	35	Yes
R19	17 Sutherland Avenue	<30	35	Yes
R20	11 Sutherland Avenue	<30	35	Yes
R21	56 Old Gostwyck Road	<30	35	Yes
R22	205 Dangarsleigh Road	<30	35	Yes
R23	240 Dangarsleigh Road	<30	35	Yes
R24	25 Simmons Road	<30	35	Yes
R25	28 Simmons Road	<30	35	Yes

Table 15 Predicted Operational Noise Levels				
Receiver ID	Description/Address	Predicted Noise Level dB $LA_{eq(15min)}$	Limiting Night PNTL dB $LA_{eq(15min)}$	Compliance Achieved
R26	276 Dangarsleigh Road	<30	35	Yes
R27	68 Simmons Road	<30	35	Yes
R28	46 Simmons Road	<30	35	Yes
R29	2 Durham Road	<30	35	Yes
R30	1 Durham Road	<30	35	Yes
R31	3 Durham Road	<30	35	Yes
R32	4 Durham Road	<30	35	Yes
R33	18 Durham Road	<30	35	Yes
R34	25 Durham Road	<30	35	Yes
R35	13 Red Hill Way	<30	35	Yes
R36	347 Dangarsleigh Road	<30	35	Yes
R37	24 Durham Road	<30	35	Yes
R38	30 Durham Road	<30	35	Yes
R39	29 Durham Road	<30	35	Yes
R40	88 Simmons Road	<30	35	Yes
R41	87 Old Gostwyck Road	<30	35	Yes
R42	71 Old Gostwyck Road	<30	35	Yes
R43	69 Old Gostwyck Road	<30	35	Yes
R44	345 Dangarsleigh Road	<30	35	Yes
R45	85 Lucas Lane	<30	35	Yes
R46	55 Lucas Lane	<30	35	Yes
R47	39 Lucas Lane	<30	35	Yes
R48	8 Lucas Lane	<30	35	Yes
R49	264 Long Swamp Road	<30	35	Yes
R50	267 Long Swamp Road	<30	35	Yes
R51	15 Gainsborough Lane	<30	35	Yes
R52	29 Gainsborough Lane	<30	35	Yes
R53	31 Gainsborough Lane	<30	35	Yes
I1	Industrial Area	<30	73	Yes

6.3 Maximum Noise Level Assessment - Operations

A detailed maximum noise level assessment is not required as predicted noise levels for night time operations do not exceed the maximum noise level screening criterion of 40dB $LA_{eq(15min)}$ and/or 52dB LA_{max}.

6.4 Road Traffic Noise Assessment

Dangarsleigh Road would be the major transport route for all vehicles to the access the project site. 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 four heavy vehicles (semi-trailers or B-doubles) per hour and 20 light commercial vehicles or equivalent mini buses for worker transport during the morning and afternoon peak hour periods.

Predicted $LA_{eq(1hr)}$ noise levels from project related construction traffic at the closest receiver (64 Dangarsleigh Road) between the project site and the township (20m from the road) has been completed using the United States (US) Environment Protection Agency's road traffic calculation method is presented in **Table 16**.

Table 16 Predicted Construction Road Traffic Noise Levels

Road Name	Nearest Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Compliance Achieved
Dangarsleigh Road	20m	53dB $LA_{eq(1hr)}$	55dB $LA_{eq(1hr)}$	Yes

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

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7 Recommendations

7.1 Construction Noise Recommendations

It is noted that construction noise emissions are expected to exceed the relevant NMLs depending on proximity of activities to receivers. Recommendations for consideration during construction activities to reduce emissions to the surrounding community for this project may include:

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;
- where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (eg unloading and laydown areas);
- operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations;
- selection of the quietest suitable machinery available for each activity;
- avoidance of noisy plant/machinery working simultaneously where practicable;
- minimise impact noise wherever possible;
- utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm;
- provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities;
- signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site; and
- utilise project related community consultation forums to notify residences within close proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

7.2 Operational Noise Recommendations

Operational noise predictions identify that relevant noise criteria would be satisfied at all receivers. Notwithstanding, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project it is recommended that a one-off noise validation monitoring assessment be completed to quantify emissions from site and to confirm emissions meet relevant criteria.

8 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by ITP Development Pty Ltd (ITP) to complete a Noise Assessment (NA) for the proposed Petersons Solar Farm near Armidale, NSW. The assessment has quantified potential noise emissions associated with the construction and operation of the project.

The results of the NA demonstrate that construction noise levels have potential to exceed relevant construction NMLs at ten receiver locations. Recommendations have been provided to minimise the potential noise impacts from construction, albeit of a temporary nature during the daytime over a three month construction period.

Operational noise levels satisfy the NPI PNTLs for assessed receivers. However, recommendations to ensure noise levels are verified have been provided in this report.

Additionally, the NA demonstrates that the road noise criteria as specified in the RNP will be satisfied at all receivers on the proposed transport route.

Based on the NA results, there are no noise related issues which would prevent the approval of the project. The results of the assessment shows compliance with the relevant operational and road noise criteria. Accordingly, no additional ameliorative measures will be required.

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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 Terms

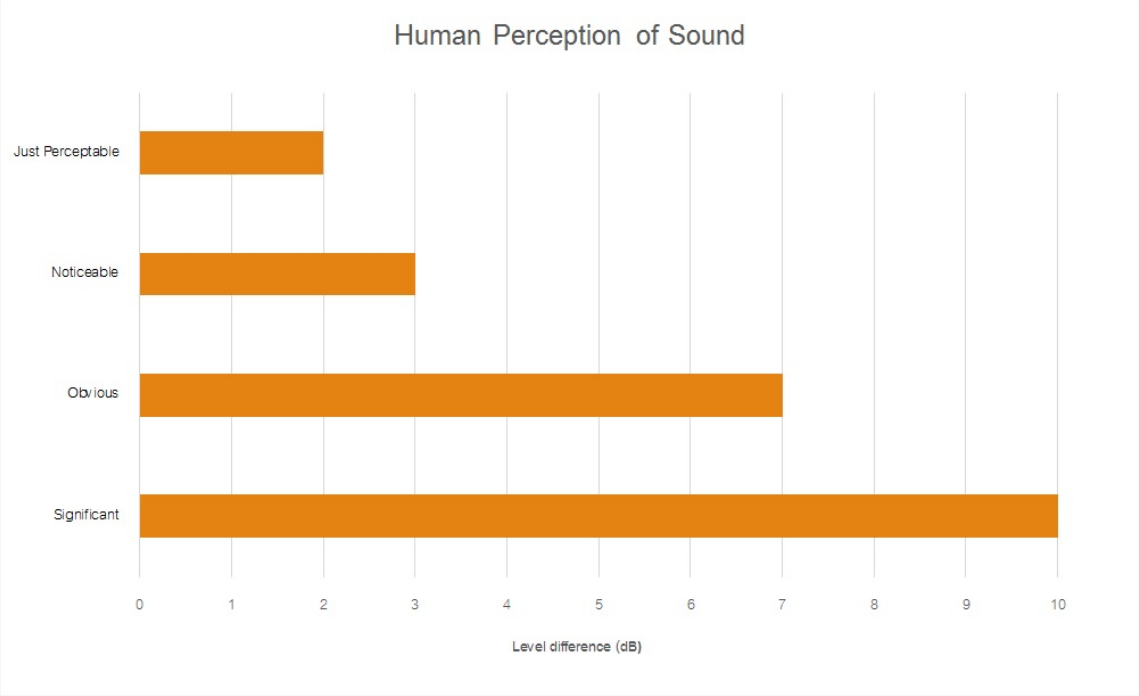
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically, a composite of sounds from many 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 noise.
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 Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	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 intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

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 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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