Noise Assessment

Gunnedah Solar Farm
Gunnedah, NSW

Prepared for: KDC Pty Ltd
February 2021
MAC190968-04RP1V3

Muller Acoustic Consulting

Document Information

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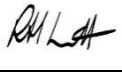
DOCUMENT ID	STATUS	DATE	PREPARED BY	SIGNED	REVIEWED BY	SIGNED
MAC190968-04RP1V3	Final	2 February 2021	Rod Linnett		Oliver Muller	

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by KDC Pty Ltd (KDC) to complete a Noise Assessment (NA) on behalf of Providence Asset Group (PAG) for the proposed Gunnedah Solar Farm near Gunnedah, 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 Gunnedah 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;
- 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 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

PAG propose to construct and operate a 5 Megawatt (MW) solar farm using photovoltaic (PV) technology at Hunts Road, Gunnedah, NSW approximately 3km south west of Gunnedah, 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 of approximately 1.5m in height. An estimated 14,000 PV panels will be installed using a single axis tracking system, tilting along the north-south axis. The PV mounting structure would comprise steel posts driven 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.

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. Most of the infrastructure would be pre-fabricated of-site, delivered and assembled on-site.

It is anticipated that the solar farm would be constructed in stages, with two to three stages in

construction at any one time over a six month period during standard construction hours.

All vehicles would access the project via Blackjack 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 7m spacing between each row. The hub height of each tracker is 1.5m with the peak of the modules reaching a height of 2.3m 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 adjacent existing powerline. 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 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, address and coordinates. These are reproduced visually in **Figure 1**.

Table 1 Noise Sensitive Receivers				
ID	Description/Address	Receiver Type	Coordinates (GDA94/MGA56)	
			Easting	Northing
R01	170 Bushs Lane	Residential	233394	6566002
R02	262 Hunts Road	Residential	233838	6566123
R02A	262 Hunts Road	Residential	233816	6566192
R04	295 Hunts Road	Residential	234033	6565874
R05	94 Bushs Lane	Residential	234151	6565888
R06	82 Bushs Lane	Residential	234233	6565828
R07	78 Bushs Lane	Residential	234400	6566050
R08	56 Bushs Lane	Residential	234451	6565893
R09	54 Bushs Lane	Residential	234581	6565973
R10	46 Bushs Lane	Residential	234678	6565862
R11	35 Bushs Lane	Residential	234773	6565912
R12	17 Bushs Lane	Residential	234865	6565637
R13	29 Bushs Lane	Residential	234759	6565588
R14	45 Bushs Lane	Residential	234604	6565636
R15	61 Bushs Lane	Residential	234459	6565656
R16	79 Bushs Lane	Residential	234232	6565669
R17	95 Bushs Lane	Residential	234072	6565682
R18	117 Bushs Lane	Residential	233908	6565715
R19	7 Robert Gordon Road	Residential	233759	6565735
R20	17 Robert Gordon Road	Residential	233750	6565636
R21	23 Robert Gordon Road	Residential	233724	6565530
R22	18 Bushs Lane	Residential	234874	6565862
R22A	18 Bushs Lane	Residential	234919	6565816
R23	540 Blackjack Road	Residential	232759	6566106
R23A	540 Blackjack Road	Residential	232502	6566111
R24	288 Bushs Lane	Residential	232341	6566277
R25	530 Blackjack Road	Residential	232645	6566485
R26	500 Blackjack Road	Residential	232961	6566709
R27	474 Blackjack Road	Residential	233002	6566934
R28	513 Blackjack Road	Residential	233482	6566611
R29	216 Hunts Road	Residential	233656	6566870

Table 1 Noise Sensitive Receivers				
ID	Description/Address	Receiver Type	Coordinates (GDA94/MGA56)	
			Easting	Northing
R30	221 Hunts Road	Residential	234473	6566444
R31	215 Hunts Road	Residential	234767	6566630
R32	104 Kerry Elizabeth Drive	Residential	233875	6565229
R33	3 Robert Gordon Road	Residential	233764	6565775
R34	13 Robert Gordon Road	Residential	233752	6565676
R35	23 Robert Gordon Road	Residential	233743	6565583
R36	103 Bushs Lane	Residential	233989	6565696

Note 1: Registered address for Gunnedah Chainsaw & Mowers


FIGURE 1
PROJECT LAYOUT
MAC190968-04
Gunnedah Solar Farm
KEY
Receivers
Receivers
Access Route
Panel Array
Construction Compound
Project Boundary
0 100 200 300 400 500 m
N
MAC
Matter Acoustic Consulting
45 dBA Trenching
45 dBA Assembly
BLACK JACK ROAD
HUNTS ROAD
ROBERT GORDON ROAD
WANDOBAH ROAD
BUSHS LANE
KERRY ELIZABETH DRIVE
R01
R02
R02A
R03
R04
R05
R06
R07
R08
R08A
R09
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R22A
R23
R23A
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36

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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;
- NSW 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 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.
Commercial	70dBA	Offices, retail outlets
Industrial	75dBA	Industrial premises

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 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.

The adopted RBLs relevant to the project are contained in **Section 4.1**.

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 project amenity noise level 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 amenity noise levels (ie areas where existing traffic noise levels are 10dB greater than the recommended amenity noise level).

The recommended amenity noise levels as per Table 2.2 of the NPI are reproduced in **Table 4**.

Table 4 Amenity Criteria

Receiver Type	Noise Amenity Area	Time of day	Recommended amenity noise level dB LAeq(period)
Residential	Rural	Day	50
		Evening	45
		Night	40
Commercial premises	All	When in use	65

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 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 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 4.4**.

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4 Noise 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 $L_{Aeq(15min)}$ (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, dB LA90(period)	NML dB LAeq(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	All Periods	N/A	65

Note 1: See Table 2 of this report for Recommended Standard Hours for Construction.

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.

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. The Construction Noise Strategy (Transport for NSW, 2018) sets out safe working distances to achieve the human response criteria for vibration. The key vibration generating sources proposed to be used are a small pile driver for panel mounts and a vibratory roller used for road construction. For a large vibratory roller, the Construction Noise Strategy sets a safe working distance of 25m to achieve the residential human response criteria for continuous vibration. Therefore, as the nearest receivers to the project are greater than 25m, 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 Criteria

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 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 LAeq(period)[2]	PANL dB LAeq(period)[3]	PANL dB LAeq(15min)[4]
Residential	Rural	Day	50	50	53
		Evening	45	45	48
		Night	40	40	43
Commercial		When in use	65	60	63

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 15-minute assessment period as per Section 2.2 of the NPI.

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 LAeq(15min)	PANL dB LAeq(15min)	PNTL dB LAeq(15min)
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Commercial	When in use	--	63	63

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.

4.3.4 Maximum Noise Trigger Levels

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

Table 9 Maximum Noise Trigger Levels

Residential Receivers			
dB LAeq(15min)		dB LAmax	
40dB LAeq(15min) or RBL + 5dB		52dB LAmax 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 trigger level.

4.4 Road Traffic Noise Criteria

The road traffic noise criteria are provided in the RNP. For this assessment, the 'sub arterial road' category for Blackjack Road has been adopted. It is acknowledged that the functional classification of Blackjack Road is a 'Collector Road' 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. 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)
Arterial Roads Sub Arterial Roads	Blackjack Road	Existing residences affected by additional traffic on existing arterial roads generated by land use developments	60dB LAeq(15hr) external	55dB LAeq(9hr) 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.

5 Noise Assessment Methodology

A computer model was developed to quantify project noise emissions to neighbouring receivers for typical construction activities and operations. DGMR (iNoise, Version 2020.0) noise modelling software was used to quantify noise emissions from typical construction activities and operations. iNoise is a new 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.

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 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

[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

- assembly of the panels.

It is envisaged that all four construction scenarios have the potential to occur simultaneously at up to two 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} 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 (loading & unloading materials)	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	196	78	84
2.5MW Inverter[2]	Constant	2	81	84
5MVA Transformer[2]	Constant	1	77	77

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.

During the day the panels track the sun from east to west, operating less than one minute every fifteen minutes. At sundown or before sunrise, the trackers reposition from a 60 degree tilt in the west to a 30 degree tilt in the east to the east. The worst case emissions scenario is when the panels reposition or reset requiring all trackers to operation simultaneously for 2 minutes.

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, Noise Enhancing Meteorological Conditions as per Table D1 of the NPI have been adopted in the noise modelling assessment and are summarised in **Table 13**.

Table 13 Modelled Site Specific Meteorological Parameters – Noise Enhancing Meteorological Condition

Assessment Condition[1]	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
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.

5.3 Road Traffic Noise Assessment Methodology

The project is anticipated to generate low traffic volumes over a typical day during the construction phase. As such, road traffic noise calculation methods such as Calculation of Road Traffic Noise (CRTN - ISBN 0 11 550847 3) by Department of Transport (UK) 1988 or Traffic Noise Model (TNM) by the United States Department of Transport, Federal Highway Administration are not considered appropriate. These methods are primarily intended to calculate noise emissions from motorways and highways. Whilst each method has a low volume correction, the project traffic volume is out of the scope of these methods. Therefore, road traffic noise has been modelled using iNoise modelling software using ISO 9613-1 and ISO 9613-2 calculation methods, representing the road traffic as “moving sources” along the transport route using the parameters presented in **Table 14.**

Table 14 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 Results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities for standard construction hours. **Table 15** summarises the predicted noise level range and maximum predicted noise level for each construction activity (trenching, piling and assembly) at identified receivers.

Table 15 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	170 Bushs Lane	39-60	**60**	45	**No**
R02	262 Hunts Road	30-48	**48**	45	**No**
R02A	262 Hunts Road	30-49	**49**	45	**No**
R04	295 Hunts Road	26-44	44	45	Yes
R05	94 Bushs Lane	32-41	41	45	Yes
R06	82 Bushs Lane	30-40	40	45	Yes
R07	78 Bushs Lane	29-39	39	45	Yes
R08	56 Bushs Lane	28-37	37	45	Yes
R09	54 Bushs Lane	27-36	36	45	Yes
R10	46 Bushs Lane	26-35	35	45	Yes
R11	35 Bushs Lane	25-34	34	45	Yes
R12	17 Bushs Lane	24-34	34	45	Yes
R13	29 Bushs Lane	23-44	44	45	Yes
R14	45 Bushs Lane	23-37	37	45	Yes
R15	61 Bushs Lane	25-39	39	45	Yes
R16	79 Bushs Lane	26-39	39	45	Yes
R17	95 Bushs Lane	28-38	38	45	Yes
R18	117 Bushs Lane	30-40	40	45	Yes
R19	7 Robert Gordon Road	32-42	42	45	Yes
R20	17 Robert Gordon Road	37-47	**47**	45	**No**
R21	23 Robert Gordon Road	30-43	43	45	Yes
R22	18 Bushs Lane	28-42	42	45	Yes
R22A	18 Bushs Lane	23-33	33	45	Yes
R23	540 Blackjack Road	23-32	32	45	Yes
R23A	540 Blackjack Road	34-54	**54**	45	**No**
R24	288 Bushs Lane	28-49	**49**	45	**No**

Table 15 Predicted Construction Noise Levels					
Receiver ID	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
R25	530 Blackjack Road	25-46	**46**	45	**No**
R26	500 Blackjack Road	28-49	**49**	45	**No**
R27	474 Blackjack Road	26-48	**48**	45	**No**
R28	513 Blackjack Road	24-45	45	45	Yes
R29	216 Hunts Road	29-50	**50**	45	**No**
R30	221 Hunts Road	24-44	44	45	Yes
R31	215 Hunts Road	23-39	39	45	Yes
R32	104 Kerry Elizabeth Drive	24-38	38	45	Yes
R33	3 Robert Gordon Road	28-48	**48**	45	**No**
R34	13 Robert Gordon Road	24-44	44	45	Yes
R35	23 Robert Gordon Road	23-43	43	45	Yes
R36	103 Bushs Lane	21-41	41	45	Yes

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

Predicted noise levels are expected to exceed the NMLs by up 5dB at nine receivers when works are at their nearest proximity which would be considered negligible in the context of construction noise which is not a permanent noise source.

At receivers R01 and R23A, predicted noise levels are expected to exceed the NMLs by up 15dB when works are at their nearest proximity. Exceedances greater than 10dB would be considered significant although the works would be temporary, of short duration and are primarily due to piling activities. **Figure 2** shows the 45dBA noise contour for each activity – piling, trenching and assembly. Receivers inside the respective 45dBA would experience noise levels above the NMLs.

Therefore, it is recommended that mitigation measures be implemented for when piling activities are occurring.


R27
R29
R26
R28
R31
R25
R30
R24
R03
R02A
R23A
R23
R02
R07
R01
R09
R04
R05
R08
R11
R10
R22
R06
R22A
R33
R08A
R19
R18
R36
R17
R16
R34
R15
R14
R13
R12
R20
R35
R21
R32
BLACK JACK ROAD
HUNTS ROAD
BUSHS LANE
ROBERT GORDON ROAD
WANDOBAH ROAD
KERRY ELIZABETH DRIVE
45 dBA Trenching
45 dBA Assembly
45 dBA Piling
FIGURE 2
Predicted Noise Levels
Construction Activities
MAC190968-04
Gunnedah Solar Farm
KEY
Receivers
Receivers
Panel Array
Construction Compound
Project Boundary
45 dBA Trenching
45 dBA Assembly
45 dBA Piling
0
100
200
300
400
500 m
N
MAC

6.2 Operational Noise Results

Noise levels were predicted at each assessed receiver assuming heights of 1.5m above ground level during the night time for noise enhancing meteorological conditions as described in **Table 13**. **Table 16** summarises the predicted noise levels for normal operations and when the tracking motors reset to the east position at the end of the day. Predicted noise levels are expected to comply with the limiting night time PNTL of 35dB $LA_{eq(15min)}$ at all residential receivers. Predicted noise levels are also expected to comply with the PNTL of 68dB $LA_{eq(15min)}$ at the identified commercial receiver, C1.

Table 16 Predicted Operational Noise Levels - Noise Enhancing Meteorological Conditions

Receiver ID	Description/Address	Predicted Noise Level Normal Operations dB $LA_{eq(15min)}$	Predicted Noise Level Tracker Reset dB $LA_{eq(15min)}$	Compliance Achieved
R01	170 Bushs Lane	33	33	Yes
R02	262 Hunts Road	<30	<30	Yes
R02A	262 Hunts Road	<30	<30	Yes
R04	295 Hunts Road	<30	<30	Yes
R05	94 Bushs Lane	<30	<30	Yes
R06	82 Bushs Lane	<30	<30	Yes
R07	78 Bushs Lane	<30	<30	Yes
R08	56 Bushs Lane	<30	<30	Yes
R09	54 Bushs Lane	<30	<30	Yes
R10	46 Bushs Lane	<30	<30	Yes
R11	35 Bushs Lane	<30	<30	Yes
R12	17 Bushs Lane	<30	<30	Yes
R13	29 Bushs Lane	<30	<30	Yes
R14	45 Bushs Lane	<30	<30	Yes
R15	61 Bushs Lane	<30	<30	Yes
R16	79 Bushs Lane	<30	<30	Yes
R17	95 Bushs Lane	<30	<30	Yes
R18	117 Bushs Lane	<30	<30	Yes
R19	7 Robert Gordon Road	<30	<30	Yes
R20	17 Robert Gordon Road	<30	<30	Yes
R21	23 Robert Gordon Road	<30	<30	Yes
R22	18 Bushs Lane	<30	<30	Yes

Table 16 Predicted Operational Noise Levels - Noise Enhancing Meteorological Conditions				
Receiver ID	Description/Address	Predicted Noise Level Normal Operations dB $LA_{eq(15min)}$	Predicted Noise Level Tracker Reset dB $LA_{eq(15min)}$	Compliance Achieved
R22A	18 Bushs Lane	<30	<30	Yes
R23	540 Blackjack Road	<30	<30	Yes
R23A	540 Blackjack Road	<30	<30	Yes
R24	288 Bushs Lane	<30	<30	Yes
R25	530 Blackjack Road	<30	<30	Yes
R26	500 Blackjack Road	<30	<30	Yes
R27	474 Blackjack Road	<30	<30	Yes
R28	513 Blackjack Road	<30	<30	Yes
R29	216 Hunts Road	<30	<30	Yes
R30	221 Hunts Road	<30	<30	Yes
R31	215 Hunts Road	<30	<30	Yes
R32	104 Kerry Elizabeth Drive	<30	<30	Yes
R33	3 Robert Gordon Road	<30	<30	Yes
R34	13 Robert Gordon Road	<30	<30	Yes
R35	23 Robert Gordon Road	<30	<30	Yes
R36	103 Bushs Lane	<30	<30	Yes

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 - Operations

A detailed maximum noise level assessment is not required as predicted noise levels for night time as operations do not exceed the maximum noise level screening criterion of 40dB $LA_{eq(15min)}$ and there are no operational noise sources that generate significant maximum noise events.

6.4 Road Traffic Noise Assessment

The major transport route for all vehicles to the access the project site from the Oxley Highway would be via Blackjack Road from the Oxley Highway. 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 noise levels from project related construction traffic at the closest receiver (30m offset) on Blackjack Road has been calculated using the methodology described in **Section 5.3** and the parameters presented in **Table 14**. The results presented in **Table 17** 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 17 Predicted Construction Road Traffic Noise Levels

Road Name	Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Compliance
Blackjack Road	30m	48dB LAeq(15hr)	60dB LAeq(15hr)	Yes

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

Existing road traffic flows on the Oxley Highway are not available. The project proposes to add an additional 20 light vehicles per day and 100 heavy vehicles over a six month construction period, which would be considered a negligible increase to existing traffic flows resulting in a negligible increase in road traffic noise.

Therefore, it is concluded that project related road traffic noise levels would satisfy the relevant RNP criteria at any residential receiver along the proposed transport routes and not increase existing noise levels by more than 2dB.

7 Recommendations

7.1 Construction Noise Recommendations

It is noted that construction noise emissions are anticipated to exceed the relevant NMLs at the nearest receivers by more than 10dB – particularly when piling activities are occurring. The following noise mitigation measures should be considered during the construction phase to reduce emissions to the surrounding community:

- 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 piling rig/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);
- minimise noisy plant/machinery (pile driver) working simultaneously with other construction activities where practicable;
- 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;
- 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 proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

The reduction achieved from the mitigation measures will depend on the specific measures implemented. Monitoring with and without the measures in place will provide an indication of the reduction achieved. A Construction Noise Management Plan may be required to adequately address potential exceedance of NMLs and to minimise noise impacts during the construction phase.

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 operational noise emissions from site and to confirm emissions meet relevant criteria. The monitoring assessment would consist of operator attended noise measurements during normal operation to determine the noise contribution from the project.

8 Discussion and Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by KDC Pty Ltd (KDC) to complete a Noise Assessment (NA) for the proposed Gunnedah Solar Farm, near Gunnedah, 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 several receiver locations. Recommendations have been provided to minimise the potential noise impacts from construction, albeit of a temporary nature during the daytime over a six 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.

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

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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

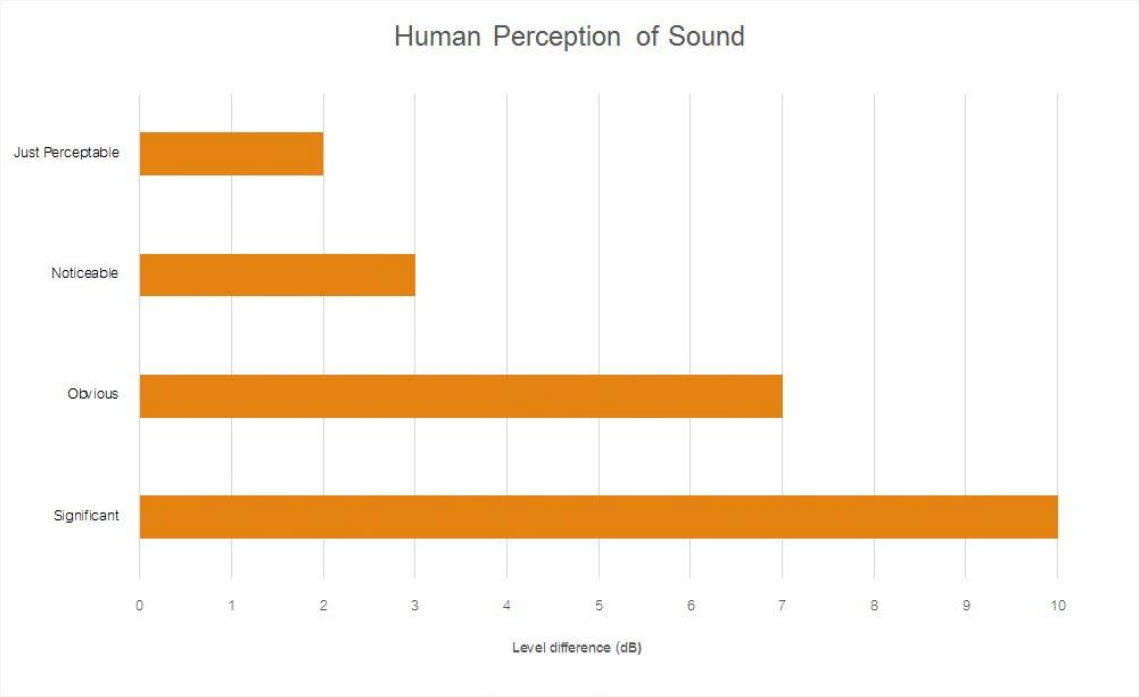
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 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.
Extraneous Noise	Noise resulting from activities that are not typical of the area. Atypical activities include sources such as construction and holiday period traffic.
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,T	The summation of noise over a time period, T. 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 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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