APPENDIX

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Noise and vibration impact assessment

Birriwa Solar and Battery Project

Noise and Vibration Impact Assessment

Prepared for ACEN Australia Pty Ltd

July 2022

Birriwa Solar and Battery Project

Noise and Vibration Impact Assessment

ACEN Australia Pty Ltd

J210553 Birriwa Solar and Battery Project - NVIA

July 2022

Version	Date	Prepared by	Approved by	Comments
1	24 June 2022	Alex Dundon	Anthony Welbourne	Draft for ACEN review.
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Approved by

Anthony Welbourne
Associate Director
21 July 2022

Level 4 74 Pirie Street
Adelaide SA 5000

Executive Summary

ACEN Australia Pty Ltd (ACEN), formerly known as UPC\AC Renewables Australia (UPC\AC) proposes to develop the Birriwa Solar and Battery Project; a large scale solar photovoltaic (PV) electricity generation facility along with battery storage and associated infrastructure (the project). The solar component of the project will have an indicative capacity of around 600 megawatts (MW) and will include a centralised battery energy storage system (BESS) of up to 600 MW for a 2 hour duration. The BESS will enable energy from solar to be stored and then released during times of demand. The project will be developed within a study area of approximately 1,300 hectares and will connect to the proposed Central-West Orana Renewable Energy Zone Merotherie Hub.

The construction phase of the project would last for approximately two years utilising a workforce of up to 800 people. The operational phase would last for about 30 years utilising a workforce of approximately 20 people.

The project is in the localities of Birriwa and Merotherie, approximately 15 kilometres south-west of the township of Dunedoo, in the Central West of New South Wales (NSW). The project is within the Central-West Orana (CWO) Renewable Energy Zone (REZ) and is within the Mid-Western Regional Council (MWRC) local government area (LGA) with parts of its access route within Warrumbungle Shire Council LGA.

A noise and vibration impact assessment (NVIA) has been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE) which were set out in the Planning Secretary's Environmental Assessment Requirements (SEARs) for the project. The SEARs identify matters which must be addressed in the EIS and essentially form its terms of reference. This report includes an assessment of:

- construction noise impacts on surrounding sensitive receivers in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009);
- construction vibration impacts on nearby structures and other sensitive uses in accordance with *Assessing Vibration – a technical guideline* (DEC 2006);
- increases in road traffic noise due to construction works in accordance with the *Road Noise Policy* (RNP) (DECCW 2011); and
- assessment of operational noise in accordance with the *Noise Policy for Industry* (NPfI) (EPA 2017).

Construction works are proposed to occur in standard hours and Saturday afternoons (ie Monday to Friday 7.00 am to 6.00 pm and Saturday 8.00 am to 6.00 pm). Maximum construction noise and vibration impacts are expected to occur during the site establishment phase. Predictions based on proposed construction methodology indicate that construction works will comply with noise management levels under the ICNG by incorporating an exclusion zone for site establishment works within 650 metres of residences during Saturday afternoons. Based on setback distances from proposed works, construction vibration impacts are considered negligible.

During peak construction, increases in road traffic noise will occur along Castlereagh Highway, Birriwa Bus Route South and Barneys Reef Road. Assessed road traffic noise levels indicate increases of between 2 dB and 4 dB at several residences; however, the predicted levels are below the thresholds provided under the RNP.

The assessment of operational noise considered different scenarios, based on three different BESS designs at one of two proposed operational infrastructure areas (ie a containerised solution for battery racks, outdoor racks or dedicated buidlings). Consideration of tonal characteristics was included within this assessment based on anticipated tonal characteristics being present from several sources. Assessment of operational noise concluded that NPfI (EPA 2017) criteria could be achieved with the implementation of some mitigation and management measures.

Given the preliminary nature of information available regarding equipment noise emissions, mitigation and management measures should be revisited during the detailed design stage to confirm and refine these measures.

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1 Introduction

1.1 Overview

ACEN Australia Pty Ltd (ACEN), formerly known as UPC\AC Renewables Australia (UPC\AC) proposes to develop the Birriwa Solar and Battery Project; a large scale solar photovoltaic (PV) electricity generation facility along with battery storage and associated infrastructure (the project). The solar component of the project will have an indicative capacity of around 600 megawatts (MW) and will include a centralised battery energy storage system (BESS) of up to 600 MW for 2 hour duration. The BESS will enable energy from solar to be stored and then released during times of demand.

The project is in the localities of Birriwa and Merotherie, approximately 15 kilometres (km) south-west of the township of Dunedoo, in the Central West of New South Wales (NSW) (Figure 2.1). The project is within the Central-West Orana (CWO) Renewable Energy Zone (REZ) and is within the Mid-Western Regional Council local government area (LGA), with part of the access route from the Castlereagh Highway being within the Warrumbungle Shire Council LGA.

The project is State Significant Development (SSD) pursuant to Schedule 1 of the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP). Therefore, a development application for the project is required to be submitted under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This noise and vibration impact assessment (NVIA) forms part of the Environmental Impact Statement (EIS).

1.2 Purpose of this report

This NVIA supports the EIS for the proposed Birriwa Solar and Battery Project. It documents the existing noise environment, applicable impact assessment criteria, source of noise and vibration, noise modelling of operational and construction activities including traffic, and assessment of predicted impacts relative to criteria.

This NVIA consists of the following sections:

- a description of the local setting and surrounds of the site;
- a description of the existing environment, including existing noise environment;
- a list of plant and equipment adopted for noise modelling of construction and operation of the proposed development;
- noise modelling of operational and construction noise emissions;
- assessment of road traffic noise as a result of construction related vehicles on public roads; and
- an overview of compliance, noise mitigation measures and residual impacts where relevant.

This NVIA has been prepared in general accordance with the guidelines specified in:

- NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry* (NPfI);
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*;
- NSW Department of Environment Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);

- Australian and New Zealand Environment Council 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*;
- BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*;
- British Standard 6472 – 2008, *Evaluation of human exposure to vibration in buildings* (1-80Hz); and
- German Standard DIN 4150 Part 2 1975.

This assessment has been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE) which were set out in the Planning Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 5 November 2021. The SEARs identify matters which must be addressed in the EIS and essentially form its terms of reference. Table 1.1 lists individual requirements relevant to this NVIA and where they are addressed.

Table 1.1 Noise and Vibration related SEARs

Requirement	Section addressed
The EIS must address the following specific matters: Noise – including an assessment of the construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG), operational impacts in accordance with Noise Policy for Industry (2017), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria.	This document.

1.3 Other relevant reports

This NVIA has been prepared with reference to other technical reports that have been prepared in support of the Birriwa Solar and Battery Project EIS. The other relevant report referenced in this NVIA is the Traffic Impact Assessment (EMM 2022), appended to the EIS.

2 Project description

2.1 Project overview

A full project description is provided in Chapter 3 of the EIS. The project will comprise the following key components:

- a network of approximately 1 million solar PV panels and associated mounting infrastructure;
- a BESS with a capacity of up to 600 MW capacity and storage duration of up to 2 hours;
- an onsite substation with a connection voltage of up to 500/330 kV;
- electrical collection and conversion systems, including inverter and transformer units, switchyard and control room;
- underground and aboveground cables;
- an operational infrastructure area, including demountable offices, amenities and equipment sheds;
- parking and internal access roads;
- temporary construction compound (during construction and decommissioning only); and
- upgrade of the access route from the Castlereagh Highway into the development footprint (Barneys Reef Road and part of Birriwa Bus Route South).

The impact footprint (comprising the development footprint and road upgrade corridor) is shown on Figure 2.1.

The project will connect to the proposed CWO REZ Merotherie Energy Hub. Details of the connection to the proposed Energy Hub are still being discussed with EnergyCo and are described further in Chapter 1 of the EIS.

2.2 The study area

The project will be developed within a study area of approximately 1,300 hectares (ha) and is comprised of 18 freehold land parcels (Figure 2.1). The study area is the area of assessment for baseline surveys and studies conducted for the EIS. The study area comprises the maximum area considered for the project based on the extent of land where ACEN hold landholder agreements and the area of potential impact for road upgrades.

The properties within the study area are currently primarily used for sheep and cattle grazing as well as low intensity dry land cropping. There are four associated residences within close proximity to the study area (A2, A4, A6 and A8). There are 21 non-associated residences within 2 km of the study area, many of them in the township of Birriwa, and another 22 between 2 km and 5 km away (Figure 2.1).

The development footprint (Figure 2.1) is the area to be developed within land where ACEN holds landholder agreements. All operational components of the project will be within the development footprint. The development footprint is the outcome of the iterative process outlined in Chapter 2 of the EIS which led to excluding certain areas of environmental or social constraint.

The road upgrade corridor is the area of direct impact for public road upgrade works along the access route, which comprises part of Barneys Reef Road and Birriwa Bus Route South (connecting the access point to site with the Castlereagh Highway).

The primary vehicle access route will be via the Castlereagh Highway, Barneys Reef Road and Birriwa Bus Route South (Figure 2.1). From the project access point, private internal roads will be used to traverse the development footprint. A section of Barneys Reef Road and Birriwa Bus Route South will require upgrades to provide safe access to the development footprint during construction of the project.

2.3 Construction

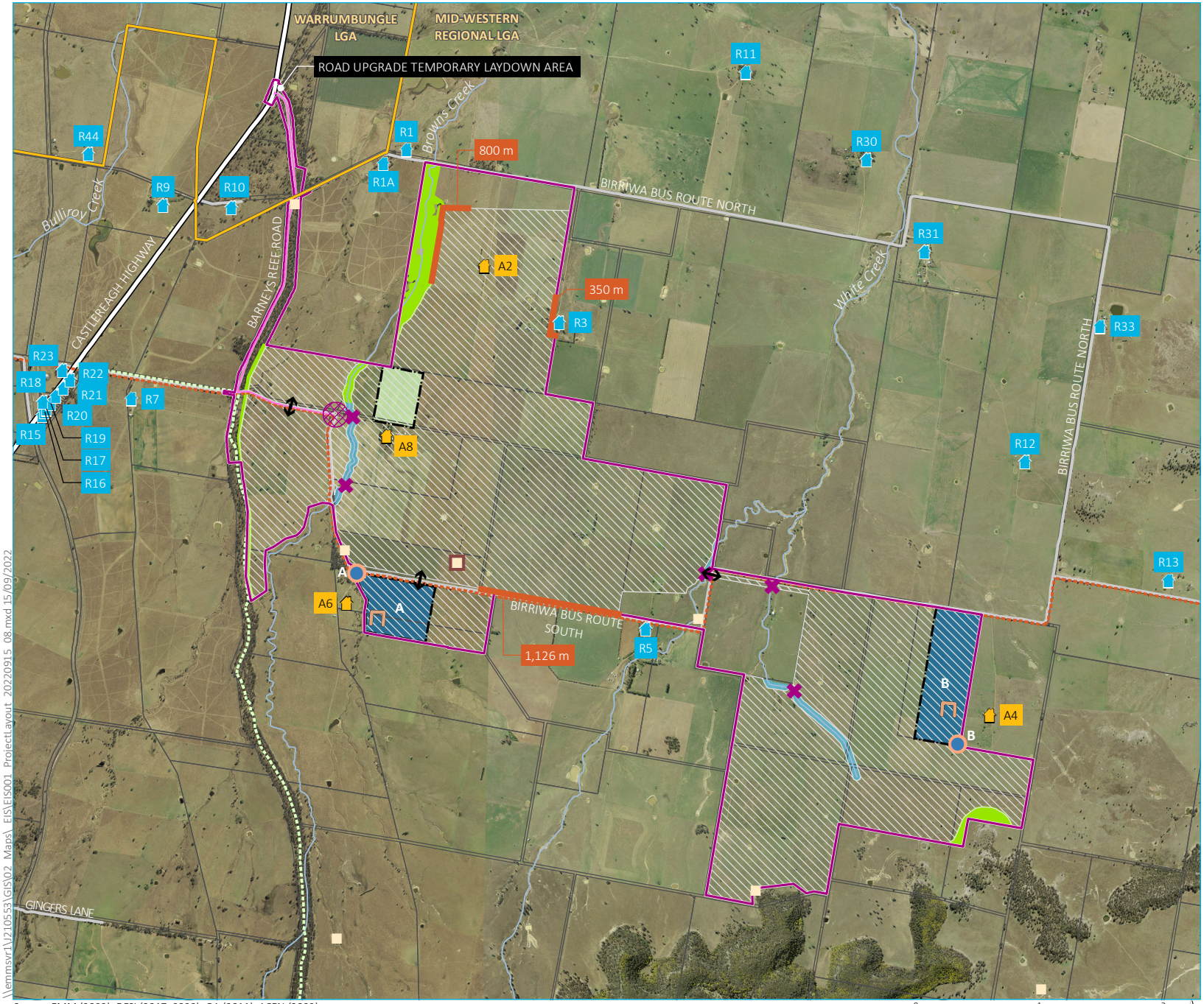
2.3.1 Construction activities

Site establishment works and preparation for construction may include:

- the establishment of a temporary construction compound in a fenced-off area within the development footprint;
- construction of access tracks and installation of boundary fencing;
- site survey to confirm infrastructure positioning and placement;
- ongoing geotechnical investigations to confirm the ground conditions;
- preliminary earthworks and installation of environmental controls including erosion and sediment management structures; and
- identification and demarcation of no-go zones around trees and vegetation to be retained.

Upon completion of the site establishment and pre-construction activities described above, construction activities will typically be rolled out as follows:

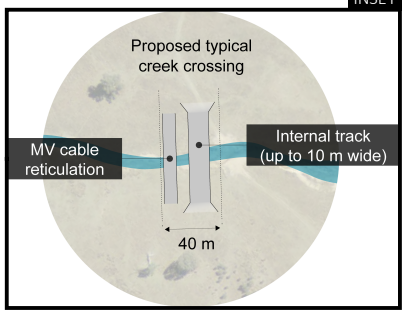
- installation of steel piles and mounting system for the tracking system and PV modules;
- secure PV modules to mounting system;
- trenching and installation of DC cabling and medium voltage cables;
- installation of PCUs either on steel skids, concrete pads or in modified shipping containers;
- construction of workshop and associated infrastructure, temperature-controlled spare parts storage facility, permanent staff office, operations and control room, meeting facilities, amenities and carparking;
- construction of the substation (including grid connection-related infrastructure);
- establishment of the BESS compound;
- installation of battery racks either in cabinets, modified shipping containers or sheds;
- installation of inverters associated with the BESS;
- test and commission project infrastructure; and
- removal of temporary construction facilities.



KEY

- Study area
- Impact footprint
  - Development footprint
  - Road upgrade corridor
  - Restricted development area
  - Potential public road crossing location
- Project layout
  - Potential creek crossing point (refer to inset below for indicative design)
  - Proposed access point to the project
  - Connection point (option A or B)
  - Proposed operational infrastructure area including substation, operational facility and BESS (option A or B)
  - Temporary construction compound
  - Landscape screen planting
  - Indicative noise wall location
- Existing environment
  - Dwelling not associated with the project
  - Dwelling associated with the project
  - Aboriginal heritage site (to be salvaged)
  - Aboriginal heritage site (to be avoided)
  - Vegetation to be retained
  - Major road
  - Minor road
  - Watercourse
  - Cadastral boundary
  - Local government area boundary
- Central West Cycle (CWC) Trail
  - CWC main route - Gulgong to Dunedoo
  - CWC alternate route - Slap Dash Creek side trail

INSET



Project overview

Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

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GDA 1994 MGA Zone 55

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Figure 2.1

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2.3.2 Construction hours

Proposed construction hours for the project will include ICNG (DECC 2009) recommended standard construction hours for normal construction and Saturday afternoon works, namely:

- Monday to Friday: 7.00 am to 6.00 pm;
- Saturday: 8.00 am to 6.00 pm; and
- no works of Sunday and public holidays.

Certain activities may be required outside of the standard construction hours. These activities potentially include:

- delivery of plant and equipment for safety reasons (eg oversize over-mass vehicles);
- commissioning and testing activities that must align with demands on the grid; and
- situations where agreement is reached with nearby affected receivers and local council.

The follow construction activities may also be undertaken outside these hours:

- activities that are inaudible at non-associated residences;
- the delivery of materials as requested by the NSW Police Force or other authorities for safety reasons; or
- emergency work to avoid the loss of life, property and/or material harm to the environment.

2.3.3 Plant and equipment

Typical plant and equipment required for construction will include items listed in Table 2.1.

The majority of plant and equipment will be delivered to site on rigid and semi-trailer low-loaders. Construction materials will be delivered via rigid concrete agitators, truck and dog, and semi-trailer dump trucks.

Table 2.1 Typical construction plant and equipment

Construction phase	Plant type
Enabling works	• Front end loaders • Dump trucks • Road trucks • Water trucks • Excavators • Graders • Compactors and rollers • Light vehicles • Scissor lifts • Franna cranes
Construction and commissioning works	• Front end loaders • Dump trucks • Road trucks • Water trucks • Concrete trucks and pumps • Excavators • Graders • Compactors and rollers • Scrapers • Backhoe • Concrete saws and grinders • Light vehicles • Scissor lifts • Franna cranes • Mobile cranes • Generators • Welding equipment • Compressors
Commissioning	N/A
Demobilisation	• Road trucks • Water trucks • Concrete saws and grinders • Excavators • Franna cranes • Backhoes • Compactors and rollers

2.3.4 Construction traffic

The following peak construction vehicle movements are anticipated:

- up to 530 light vehicles per day (530 in and 530 out) during the construction works phase;
- up to 120 heavy vehicles per day (120 in and 120 out) during the construction works phase; and
- a maximum of 1 oversize overmass (OSOM) vehicle per day.

Passenger vehicles are expected to arrive at the development footprint prior to commencement of construction shifts. Construction workforce vehicles are anticipated to originate primarily from regional centres including Mudgee/Gulgong (60%) and Dubbo (20%) and are anticipated to travel to the development footprint via the Castlereagh Highway.

2.4 Operations

The project will operate 24 hours a day, 7 days a week.

Regular maintenance activities will be required throughout the project's operational life. This maintenance may potentially include the replacement of components. Light vehicles will access the site throughout the operations phase for maintenance activities. Heavy vehicles may also occasionally access the site to replace larger components as necessary.

Over the operational life of the project, components may be upgraded. These works, if required, would not be intensive and are likely to be generate significantly lower noise emissions than the construction works assessed in this EIS. Upgrade works may also provide additional generation capacity without increasing the disturbance area associated with the project.

The operation of the project is expected to commence from 2024 for a period of approximately 30 years. Once the project reaches the end of its investment and operational life, the project infrastructure will be decommissioned and the development footprint returned to its pre-existing land use, namely suitable for grazing of sheep and cattle, or another land use as agreed by the project owner and the landholder at that time.

The project is expected to contribute to the employment of up to 20 employees during operation.

3 Existing environment

The site surrounds accommodate a variety of rural and agricultural uses. Ambient noise levels would be controlled by natural elements and limited human activity including traffic and agricultural activities. There are four associated residences within close proximity to the study area. These four associated residences have agreed to noise impacts under a landholder agreement with ACEN. There are 21 non-associated residences within 2 km of the study area, many of them within the township of Birriwa, and another 22 non-associated residences between 2 km and 5 km from the study area.

3.1 Noise and vibration assessment locations

The nearest representative noise sensitive locations to the project have been identified for the purpose of assessing potential noise and vibration impacts. Details are provided in Table 3.1 and their locations are shown in Figure 3.1. They are referred to in this report as assessment locations. Distances shown are the distances to the development footprint.

Table 3.1 Noise assessment locations

ID	Classification	Easting[1]	Northing[1]	Distance to development footprint (m)
R1	Residential	735592	6445545	553
R3	Residential	736829	6444145	63
R5	Residential	737525	6441670	253
R7	Residential	733370	6443534	851
R9	Residential	733628	6445094	1,013
R10	Residential	734180	6445077	464
R11	Residential	738332	6446171	1,804
R12	Residential	740589	6443022	1,283
R13	Residential	741745	6442063	1,533
R15	Residential	732652	6443401	1,579
R16	Residential	732670	6443424	1,558
R17	Residential	732688	6443451	1,538
R18	Residential	732655	6443508	1,567
R19	Residential	732719	6443494	1,504
R20	Residential	732761	6443551	1,460
R21	Residential	732823	6443618	1,398
R22	Residential	732878	6443685	1,346
R23	Residential	732818	6443761	1,412
R24	Residential	734613	6448010	1,983
R25	Residential	734807	6448202	2,192

Table 3.1 Noise assessment locations

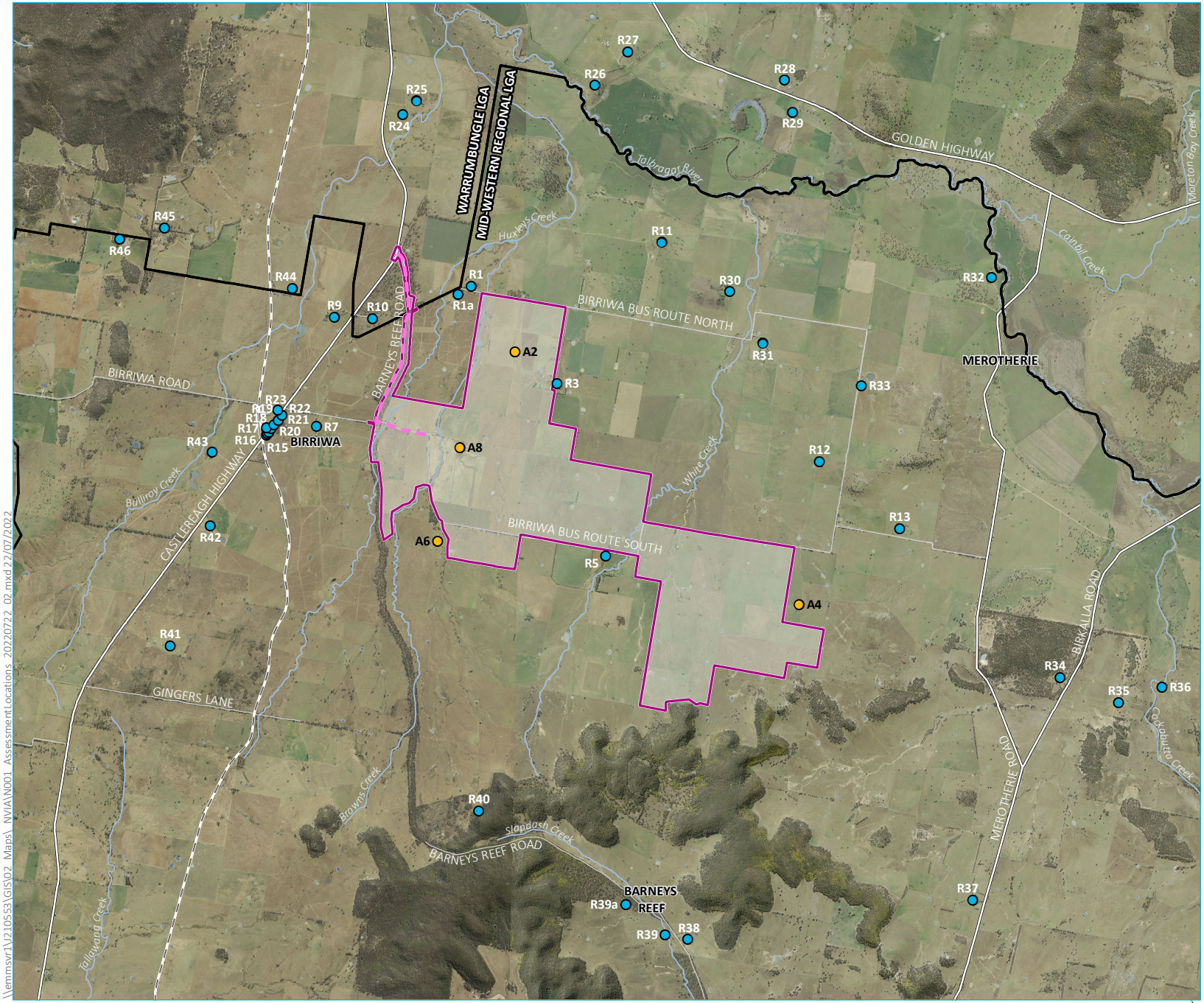
ID	Classification	Easting[1]	Northing[1]	Distance to development footprint (m)
R30	Residential	739307	6445466	2,426
R31	Residential	739777	6444720	2,470
R33	Residential	741194	6444116	2,517
R39	Residential	737813	6436663	3,221
R40	Residential	735702	6438010	2,758
R42	Residential	731850	6442099	2,467
R43	Residential	731877	6443162	2,366
R44	Residential	733024	6445509	1,564

Notes: 1. GDA 94 MGA Zone 55

3.2 Background noise

In terms of the existing noise environment, EMM adopted the minimum background noise thresholds of the NPfI on the basis that land use is largely rural with limited traffic and industry. The minimum thresholds in the NPfI are:

- day 35 dB;
- evening 30 dB; and
- night 30 dB.



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Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

Noise assessment locations

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Figure 3.1

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4 Assessment criteria

This chapter presents the construction and operational noise assessment criteria established for the project in accordance with the NPfI, RNP and the ICNG.

4.1 Operational noise

4.1.1 Noise Policy for Industry

Noise from development in NSW is regulated by the local council, DPE and/or the EPA, and sites generally have a licence and/or development consent conditions stipulating noise limits. These limits are typically derived from project specific trigger or operational noise levels predicted at assessment locations. They are based on EPA guidelines (eg NPfI) or noise levels that can be achieved by a specific site following the application of all feasible and reasonable noise mitigation.

The objectives of noise trigger levels established in accordance with the NPfI are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides project specific noise trigger levels, namely intrusiveness and amenity.

i Intrusiveness noise levels

The NPfI intrusiveness noise triggers require that $L_{Aeq,15min}$ noise levels (energy average noise level over a 15-minute period) from the project do not exceed the rated background level (RBL) by more than 5 dB during the relevant operational periods. The intrusiveness noise levels are only applicable at residential assessment locations.

Table 4.1 presents the intrusiveness noise levels determined for the project based on the adopted RBLs.

Table 4.1 Project intrusiveness noise levels

Residential assessment location	Assessment period[1]	Adopted RBL, dBA	Project intrusiveness noise level (RBL + 5 dB), $L_{Aeq,15min}$, dB
All residential assessment locations[2]	Day	35	40
	Evening	30	35
	Night	30	35

Notes: 1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; Night: remaining periods.

2. Excluding associated residences.

ii Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail traffic noise. Where the measured existing industrial noise approaches recommended amenity noise levels, it needs to be demonstrated that noise levels from new developments will not contribute to existing industrial noise such that amenity noise levels are exceeded.

To ensure that industrial noise levels ('existing' plus the 'new' project) remain within the recommended amenity noise levels for an area, the project amenity noise level for a new industrial development is the recommended amenity noise level (outlined in Table 2.2 of the NPfI) minus 5 dB. It is noted that this approach is based on a receiver being impacted by multiple industrial sites (or noise sources).

Residential areas potentially affected by the project's operational noise are located to the north, east, south and west of the project. The project amenity noise levels for the identified assessment locations are presented in Table 4.2 based on a rural noise amenity area. The NPfI defines rural as an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse, which is consistent with the area surrounding the project.

Table 4.2 Project amenity noise levels

Assessment location	Time period[1]	Indicative area	Project amenity noise level[2] dB, $L_{Aeq,period}$
All residential assessment locations[3]	Day	Rural	50 (55–5)
	Evening		40 (45–5)
	Night		35 (40–5)

Source: NPfI (EPA 2017).

1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; night: remaining periods.

2. Project amenity noise level is Amenity noise level (Table 2.2 of NPfI) -5 dB in accordance with NPfI Section 2.4.2.

3. Excluding associated residences.

iii Project noise trigger level

The project noise trigger level (PNTL) is the lower of the calculated intrusiveness or amenity noise levels. Taking account of the adopted background noise levels, project intrusive noise levels and project amenity levels for residential assessment locations, a summary of PNTLs for the assessment of noise from the project operations is presented in Table 4.3.

Table 4.3 Project noise trigger levels

Assessment location	Assessment period[1]	Intrusiveness noise level, $L_{Aeq,15min}$, dB	Amenity noise level[2], $L_{Aeq,15min}$, dB	PNTL[3], $L_{Aeq,15min}$, dB
All non-participating residences	Day	40	53	40
	Evening	35	43	35
	Night	35	38	35

Notes: 1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; night: remaining periods.

2. Project amenity $L_{Aeq,15min}$ noise level is the recommended amenity noise level $L_{Aeq,period}$ +3 dB as per the NPfI.

3. PNTL is the lower of the calculated intrusiveness or amenity noise levels.

iv Sleep disturbance

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where operation or construction night-time noise levels at a residential location exceed screening levels of:

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

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon numerous studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current (2011) level of understanding, it is not possible to establish absolute noise level criteria that will correlate to an acceptable level of sleep disturbance.

Additional information is outlined in *Night Noise Guidelines for Europe* (WHO 2009) and the *Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep* (Basner and McGuire 2018). Further guidance is also provided in the RNP "as a rule for planning for short-term or transient noise events, for good sleep over 8 hours the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) L_{Amax} more than 10 or 15 times per night". It is commonly accepted by acoustic practitioners and regulatory bodies (ie EPA) that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 55 dB calculated at the facade of a residence is unlikely to impact sleep according to the RNP.

If noise levels over the screening criteria are identified, then additional analysis will consider factors such as:

- how often the events will occur;
- the time the events will occur;
- 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 scientific literature available regarding the impact of maximum noise level events at night.

Table 4.4 provides the noise level event screening criteria for the residential assessment locations.

Table 4.4 Sleep disturbance screening criteria at residences

Assessment location	Adopted night RBL, dB	Night-time maximum noise level event screening criteria, dB	
		$L_{Aeq,15\ minute}$	L_{Amax}
Non-associated residences	30	40	52

4.1.2 Mitigating noise

Where noise levels above the PNTLs are predicted, all feasible and reasonable mitigation are to be considered for the project to reduce noise levels towards the PNTLs, before any residual impacts are determined and addressed.

The significance of the residual noise impacts is generally based around the human perception to changes in noise levels as explained in the glossary of acoustic terms. For example, a change in level of 1 to 2 dB is typically indiscernible to the human ear. The characterisation of a residual noise impact of 0 to 2 dB above the PNTL is therefore considered negligible. The NPfI characterisation of residual noise impact is outlined further in Table 4.5.

Table 4.5 Significance of residual noise impacts

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of the residual noise level is:
≤2 dB	Not applicable	Negligible
≥3 but ≤5 dB	• less than recommended amenity noise level; or • greater than recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from development is ≤1 dB.	Marginal
≥ 3 but ≤5 dB	Greater than recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is >1 dB.	Moderate
>5 dB	Less than or equal to recommended amenity noise level.	Moderate
>5 dB	Greater than recommended amenity noise level.	Significant

Source: NPfI (EPA 2017).

4.2 Construction noise

The ICNG was jointly developed by NSW Government agencies, including the EPA and Department of Planning (DoP) (now DPE). The objectives of this guideline relevant to the planning process are to promote a clear understanding of ways to identify and minimise noise from construction and to identify 'feasible' and 'reasonable' work practices. It recommends standard construction hours where noise from construction activities is audible at residential premises (ie assessment locations), as follows:

- Monday to Friday 7.00 am to 6.00 pm;
- Saturday 8.00 am to 1.00 pm; and
- no construction work is to take place on Sundays or public holidays.

The ICNG acknowledges that works outside standard hours may be necessary, however, justification should be provided to the relevant authorities.

The ICNG provides two methodologies to assess construction noise emissions, quantitative and qualitative. The first is a quantitative approach, which is suited to major construction projects with typical durations of more than three weeks. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended levels.

The second is a qualitative approach, which is a simplified assessment process that relies more on noise management strategies. This method is suited to short-term infrastructure and maintenance projects of no more than three weeks.

This assessment has adopted a quantitative approach. The qualitative aspects of the assessment include identification of assessment locations, description of works involved including predicted noise levels and proposed management measures that include a complaints handling procedure.

4.2.1 Construction noise management levels - residents

Table 4.6 provides ICNG noise management levels (NML) which apply to residential assessment locations.

Table 4.6 ICNG construction noise management levels for residences

Time of day	NML $L_{Aeq,15min}$	Application
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm, Saturday 8.00 am to 1.00 pm, no work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{eq(15\text{-}min)}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	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: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); and 2. 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 + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Source: ICNG (DECC 2009).

4.2.2 Construction noise management levels – other noise sensitive land uses

Table 4.7 summarises the ICNG recommendations and provides NMLs for other land uses.

Table 4.7 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15\ minute}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Hotels[1]	External noise level 65 dB (7 am to 10 pm) 60 dB (10 pm to 7 am)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC 2009).

1. NML based on AS2017 recommend maximum internal noise level and the premise that windows and doors for such development would typically remain closed, providing 20 dB of outdoor to indoor construction noise level reduction.

4.2.3 Project specific construction noise management levels

The project construction NMLs for recommended standard and out of hour periods are presented in Table 4.8 for all assessment locations.

Table 4.8 Construction noise management levels – all assessment locations

Assessment location	Period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
Non-associated residences	Day (standard ICNG hours)	35	45
	Day (non-standard ICNG hours)	35	40

Note: 1. The RBLs adopted from Section 3.2.

4.3 Construction vibration

4.3.1 Human perception of vibration

Humans can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not in itself be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2 1999. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in Table 4.9.

Table 4.9 suggests that people will just be able to feel floor vibration at levels of approximately 0.15 millimetres per second (mm/s) and that the motion becomes “noticeable” at a level of approximately 1 mm/s.

Table 4.9 Peak vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hertz (Hz) to 80 Hz.

4.3.2 Assessing vibration - a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC 2006) (the guideline) is based on BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1–80 Hz).

The guideline presents preferred and maximum vibration values for the use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended that the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 4.10.

Table 4.10 Examples of types of vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to three distinct vibration events in an assessment period, eg occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZEC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Source: DEC (2006).

Continuous vibration associated with compaction of road base for new site access road and hard stand areas is most relevant to the construction of the BESS and substation.

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Intermittent vibration is representative of heavy vehicle pass-bys and construction activities such as impact hammering, rolling or general excavation work.

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted rms (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz.

To calculate VDV the following formula is used (refer to Section 2.4.1 of the guideline):

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV for intermittent vibration are reproduced in Table 4.11.

Table 4.11 Acceptable vibration dose values for intermittent vibration

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: Day time is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline recommends that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

4.3.3 Structural vibration

i Australian Standard AS 2187.2 – 2006

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 *Explosives - Storage and Use - Use of Explosives* recommends that the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* be used as they are "applicable to Australian conditions".

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to manage minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4.12 and graphically in Figure 4.1.

Table 4.12 Transient vibration guide values - minimal risk of cosmetic damage

Line[1]	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Notes: 1. Refers to the "Line" in Figure 4.1.

The standard notes that the guide values in Table 4.12 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 4.12 may need to be reduced by up to 50%.

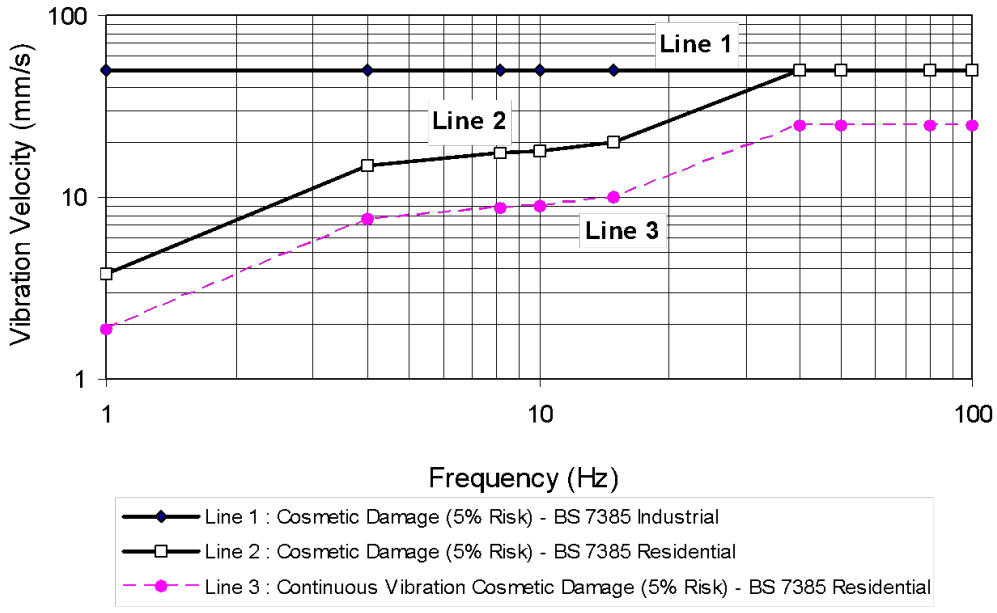


Figure 4.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz (as shown in Figure 4.1).

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 4.12 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be made at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 4.12.

It is noteworthy that in addition to the guide values nominated in Table 4.12 the standard states that:

> Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.

4.4 Road traffic noise

Construction and operational traffic require consideration for potential noise impacts. The principal guidance to assess the impact of road traffic noise on assessment locations is in the RNP (EPA 2011). Table 4.13 presents the road noise assessment criteria for residential land uses (ie assessment locations), reproduced from Table 3 of the RNP for road categories relevant to construction and use of the project. Under the definitions of the RNP, Castlereagh Highway would be an arterial road, with Birriwa Bus Route South and Barneys Reef Road being local roads.

Table 4.13 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria – dBA	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq,15hr}$ 60 (external)	$L_{eq,9hr}$ 55 (external)
Local roads	Existing residences affected by additional traffic on local roads generated by land use developments.	$L_{eq,15hr}$ 55 (external)	$L_{eq,9hr}$ 50 (external)

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to an increase of up to 2 dB.

In addition to meeting the assessment criteria in Table 4.13 any significant increase in total traffic noise at the relevant residential assessment locations must be considered. Residential assessment locations experiencing increases in total traffic noise levels above those presented in Table 4.14 should be considered for mitigation.

Table 4.14 Road traffic relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase – dBA	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/ sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external)

Appendix B of the RNP, states that noise levels shall be rounded to the nearest integer, whilst difference between two noise levels are to be rounded to a single decimal place.

Relative increase criteria are not available for local roads and therefore have been excluded from this assessment.

5 Assessment method

5.1 Noise modelling

This section presents the methods and base parameters used to model construction noise and vibration and operational emissions from project.

Operational and construction noise levels were predicted using a computer-generated model using SoundPlan 8.2 modelling software with the CONCAWE algorithm.

The model calculates total noise levels at assessment locations from concurrent operation of multiple noise sources. It considers factors that influence noise propagation such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the site and surrounding area and applicable meteorological conditions.

The model was populated with 3-D topography of the study area and surrounds, extending out past nearest assessment locations. Plant and equipment representing the range of proposed construction and operation scenarios was placed at locations which would represent worst case noise levels throughout the construction and operational scenarios.

5.2 Construction noise

5.2.1 Hours

Project construction will be during daytime hours only (including Saturday afternoons until 6.00 pm) and has an envisaged duration of up to 28 months. Key stages in construction will include:

- earthworks, filling, compaction and drainage;
- trenching and boring of foundations for battery modules, inverters, transformers and transmission line towers or trenching subject to design;
- modular battery, inverter, transformer and transmission line installation and commissioning; and
- control building, switch room, operations and maintenance building and substation construction.

5.2.2 Equipment sound power levels

The construction noise impact assessment has adopted sound power levels from the EMM noise database and the UK Department of Environment, Food and Rural Affairs (DEFRA) for plant and equipment items used for similar works. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 5.1.

Phases have been estimated for the project based on proposed construction activities provided in Section 2.3.

The assumed list of plant and equipment for each construction scenario that is provided in Table 5.1 is considered to be representative of a worst-case period of construction in an active works area. However, due to the practicalities of constructing a project of this nature, the plant and equipment quantities may vary from time-to-time to cater for the requirements of the project's construction.

If the actual fleet of plant and equipment required varies significantly from that assumed within Table 5.1, a risk assessment of the proposed works will be undertaken to determine the likelihood of noise impacts on surrounding residential assessment locations. Appropriate management and mitigation measures will be used, where required. A Construction Environmental Management Plan (CEMP) is expected to be developed as part of the project and will include the risk assessment protocol and detail the management and mitigation measures to be implemented during construction consistent with best practice requirements.

Table 5.1 Typical construction plant and equipment

Description	Equipment	Quantity	Item $L_{Aeq,15min}$	Overall $L_{Aeq,15min}$
Phase 1 – Site establishment	Dozer	2	110	120
	Grader	1	104	
	Excavator	2	107	
	Roller	1	116	
	Bobcat	2	103	
	Front End Loader	1	107	
	Road truck (deliveries)	2	106	
	Concrete truck	2	106	
	Drilling Rig SM 14	1	106	
	Light vehicle	4	76	
Phase 2 – Delivery of solar components and BESS infrastructure	Road truck (deliveries)	2	106	114
	Light vehicle	4	76	
	Crane	2	106	
	Forklift	2	106	
	Hand tools	2	80	
Phase 3 – Installation of infrastructure	Road truck (deliveries)	2	106	113
	Light vehicle	4	76	
	Crane	2	106	
	Hand tools	2	80	

Notes: 1. Standard hours: Monday to Friday 7.00 am to 6.00 pm, Saturday 7.00 am to 1.00 pm and no construction work on Sundays or public holidays.

2. Plant and equipment items have been assumed to operate continuously in any 15-minute period unless otherwise specified.

5.2.3 Noise predictions

i Single point predictions

To assess a potential worst-case construction scenario, the assessment has considered the identified plant and equipment in Table 5.1 operating continuously over a 15-minute period. Construction noise levels were predicted to the assessment locations listed in Table 3.1 and identified in Figure 3.1.

ii Noise contours

Further to the above approach and acknowledging other residential areas to the north, east, south and west of the development footprint, noise contours have been generated for the day construction activities to evaluate noise exposure surrounding the development footprint.

5.2.4 Noise enhancing meteorology

Construction is proposed to occur during day hours only with modelling of construction noise considering default noise enhancing weather conditions of 3 m/s wind to all receptors.

5.3 Construction vibration

5.3.1 Mobile plant and equipment

Safe working distances for typical items of vibration intensive plant are listed in Table 5.2. The safe working distances are quoted for both "Cosmetic Damage" (refer British Standard BS 7385) and "Human Comfort" (refer British Standard BS 6472-1).

Table 5.2 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Medium hydraulic hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	N/A
Vibratory Rollers	<50 kN (typically 1–2 tonnes)	5 m	15 to 20 m
	<100 kN (typically 2–4 tonnes)	6 m	20 m
	<200 kN (typically 4–6 tonnes)	12 m	40 m
	<300 kN (typically 7–13 tonnes)	15 m	100 m
	>300 kN (typically 13–18 tonnes)	20 m	100 m
	>300 kN (>18 tonnes)	25 m	100 m

Source: From Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007 – based on residential building.

Safe work distances relate to continuous vibration. For most construction activity, vibration emissions are intermittent in nature. The safe working distances are therefore conservative.

The safe working distances presented in Table 5.2 are indicative and will vary depending on the item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

The safe working distances have been used to assess the potential for contraction vibration impacts based on proposed construction activities.

5.4 Operational noise

Operational noise associated with the project will principally be from fixed plant and equipment including tracker motors, battery cubicles, inverters, LV/HV transformers and HV transformers.

5.4.1 Design drawings

The acoustic assessment has been based on preliminary layout drawing (Figure 2.1).

5.4.2 Plant and equipment

Noise impact from the operation of the project was considered at assessment locations outlined in Section 3.1.

As part of the detailed design process, the final locations for potential noise-generating infrastructure, in particular the solar arrays, substation and BESS facilities, will consider the distance between this type of infrastructure and non-associated residences, so as to minimise operational noise impacts, where practicable.

Noise sources considered during the operational phase of the project include tracker motors, battery cubicles, power conversion systems (PCS) and high voltage transformers. Envisaged operational noise sources are presented in Table 5.3. Based on manufacturer data and assuming constant operation of the LV/HV transformers and HV transformers, Table 5.3 also incorporates the reduced total sound power levels under varying utilisation levels and cooling system operation of the battery cubicles and inverters.

Three different options were assessed for battery racks:

- Option 1: outdoor battery racks;
- Option 2: battery racks contained within converted shipping containers fitted with HVAC equipment to provide necessary cooling; and
- Option 3: battery racks located within dedicated building fitted with HVAC equipment to provide necessary cooling.

Table 5.3 Operational noise source sound power levels

Noise source	L_{Aeq} sound power level per unit, dB[1]	Total sound power level, dB
Solar tracker motors (x20,000)	49	92
Solar Inverters (x268)	88	112
50 MVA LV-MV transformers (x24)	90	104
200 MVA MV-HF transformers (6)	98	106
Total (excluding BESS)		114
BESS Option 1 – Non-containerised solution		
Outdoor battery racks (x1,622)	74	106
PCU Skids (x166)	87	109
BESS Option 2 – Containerised solution		
Battery cubicles/containers (x161)	92	114
PCU Skids (x161)	87	109
BESS Option 3 – Building solution		
Indoor battery racks (x1622)	74	106[2]
HVAC (x27)	80	102

Table 5.3 Operational noise source sound power levels

Noise source	L_{Aeq} sound power level per unit, dB[1]	Total sound power level, dB
BESS Transformers		
290 MVA HV transformer (x4)	98	104
1200 MVA HV Grid transformer	113	113

Notes: 1. The combined noise levels will be subject to final quantity, configuration and layout of equipment as well as any noise attenuating measures.

2. This level is an internal level, and overall emissions will be reduced by the construction of the building

BESS levels have been modelled assuming 100% utilisation for day, evening and night, although based on experience night utilisations are likely to be much lower (typically 20% to 40%), resulting in lower noise emissions. Noise levels from solar infrastructure have been modelled as an overall value of 104 dB(A) for evening and night time operations to account for lower electrical and heat loads. Actual noise levels from solar infrastructure are likely to be much lower than this during night periods.

Noise levels from inverters and battery container solutions are controlled by noise from cooling fans which is expected to mask tonal components of noise emissions from these sources. However, it has been assumed that outdoor racks and transformers will have tonal characteristics, and as such will require adjustment in accordance with NPfI.

The operation of the BESS does not result in L_{Amax} noise level events hence this assessment has considered potential sleep disturbance impacts against L_{Aeq} 40dB during night hours.

5.4.3 Noise predictions

i Single point predictions

To assess potential operational noise, this assessment has considered the identified plant and equipment in Table 5.3 operating continuously over a 15 minute period. Operational noise levels were predicted to the assessment locations listed in Table 3.1 and identified in Figure 3.1.

ii Noise contours

Further to the above approach and acknowledging adjacent industrial land uses and other residential areas to the north, east and west of the development footprint, noise contours have been generated for the day (Figure 6.3) and night (Figure 6.4) operational activities to determine the potential extent of noise exposure.

5.4.4 Noise enhancing meteorology

Modelling of operational noise has been undertaken considering default noise enhancing weather conditions of 3 m/s wind to all receptors during day and evening periods, and a mild temperature inversion for night periods, in accordance with NPfI.

5.5 Road traffic noise

The UK Calculation of Road Traffic Noise (CoRTN) algorithm was used in the assessment of road traffic noise. The CoRTN algorithm has been used across Australia for several decades and has been extensively validated against specific Australian conditions. A summary of the road sections and assessment methodology is provided in Table 5.4.

Table 5.4 Road segments considered in noise assessment

ID	Road segment/name	AADT	Assessment methodology
1	Castlereagh Highway	1250	CoRTN

Road traffic movements associated with construction and operation of the project have been referenced from the Traffic Impact Assessment (EMM 2022) and adapted to suit RNP assessment requirements (Section 4.4).

Road traffic noise levels from the project have been assessed by calculating existing and existing plus project traffic at representative residential assessment locations using the CoRTN method. The following assumptions have been adopted:

- speed limit for Castlereagh Highway 80 km/h at Birriwa Bus Route South and 100 km/h at Barneys Reef Road (as signposted);
- there are no buildings or other intervening objects that will act like a noise barrier between the road and the noise assessment point (ie we are assessing the locations directly exposed to the road);
- 10% heavy vehicles; and
- a facade reflection has been added to predicted noise levels as appropriate.

There are no non-associated residences within 450 m of the segments of Birriwa Bus Route South and Barneys Reef Road that will be used by project-related vehicles to access the development footprint. Further, as relative increase criteria are not available for local roads, these roads have been excluded from this assessment.

Operational traffic associated with the project will typically be restricted to occasional maintenance vehicles only with expected maximum of 20 light vehicles a day. Accordingly, operational traffic from the project is not a concern or assessed further in this report. Assessment of construction traffic is provided in Section 6.3.

6 Impact assessment

6.1 Construction noise

6.1.1 Single point predictions

In accordance with procedures outlined in Section 5.2, prediction of construction noise levels is provided in Table 6.1 for normal day periods for the potential worst impact (ie Phase 1 construction works in Table 5.1). The construction noise level presented for each assessment location represents the energy-average noise level over a 15-minute period and assumes all plant operating concurrently.

Construction works will be undertaken during standard hours of 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 6.00 pm Saturday.

Table 6.1 Predicted construction noise levels – Non-associated residences

Assessment location	Classification	Predicted construction noise level, dB $L_{Aeq,15min}$	Compliance with daytime standard construction hours	Compliance with daytime non-standard construction hours (ie Saturday 1.00 pm to 6.00 pm)
R1	Residential	36	Compliant	Compliant
R3	Residential	44	Compliant	Non-compliant
R5	Residential	40	Compliant	Compliant
R7	Residential	35	Compliant	Compliant
R9	Residential	32	Compliant	Compliant
R10	Residential	32	Compliant	Compliant
R11	Residential	28	Compliant	Compliant
R12	Residential	37	Compliant	Compliant
R13	Residential	33	Compliant	Compliant
R15	Residential	29	Compliant	Compliant
R16	Residential	29	Compliant	Compliant
R17	Residential	29	Compliant	Compliant
R18	Residential	29	Compliant	Compliant
R19	Residential	29	Compliant	Compliant
R20	Residential	29	Compliant	Compliant
R21	Residential	29	Compliant	Compliant
R22	Residential	29	Compliant	Compliant
R23	Residential	22	Compliant	Compliant
R24	Residential	22	Compliant	Compliant
R25	Residential	22	Compliant	Compliant
R30	Residential	28	Compliant	Compliant

Table 6.1 Predicted construction noise levels – Non-associated residences

Assessment location	Classification	Predicted construction noise level, dB $L_{Aeq,15min}$	Compliance with daytime standard construction hours	Compliance with daytime non-standard construction hours (ie Saturday 1.00 pm to 6.00 pm)
R31	Residential	29	Compliant	Compliant
R33	Residential	28	Compliant	Compliant
R39	Residential	22	Compliant	Compliant
R40	Residential	24	Compliant	Compliant
R42	Residential	27	Compliant	Compliant
R43	Residential	26	Compliant	Compliant
R44	Residential	26	Compliant	Compliant

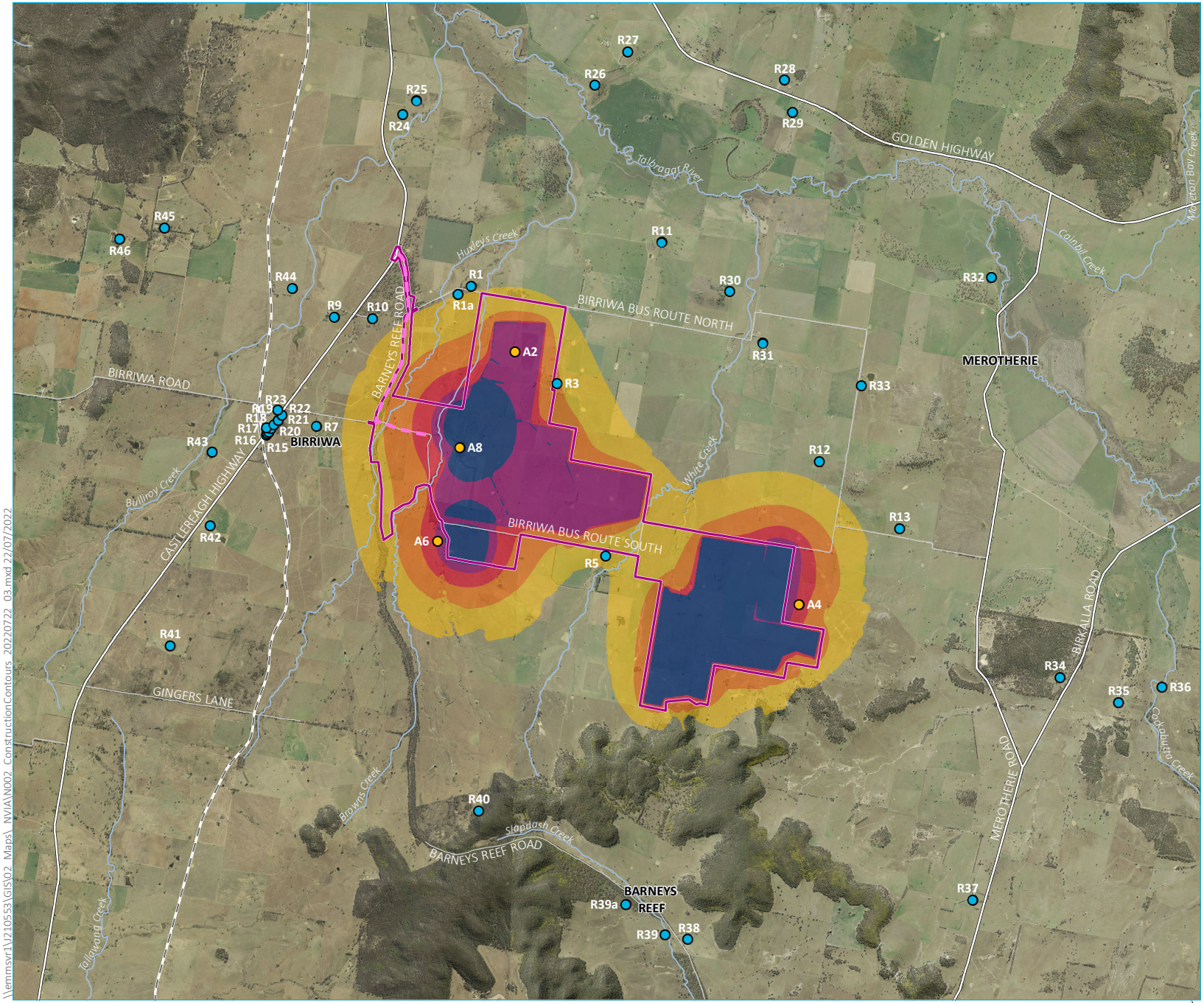
The results of the modelling demonstrate predictions of compliance with the construction NML for all assessment locations during daytime standard construction hours.

Exceedance of the ICNG noise goals is predicted at R3 during Saturday afternoon works (ie 1.00 pm to 6.00 pm). In order to achieve compliance, the following mitigation measures are recommended:

- during site establishment works, a construction exclusion zone of 650 metres from non-associated residences should be incorporated on Saturdays from 1.00 pm to 6.00 pm; and
- during infrastructure delivery and installation, a construction exclusion zone of 300 metres from non-associated residences should be incorporated on Saturdays from 1.00 pm to 6.00 pm.

6.1.2 Noise contours

Predicted $L_{Aeq,15minute}$ construction contours representing the worst-case noise level footprint from Phase 1 construction works listed in Table 5.1 are provided in Figure 6.1. Construction noise contours ($L_{Aeq,15minute}$) for Saturday afternoon works with the mitigation measures identified in Section 6.1.1 are presented in Figure 6.2.



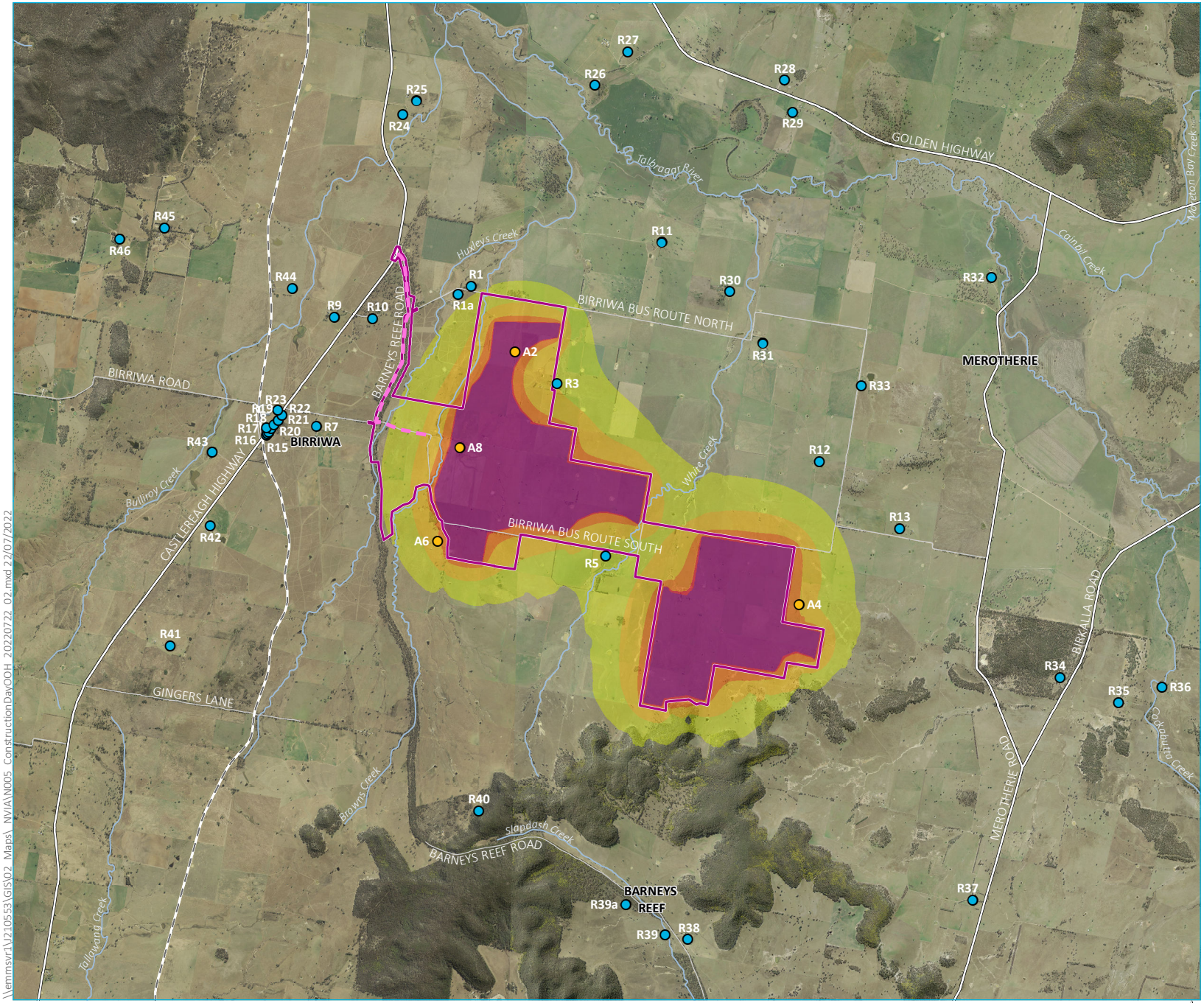
\\emmsvr1\J210553\GIS\02 Maps\ NVIA\N002 ConstructionContours 20220722 03.mxd 22/07/2022

Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

Construction noise contours - day

Birriwa Solar and Battery Project
Noise and Vibration Impact Assessment
Figure 6.1

EMM
creating opportunities



\\emmsvr1\210553\GIS\02 Maps\ NVIA\N005 ConstructionDayOOH 20220722 02.mxd 22/07/2022

Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

Construction noise contours - day OOH

Birriwa Solar and Battery Project
Noise and Vibration Impact Assessment
Figure 6.2

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6.2 Construction vibration

In relation to human comfort response, the safe working distances in Table 5.2 relate to continuous vibration and apply to residential assessment locations. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, as discussed in BS 6472-1.

The nearest non-associated residences are located beyond 100 metres from the closest proposed construction activities likely to produce significant vibration levels within the development footprint. These assessment locations are beyond the safe working distances for structural damage and subject to size of vibratory roller required, likely below the levels for human response (Table 5.2). Vibration impacts from construction at residential assessment locations are considered unlikely.

The safe working distances for cosmetic damage should be monitored throughout the construction process. Based on the safe working distances guide in Table 5.2, if construction is within 25 m of sensitive structures, then work practices should be reviewed so that the safe working distances in Table 5.2 are followed.

If safe working distances need to be encroached, real time vibration monitoring with audible and visual alarms should be installed at vibration sensitive structures so actual vibration levels can be monitored and managed appropriately in real-time.

6.3 Road traffic noise

Road traffic noise level predictions for peak construction traffic were carried out based on the following assumptions:

- 530 additional light vehicles (1,060 daily movements) travelling to the development footprint, with 70% of these coming from south (Mudgee and Gulgong), and 30% coming from the north (Dubbo);
- 120 additional heavy vehicles (240 daily movements) travelling to the development footprint, split evenly between those arriving via Castlereagh Highway to the north and south;
- current traffic volumes on Barneys Reef Road and Birriwa Bus Route South are negligible; and
- construction traffic will access the development footprint via Barneys Reef Road and Birriwa Bus Route South only.

The results of road traffic noise calculations carried out are provided in Table 6.2. Note that predictions have been carried out at locations within 500 m of roads, due to limitations of prediction accuracy beyond these distances. Receivers not presented in Table 6.2 are expected to experience lower levels of road traffic noise than those shown below.

Table 6.2 Road traffic noise calculations - day (7am to 10pm)

Receiver	Nearest road segment	Predicted existing road traffic noise level, $L_{eq,15hr}$	Predicted future road traffic noise level, $L_{eq,15hr}$	Noise level increase due to construction traffic
R9	Castlereagh Highway	40	44	3.5
R10	Castlereagh Highway	38	41	3.8
R15	Castlereagh Highway	49	52	2.8
R16	Castlereagh Highway	49	52	2.8
R17	Castlereagh Highway	49	52	2.9
R18	Castlereagh Highway	49	52	2.9
R19	Castlereagh Highway	50	52	2.9
R20	Castlereagh Highway	50	52	2.9
R21	Castlereagh Highway	47	50	2.8
R22	Castlereagh Highway	47	50	2.8
R23	Castlereagh Highway	46	49	2.7
R42	Castlereagh Highway	38	41	2.8
R43	Castlereagh Highway	30	33	2.4

While traffic levels on Castlereagh Highway are expected to increase by more than 2 dB during construction, the daytime traffic noise levels ($L_{Aeq,15hour}$) are below the minimum threshold of $L_{Aeq,15hr}$ 55 dB(A) for arterial roads under the RNP.

Following completion of construction, light vehicle traffic movements are expected to fall to around 20 per day, resulting in negligible changes in road traffic noise levels from Castlereagh Highway.

6.4 Operational noise

In accordance with procedures outlined in Section 5.4.3, prediction of single point operational noise levels was undertaken for day, evening and night periods. The levels presented for each assessment location represents the energy-average noise level over a 15 minute period and assumes all plant operating concurrently under adverse meteorological conditions (Section 5.4.4).

Predictions were assessed for six scenarios. These six scenarios were based on whether or not battery racks would be located outside, or within a containerised solution or dedicated building as presented in Section 5.4. Additionally, two different locations for the BESS were assessed. The assessed scenarios were:

- Scenario 1: BESS within Operational Infrastructure Area A with containerised racks;
- Scenario 2: BESS within Operational Infrastructure Area A with non-containerised racks;
- Scenario 3: BESS within Operational Infrastructure Area A with dedicated building;
- Scenario 4: BESS within Operational Infrastructure Area B with containerised racks;
- Scenario 5: BESS within Operational Infrastructure Area B with non-containerised racks; and

- Scenario 6: BESS within Operational Infrastructure Area B with dedicated building.

The results of these predictions are outlined within the following sections. Assessment criteria for all non-associated residences is L_{Aeq} 40 dB day and L_{Aeq} 35 dB for evening and night periods.

Each scenario also assesses operational noise generated by other project infrastructure, including tracker motors, PCSs and high voltage transformers (refer Section 5.4).

6.4.1 BESS within Operational Infrastructure Area A – Containerised

The containerised solution for the BESS consists of racks installed within containers with associated heating ventilation air conditioning (HVAC) for cooling. Noise emissions from these containers are controlled by HVAC and are expected to be relatively broadband in nature.

Table 6.3 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	33	28	27	Yes
R3	Residential	40	33	33	Yes
R5	Residential	38	35	35	Yes
R7	Residential	32	31	31	Yes
R9	Residential	28	26	26	Yes
R10	Residential	30	28	27	Yes
R11	Residential	24	19	19	Yes
R12	Residential	27	20	20	Yes
R13	Residential	24	14	14	Yes
R15	Residential	29	28	28	Yes
R16	Residential	29	28	28	Yes
R17	Residential	29	28	28	Yes
R18	Residential	29	28	28	Yes
R19	Residential	29	28	28	Yes
R20	Residential	29	28	28	Yes
R21	Residential	30	29	28	Yes
R22	Residential	30	29	29	Yes
R23	Residential	29	28	28	Yes
R24	Residential	16	<10	<10	Yes
R25	Residential	16	<10	<10	Yes
R30	Residential	21	15	15	Yes

Table 6.3 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R31	Residential	25	19	19	Yes
R33	Residential	21	11	11	Yes
R39	Residential	<10	<10	<10	Yes
R40	Residential	33[1]	32[1]	32[1]	Yes
R42	Residential	27	27	26	Yes
R43	Residential	27	26	26	Yes
R44	Residential	25	24	23	Yes

Notes: 1. Level adjusted by 5 dB due to presence of tonal characteristics at this location.

Compliance is predicted at all noise sensitive receivers.

6.4.2 BESS within Operational Infrastructure Area A – Non-containerised

The non-containerised solution for the BESS consists of outside racks. As there are fewer cooling requirements, noise emissions are generally lower, although less masking of tonal characteristics is expected.

Table 6.4 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (non-containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	32	*30*[1]	*30*[1]	Yes
R3	Residential	39	31	31	Yes
R5	Residential	36	32	32	Yes
R7	Residential	29	*32*	*32*	Yes
R9	Residential	27	*28*[1]	*28*[1]	Yes
R10	Residential	28	*30*[1]	*29*[1]	Yes
R11	Residential	24	*22*[1]	*21*[1]	Yes
R12	Residential	27	18	18	Yes
R13	Residential	24	15	14	Yes
R15	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R16	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R17	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R18	Residential	*32*[1]	*30*[1]	*30*[1]	Yes

Table 6.4 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (non-containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R19	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R20	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R21	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R22	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R23	Residential	*32*[1]	*30*[1]	*30*[1]	Yes
R24	Residential	17	<10	<10	Yes
R25	Residential	16	<10	<10	Yes
R30	Residential	21	*18*[1]	*18*[1]	Yes
R31	Residential	25	*22*[1]	*22*[1]	Yes
R33	Residential	21	11	11	Yes
R39	Residential	<10	<10	<10	Yes
R40	Residential	*31*[1]	*30*[1]	*30*[1]	Yes
R42	Residential	25	*28*[1]	*28*[1]	Yes
R43	Residential	24	*28*[1]	*27*[1]	Yes
R44	Residential	24	*26*[1]	*25*[1]	Yes

Notes: 1. Levels adjusted by 5 dB due to presence of tonal characteristics at this location

Compliance is predicted at all noise sensitive receivers.

6.4.3 BESS within Operational Infrastructure Area A – Dedicated Building

The dedicated building solution for the BESS consists of racks installed within a building, with HVAC services installed to supply cooling requirements.

Table 6.5 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (dedicated building)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	31	23	23	Yes
R3	Residential	39	30	30	Yes
R5	Residential	35	27	27	Yes
R7	Residential	30	28	28	Yes
R9	Residential	26	22	22	Yes

Table 6.5 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area A (dedicated building)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R10	Residential	28	23	23	Yes
R11	Residential	24	14	14	Yes
R12	Residential	27	17	17	Yes
R13	Residential	25	14	14	Yes
R15	Residential	*33*[1]	26	26	Yes
R16	Residential	*33*[1]	26	26	Yes
R17	Residential	*33*[1]	26	26	Yes
R18	Residential	*33*[1]	26	26	Yes
R19	Residential	*33*[1]	26	26	Yes
R20	Residential	*33*[1]	26	26	Yes
R21	Residential	*33*[1]	26	26	Yes
R22	Residential	*33*[1]	26	26	Yes
R23	Residential	*33*[1]	26	26	Yes
R24	Residential	17	<10	<10	Yes
R25	Residential	16	<10	<10	Yes
R30	Residential	21	11	11	Yes
R31	Residential	24	14	14	Yes
R33	Residential	22	11	11	Yes
R39	Residential	<10	<10	<10	Yes
R40	Residential	20	17	17	Yes
R42	Residential	25	24	24	Yes
R43	Residential	25	24	23	Yes
R44	Residential	25	22	22	Yes

Notes: 1. Levels adjusted by 5 dB due to presence of tonal characteristics at this location

Compliance is predicted at all noise sensitive receivers.

6.4.4 BESS within Operational Infrastructure Area B – Containerised

The containerised solution for the BESS consists of racks installed within containers with associated HVAC for cooling. Noise emissions from these containers are controlled by HVAC and are expected to be relatively broadband in nature.

Table 6.6 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area B (containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	31	21	21	Yes
R3	Residential	38	29	30	Yes
R5	Residential	36	32	33	Yes
R7	Residential	25	15	15	Yes
R9	Residential	24	14	14	Yes
R10	Residential	26	16	16	Yes
R11	Residential	23	13	13	Yes
R12	Residential	34	33	34	Yes
R13	Residential	34	33	34	Yes
R15	Residential	22	12	12	Yes
R16	Residential	22	12	12	Yes
R17	Residential	22	12	12	Yes
R18	Residential	22	12	12	Yes
R19	Residential	23	13	13	Yes
R20	Residential	23	13	13	Yes
R21	Residential	23	13	13	Yes
R22	Residential	23	13	13	Yes
R23	Residential	23	13	13	Yes
R24	Residential	17	<10	<10	Yes
R25	Residential	16	<10	<10	Yes
R30	Residential	25	24	23	Yes
R31	Residential	28	26	26	Yes
R33	Residential	28	27	27	Yes
R39	Residential	22	22	21	Yes
R40	Residential	17	<10	<10	Yes
R42	Residential	19	<10	<10	Yes
R43	Residential	20	10	<10	Yes
R44	Residential	21	11	11	Yes

Compliance is predicted at all noise sensitive receivers.

6.4.5 BESS within Operational Infrastructure Area B – Non-containerised

The non-containerised solution for the BESS consists of outside racks. As there are fewer cooling requirements, noise emissions are generally lower, although less masking of tonal characteristics is expected.

Table 6.7 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area B (non-containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	30	21	21	Yes
R3	Residential	38	29	30	Yes
R5	Residential	35	34[1]	35[1]	Yes
R7	Residential	25	15	15	Yes
R9	Residential	24	14	14	Yes
R10	Residential	26	16	16	Yes
R11	Residential	23	13	13	Yes
R12	Residential	36[1]	35[1]	35[1]	Yes
R13	Residential	36[1]	35[1]	35[1]	Yes
R15	Residential	22	12	12	Yes
R16	Residential	22	12	12	Yes
R17	Residential	22	12	12	Yes
R18	Residential	22	12	12	Yes
R19	Residential	23	13	13	Yes
R20	Residential	23	13	13	Yes
R21	Residential	23	13	13	Yes
R22	Residential	23	13	13	Yes
R23	Residential	23	13	13	Yes
R24	Residential	17	7	6	Yes
R25	Residential	16	6	6	Yes
R30	Residential	23	25[1]	25[1]	Yes
R31	Residential	26	28[1]	28[1]	Yes
R33	Residential	31[1]	29[1]	29[1]	Yes
R39	Residential	24[1]	24[1]	23[1]	Yes
R40	Residential	17	9	9	Yes
R42	Residential	19	9	8	Yes
R43	Residential	20	10	9	Yes

Table 6.7 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area B (non-containerised)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R44	Residential	21	11	11	Yes

Notes: 1. Levels adjusted by 5 dB due to presence of tonal characteristics at this location

Compliance is predicted at all noise sensitive receivers.

6.4.6 BESS within Operational Infrastructure Area B – Dedicated building

The dedicated building solution for the BESS consists of racks inside a building, with cooling requirements serviced with HVAC.

Table 6.8 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area B (dedicated building)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R1	Residential	30	21	22	Yes
R3	Residential	38	28	29	Yes
R5	Residential	34	26	27	Yes
R7	Residential	25	15	15	Yes
R9	Residential	24	14	14	Yes
R10	Residential	26	16	17	Yes
R11	Residential	23	13	13	Yes
R12	Residential	28	24	24	Yes
R13	Residential	27	24	24	Yes
R15	Residential	22	12	12	Yes
R16	Residential	22	12	12	Yes
R17	Residential	23	13	12	Yes
R18	Residential	22	12	12	Yes
R19	Residential	23	13	13	Yes
R20	Residential	23	13	13	Yes
R21	Residential	23	13	13	Yes
R22	Residential	23	13	13	Yes
R23	Residential	23	13	13	Yes
R24	Residential	17	<10	<10	Yes

Table 6.8 Predicted operational noise levels – adverse meteorological conditions – BESS within Operational Infrastructure Area B (dedicated building)

Receiver	Classification	Predicted noise level			Compliance
		Day	Evening	Night	
R25	Residential	16	<10	<10	Yes
R30	Residential	22	21	20	Yes
R31	Residential	25	18	18	Yes
R33	Residential	23	18	18	Yes
R39	Residential	15	14	14	Yes
R40	Residential	17	<10	<10	Yes
R42	Residential	19	<10	<10	Yes
R43	Residential	20	10	<10	Yes
R44	Residential	21	11	11	Yes

Notes: 1. Levels adjusted by 5 dB due to presence of tonal characteristics at this location

Compliance is predicted at all noise sensitive receivers.

6.4.7 Mitigation

To achieve compliance with operational noise criteria, the following mitigation measures were incorporated into the modelling:

- no electrical infrastructure (i.e transformers or inverters) installed within 250 m of the property boundary of R3; and
- the 1,200 MVA grid transformer, which will form part of the BESS, was modelled with a 6.5 m high barrier, positioned to reduce noise impacts on nearby sensitive receivers.

The location of the transformer and associated barrier has not been selected, and exact geometry of the transformer is not yet known. However, the barrier has been designed to break line of sight from the top of the transformer, and to provide returns either side of the transformer, as shown below in Plate 6.1. Exact lengths and dimensions of the transformer are not shown as these are subject to change based on final equipment selections.

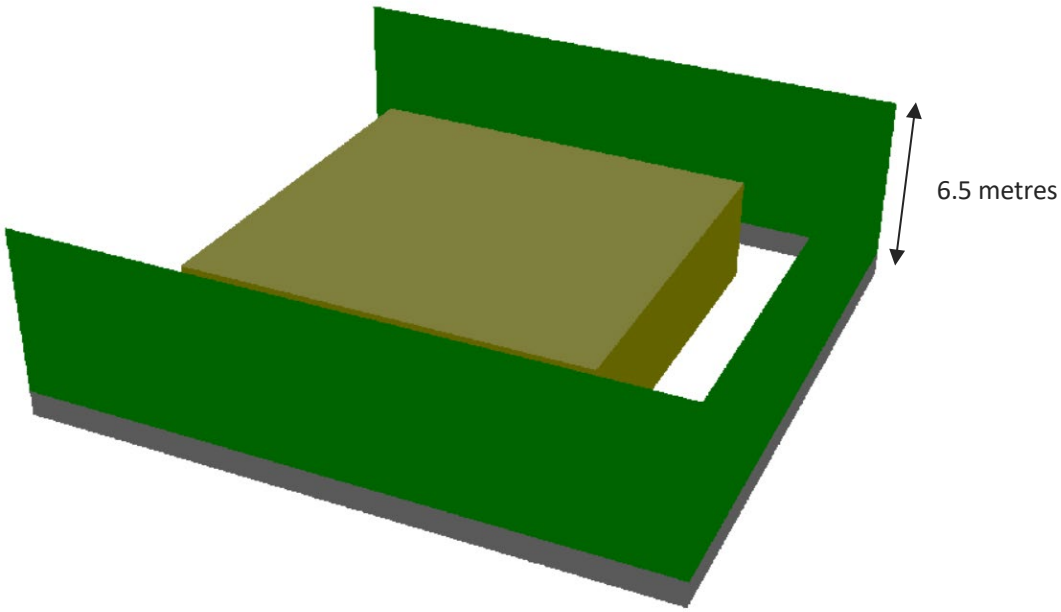


Plate 6.1 Indicative noise barrier location for high voltage transformer

As there exists a degree of uncertainty about anticipated electrical and heat loads and final equipment selection, conservative assumptions were made about emissions that will likely result in actual noise levels being lower than the predicted values presented in this section. Mitigation measures as outlined above may not be required to achieve compliance when more information is available (eg during detailed design). It is recommended that additional noise modelling be completed during detailed design to refine required mitigation and confirm compliance with the NPfI.

During the detailed design phase of the project, all plant and equipment will be reviewed to ensure noise levels predicted can be achieved through; selection of plant and equipment; site layout and orientation of equipment; provision of acoustic barrier (wall/retaining wall and batter or earth mounds); utilisation and operational procedures consistent with the assumptions in this NVIA; or a combination of the above measures.

6.4.8 Contours

Predicted $L_{Aeq,15min}$ noise contours representing day and night operations for the containerised options are provided in Figure 6.3 and Figure 6.4 respectively.

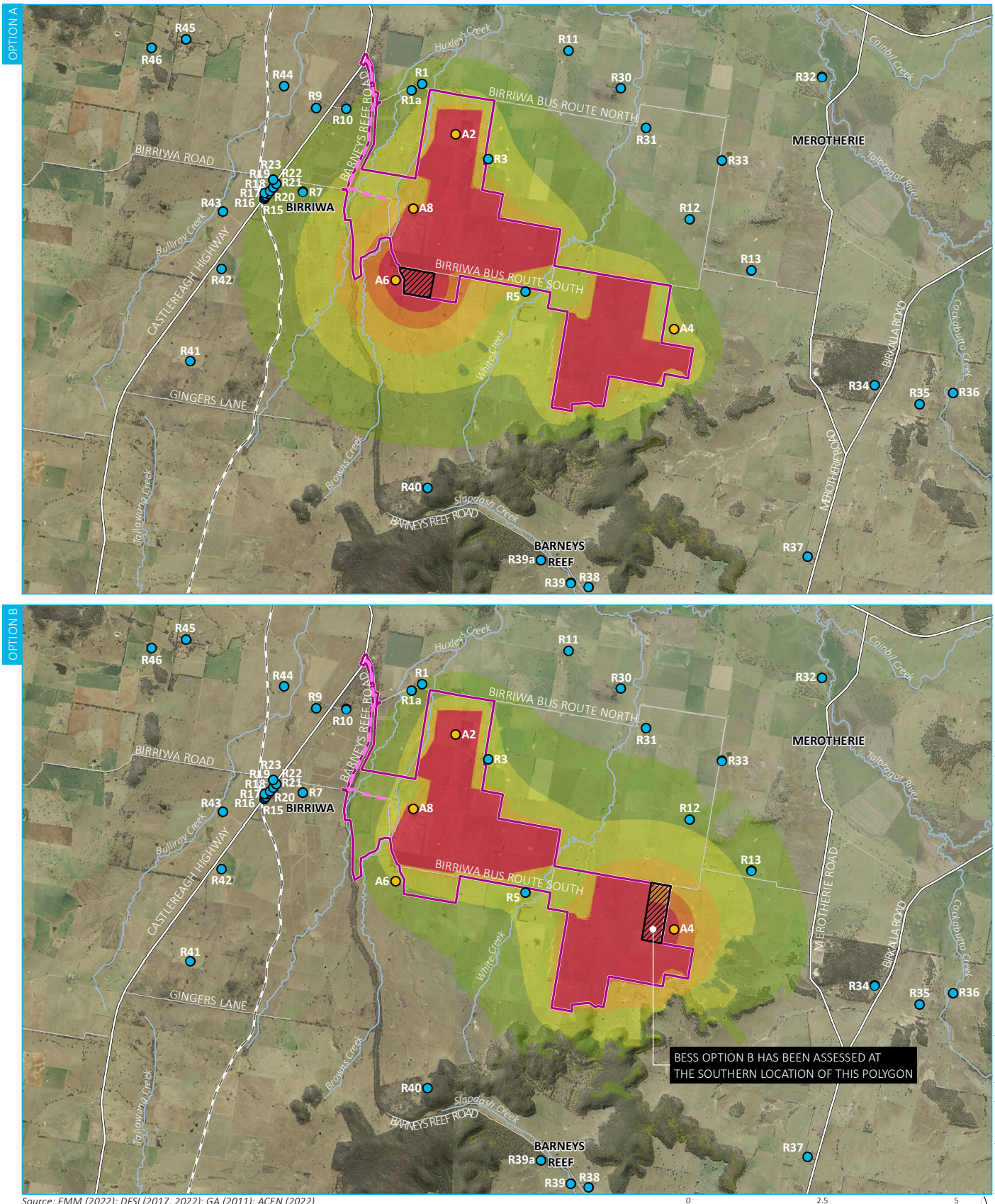
The figures represent the predicted operational noise levels during noise enhancing conditions (Section 5.4.4) for day, night under the stated BESS utilisations.

6.5 Cumulative operational noise impacts

The potential for cumulative noise impacts associated with the operation of the project and other approved or constructed renewable energy projects needs to be considered.

A review of nearby projects identified only the Barneys Reef Wind Farm project within 10 km of the project, which is proposed approximately 6 km to the south.

Due to the distance to nearest proposed wind turbines as part of the Barneys Reef Wind Farm project, cumulative noise impacts from other projects are not anticipated to be significant to this project.



Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Study area
- Road upgrade corridor
- Proposed operational infrastructure area including substation, operational facility and BESS (option A (top frame), option B (bottom frame))

Noise contour

- 30 - 35 dB(A)
- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- > 50 dB(A)

Existing environment

- Dwelling not associated with the project
- Dwelling associated with the project
- Rail line
- Major road
- Minor road
- Named watercourse

Operational noise contours - day

Birriwa Solar and Battery Project
Noise and Vibration Impact Assessment
Figure 6.3

EMM creating opportunities

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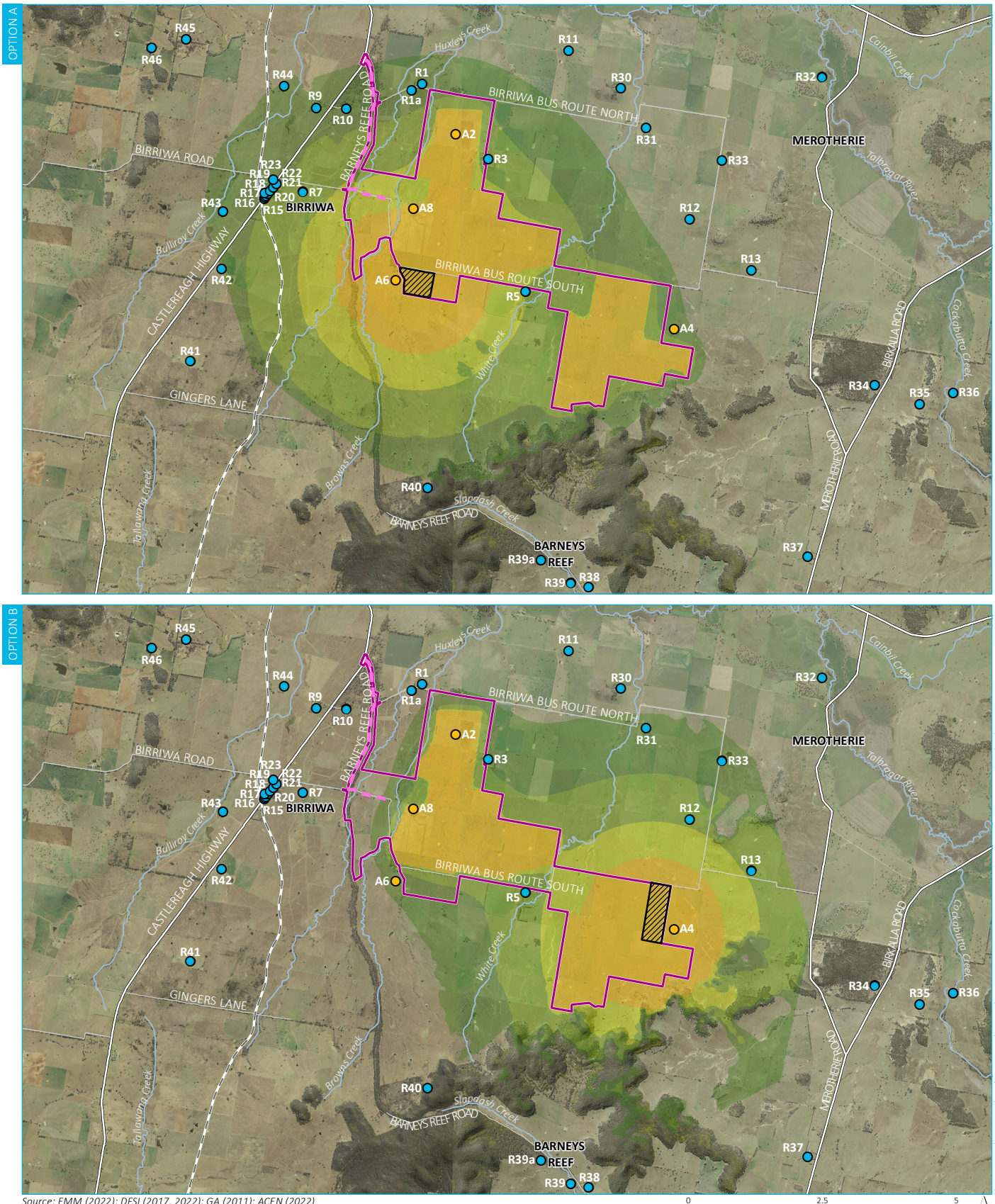

Source: EMM (2022); DFSI (2017, 2022); GA (2011); ACEN (2022)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

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KEY

- Study area
- Road upgrade corridor
- Proposed operational infrastructure area including substation, operational facility and BESS (option A (top frame), option B (bottom frame))

Noise contour

- 25 - 30 dB(A)
- 30 - 35 dB(A)
- 35 - 40 dB(A)
- > 40 dB(A)

Existing environment

- Dwelling not associated with the project
- Dwelling associated with the project
- Rail line
- Major road
- Minor road
- Named watercourse

Operational noise contours - night

Birriwa Solar and Battery Project
Noise and Vibration Impact Assessment
Figure 6.4

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7 Conclusion

This NVIA has been prepared to support an EIS for the Birriwa Solar and Battery Project at Birriwa, NSW. It has documented the methods and results, the initiatives built into the project design to avoid and minimise associated impacts, and the mitigation and management measures recommended to address any residual impacts not able to be feasibly and reasonably avoided.

7.1 Evaluation of the project

Construction noise levels from the project are predicted to be less than noise management levels (NMLs) at all non-associated residences with the management and mitigation measures implemented as per Section 6.1.

Operational noise has been assessed under adverse weather conditions. Noise mitigation measures have been included in the modelling. With the implementation of these measures, compliance with the NPfI criteria is predicted at all non-associated residences.

Due to high levels of uncertainty in the technology proposed for the project, a number of highly conservative assumptions have been made in the modelling. Confirmation and refinement of any mitigation requirements should be refined through the detailed design phase.

The potential for road traffic noise impacts on public roads due to project-related traffic has been assessed in accordance with the RNP for maximum daily project traffic movements during construction. The assessment has confirmed that road traffic associated with the construction of the project will increase existing road traffic noise levels by more than 2 dB; however, will remain under the minimum thresholds for arterial roads under the RNP.

During the detailed design phase of the project, all plant and equipment will be reviewed to ensure noise levels predicted in this NVIA can be achieved through selection of plant and equipment; site layout and orientation of equipment; provision of acoustic barrier (wall/retaining wall and batter or earth mounds); utilisation and operational procedures consistent with the assumptions in this NVIA; or a combination of the above measures.

References

Australian and New Zealand Environment Council 1990, *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*.

DEC 2006, *Assessing Vibration: A Technical Guideline.*

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DECCW 2011, *Road Noise Policy*.

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EMM 2022, *Birriwa Solar and Battery Project – Traffic Impact Assessment*. Report prepared by EMM for ACEN.

EPA 2017, *Noise Policy for Industry*.

Abbreviations

Item	Definition
AC	Alternating current
Access route	The route that will be used to access the project between the Castlereagh Highway and the access point to the site. The access route uses a section of Barneys Reef Road and a section of Birriwa Bus Route South.
ACEN	ACEN Australia Pty Ltd
ARL	Acoustic Research Laboratories
Associated residence	A residence that is associated with the project – i.e. they have a landholder agreement with ACEN for the project. Residences identified with an 'A' are associated.
BESS	Battery energy storage system
CEMP	Construction Environmental Management Plan
CWO	Central-West Orana
DC	Direct current
DEFRA	Department of Environment, Food and Rural Affairs (United Kingdom)
Development footprint	The area to be developed within land where ACEN hold landholder agreements. All operational components of the project will be within the development footprint. The development footprint is the outcome of the iterative process outlined in the EIS which led to excluding certain areas of environmental or social constraint.
DPE	Department of Planning and Environment
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
EnergyCo	Energy Corporation of NSW
EPA	NSW Environment Protection Authority (EPA)
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
ha	hectares
km	kilometres
kV	Kilovolt
LGA	Local government area
MW	Megawatts
NML	Noise management level
Non-associated residence	A residence that is not associated with the project, with no landholder agreement with ACEN. Residences identified with an 'R' are non-associated.
NSW	New South Wales
NVIA	Noise and vibration impact assessment
OOH	Out of hours
Operational infrastructure area	The proposed location of key operational infrastructure, including the BESS, substation, T-Link connection point, offices, car park, amenities and storage. Two locations are considered for the operational infrastructure area, but only one of the two location options will be implemented.

Item	Definition
PCS	Power conversion system
Planning Systems SEPP	*State Environmental Planning Policy (Planning Systems) 2021*
PV	Photovoltaic
RBL	rating background level
Restricted development area	Land within the development footprint where disturbance will be avoided wherever possible, with the exception of that required for the provision of access and electrical reticulation (i.e. private internal access roads and electrical cables).
REZ	Renewable Energy Zone
Road upgrade corridor	The area of direct impact for public road upgrade works along the access route, which comprises part of Barneys Reef Road and Birriwa Bus Route South (connecting the access point to the site with the Castlereagh Highway).
SEARs	Secretary's Environmental Assessment Requirements
SSD	State significant development
Study area	The area of assessment for baseline surveys and studies conducted for the EIS. The study area comprises the maximum area considered for the project based on the extent of land where ACEN hold landholder agreements and the area of potential impact for road upgrades
T-Link	Transmission link - NSW Energy Corporation's planned new 500/330 kV transmission line, substation(s) and related infrastructure within the CWO REZ.
The project	Birriwa Solar and Battery Project; a large scale solar photovoltaic generation facility along with battery storage and associated infrastructure. 'The project' refers to the project in its entirety; encompassing arrays of PV modules, power conversion units, BESS, connection infrastructure, road upgrades and ancillary infrastructure.
VDV	Vibration dose value

Glossary

Technical terms

Term	Meaning
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{A90} statistical noise levels.
Amenity noise level	The amenity noise levels relate to the overall level of industrial noise subject to land zoning or use
A-weighting	There are several different weightings utilised for describing noise, the most common being the 'A-weighting'. This attempts to closely approximate the frequency response of the human ear.
Day period	Monday–Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB	Noise is measured in units called decibels (dB).
EPA	NSW Environment Protection Authority (formerly the Department of Environment, Climate Change and Water).
Evening period	Monday–Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays
ICNG	Interim Construction Noise Guideline
Intrusive noise level	The intrusive noise level refers to noise that intrudes above the background level by more than 5 dB.
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The A-weighted noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The A-weighted energy average noise level. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq(15\text{-}minute)}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum A-weighted sound pressure level received during a measurement interval.
Night period	Monday–Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NMP	Noise management plan
PNTL	The project noise trigger levels (PNTLs) are targets for a particular industrial noise source or industry. The PNTLs are the lower of either the project intrusive noise level or project amenity noise level.
POEO Act	NSW *Protection of the Environment Operations Act 1997* (NSW)
RBL	The rating background level (RBL) is an overall single value 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 average background levels.
RNP	Road Noise Policy

Technical terms

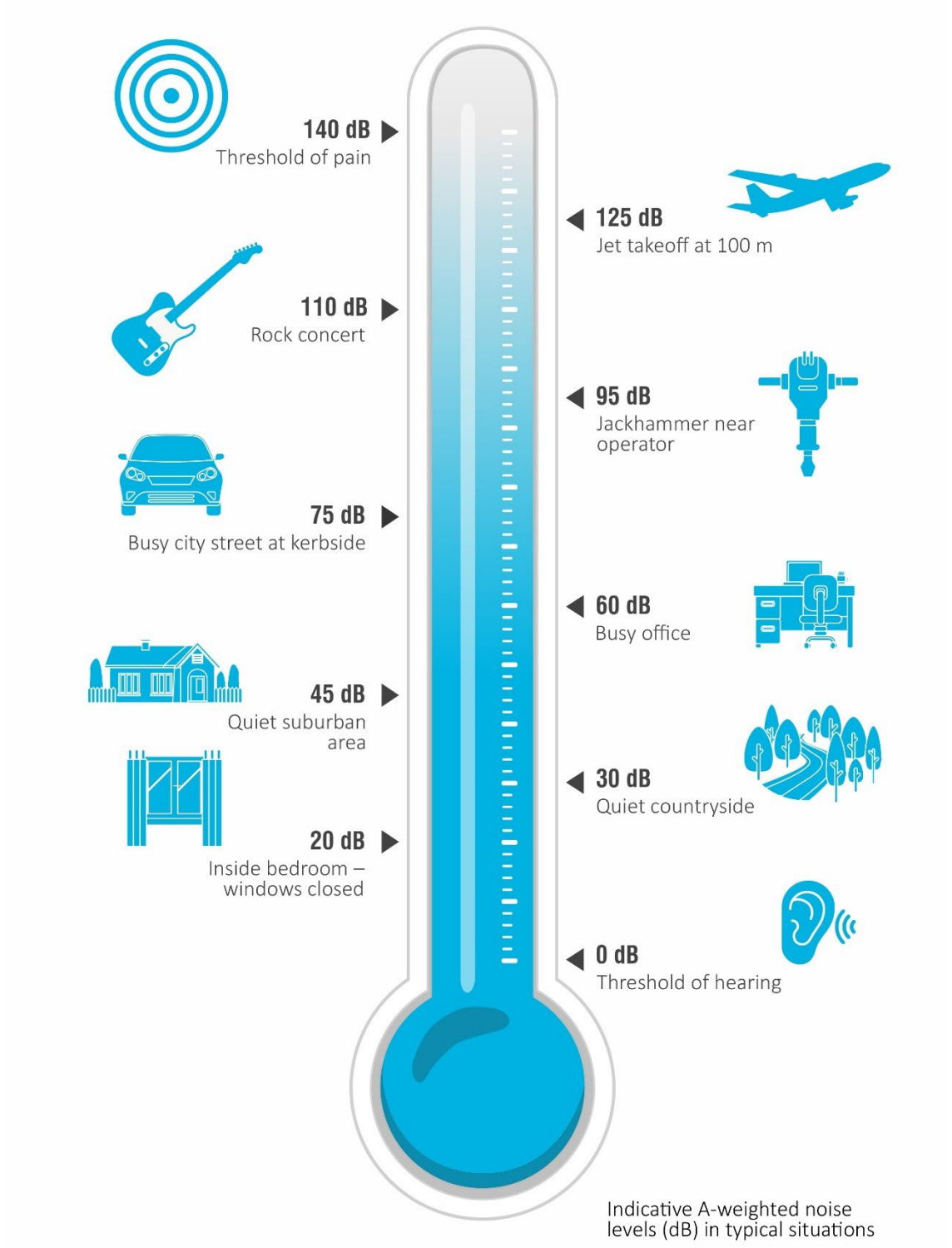
Term	Meaning
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

Common noise levels

The table below gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels encountered on a daily basis are provided in the figure below.

Perceived change in noise

Change in sound level (dB)	Perceived change in noise
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times as loud (or quarter) as loud.



Source: Road Noise Policy (DECCW 2011)

Figure G **Common sources of noise with levels**

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2 Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8 454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9 109 St Georges Terrace
Perth WA 6000

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1

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