Appendix H. Noise and Vibration Impact Assessment

Hume Battery Energy Storage System Project

Noise and Vibration Impact Assessment

IA213400_Hume BESS_NVIA | Final

29 July 2020

Meridian Energy Australia

Hume Battery Energy Storage System Project

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Project Manager:	Thomas Muddle
Author:	Luke Spencer
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Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 4, 12 Stewart Avenue
Newcastle West NSW 2302 Australia
PO Box 2147 Dangar NSW 2309 Australia
T +61 2 4979 2600
F +61 2 4979 2666
www.jacobs.com

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Executive Summary

Background

Meridian Energy Australia Pty Ltd (Meridian) is seeking an approval to undertake the Hume Battery Energy Storage System Project. The *Secretary's Environmental Assessment Requirements* (SEARs) for the Project identified noise and vibration as key matters requiring assessment. Consistent with the SEARs, an assessment was completed in accordance with the "Interim Construction Noise Guideline" (ICNG) (Department of Environment and Climate Change [DECC], 2009), the "Noise Policy for Industry" (NPI) (NSW Environment Protection Authority, 2017) and Assessing Vibration: a technical guideline (NSW Department of Environment and Conservation [DEC], 2006) to identify and evaluate the potential for noise and vibration-related impacts during the construction and operation of the Project.

Key features of the existing environment

A review of available information was completed to characterise key features of the existing environment. Aerial imagery was reviewed to identify sensitive receivers around the Project. Nearby heritage structures that can be more sensitive to vibration were identified by reviewing the Aboriginal Cultural Heritage Assessment Report and Statement of Heritage Impact (non-Aboriginal) prepared for the Project. Noting that certain meteorological conditions can enhance the propagation of noise, data collected at the nearby Department of Planning, Industry and Environment air quality and meteorological monitoring station at Albury were reviewed. These data indicated that the frequency of winds blowing in particular directions and the frequency of occurrence of temperature inversions in winter months were 'significant', and that noise-enhancing meteorological effects required consideration. In leu of monitored background noise levels, minimum rating background levels (RBLs) from the NPI were used for the purpose of the assessment.

Estimation of emissions

Construction staging and operational noise emissions information provided by Meridian were used to develop emissions inventories. Reference sound power levels (SWLs) from various standards and guidelines were used to estimate overall SWLs from different phases of construction. These inventories were cross-referenced against recommended safe setback guidance for avoiding vibration-related building cosmetic structural and human health impacts to identify vibration-generating plant/equipment identified to be used.

Assessment of impacts

Noise impacts during construction and operation were quantitatively evaluated by developing a site noise model using the SoundPlan acoustic software package. Predictions at surrounding sensitive receivers were compared against criteria developed using guidance from the ICNG, NPI and Assessing Vibration: a technical guideline, as well as other relevant standards to evaluate the potential for impacts. During construction 29 instances of exceedances of less than 10 dB(A) above standard daytime NMLs were predicted surrounding residential and temporary accommodation receivers during civil and mechanical/structural activities. Levels exceeding the day time NML by more than 10 dB(A) were predicted at residential receiver 'RR01' (located approximately 250 metres to the north of the Project along Trout Road) during the civil works phase. Noise resulting from operations was predicted to be well below the criteria established for the assessment, and the potential for cumulative impacts was also determined to be negligible.

Regarding the potential for noise impacts from additional traffic generated during construction, roads and Maritime Service's Construction Noise Estimator (CNE) tool was used to estimate where the change would result in increase of 2.1 dB(A) or more at nearby sensitive receivers. Using this approach, it was determined that increases in traffic noise as a result of additional traffic generated during construction would be negligible (i.e. 0.1 dB(A) or less), and that the 2.1 dB(A) relative increase criterion would not be exceeded.

Finally, considering relevant safe setback distance guidance and the location of surrounding receivers and it was determined that vibration impacts would also be unlikely during the Project. Regarding heritage structures,

recommendations were made to avoid impacts during compaction activities for the installation of the 11 kV electricity cabling infrastructure from the existing switchyard to the BESS.

Conclusion and recommendations

The assessment found that, based on the modelling and assessment undertaken in accordance with regulatory guidelines and to meet the requirements of the SEARs, that noise and vibration impacts during the project would be limited. Only noise during civil and mechanical/structural construction activities was identified as presenting a potential risk to amenity at some surrounding sensitive receivers. To control this risk, standard measures were recommended in accordance with the ICNG, as well as specific measures at residential receiver 'RR01', where levels up to 12 dB(A) above the adopted NML were predicted during the civil works construction phase in the absence of mitigation measures. Vibration management measures were also recommended in accordance with "Assessing Vibration: a technical guideline", (DECC, February 2006).

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts for the Hume Battery Energy Storage System Project in accordance with the scope of services set out in the contract between Jacobs and Meridian Energy Australia Pty Ltd (Meridian). That scope of services, as described in this report, was developed with Meridian.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Meridian and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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1. Introduction

Meridian Energy Australia Pty Ltd (Meridian) is proposing to undertake the Hume Battery Energy Storage System Project. The Project would involve the construction and operation of a battery energy storage system (BESS) with an estimated capacity of approximately 20 megawatts (MW) and associated infrastructure adjacent to Hume Dam Hydro Power Station (HPS) near Lake Hume Village, NSW. Meridian has engaged Jacobs Group Australia Pty Ltd (Jacobs) to complete an Environmental Impact Statement (EIS) for the proposed development. The *Secretary's Environmental Assessment Requirements* (SEARs) (No. SSD 10460 dated 14 May 2020) issued for the Project identify the key environmental matters requiring assessment as part of the EIS. Noise and vibration associated with construction and operations is identified as a key issue. The requirements for noise and vibration assessment from the SEARs is the subject of this Noise and Vibration Impact Assessment (NVIA) report. These requirements, including where they are addressed in the NVIA are reproduced below:

Table 1-1 Noise and vibration-related SEARs and where they are addressed in this report.

Requirements of SEARs (No. SSD 10460 dated 14 May 2020)	Where addressed in this report
Noise – including an assessment of the construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG),	**Sections 6.2**, **6.3** and **6.6**
operational noise impacts in accordance with the NSW Noise Policy for Industry (2017),	**Section 6.4**
cumulative noise impacts (considering other developments in the area), and	**Section 6.5**
a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria	**Section 7**

In meeting these requirements, the objectives of this assessment were to:

- Describe the Project setting, details and potential noise and vibration-related risks (**Section 2**)
- Outline key features of the existing environment including surrounding receivers, meteorology and background noise levels (**Section 3**)
- Establish suitable assessment criteria (**Section 4**)
- Estimate noise and vibration-related emissions associated with the construction and operational phases of the Project (**Section 5**)
- Predict the potential for noise and vibration-related impacts (including the potential for cumulative impacts) (**Section 6**)
- Recommend mitigation and management measures (**Section 7**).

2. Project description

2.1 Project setting

Figure 2-1 below displays the locality around the Project. As shown the nearest sensitive receivers are located approximately 300 metres to the north off Trout Farm Road, and around 300 metres to the east along Murray Street. In addition to residential and temporary accommodation receivers, industrial, commercial and recreational land uses are also located in the vicinity of the project.

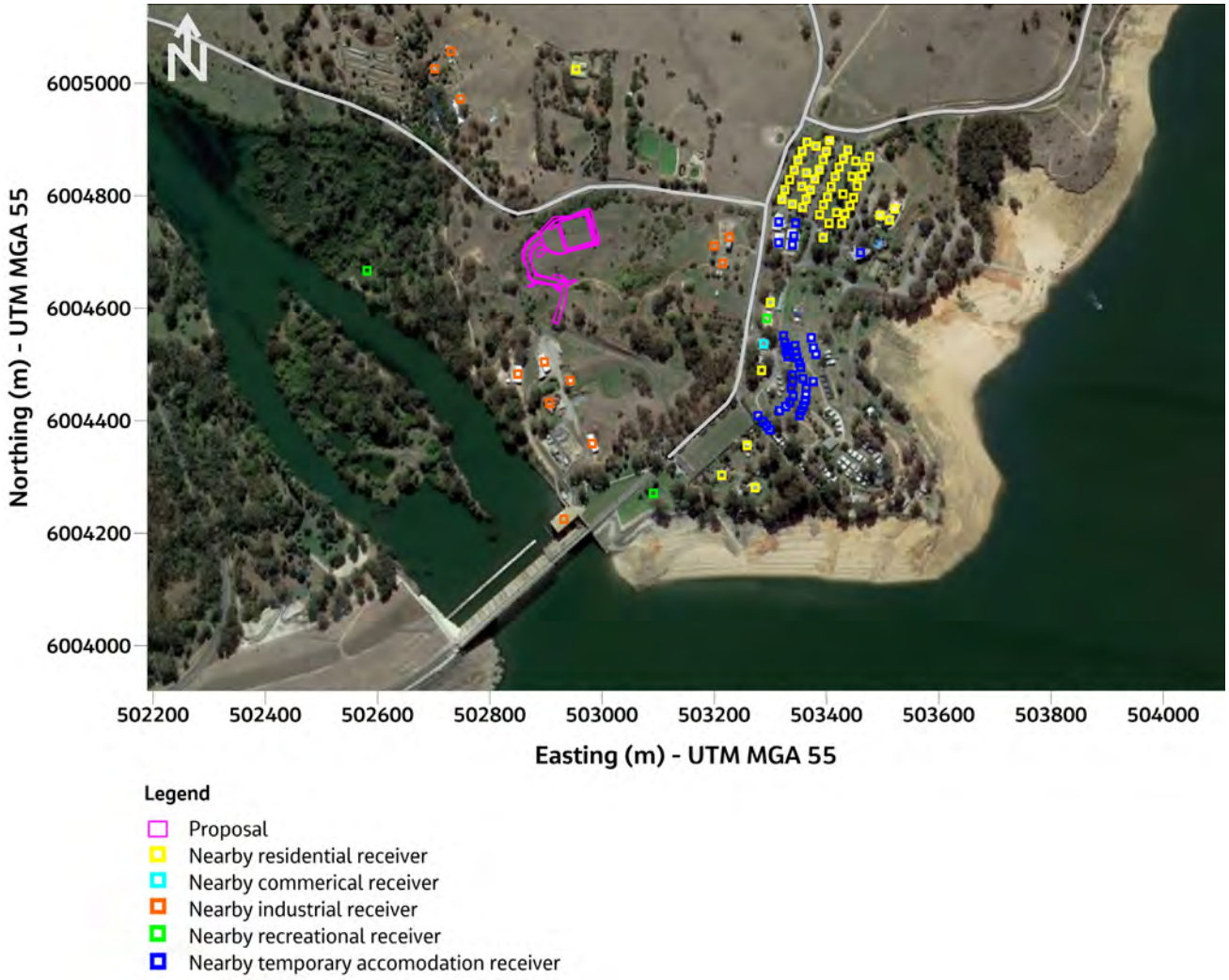

Figure 2-1 Project location

2.2 Project details

The Project works would include the following elements:

- Installation, commissioning, and operation of a 20MW/40MWh BESS
- Construction and operational access track from existing internal WaterNSW access road
- Ancillary upgrades to the existing substation switchyard to connect the BESS to the National Energy Market
- Underground 11 kV electricity cabling infrastructure from the existing switchyard to the BESS
- Construction of fencing around the perimeter of the BESS compound.

The BESS would have storage capacity to facilitate maximum discharge for a two-hour period. During operation, power generated by the HPS would be used to charge the BESS during periods of low energy demand. This energy would then be available for distribution to the National Energy Market in periods of higher demand. The BESS would also be able to charge from the NEM in circumstances where the HPS is not generating.

The BESS would be connected to the existing TransGrid transmission lines to Albury and the existing Ausnet transmission line to Wodonga. The connection would be established via a short below ground cable to the existing switchyard which would require minor augmentation.

Construction of the BESS would involve the excavation of approximately 8,000 cubic metres (m^3), with 8,000 m^3 placed at the site compound area (shown above in **Figure 2-1**). The approximate footprint would be of the order of around 1.5 hectares (ha) and the total duration of construction activities would be approximately nine months. Works would be completed during standard construction hours (i.e. Monday-Friday 0700-1800, Saturday 0800-1300 and no works on Sunday or public holidays). Access during construction would be via the existing WaterNSW access road of Murray Street in Lake Hume Village.

Once constructed the Project would be operated remotely with only occasional access for periodic maintenance. The facility could be in-use on a 24-hour, seven days per week basis when connected to the direct current interconnector and not running through the batteries. Otherwise the facility would be in-use up to around 5 hours per day.

2.3 Primary noise and vibration-related risks

Noise and vibration-related impacts can arise when levels from an industry or construction activities result in unacceptable levels at surrounding sensitive receivers. Noise and vibration have the potential to be generated during the construction and operational phases of the Project. The key activities with the potential to generate noise and vibration during the Project include:

- Civil, structural and electrical construction phases of the project including associated traffic movements
- Noise during operations.

3. Existing environment

3.1 Surrounding land uses and receivers

Surrounding land uses and nearby receivers in relation to the Project are displayed above in **Figure 2-1**. As noted in Section 2.1, the nearest residential and temporary accommodation receivers are located approximately 300 metres from the Project. Additionally, there are also industrial, commercial and recreational receiver locations near the Project. **Appendix A** lists Individual receiver identifiers for each receiver displayed in **Figure 2-1**

Vibration-sensitive receivers

Whilst all receivers and surrounding structures are sensitive to vibration impacts, heritage and precision industries are more typically more susceptible and are subject to more stringent criteria. A review of the Aboriginal Cultural Heritage Assessment Report and Statement of Heritage Impact (non-Aboriginal) prepared for the Project identified that the nearest heritage structure in relation to the Project are approximately 150 metres to the south of the BESS compound (State-listed Hume Dam Nissan Huts). The proposed cable trench connecting the BESS to the NEM via the existing HPS switchyard would be installed approximately 10 metres from these structures.

3.2 Meteorology

Certain meteorological conditions can enhance the propagation of noise and their influence is required to be accounted for where they are found to be a feature of the locality. A review was undertaken to assess whether prevailing winds and temperature inversions were 'significant' features of the local environment, consistent with the methods detailed in Fact Sheet D of the NSW Environment Protection Authority's (EPA's) "Noise Policy for Industry" (NPI) (2017). This review was undertaken using data collected in 2019 at the Albury air quality and meteorological monitoring station operated by the Department of Planning, Industry and Environment (DPIE). This review found that there were directions where the frequency of winds blowing were 'significant' and that the frequency of occurrence of temperature inversions in winter months was also 'significant' such that noise-enhancing meteorological effects required consideration as part of the operational noise review.

3.3 Background noise levels

The estimation of background noise levels is necessary to determine a localities sensitivity to changes in the acoustic environment. In the absence of monitored background noise levels the NPI provides the following minimum rating background levels (RBLs) to be used for the purpose of noise assessment:

Table 3-1 Adopted background noise levels

Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
35	30	30

4. Policy setting and criteria

4.1 Construction noise

4.1.1 Noise management levels

The "Interim Construction Noise Guideline" (ICNG) (Department of Environment and Climate Change [DECC], 2009) provides guidance for assessing noise from construction activities in NSW. It establishes noise management levels (NMLs) according to the hours in which construction may take place. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the noise management levels. **Table 4-1** lists ICNG guidance for establishing construction NMLs at residential receivers.

Table 4-1 ICNG guidance for establishing construction NMLs at residential receivers

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours (SH): Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected Rating Background Level (RBL) + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH) - All other times including public holidays	Noise affected RBL + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Considering the adopted RBLs presented in **Table 3-1** and the guidance above from the ICNG, the following NMLs listed in **Table 4-2** were established to assess potential construction noise impacts at the identified surrounding residential receiver locations.

Table 4-2 ICNG NMLs for residential receivers

Receiver type	Day (during standard hours)		Day (outside standard hours)		Evening		Night	
	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)
Residential	35	45	35	40	30	35	30	35

The ICNG also provides construction NMLs for non-residential land uses. This guidance has been reproduced below in **Table 4-3**.

Table 4-3 ICNG NMLs for non-residential receivers

Non-residential receiver type	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level – 65 dB(A)
Industrial premises	External noise level – 75 dB(A)
Offices, retail outlets	External noise level – 70 dB(A)

For temporary accommodation type receivers (e.g. hotels, holiday parks) the ICNG refers to guidance presented in *Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics: Recommended design sound levels and reverberation times for building interiors* (AS/NZS 2107:2016). For sleeping areas within temporary accommodation facilities AS/NZS 2107:2016 provides a maximum design target value of 35 dB(A). Windows often allow the greatest amount of sound transmission from outside to inside across a building façade. Noting guidance presented in *Australian Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites* AS2436-2010, Where bedrooms are ventilated by an opened window a transmission loss of 10 dB(A) would apply. Considering this an external NML of 45 dB(A) was conservatively applied at surrounding temporary accommodation receivers.

4.1.2 Construction traffic noise impacts

Section 9 of the "Construction Noise and Vibration Guideline" (CNVG), (NSW Roads and Maritime, 2016) provides guidance for the assessment of noise associated with additional traffic generated during construction. This guidance was adopted for this assessment and has been reproduced below:

> *'For RMS projects an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2dB(A) due to construction traffic or a temporary reroute due to a road closure. Where increases are 2dBA or less no further assessment is required.*
>
> *Where noise levels increase by more than 2dB(A) [i.e. 2.1 dBA] further assessment is required using Roads and Maritimes Criteria Guideline. This documents RMS' approach to implementing the Road Noise Policy. Consideration should be given under the Noise Criteria Guideline as to whether construction traffic or temporary reroute triggers new road criteria due to changes in road category'.*

This guidance was considered for the purpose of reviewing potential noise associated with additional traffic generated as a result of the Project.

4.2 Operational noise

4.2.1 Overview

Operational noise criteria for the Project are determined in accordance with the NSW EPA's NPI which seeks to regulate noise impact from 'industrial activity' pertaining to noise from fixed industry and mechanical plant rather than from road, rail or construction sources. To achieve this, the NPI applies two separate noise levels: one aimed at limiting the intrusiveness of the Project's noise against the prevailing level of background noise, and the other focused on achieving suitable acoustic amenity for the surrounding land uses from industry. The more stringent of these is used to define the operational noise criteria for a Project.

4.2.2 Intrusiveness noise level

A noise source will be deemed to be non-intrusive if the monitored $L_{Aeq\ (period)}$ noise level of the development does not exceed the RBL by more than 5 dB(A). Based on the RBLs adopted in **Table 4-2** the following criteria noise intrusiveness criteria would apply:

Table 4-4 NPI intrusiveness noise levels

Receiver type	Time of Day	L_{90} (RBL) dB (A)	Allowance	Noise intrusiveness criteria dB(A)
Residential receivers	Day (7 am to 6 pm)	35	+5 dB(A)	40
	Evening (6 pm to 10 pm)	30		35
	Night (10 pm to 7 am)	30		35

4.2.3 Amenity noise level

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the Project amenity noise level represents the objective for noise from a single industrial development at a receiver location. To ensure that industrial noise levels remain within the recommended amenity noise levels for an area, the following Project amenity noise levels would apply:

Table 4-5 NPI amenity noise criteria, residential receivers

Receiver type	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{Aeq\ 15\ minute}$ Noise Level dB(A)
Residential receivers	Day (7 am to 6 pm)	55	53
	Evening (6 pm to 10 pm)	45	43
	Night (10 pm to 7 am)	40	38

The NPI also presents amenity noise levels for non-residential receivers. These have been reproduced below in **Table 4-6**.

Table 4-6 NPI amenity noise criteria, other receivers

Receiver type	Time of day	Recommended amenity $L_{Aeq\ 15\ minute}$ Noise Level dB(A)
Hotels, motels, holiday accommodation, permanent resident caravan parks	Day (7 am to 6 pm)	58
	Evening (6 pm to 10 pm)	48
	Night (10 pm to 7 am)	42
Commercial premises	When in use	63
Industrial premises	When in use	68
Active recreational area	When in use	53

4.2.4 Project operational noise criteria

Considering the intrusive and amenity criteria developed above, the NPI recommends that the more stringent values be applied for each period of assessment. Considered this, the following criteria were adopted for the purpose of assessing the potential for operational noise impacts from the Project:

Table 4-7 Project operational noise criteria

Receiver type	Time of day	Recommended L_{Aeq} Noise Level dB(A)
Residential receivers	Day (7 am to 6 pm)	40
	Evening (6 pm to 10 pm)	35
	Night (10 pm to 7 am)	35
Hotels, motels, holiday accommodation, permanent resident caravan parks	Day (7 am to 6 pm)	58
	Evening (6 pm to 10 pm)	48
	Night (10 pm to 7 am)	42
Commercial premises	When in use	63
Industrial premises	When in use	68
Active recreational area	When in use	53

4.2.5 Sleep disturbance

For industrial premises where night operations occur, the potential for noise levels to lead to sleep disturbance should be considered. Where noise levels from an industrial source at a residential receptor at night exceeds the following, a maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40dB(A) or the RBL + 5dB(A), whichever is greater, and/or;
- L_{AFMax} 52 dB(A) or the RBL +15 dB(A), whichever is greater.

Based on this guidance, a sleep disturbance screening criterion of $L_{Aeq,15min}$ 45 dB(A) was applied.

4.3 Vibration

4.3.1 Overview

Vibration arising from construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two outcomes have different criteria levels, with the effects of vibration on human comfort having a lower threshold.

4.3.2 Human comfort

With respect to human comfort, vibration arising from construction activities must comply with criteria presented in "Assessing Vibration: a technical guideline", (DECC, February 2006) and *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* [BS 6472-1: 2008]. DECC, 2006 identifies three different forms of vibration associated with construction activities:

- Continuous: uninterrupted vibration occurring over a defined period
- Impulsive: short-term (typically less than two seconds) bursts of vibration which occurs up to three times over an assessment period
- Intermittent: interrupted periods of continuous or repeated impulsive vibration, or continuous vibration that varies significantly in magnitude

Continuous vibration may result from steady road traffic or steady use of construction equipment (e.g. generator). Impulsive vibration may arise during the loading or unloading of heavy equipment or materials or infrequent use of hammering equipment. Intermittent vibration may arise from the varied use of construction equipment (i.e. a dump truck moving around a site, idling while being loaded with materials, and then dumping the materials) or repeated high-noise activities such as hammering, piling or cutting.

Preferred and maximum values of human exposure for continuous and impulsive vibrations are listed (DECC, February 2006) below.

Table 4-8 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x and y axis	z-axis	x and y axis
Continuous vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night	0.020	0.014	0.040	0.028
Impulsive vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14
Offices, schools, educational	Day or night	0.64	0.46	1.28	0.92

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x and y axis	z-axis	x and y axis
institutions and places of worship					
Workshops	Day or night	0.64	0.46	1.28	0.92

[1] Daytime is 7am to 10pm. Night-time is 10pm to 7am

[2] includes hospital operating theatres or precision laboratories.

Intermittent vibration is assessed differently using vibration does values (VDV). Preferred and maximum VDVs for different types of receivers have been reproduced below.

Table 4-9 Preferred and maximum VDVs for intermittent vibration (ms-$^{1.75}$), (DECC, 2006)

Location	Day time (7 am to 10 pm)		Night time (10 pm to 7 am)	
	Preferred VDV	Maximum VDV	Preferred VDV	Maximum VDV
Critical areas[1]	0.10	0.20	0.10	0.2
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

[1] Includes operating theatres, precision laboratories and other areas where vibration-sensitive activities may occur.

4.3.3 Buildings and structures

Section J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundbourne vibration* [BS7385-2:1993] and are shown below.

Table 4-10 Transient vibration guideline values for cosmetic damage

Type of building	Peak particle velocity (ppv) mm/s		
	4 to 15 Hz	15 to 40 Hz	40 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50		
Un-reinforced or light-framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

Guidance for more sensitive structures is presented in the German standard, *DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures* (DIN 4150-3: 2016). Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard.

4.3.4 Construction Noise and Vibration Guideline

Section 7 of the CNVG provides useful guidance for safe working distances to achieve human comfort (*Assessing Vibration: a technical guideline*, (DECC, February 2006) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These have been reproduced below.

Table 4-11 Recommended safe setback distances

Plant	**Rating / description**	**Safe working distance (meters)**	
		Cosmetic damage (BS7385-2: 1993)	**Human response (DECC, 2006)**
Vibratory Roller	<50 kN (typically 1-2 tonne) <100 kN (typically 2-4 tonne) <200 kN (typically 4-6 tonne) <300 kN (typically 7-13 tonne) >300 kN (typically 13-18 tonne) >300 kN (> 18 tonne)	5 metres 6 metres 12 metres 15 metres 20 metres 25 metres	15 m to 20 metres 20 metres 40 metres 100 metres 100 metres 100 metres
Small hydraulic hammer	300 kg – 5 to 12 tonne excavator	2 metres	7 metres
Medium hydraulic hammer	900 kg – 12 to 18 tonne excavator	7 metres	23 metres
Large hydraulic hammer	1600 kg – 18 to 34 tonne excavator	22 metres	73 metres
Vibratory pile driver	Sheet piles	2 to 20 metres	20 metres
Pile boring	≤800 mm	2 metres (nominal)	4 metres
Jackhammer	Hand held	1 metres (nominal)	2 metres

5. Estimation of emissions

5.1 Noise emissions during construction

Overall sound power levels (SWLs) were predicted for each phase of construction. These were determined based on sequencing and plant and equipment provided by Meridian. The overall SWLs were estimated with reference to individual plant and equipment levels presented in national and international standards and guidelines, as well as from Jacobs measurement database. **Table 5-1** below summarises estimated overall noise emissions for the agreed assessment scenarios.

Table 5-1 Estimated noise emissions during construction

Construction phase	Plant/equipment	Approximate duration (weeks)	Overall sound power level (SWL) dB(A)
1. Civil works	Grader Digger x 2 Bobcat Front end loader Trucks Drilling rig Light vehicles	8 weeks	118
2. Mechanical/structural activities	Crane Forklift Franna Hand tools Light vehicles Delivery trucks	20 weeks	112
3. Electrical works	Light vehicles Franna Hand tools	20 weeks	104

The project would also result in additional traffic movements which could result in additional vehicle-related noise emissions. The additional flows forecast are summarised below:

- During construction:
  - Up to around 24 additional light vehicle movements per day
  - Approximately 4 additional heavy vehicle movements per day
- During operations:
  - Negligible. Estimated that the project would generate only one vehicle movement every 6-months.

5.2 Noise emissions during operations

During operations the only source of noise emissions would be from the BESS and periodic maintenance activities. For the purpose of the assessment, a maximum sound pressure level of 79 dB(A) at 1 metre from the facility was advised.

5.3 Vibration-generating plant and equipment

Of the plant and equipment expected to be used during construction listed above in **Table 5-1** the drilling rig to be used during site civil works has the potential to generate vibration impacts. Relevant guidance from the CNVG for this plant has been reproduced below in Error! Reference source not found..

Table 5-2 Recommended safe working distances for use of drilling rig near residential receivers

Plant	Rating / description	Safe working distance (meters)	
		Cosmetic damage (BS7385-2: 1993)	Human response (DECC, 2006)
Pile boring (drilling rig)	≤800 mm	2 metres (nominal)	4 metres

In addition to this, small compaction equipment may be used during the installation of the 11 kV electricity cabling infrastructure from the existing switchyard to the BESS.

6. Assessment of impacts

6.1 Assessment approach

To evaluate potential noise impacts during construction and operations a site noise model was developed using the SoundPlan acoustic software package. Predictions were compared against the noise management levels (construction, see **Section 4.1.1**) and Project operational noise criteria (operations, see **Section 4.2.4**). Setup details for the site noise model are listed below in **Table 6-1**.

Table 6-1 Noise model setup details

Model input	Details
Topography	One second (approximately 30-meter resolution) shuttle radar topography mission (SRTM) terrain data
Buildings	Footprints for receiver and other ancillary buildings were determined from aerial photography. Heights were estimated from Google Street view, or otherwise, assuming a building floor height of 3 metres per level.
Non-building receivers	Set at a height of 1.5 metres around the worst affected areas of these locations.
Ground absorption	Water and barren areas – 0.0 Residential areas – 0.5 Open grassland and vegetation areas – 0.75
Noise sound power levels	As listed in **Section 5**
Meteorology	Standard (construction) and noise-enhancing meteorological conditions (operations)
Prediction method	CONCAWE algorithm

Noise associated with addition traffic movements generated during construction was predicted using TFNSW's Construction Noise Estimator (CNE) tool. Finally, the potential for vibration-related impacts was evaluated by comparing the recommended safe setback distances for relevant plant and equipment with the locations of the identified surrounding sensitive receivers and heritage structures.

6.2 Construction noise

Noise levels resulting from the three phases of construction (civil, mechanical/structural and electrical works as listed in **Table 5-1**) were predicted at the surrounding sensitive receivers identified in **Figure 2-1**. These results are presented as contours below in **Figure 6-1** (civil works), **Figure 6-2** (mechanical/structural works) and **Figure 6-3** (electrical works), with tabulated predictions at each receiver listed in **Appendix B**. The range of results predicted are summarised below in **Table 6-2**.

Table 6-2 Range of predicted noise levels, construction

Receiver type	Noise management level dB(A)	Range of predicted noise level $L_{Aeq\ 15\ minute}$ dB(A) by construction phase		
		1. Civil works	2. Mechanical / structural activities	3. Electrical works
Residential	45	32.0 to **57.2**	26 to **51.2**	<20 to 43.2
Accommodation	45	37.1 to **53.4**	31.1 to **47.4**	23.1 to 39.4

Receiver type	Noise management level dB(A)	Range of predicted noise level $L_{Aeq\ 15\ minute}$ dB(A) by construction phase		
		1. Civil works	2. Mechanical / structural activities	3. Electrical works
Commercial	70	53.0	47.0	39.0
Industrial	75	55.8 to 61.0	49.8 to 54.8	41.8 to 46.8
Recreational	65	46.2 to 53.6	40.1 to 46.5	32.1 to 38.5

During the completion of phase 1 (civil works), levels above the day time NML of 45 dB(A) were predicted at some residential receivers. This was also the case at some temporary accommodation receivers. Levels at surrounding commercial, industrial and recreational receivers were predicted to remain below applicable NMLs. During phase 2 (mechanical/structural works) levels above the day time NML of 45 dB(A) were also predicted at some residential and accommodation receivers. During this phase, no exceedances were predicted at surrounding commercial, industrial and recreational receivers. Finally, no exceedances were predicted during the completion of phase 3 (electrical works). **Table 6-3** below provides further details for the predicted potential exceedances.

Table 6-3 Summary of predicted exceedances during construction

Construction phase	Residential receivers			Accommodation receivers		
	No. with level exceeds 45 dB(A) NML	No. exceedances < 10 dB(A) above NML	No. exceedances > 10 10 dB(A) above NML	No. with level exceeds 45 dB(A) NML	No. exceedances < 10 dB(A) above NML	No. exceedances > 10 10 dB(A) above NML
1. Civil works	17	16	1	2	2	0
2. Mechanical / structural works	8	8	0	2	2	0

As listed, levels above standard day time NMLs were predicted at 17 residential and 2 temporary accommodation receivers during phase 1 (civil works), and at 8 residential receivers and 2 temporary accommodation receives during phase 2 (mechanical /structural activities). Of the exceedances predicted, all but one were instances where the predicted level was less than 10 dB(A) above the NML. Appendix C of the CNVG provides guidance for evaluating the significance of noise exceedances during construction. Exceedances less than 10 dB(A) during standard hours are considered to be at a level that is 'clearly audible', but not at a magnitude requiring additional measures beyond standard best-practice controls. At the receiver located 250 metres to the north of the Project along Trout Road (denoted receiver 'RR01' in **Appendix A** and **Appendix B**) during phase 1 civil works, a noise level of 57 dB(A) was predicted. A 12 dB(A) exceedance during standard hours is considered to be 'moderately intrusive', and the CNVG recommends additional mitigation measures. These measures, as well as the standard noise controls for the Project are presented below in **Section 7**.

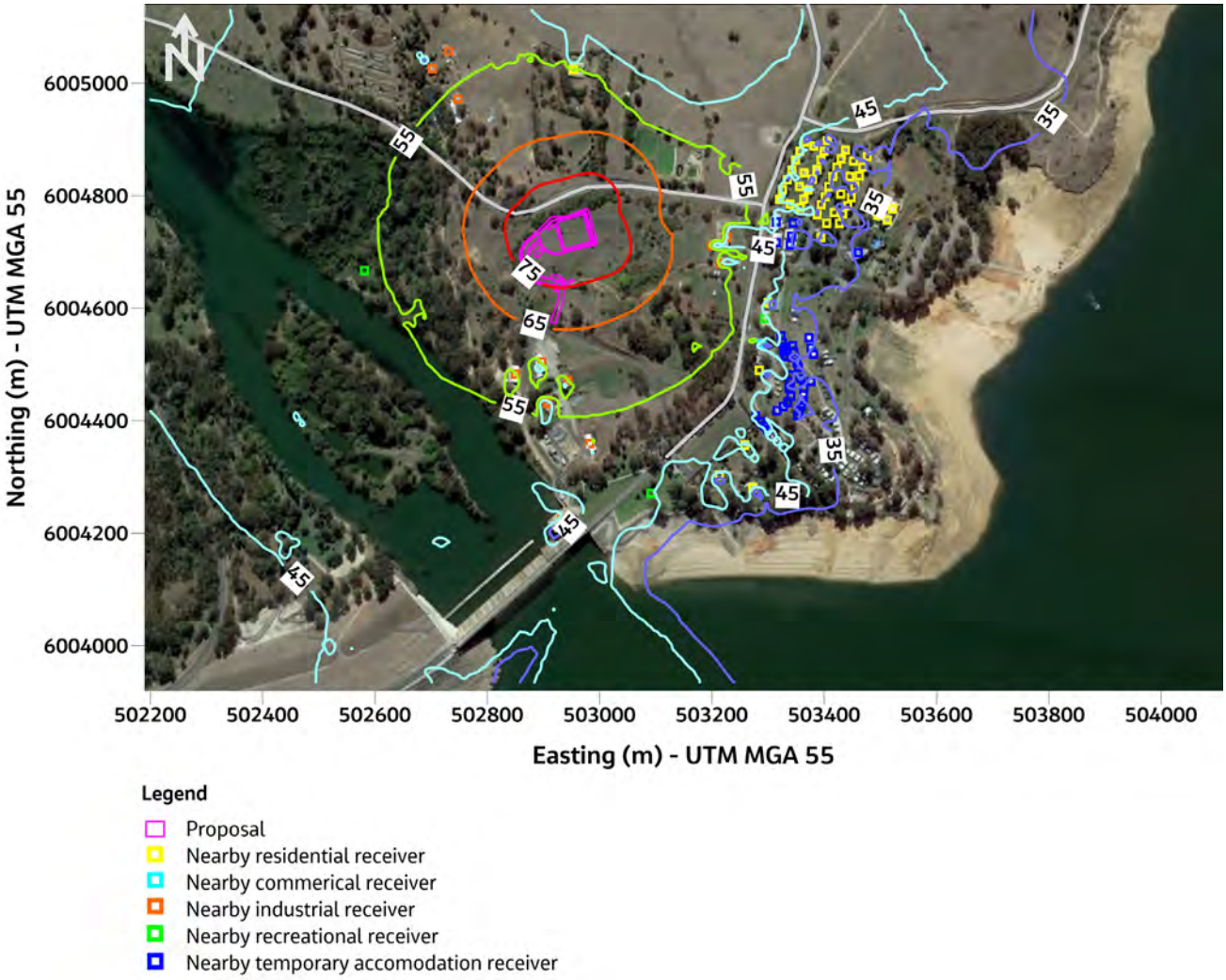

Figure 6-1 Predicted construction noise levels $L_{Aeq\ 15\ minute}$ dB(A), construction phase 1 (Civil works)

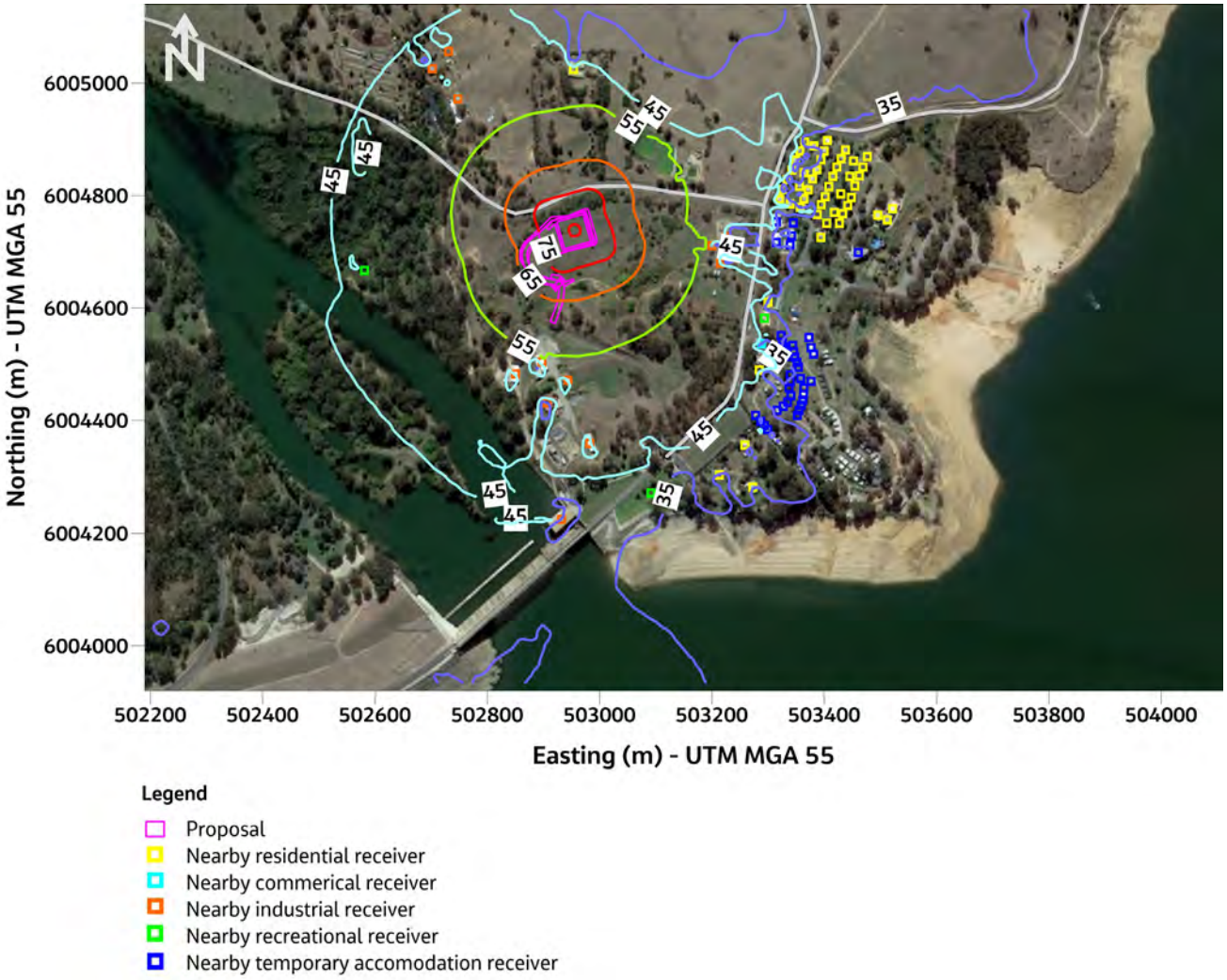

Figure 6-2 Predicted construction noise levels $L_{Aeq\ 15\ minute}$ dB(A), construction phase 2 (mechanical / structural works)

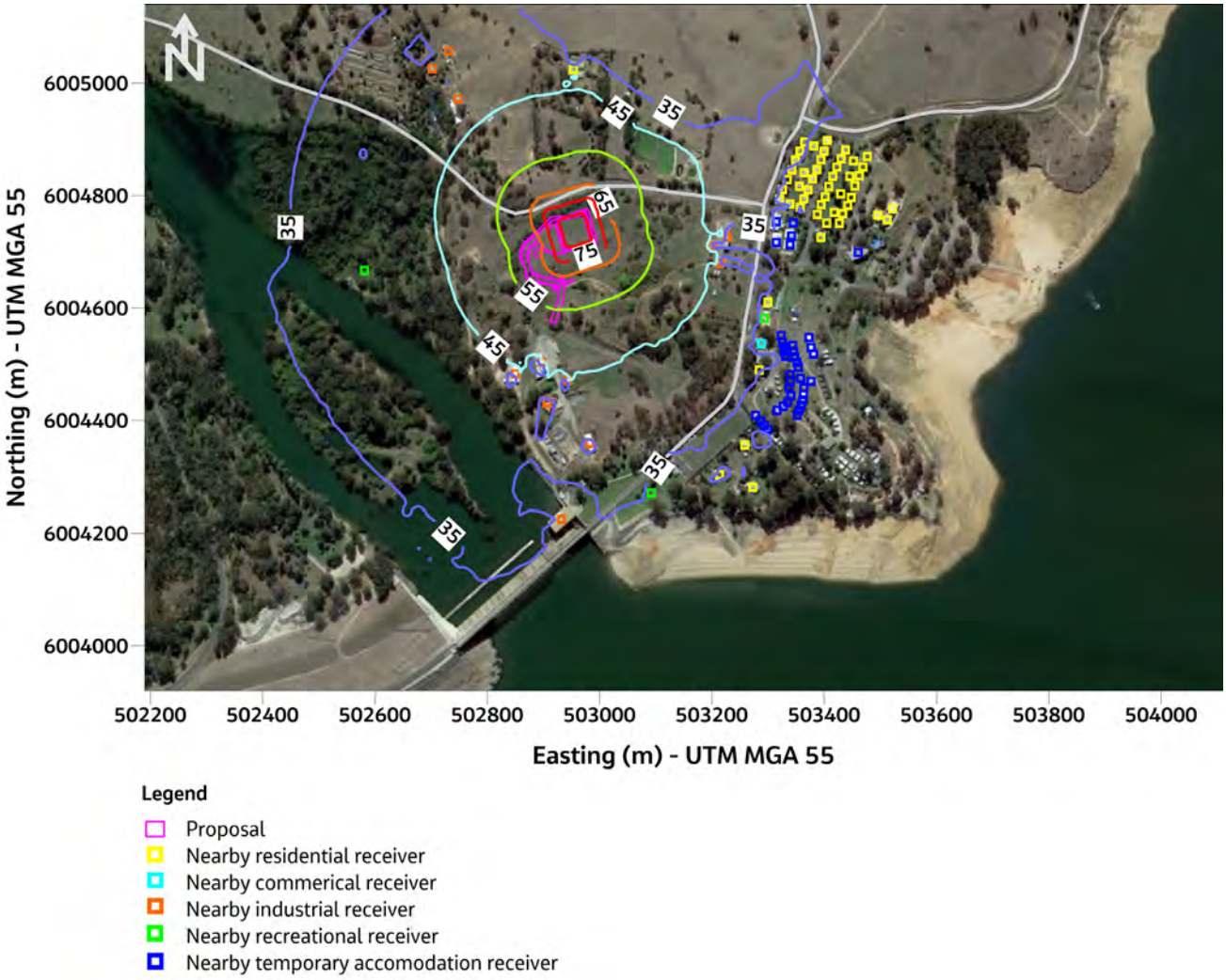

Figure 6-3 Predicted construction noise levels $L_{Aeq\ 15\ minute}$ dB(A), construction phase 3 (electrical works)

6.3 Noise resulting from traffic generated during construction

As outlined in **Section 2.2**, access to the site during construction would be via the existing WaterNSW access road of Murray Street. Daily traffic volumes were collected along Murray Street in 2006 at station 95469. One-way flows of 1,142 vehicles per day were measured with average flows one-way flows of 897 vehicles during standard daytime hours.

Despite the age and limitations of these data, in leu of more recent information they were applied to estimate existing traffic flows for the purpose of assessing whether traffic generated during construction could result in increases of 2.1 dB(A) or more at nearby receivers. Considering worst-case estimate of 24 additional light and 4 additional heavy vehicle movements generated as a result of construction, using the Construction Noise Estimator it was determined that noise from road traffic would increase by around 0.1 dB(A) at the most-affected receiver along Murray Street. Considering this, it was determined that the 2.1 dB(A) criterion would not be exceeded.

6.4 Operational noise

Worst-case (i.e. with noise-enhancing meteorology) operational noise contours are displayed below in **Figure 6-4**.

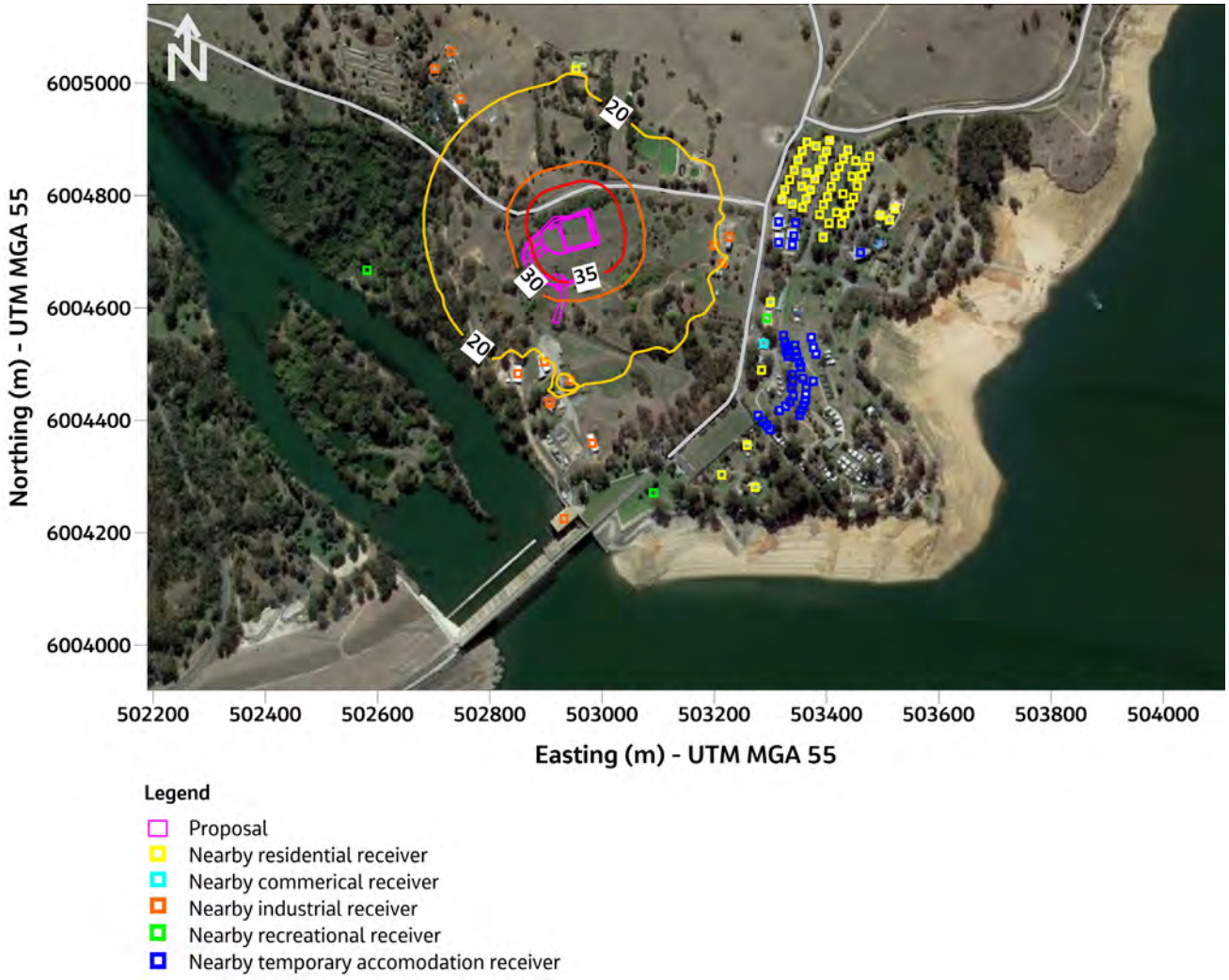

Figure 6-4 Predicted operational noise levels $L_{Aeq\ 15\ minute}$ dB(A), worst-case meteorological conditions

As shown, the highest predicted noise contribution at a nearby residential receiver was less than 20 dB(A). This is well below the lowest allowable operational criterion of 35 dB(A). Levels up to approximately 22 dB(A) were predicted at the industrial receivers to the south; well below the operational criterion of 68 dB(A). Considering these findings it was determined that noise from operations at the facility would be at an acceptable level at surrounding receivers that would not result in sleep disturbance impacts, and that no control measures would be required.

6.5 Cumulative noise impacts

Cumulative noise impacts can occur when noise from more than one development affects the same sensitive receiver(s). This can cause cumulative noise levels up to around 3 dB(A) higher than the noise level from the highest individual contribution. This increase could result in additional receivers exceeding applicable criteria, as well as the changes to the significance (i.e. extent) of exceedance(s). Contributions from surrounding local noise sources are considered as already being accounted for in the adopted background noise levels. During construction, cumulative impacts would be negligible at receivers where noise from construction activities exceed background noise levels by more than 10 dB(A). Regarding operations, Project contributions were more

than 10 dB(A) below the adopted background noise levels at surrounding residential receivers. Considering this, cumulative impacts were considered to be negligible. Noise levels from existing operations at the identified industrial receivers are expected to be more than 10 dB(A) higher than the highest level of 25 dB(A) predicted, such that cumulative noise impacts at these locations are also expected to be negligible.

6.6 Vibration

As identified in **Section 5.3** a drilling rig would be used during construction at the BESS compound, which is considered to be a vibration-generating item of plant. Considering the location of the nearest sensitive receivers (including the nearest heritage structures) being several orders of magnitude higher than the recommended safe setback distances in **Error! Reference source not found.** it was concluded that vibration impacts would be unlikely.

Small compaction equipment (e.g. plate compactor) may also be used during the installation of the 11 kV electricity cabling infrastructure from the existing switchyard to the BESS. Depending on intervening ground conditions, peak particle velocities reduce to around 3 mm/s at distances of 15 to 20 metres from plate compactor operations. If the nearby heritage structures are sound, the 3 mm/s criterion from DIN 4150-3: 2016 would be conservative and a higher level of 7.5 mm/s PPV limit representing 50% of the 15 mm/s PPV limit for 'unreinforced or light framed structures' from British Standard 'BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites'. Levels decrease to around 7.5 mm/s at around 10 metres. Care will need to be taken if compaction activities are required within the setback distance appropriate to the integrity of these structures.

7. Mitigation and management

Consistent with the requirements of the SEARs, this section presents measures to be included in the Project noise management plan. Standard techniques for controlling noise impacts during construction are presented in the ICNG. Controls relevant to the Project have been reproduced below in **Table 7-1**.

Table 7-1 Standard measures, noise during construction

Measure	Details	Timing
Time constraints and scheduling	• Wherever possible and safe, limit works to standard hours of construction. • Where possible, perform noisy work prior to 11 pm. • Limit the completion of out of hours works over consecutive nights.	During construction
Equipment restrictions	• Select low-noise plant and equipment. Ensure equipment mufflers operate in a proper and efficient manner.	Prior to and during construction
Substitute methods	• Where possible, use quieter and less vibration emitting construction methods.	During construction
Limit equipment use	• Only have necessary equipment on-site and turn off when not in use.	During construction
Limit activity duration	• Where possible, concentrate noisy activities at one location and move to another as quickly as possible.	During construction
Site access	• Vehicle movements, including deliveries outside standard hours should be minimised and avoided where possible.	During construction
Equipment maintenance	• Ensure all plant and equipment is well maintained and where possible, fitted with silencing devices.	Prior to and during construction
Reduce equipment power	• Use only the necessary size and powered equipment for tasks.	During construction
Quieter working practices	• Implement training to induct staff on noise sensitivities	Prior to and during construction
Reversing alarms	• Where possible, consider the application of less intrusive alternatives to reverse beepers such as 'squawker' or 'broadband' alarms.	During construction
Noise barriers	• Consider the installation of temporary construction noise barriers for concentrated, noise-intensive activities.	During construction
Enclosures	• Where practicable, install enclosures around noisy mobile and stationary equipment as necessary.	During construction
Use and siting of plant	• Where possible, avoid simultaneous operation of two or more noisy plant close to receivers. • The offset distance between noisy plant and sensitive receivers should be maximised.	During construction

Measure	Details	Timing
Plan work sites and activities to minimise noise and vibration	• Plan traffic flow, parking and loading/unloading areas to minimise reversing movements.	Prior to and during construction
Minimise disturbance arising from delivery of goods to construction sites	• Delivery and loading / unloading of materials should occur as far as possible from sensitive receivers. • Select site access points and roads as far as possible from sensitive receivers.	During construction
Monitoring	• Complete routine monitoring to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision.	During construction

In addition to these standard measures, the assessment indicated that additional actions were required at residential receiver 'RR01' (located 250 metres to the north of the Project along Trout Road in **Figure 2-1**). Prior to commencement of civil works, this residence should be notified of the potential for noise impacts during the construction phase of the project. Noise monitoring should also be completed to verify the resulting noise levels at this location to confirm that other measures would not be required.

Assessing Vibration: a technical guideline, (DECC, February 2006) provides general guidance for limiting vibration impacts during construction. Relevant recommendations have been reproduced below and should be considered as appropriate.

Table 7-2 Vibration management measures from DECC, 2006.

Control measure	Details
Controlling vibration levels from the source	• Choosing alternative, lower-impact equipment or methods wherever possible. • Scheduling the use of vibration-causing equipment at the least sensitive times of the day (wherever possible). • Locating high vibration sources as far away from sensitive receiver areas as possible. • Sequencing operations so that vibration-causing activities do not occur simultaneously. • Keeping equipment well maintained. • Do not conduct vibration intensive works within the recommended safe setback distances. Avoid the use of vibration intensive plant within the nominated human comfort distances.
Consultation	• Informing nearby receivers about the nature of construction stages and the vibration-generating activities.

Additionally, care should be taken during compaction activities within the vicinity of nearby heritage structures during the installation of the 11 kV electricity cabling infrastructure from the existing switchyard to the BESS. These structures should first be inspected to determine whether a 10 or 20 metre safe setback distance should be applied. Following this, these setbacks should be adhered to or where this isn't possible an attendee should be present during the works to suspend activities in the instance of any issues.

8. Conclusion

An assessment was completed to evaluate the potential for noise and vibration impacts associated with a Project to construct and operate a battery energy storage system (BESS) and associated infrastructure adjacent to HPS near Lake Hume Village, NSW.

Noise from construction and operational activities was assessed quantitatively by creating a site noise model using SoundPlan. Levels were evaluated by comparing predictions at surrounding sensitive receivers against values developed based on guidance from the ICNG (construction) and NPI (operations). During construction, 19 instances of exceedances of less than 10 dB(A) above standard daytime NMLs were predicted surrounding residential and temporary accommodation receivers during civil and mechanical/structural activities. Levels exceeding the day time NML by more than 10 dB(A) were predicted at residential receiver 'RR01' (located approximately 250 metres to the north of the Project along Trout Road) during the civil works phase. In line with the ICNG, measures were recommended to limit and mitigate impacts associated with these works including work practices, equipment selection and maintenance, scheduling and monitoring. Prior notification and monitoring were also recommended at 'RR01'.

Noise resulting from operations was predicted to be well below the criteria established for the Project, and the potential for cumulative impacts was also determined to be negligible.

Regarding the potential for noise impacts from additional traffic generated during construction, the CNE was used to estimate where the change could result in increase of 2.1 dB(A) or more at nearby sensitive receivers. Using this approach, it was determined that increases in traffic noise as a result of additional traffic generated during construction would be negligible (i.e. 0.2 dB(A) or less), and that the 2.1 dB(A) relative increase criterion would not be exceeded.

Finally, considering relevant safe setback distance guidance and the location of surrounding receivers and it was determined that vibration impacts would also be unlikely during the Project. Regarding heritage structures, recommendations were made to avoid impacts during compaction activities for the installation of the 11 kV electricity cabling infrastructure from the existing switchyard to the BESS.

9. References

British Standards Group, (1993). *British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration*

British Standards Group, (2008). *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting*

German Standards (DIN-Normen), (2016). *DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures*

NSW Department of Environment and Climate Change, (2009). *Interim Construction Noise Guideline*. DECC, Sydney South, NSW

NSW Department of Environment and Conservation, (2006). Assessing Vibration: a technical guideline

NSW Environmental Protection Authority, (2017). Noise Policy for Industry

Roads and Maritime Service, (2016). *Construction Noise and Vibration Guideline*

Standards Australia, (2006). *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives*

Standards Australia, (2010). *Australian Standard 2436-2010: Guide to noise and vibration control on construction, demolition and maintenance sites*.

Standards Australia, (2016). *Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics: Recommended design sound levels and reverberation times for building interiors*

Appendix A. Receiver IDs

Receiver ID	Type	Co-ordinates UTM MGA	
		Easting (m)	Northing (m)
RR01	Residential	502953	6005025
RR02	Residential	503365	6004896
RR03	Residential	503357	6004879
RR04	Residential	503349	6004863
RR05	Residential	503342	6004846
RR06	Residential	503334	6004828
RR07	Residential	503325	6004811
RR08	Residential	503321	6004794
RR09	Residential	503339	6004785
RR10	Residential	503356	6004817
RR11	Residential	503364	6004841
RR12	Residential	503381	6004889
RR13	Residential	503406	6004898
RR14	Residential	503400	6004879
RR15	Residential	503394	6004864
RR16	Residential	503387	6004846
RR17	Residential	503379	6004829
RR18	Residential	503372	6004810
RR19	Residential	503364	6004794
RR20	Residential	503357	6004780
RR21	Residential	503387	6004766
RR22	Residential	503395	6004784
RR23	Residential	503402	6004798
RR24	Residential	503408	6004816
RR25	Residential	503415	6004834
RR26	Residential	503423	6004851
RR27	Residential	503430	6004866
RR28	Residential	503438	6004881
RR29	Residential	503452	6004862
RR30	Residential	503446	6004834
RR31	Residential	503430	6004803
RR32	Residential	503418	6004770
RR33	Residential	503404	6004751
RR34	Residential	503427	6004751
RR35	Residential	503433	6004767
RR36	Residential	503442	6004783
RR37	Residential	503448	6004797
RR38	Residential	503454	6004817
RR39	Residential	503463	6004835

Receiver ID	Type	Co-ordinates UTM MGA	
		Easting (m)	Northing (m)
RR40	Residential	503469	6004851
RR41	Residential	503476	6004869
RR42	Residential	503495	6004765
RR43	Residential	503522	6004777
RR44	Residential	503512	6004756
RR45	Residential	503394	6004726
RR46	Residential	503300	6004611
RR47	Residential	503284	6004489
RR48	Residential	503259	6004356
RR49	Residential	503273	6004281
RR50	Residential	503213	6004302
AC01A	Accommodation	503314	6004753
AC01B	Accommodation	503314	6004716
AC01C	Accommodation	503339	6004712
AC01D	Accommodation	503341	6004728
AC01E	Accommodation	503344	6004751
AC02	Accommodation	503460	6004698
AC03A	Accommodation	503323	6004550
AC03B	Accommodation	503325	6004539
AC03C	Accommodation	503328	6004531
AC03D	Accommodation	503328	6004522
AC03E	Accommodation	503330	6004514
AC03F	Accommodation	503343	6004533
AC03G	Accommodation	503345	6004522
AC03H	Accommodation	503347	6004513
AC03I	Accommodation	503351	6004503
AC03J	Accommodation	503353	6004494
AC03K	Accommodation	503372	6004548
AC03L	Accommodation	503339	6004481
AC03M	Accommodation	503339	6004469
AC03N	Accommodation	503336	6004458
AC03O	Accommodation	503340	6004443
AC03P	Accommodation	503334	6004432
AC03Q	Accommodation	503327	6004425
AC03R	Accommodation	503315	6004418
AC03S	Accommodation	503277	6004408
AC03T	Accommodation	503286	6004398
AC03U	Accommodation	503293	6004391
AC03V	Accommodation	503299	6004384
AC03W	Accommodation	503351	6004408
AC03X	Accommodation	503355	6004418

Receiver ID	Type	Co-ordinates UTM MGA	
		Easting (m)	Northing (m)
AC03Y	Accommodation	503358	6004427
AC03Z	Accommodation	503361	6004436
AC03ZA	Accommodation	503362	6004446
AC03ZB	Accommodation	503363	6004458
AC03ZC	Accommodation	503357	6004474
AC03ZD	Accommodation	503376	6004469
AC03ZE	Accommodation	503380	6004517
AC03ZF	Accommodation	503376	6004530
CM01	Commercial	503288	6004537
IN01A	Industrial	502982	6004359
IN01B	Industrial	502906	6004431
IN01C	Industrial	502943	6004471
IN01D	Industrial	502897	6004504
IN01E	Industrial	502850	6004483
IN01F	Industrial	502931	6004225
IN02A	Industrial	502747	6004972
IN02B	Industrial	502702	6005026
IN02C	Industrial	502731	6005056
IN03A	Industrial	503227	6004726
IN03B	Industrial	503215	6004679
IN03C	Industrial	503199	6004710
RC01	Recreational	503091	6004271
RC02	Recreational	502581	6004667
RC03	Recreational	503294	6004582

Appendix B. Tabulated results, construction

Receiver ID	Type	Noise management level dB(A)	Predicted noise level $L_{Aeq\ 15\ minute}$ dB(A) by Construction phase		
			1. Civil works	2. Mechanical / structural activities	3. Electrical works
RR01	Residential	45	57.2	51.2	43.2
RR02	Residential	45	51	45	37
RR03	Residential	45	51.4	45.4	37.4
RR04	Residential	45	51.8	45.8	37.8
RR05	Residential	45	52.1	46.1	38.1
RR06	Residential	45	50.2	44.2	36.2
RR07	Residential	45	51.4	45.4	37.4
RR08	Residential	45	53	47	39
RR09	Residential	45	52.4	46.4	38.4
RR10	Residential	45	39.5	33.5	25.5
RR11	Residential	45	40.8	34.8	26.8
RR12	Residential	45	40.2	34.2	26.2
RR13	Residential	45	36.2	30.2	22.2
RR14	Residential	45	40.6	34.6	26.6
RR15	Residential	45	45.1	39.1	31.1
RR16	Residential	45	39	33	25
RR17	Residential	45	42.7	36.7	28.7
RR18	Residential	45	47.1	41.1	33.1
RR19	Residential	45	39.9	33.9	25.9
RR20	Residential	45	42.1	36.1	28.1
RR21	Residential	45	49.4	43.4	35.4
RR22	Residential	45	39.2	33.2	25.2
RR23	Residential	45	38.7	32.7	24.7
RR24	Residential	45	38.6	32.6	24.6
RR25	Residential	45	37.1	31.1	23.1
RR26	Residential	45	38.9	32.9	24.9
RR27	Residential	45	35.9	29.9	21.9
RR28	Residential	45	36	30	22
RR29	Residential	45	37.4	31.4	23.4
RR30	Residential	45	34.9	28.9	20.9
RR31	Residential	45	36.8	30.8	22.8
RR32	Residential	45	39.8	33.8	25.8
RR33	Residential	45	40	34	26
RR34	Residential	45	38.9	32.9	24.9
RR35	Residential	45	35.5	29.5	21.5
RR36	Residential	45	36.9	30.9	22.9
RR37	Residential	45	36.8	30.8	22.8

Receiver ID	Type	Noise management level dB(A)	Predicted noise level $L_{Aeq\ 15\ minute}$ dB(A) by Construction phase		
			1. Civil works	2. Mechanical / structural activities	3. Electrical works
RR38	Residential	45	35.4	29.4	21.4
RR39	Residential	45	34.8	28.8	20.8
RR40	Residential	45	35.6	29.6	21.6
RR41	Residential	45	34.5	28.5	20.5
RR42	Residential	45	34.1	28.1	20.1
RR43	Residential	45	33.3	27.3	19.3
RR44	Residential	45	32	26	18
RR45	Residential	45	38.8	32.8	24.8
RR46	Residential	45	49.5	43.5	35.5
RR47	Residential	45	52.1	46.1	38.1
RR48	Residential	45	46.7	40.7	32.7
RR49	Residential	45	48.8	42.8	34.8
RR50	Residential	45	47.9	41.9	33.9
AC01	Accommodation	45	53.4	47.4	39.4
AC02	Accommodation	45	37.1	31.1	23.1
AC03	Accommodation	45	51.4	45.4	37.4
CM01	Commercial	70	53	47	39
IN01	Industrial	75	61	54.8	46.8
IN02	Industrial	75	55.8	49.8	41.8
IN03	Industrial	75	60.2	54.2	46.2
RC01	Recreational	65	46.2	40.1	32.1
RC02	Recreational	65	53.6	46.5	38.5
RC03	Recreational	65	46.5	40.5	32.5