MARSHALL DAY Acoustics

CRANBOURNE BESS ACOUSTIC REPORT

Rp 001 R01 20210002 | 16 August 2021

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Project: **CRANBOURNE BESS**

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Attention: [redacted]

Report No.: **Rp 001 R01 20210002**

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Document Control

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1.0 INTRODUCTION

Macquarie Corporate Holdings Pty Ltd (Macquarie) has commissioned Marshall Day Acoustics Pty Ltd (MDA) to undertake an acoustic assessment of a proposed Battery Energy Storage System (BESS) at 280 Evans Road, Cranbourne West (the subject site).

This report provides details of relevant environmental noise limits, an assessment of predicted noise levels against the relevant criteria and recommended noise control measures to enable the relevant noise limits to be achieved.

A glossary of acoustic terminology is provided in Appendix A.

2.0 DOCUMENTS REVIEWED

The assessment has been based on documentation listed below.

Table 1: Reviewed documents

Drawing/Doc No.	Revision	Title	Date
CBN_200_400_XXX	0	Cranbourne BESS Planning Layout	18/04/2021
FSIC05049BI	B	Technical Report – Sound Pressure Level In FREEMAQ PCSK/FREESUN HEMK Inverters	28/04/2020
1661-0027-RPT-001	0	Fluence Cube Vibration and Noise Data Collection Report	31/01/2021
130328LD02	D	Planting & Layout Plan	26/09/2003
6156-1.1R	-	Greenacre Zone Substation Environmental Noise Assessment	09/05/2017

3.0 SITE DESCRIPTION

The subject site is located at 280 Evans Road, Cranbourne West and is zoned UGZ1 Urban Growth Zone. The relevant planning map for the site is provided in Appendix B.

The site is adjacent existing AusNet infrastructure which is unaffiliated with the proposal and is nearby several residential areas.

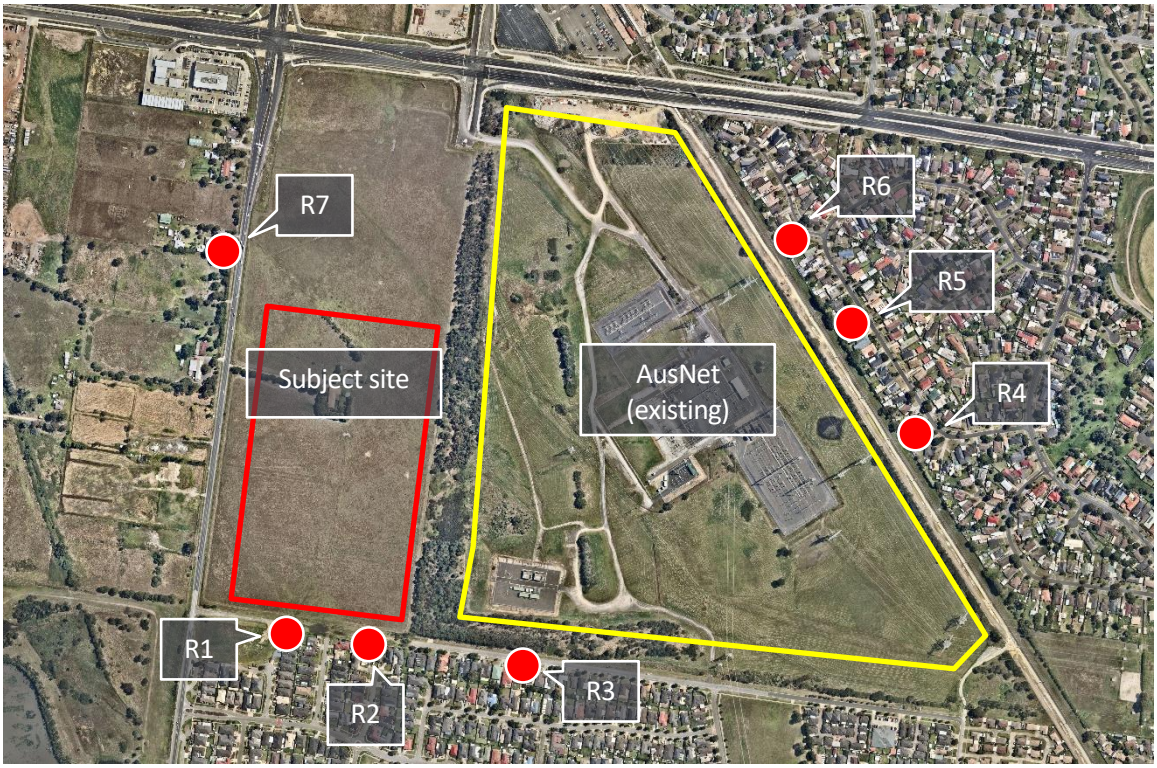
Representative noise sensitive areas (receivers) have been identified for the purpose of the noise assessment and are listed in Table 2 and presented graphically in Figure 1.

MDA have been informed by the client that dwellings adjacent to the site to the west, across Evans Road, will soon be demolished and should therefore not be considered as part of this assessment.

Table 2: Representative receivers

ID	Description
R1	15 Karwarren Way Single storey dwelling located approximately 40 m south-west of the subject site boundary
R2	7 Nandaly Place Single storey dwelling located approximately 30 m south of the subject site boundary
R3	51 Breens Road Single storey dwelling located approximately 180 m south-east of the subject site boundary
R4	18 Toirram Crescent Single storey dwelling located approximately 700 m east of the subject site
R5	42 Toirram Crescent Single storey dwelling located approximately 600 m east of the subject site
R6	3 Tamworth Court Single storey dwelling located approximately 550 m north-east of the subject site
R7	305 Evans Road Single storey dwelling located approximately 300 m north-west of the subject site *It is understood that this residence and the two residences located to the north are currently occupied, however are planned to be demolished and the land redeveloped as industrial/warehouse premises*

Figure 1: Subject site and surrounds



4.0 PROPOSAL DESCRIPTION

4.1 Summary of proposal

The proposal includes the development of a Battery Energy Storage System (BESS) at the subject site. The BESS includes transformers, inverters, and individual battery units with dedicated cooling systems. Although noise generation at the site is not expected to consistently occur, the development has the potential to generate noise at any time during the day, evening or night.

4.2 Proposed equipment

The following equipment is proposed at the site:

- 760 x DC battery units, each with a dedicated cooling system
- 76 x inverters
- 76 x MV transformers
- 1 x power transformer

The proposed site layout is provided in Appendix C.

Details of the exact proposed equipment and arrangement are subject to final detailed design, however the current proposed design is considered representative for noise assessment purposes and sufficient to progress the town planning process. The final design shall be consistent with the findings of this report.

5.0 LEGISLATION & GUIDELINES

A summary of the relevant Victorian legislation and guidelines is provided in Table 3. Refer to Appendix D for further details.

Table 3: Relevant noise legislation and guidelines

Document	Overview
Environment Protection Act 2017 (the Act), as amended by the *Environment Protection Amendment Act 2018*	The Act provides the overarching legislative framework for the protection of the environment in Victoria. It establishes a general environmental duty to minimise the risks of harm to human health or the environment from pollution or waste, including noise, so far as reasonably practicable. The Act does not specify noise limit values, but prohibits the emission of unreasonable or aggravated noise from non-residential premises. The Act provides general definitions of unreasonable and aggravated noise; definitions that are specific to commercial, industrial and trade premises are provided in supporting publications (see below). Section 93 of the Act provides for the creation of an environmental reference standard to be used to assess and report on environmental conditions in the whole or any part of Victoria (see below).
Environment Protection Regulations 2021 (the Regulations)	The objectives of the Regulations are to further the purposes of, and give effect to, the Act. Part 5.3 of the Regulations sets out requirements that are specific to environmental noise. It states that the prediction, measurement, assessment or analysis of noise within a noise sensitive area for the purposes of the Act or the Regulations, must be conducted in accordance with the Noise Protocol (see below). Division 3 of Part 5.3 stipulates requirements that are specific to commercial, industrial and trade premises. In particular, noise from these types of premises is prescribed as unreasonable if it exceeds a noise limit or alternative criterion determined in accordance with the Noise Protocol. Additional matters addressed in this Division include assessment time periods, minimum noise limit values, management of cumulative noise from multiple premises, noise sensitive areas where assessment requirements apply, definition of frequency spectrum as a prescribed factor, and a definition for aggravated noise.
EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* dated May 2021 (Noise Protocol)	The Noise Protocol defines the method for setting the noise limits for new and existing commercial, industrial and trade premises and entertainment venues in Victoria. It also outlines the steps that must be followed to undertake an assessment (measurement or prediction) of the effective noise level within a noise sensitive area or at an alternative assessment location. A comparison between the effective noise level and the relevant noise limit or the relevant alternative assessment criterion will determine whether the noise that is emitted from the premises is unreasonable under the Regulations. The noise limits for commercial, industrial and trade premises are determined on the basis of land zoning and background noise levels, and are separately designated for day, evening and night periods.

Document	Overview
Environment Reference Standard dated 25 May 2021 (ERS)	The ERS is made under section 93 of the Act. The ERS sets out environmental values for ambient sound that are sought to be achieved and maintained in Victoria and standards to support those values. The indicators and objectives within the standard provide a benchmark for comparing desired outcomes to the actual state of the environment and a basis for assessing actual and potential risks to the environmental values. The ERS is not a compliance standard, and the values listed within the ERS for different land uses are explicitly not noise limits nor design criteria. The primary function of the ERS is to provide assessment and reporting benchmarks for environmental values. EPA Publication 1992 *Guide to the Environment Reference Standard* states: *Indicators and objectives within the ERS are generally not relevant considerations where they relate to an aspect of the environment that is the subject of prescriptive regulation.* Therefore, we expect that compliance with the objective noise limits determined in accordance with the Noise Protocol would satisfy the environmental noise obligations of the current proposal.

6.0 EXISTING NOISE ENVIRONMENT

6.1 Site noise survey

Attended noise measurement surveys were conducted during the night-time periods on 2 February and 18-19 February 2021, in order to quantify existing ambient and background noise levels in the area suitable for the derivation of noise limits and to determine the potential noise contribution from the adjacent AusNet site.

Full details of the surveys are provided in Appendix E.

Summaries of the survey outcomes are provided in Sections 6.2 and 6.3 below.

6.2 Background noise levels

The lowest measured background noise levels at all assessed receiver location were 33 dB L_{A90}, and therefore this level has been used to derive the relevant noise limits.

6.3 Existing noise levels from the AusNet site

During both attended noise measurement surveys noise from the AusNet site was inaudible at the representative receivers.

During the first attended measurement survey corona noise from power lines on the AusNet site was audible at the southern boundary of the site at the corner of Breens Road and Calais Circuit. During the second attended measurement survey, corona noise was not audible at the southern boundary of the AusNet site. As corona noise is only generated during very specific weather conditions, this noise is not expected to be present at all times and can also be masked by the other sources of in the ambient noise environment.

7.0 NOISE PROTOCOL

7.1 Zoning of subject site

Noise Protocol noise limits are determined on the basis of the zoning of land nearby the noise sensitive area.

Currently, the subject site is zoned UGZ1 (Urban Growth Zone), which is designated type 1 unless a schedule applies in the specific planning scheme. Schedule 1 to the Urban Growth Zone in the Casey Planning Scheme identifies that the site is subject to the applied zone provisions (listed in Table 1 of Section 2.2 *Applied zone provisions*). As an industrial/employment interface/business park, Commercial Zone 2 zoning applies for the subject site.

On the basis of the above, the subject site has been considered type 2 for the purpose of noise limit derivation in accordance with the Noise Protocol.

7.2 Noise protocol noise limits

Noise protocol noise limits at the nearest receivers are listed in Table 4. Time periods are as defined in Appendix D1.

The full derivation of noise limits and design targets is provided in Appendix D.

Table 4: Noise Protocol noise limits, dB L_{eff}

	Time Period		
Receiver	**Day**	**Evening**	**Night**
R1	53	47	42
R2	52	46	41
R3-R6	50	44	39
R7	52	46	41

8.0 NOISE DATA

Equipment noise levels have been provided by the proposed equipment supplier in *Fluence Cube Vibration and Noise Data Collection Report* (See Table 1) and are listed in Table 5.

Table 5: Noise level data, dB L_{eq}

	Octave band centre frequency, Hz							
Description	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**A**
Battery cooling measured at 1 m from front of cube [1]	74[3]	74	70	70	65	65	64	72
Battery cooling measured at 1 m from rear of cube [1, 2]	76[3]	76	69	67	64	63	61	71
Inverter measured at 1 m	54[3]	54	67	68	69	70	63	79 [4]
Battery cooling measured at 1 m from the side of cube [1]	70[3]	70	63	59	54	52	49	62
MV transformer sound power level [5]	60	72	79	72	61	50	44	73
Power transformer sound power level[5]	60	72	79	72	61	50	44	73

Notes:

[1] Adjusted for background noise influence

[2] Adjusted for reflection from a nearby building structure

[3] 63 Hz octave band values were not provided. 63 Hz noise levels have been presumed to be equal to the 125 Hz values

[4] The reported octave band values do not equate to the reported overall A-weighted values. The octave band values used in the modelling have been factored to equate to the reported overall A-weighted values

[5] Based on 132/11kV. 50 MVA transformer as referenced in the Greenacre Zone Substation Environmental Noise Assessment

The noise levels provided in Table 5 have been used to derive sound power levels for the purpose of noise modelling. The derived sound power levels are provided in Appendix F.

Documentation reviewed by MDA during the course of the assessment indicated that the noise from the equipment exhibits some directional characteristics. Directivity corrections, sourced from *Technical Report – Sound Pressure Level in FREEMAQ PCSK/FREESUN HEMK Inverters* (see Table 1), and summarised in Appendix G, have been included in the noise model.

9.0 ASSESSMENT METHOD

To predict noise levels to nearby receivers, the following factors have been considered:

- Sound power level data for the equipment proposed within the subject site;
- The distance between the sources and receivers;
- The ground characteristics between the source and receiver; and
- The presence of obstacles such as buildings, earthen mounds or screens that obstruct the noise path;
- The presence of hard reflective surfaces that may enable additional noise paths.

A 3-dimensional digital noise model of the proposal and surrounding built environment has been created using SoundPLAN proprietary modelling software (version 8.2). The model has been used to predict commercial noise from the site to the nearest noise sensitive receivers.

Geometry data for the model has been sourced from public aerial photography, visual inspections of the area, and building heights defined by site inspection and site plan. Terrain for the surrounding area was only partially available on the VicPlan Spatial Datamart website[1]. As such, terrain data for the subject site and surrounds was sourced from OpenStreetMap[2].

An earthen mound located on the AusNet land to the east of the subject site was not reflected in the available terrain data and therefore has been manually included in the model based on the extent and heights indicated in the Planting and Layout Plan.

The geometries in the model are simplified representations of the built environment that have been configured to a level of detail that is appropriate for noise calculation purposes.

The SoundPLAN digital model has been used to calculate noise levels using the implementation of International Standard ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613). ISO 9613 is a general environmental noise calculation standard that has been used extensively throughout Australia, New Zealand, and Europe since its publication in 1996.

The implementation of ISO 9613 within proprietary noise modelling software enables multiple sound transmission paths, including reflected and screened paths, to be accounted for in the calculated noise levels. ISO 9613 predicts noise levels for meteorological conditions which favour the propagation of noise.

[1] https://services.land.vic.gov.au/SpatialDatamart/

[2] https://www.openstreetmap.org/

10.0 RECOMMENDED DESIGN MEASURES FOR NOISE CONTROL

Preliminary noise modelling results have been used to determine recommended design measures for incorporation into the development to enable the relevant noise limits to be achieved. These are detailed in the following sections. Note that the following noise controls are based on the best available information and are provided to progress the town planning process, and are subject to detailed design considerations.

10.1 Battery unit attenuators

Based on the assessed scenario, it is recommended to incorporate at-plant attenuators at some of the battery enclosures. Table 6 presents the recommended insertion loss values.

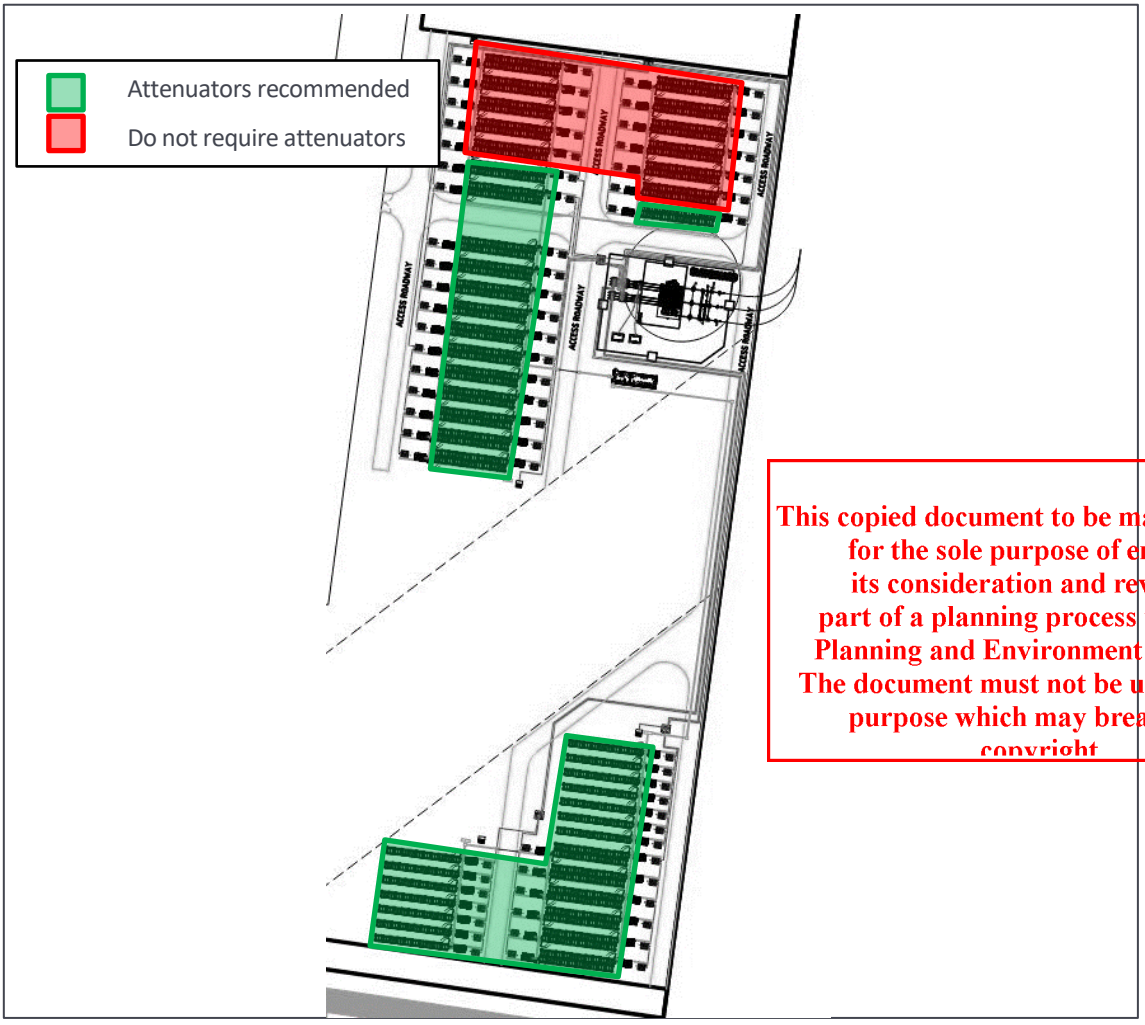
Table 6: Battery cooling attenuator insertion loss, dB

Description	Octave band centre frequency (Hz)						
	63	125	250	500	1k	2k	4k
Insertion loss (e.g. Fantech ASB NR)	5	10	14	22	27	25	21

As an example, the insertion losses listed in Table 6 can be provided by the Fantech ASB NR attenuator and have been included in the noise model.

Attenuators are recommended to be installed at the battery units indicated in Figure 2 below.

Figure 2: Recommended battery units for attenuation



10.2 Inverter at-plant attenuation

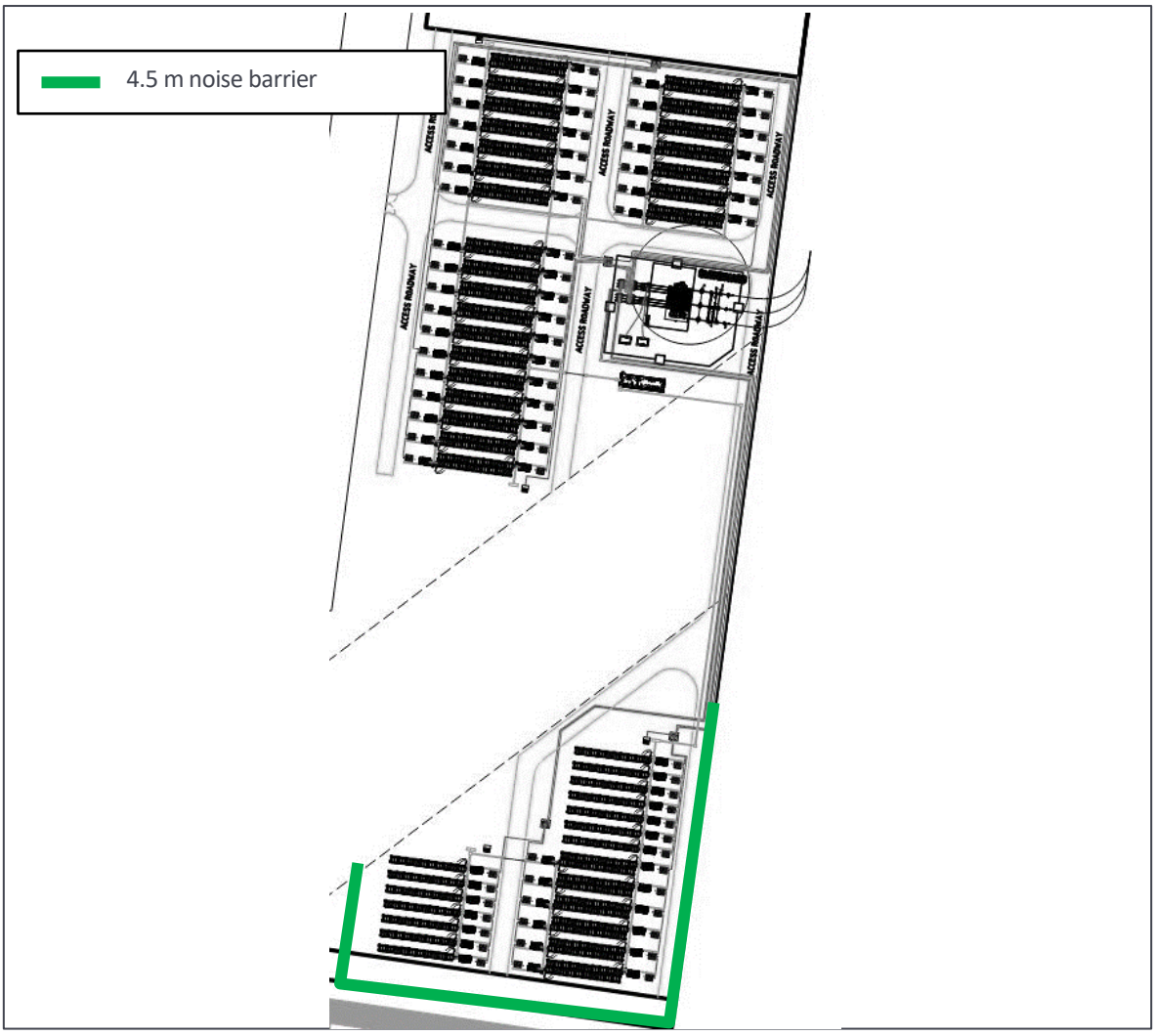
Based on the assessed scenario, it is recommended that all inverter units would incorporate at-plant attenuation providing a minimum 9 dB reduction in overall noise levels. Macquarie have consulted the equipment supplier and confirmation has been received that 9 dB reduction per unit is achievable.

At this stage the specific mechanism for noise reduction and details of how the noise reductions will impact the spectral levels have not been confirmed and therefore we recommend that the confirmed resulting noise levels are assessed during the detailed design phase to confirm that the provided reductions are sufficient that predicted noise levels comply with the noise limits.

10.3 Noise barrier

Based on the assessed scenario, a 4.5 m high noise barrier as indicated in Figure 3 is recommended.

Figure 3: Noise barrier location



The noise barrier would be required to be constructed from a material providing minimum surface density of 12-15 kg/m^2.

As an example, suitable materials include:

- 9 mm fibre cement sheeting;
- Standard masonry; or
- 25-30 mm thick timber.

Alternative materials are acceptable subject to acoustic review.

To maintain the effectiveness of any noise barrier, there must be no gaps in the barrier at junctions with adjacent panels or the ground (beyond any minimum gap required for drainage). It is common practice to require that a portion of the bottom of the barrier (say 10-20 cm) be buried in the ground.

Macquarie have provided details of the Modular Walls AcoustiMax wall system, which would provide sufficient surface density to perform as an effective noise barrier.

11.0 NOISE PROTOCOL ASSESSMENT

Table 7 below presents the predicted noise level assessment for the proposal based on the noise model inputs provided in Appendix F and the noise control measures presented in Section 10.0. Predicted noise levels from the corona noise measured from the AusNet site is predicted not to exceed 16 dB at the nearest assessed receiver and therefore its contribution would not increase the predicted noise levels presented below.

Table 7: Predicted cumulative noise level assessment, dB L_{eff}

ID	Predicted noise level	Noise limits			Complies?
		Day	Evening	Night	
R1	42	53	47	42	✓
R2	41	52	46	41	✓
R3	38	50	44	39	✓
R4	33	50	44	39	✓
R5	35	50	44	39	✓
R6	34	50	44	39	✓
R7	41	52	46	41	✓

11.1 Discussion

11.1.1 Assessment scenario

The noise levels presented in Section 11.0 are based on an inherently conservative worst-case scenario whereby all noise-emitting plant is operating at its loudest level concurrently for a full 30 minute period at any time during the day, evening or night periods.

In practice it is understood that the operation of the plant at the site shall be determined based on a range of factors including offsite energy generation, local power demand and unit cooling requirements. As such, the modelled scenario, where all equipment operate concurrently, is considered to be unlikely, particularly during the night period where the noise limits are the most stringent.

Further, battery enclosure cooling plant is only expected to operate when the ambient temperature exceeds 23°C. MDA have reviewed half-hourly weather data from the Moorabbin Airport weather station for the year 2019 (the most recent, nearby and complete data set available) and identified that less than 2 % of the half hourly night periods exceeded the trigger temperature for the battery enclosure cooling.

11.1.2 Adjustments for noise character

As specified in the Noise Protocol, measured noise levels attract a noise character adjustment where tonality, impulsiveness or intermittency are present at the receiver.

Noise sources such as those proposed at the subject site present low risk of impulsive character due to their steady-state operation, however there is the potential that the noise sources at the site could cause tonal or intermittent noise.

Given the bespoke nature of the development it is not possible to conduct measurements of equivalent operations to verify whether tonality or intermittency adjustments are likely.

The Noise Protocol specifies intermittency and tonal adjustments of 3-5 dB depending on the magnitude of audibility of the identified character(s).

Based on the available information, the MV transformers and the power transformer have the risk to present tonal characteristics. However, the noise contribution from these items is likely to be masked by the noise contribution from the rest of the plant and as such any potential tonality generated by this equipment is not likely to be audible at the receiver locations.

With regard to intermittency, we recommend that the plant is designed to include time controls such that the plant does not operate in a manner that attracts an intermittency penalty. The plant should not increase in noise level rapidly by 5 dB or more on two or more occasions during a 30-minute period.

12.0 CONCLUSION

Macquarie has commissioned Marshall Day Acoustics to undertake an acoustic assessment of a proposed Battery Energy Storage System at 280 Evans Road, Cranbourne West.

The proposal includes 760 battery units with dedicated cooling systems, 76 inverters, 76 MV transformers and 1 power transformer.

This assessment has been based on:

- Existing noise conditions at the site and surrounds based on attended noise surveys;
- Noise limits determined in accordance with the relevant Victorian EPA legislation; and
- Detailed 3-dimensional modelling of the site and surrounding environment.

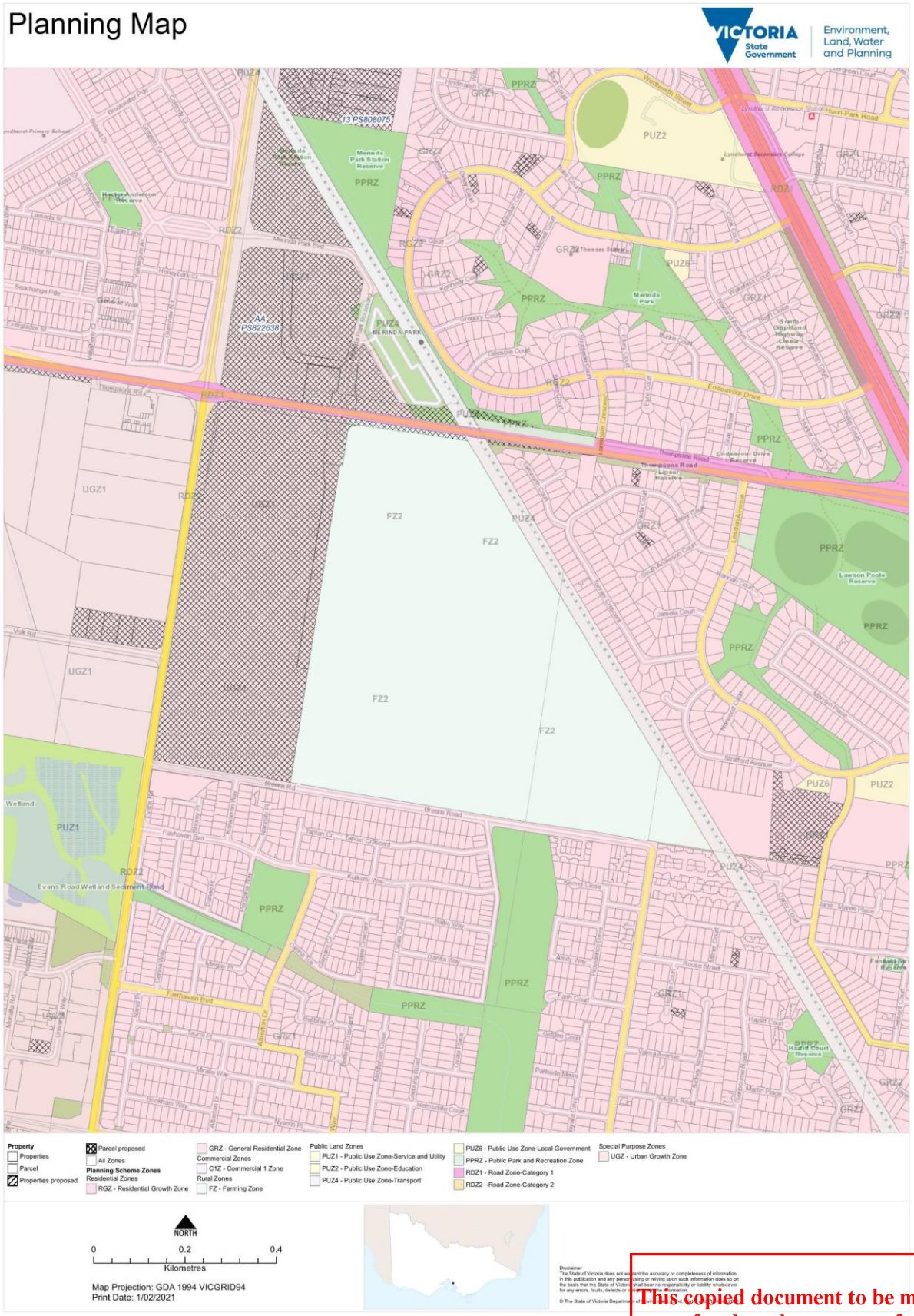
Recommended design measures for noise control based on the assessed scenario have been outlined in Section 10.0 of this report. Should these recommendations or similar approved alternatives be implemented at the site, noise levels are predicted to comply with the relevant noise limits. Subject to detailed design considerations, alternative noise control methods may be implemented for equivalent results.

The noise assessment therefore demonstrates that the subject site can be designed and developed to achieve Victorian policy requirements for operational noise.

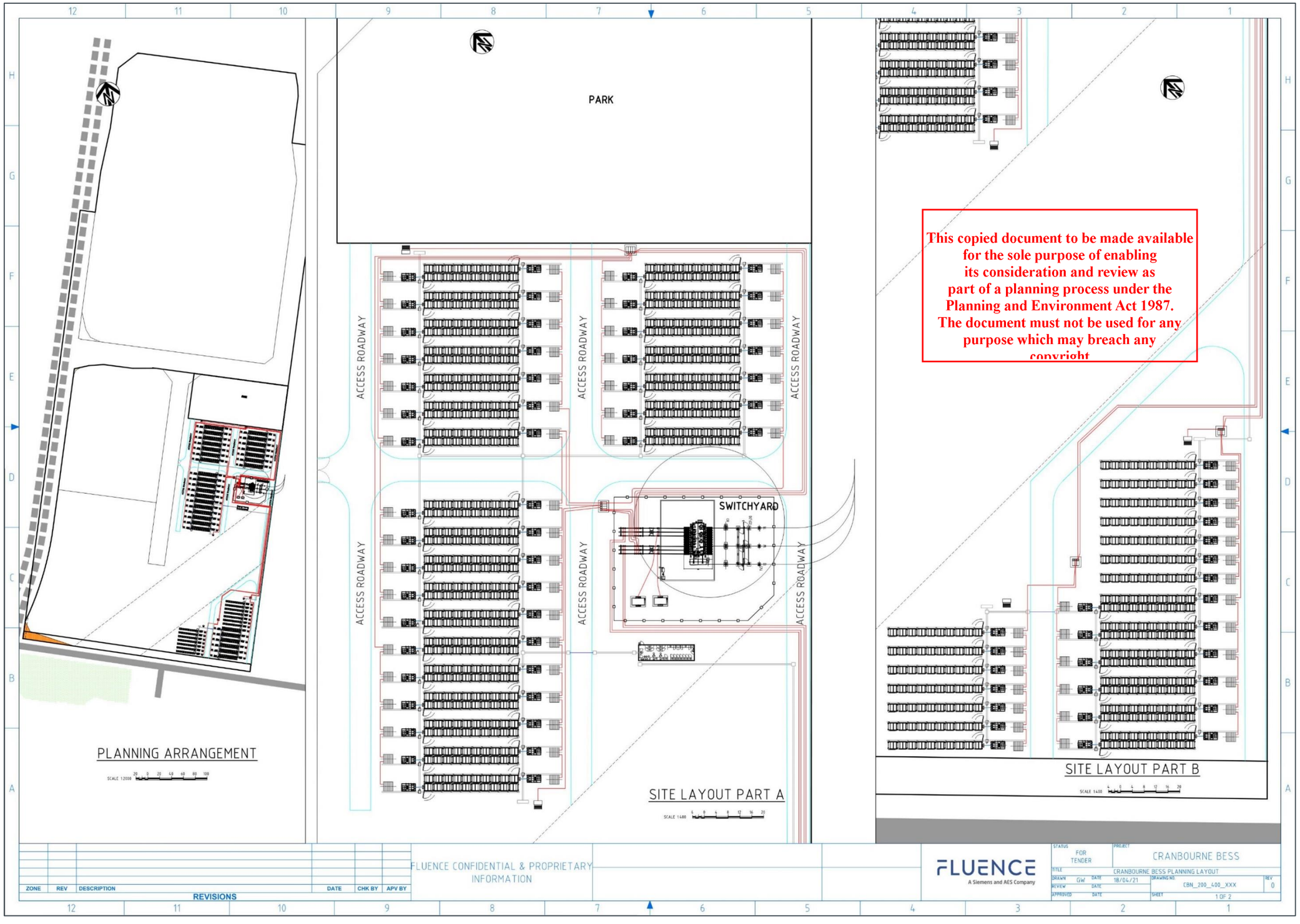
APPENDIX A GLOSSARY OF TERMINOLOGY

Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Hertz (Hz)	Hertz is the unit of frequency. One hertz is one cycle per second. One thousand hertz is a kilohertz (kHz).
Octave Band	A range of frequencies where the highest frequency included is twice the lowest frequency. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.
Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
SPL or L_p	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 µPa RMS) and expressed in decibels.
SWL or L_w	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr = 20 µPa i.e. dB = 20 x log(P/Pr)
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
L_{Aeq}	The A-weighted equivalent continuous (time-averaged) sound level. This is commonly referred to as the average noise level.
L_{A90}	The A-weighted noise level equalled or exceeded for 90 % of the measurement period. This is commonly referred to as the background noise level.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX B PLANNING MAP



APPENDIX C SITE PLAN



APPENDIX D LEGISLATION AND GUIDELINES

D1 Noise Protocol

D1.1 Application

Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol) sets noise limits that apply to commercial, industrial and trade premises in Victoria.

The Act defines a 'commercial, industrial and trade premises' as:

> *Any premises except the following –*
>
> *(a) residential premises (other than common plant under the control of an owners corporation);*
>
> *(b) a street or road, including every carriageway, footpath, reservation and traffic island on any street or road;*
>
> *(c) a railway track used by rolling stock in connection with the provision of a freight service or passenger service—*
>
> *(i) while travelling on a railway track or tramway track; or*
>
> *(ii) while entering or exiting a siding, yard, depot or workshop;*
>
> *(d) a railway track used by rolling stock in connection with the provision of a passenger service, while in a siding, yard, depot or workshop and is—*
>
> *(i) powering up to commence to be used in connection with the provision of a passenger service; or*
>
> *(ii) shutting down after being used in connection with the provision of a passenger service;*
>
> *(e) the premises situated at Lower Esplanade, St Kilda and known as "Luna Park" and being the whole of the land more particularly described in Certificate of Title Volume 1204 Folio 109;*

D1.2 Assessment method

The Noise Protocol prescribes the method and measurement procedure used to determine applicable noise limits and assessment of compliance.

A 'noise sensitive area' is defined in the *Environment Protection Regulations 2021* (the Regulations) as:

> *(a) that part of the land within the boundary of a parcel of land that is—*
>
> *(i) within 10 metres of the outside of the external walls of any of the following buildings—*
>
> *(A) a dwelling (including a residential care facility but not including a caretaker's house);*
>
> *(B) a residential building;*
>
> *(C) a noise sensitive residential use; or*

(ii) within 10 metres of the outside of the external walls of any dormitory, ward, bedroom or living room of one or more of the following buildings—

(A) a caretaker's house;

(B) a hospital;

(C) a hotel;

(D) a residential hotel;

(E) a motel;

(F) a specialist disability accommodation;

(G) a corrective institution;

(H) a tourist establishment;

(I) a retirement village;

(J) a residential village; or

(iii) within 10 metres of the outside of the external walls of a classroom or any room in which learning occurs in the following buildings (during their operating hours)—

(A) a child care centre;

(B) a kindergarten;

(C) a primary school;

(D) a secondary school; or

(b) subject to paragraph (c), in the case of a rural area only, that part of the land within the boundary of—

(i) a tourist establishment; or

(ii) a campground; or

(iii) a caravan park; or

(c) despite paragraph (b), in the case of a rural area only, where an outdoor entertainment event or outdoor entertainment venue is being operated, that part of the land within the boundary of the following are not noise sensitive areas for the purposes of that event or venue—

(i) a tourist establishment;

(ii) a campground;

(iii) a caravan park;

The assessment of noise from the subject site under the Noise Protocol is based on the calculation of a noise limit at a receiver position, taking into account a zoning noise level derived from the land zoning types in the surrounding area and the background noise level.

Once a noise limit is established, the noise level (L_{Aeq}) due to the commercial premises is measured or predicted. If necessary, the L_{Aeq} noise level is adjusted for noise character and duration to give the effective noise level (L_{eff}). If the L_{eff} level exceeds the noise limit, then remedial action is required.

D1.3 Calculation of noise limits

The Noise Protocol provides two methods for deriving the relevant noise limits, the Urban area method and the Rural area method. The Urban area method is applicable to the current study.

Using the Urban area method, noise limits are calculated taking into account land 'zoning types' within a 70 m and 200 m radius of a noise sensitive building. Zoning types are categorised as type 1, 2 or 3 as defined in Annex A of the Noise Protocol. A prescribed formula is used to calculate a corresponding Zoning Level. In general, zone type designations are as follows:

- Type 1 for residential, rural, open space or similar zones;
- Type 2 for commercial, business, office and industrial 3 [light industry] zones; or
- Type 3 for industrial 1 and 2 [general industry] and similar zones.

Greater areas of type 2 and 3 land within a 200 m radius of a noise sensitive site result in higher Zoning Levels than a site with respectively larger areas of type 1 land.

The Noise Limit is equal to the Zoning Level unless the background level at the noise sensitive site is categorised as low or high according to the Noise Protocol. If the background level is low or high, the Noise Limit is calculated from a formula taking into account the Zoning Level and the Background Level.

The limits are separately defined for the day, evening and night periods. The time periods are defined in the Regulations and shown in Table 8.

Table 8: Noise Protocol time periods

Period	Day of week	Start time	End time
Day	Monday-Saturday	0700 hrs	1800 hrs
Evening	Monday-Saturday	1800 hrs	2200 hrs
	Sunday, Public holidays	0700 hrs	2200 hrs
Night	Monday-Sunday	2200 hrs	0700 hrs

The relevant noise limits applicable to this development are shown in Table 9.

Table 9: Noise Protocol Limits

Period	Zoning level, dB L_{eff}	Background noise level, L_{A90} dB	Noise Protocol limit, dB L_{eff}
R1 – 15 Karwarren Way			
Day	53	Neutral[1]	53
Evening	47	Neutral[1]	47
Night	42	33 (neutral)	42
R2 – 7 Nandaly Place			
Day	52	Neutral[1]	52
Evening	46	Neutral[1]	46
Night	41	33 (neutral)	41
R3 – 51 Breens Road			
Day	50	Neutral[1]	50
Evening	44	Neutral[1]	44
Night	39	33 (neutral)	39
R4 – 18 Toirram Crescent			
Day	50	Neutral[1]	50
Evening	44	Neutral[1]	44
Night	39	33 (neutral)	39
R5 – 42 Toirram Crescent			
Day	50	Neutral[1]	50
Evening	44	Neutral[1]	44
Night	39	33 (neutral)	39
R6 – 3 Tamworth Court			
Day	50	Neutral[1]	50
Evening	44	Neutral[1]	44
Night	39	33 (neutral)	39
R7 – 305 Evans Road			
Day	54	Low[2]	52
Evening	48	Low[2]	46
Night	43	33 (low)	41

[1] Daytime and evening background conditions have been presumed to be neutral based on the night-time measured background noise levels.

[2] Daytime and evening background conditions have been presumed to be low based on the night-time measured background noise levels and assumed a 2 dB reduction between the zoning level and noise limit.

APPENDIX E SITE NOISE SURVEYS

Attended noise measurement surveys were conducted during the night-time periods on 2 February and 18-19 February 2021, in order to quantify existing ambient and background noise levels in the area suitable for the derivation of noise limits and to determine the potential noise contribution from the adjacent AusNet site.

In order to provide confidence that the background noise levels used for noise limit derivation were free from potential influence from the AusNet site, locations further set back from the AusNet site considered to have similar background noise conditions were selected.

Noise measurements were conducted using a Brüel and Kjær type 2250 sound level meter (serial number 2693792) located at a height of approximately 1.5 m in free field conditions and fitted with a proprietary windshield. The equipment calibration was checked with a Casell CEL 110/1 calibrator (serial number 211362) before and after measurements and no significant drift was detected.

Weather conditions were suitably calm and dry as to be conducive to noise measurements.

Noise measurement locations and the receiver locations they represent are listed in Table 10 and presented graphically in Figure 4.

Table 10: Background noise measurement locations

ID	Description	Receivers represented
M1	68 Toirram Crescent	R6
M2	12 S Anderson Court	R5
M3	37 Marilyn Place	R4
M4	Corner of Carina Terrace and Glenaire Crescent	R2, R3
M5	20 Pengana Way	R1
M6	Boundary of AusNet, Calais Street	R3
M7	51 Breens Road	R2, R3
M8	Northern boundary of AusNet site	-
M9	15 Carwarren Way	R1
M10	3 Tamworth Street	R6
M11	42 Toirram Crescent	R5
M12	18 Toirram Crescent	R4

R7 was not considered in the assessment at the time of undertaking background noise measurements. As such, the minimum background noise level of 33 dB L_{A90} was used for this location.

Figure 4: Noise measurement locations

Table 11 below presents the results of the background noise measurements.

Table 11: Background noise level measurements, dB

Measurement time	Measurement location	Measured noise levels		Comment
		L_{A90}	L_{Aeq}	
First survey, 2 February 2021				
0207 hrs – 0217 hrs	M1	33	38	L_{eq} dominated by traffic on Thompsons Road
0217 hrs – 0227 hrs	M1	33	38	L_{90} dominated by distant traffic
0237 hrs – 0247 hrs	M2	33	37	L_{eq} dominated by traffic on Thompsons Road and South Gippsland Highway
0250 hrs – 0300 hrs	M2	33	37	L_{90} dominated by streetlight humming towards the end of the street
0307 hrs – 0317 hrs	M3	33	38	L_{eq} dominated by traffic on South Gippsland Highway
0317 hrs – 0327 hrs	M3	33	39	L_{90} dominated by distant traffic

Measurement time	Measurement location	Measured noise levels		Comment
		L_{A90}	L_{Aeq}	
0339 hrs – 0349 hrs	M4	33	37	L_{eq} dominated by traffic on Evans Road
0350 hrs – 0400 hrs	M4	34	38	L_{90} dominated by distant traffic
0403 hrs – 0413 hrs	M5	33	38	L_{eq} dominated by traffic on Evans Road
0414 hrs – 0424 hrs	M5	38	43	L_{90} dominated by distant traffic Traffic noise on Evans Road increased dramatically between the measurements coinciding with an observed increase in traffic volumes
Second survey, 18-19 February 2021				
2321 hrs – 2331 hrs	M1	41	44	L_{eq} dominated by traffic on South Gippsland Highway L_{90} dominated by distant traffic
2333 hrs – 2343 hrs	M1	41	43	L_{eq} dominated by traffic on South Gippsland Highway L_{90} dominated by distant traffic
2348 hrs – 2358 hrs	M2	49	44	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Thompsons Road and cricket noise
2359 hrs – 0009 hrs	M2	44	46	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Thompsons Road and cricket noise
0016 hrs – 0026 hrs	M3	44	46	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from South Gippsland Highway and cricket noise
0026 hrs – 0036 hrs	M3	44	46	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from South Gippsland Highway and cricket noise

Measurement time	Measurement location	Measured noise levels		Comment
		L_{A90}	L_{Aeq}	
0057 hrs – 0108 hrs	M5	41	42	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Evans Road and cricket noise
0109 hrs – 0119 hrs	M5	42	43	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Evans Road and cricket noise
0122 hrs – 0132 hrs	M4	44	46	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Evans Road and cricket noise
0134 hrs – 0144 hrs	M4	44	43	High levels of insect noise were present throughout the noise measurement L_{90} dominated by cricket noise and distant traffic L_{eq} dominated by traffic noise from Evans Road and cricket noise

It is understood that the highest load and therefore loudest noise generation potential during the night-time period is expected to occur between 2200 hrs and 2300 hrs and also between 0600 hrs and 0700 hrs. During these time periods traffic noise was observed to increase dramatically.

Table 12 below presents the results of the noise measurements of the existing noise contribution from the AusNet site.

Table 12: AusNet site existing noise levels, dB

Measurement time	Measurement location	Measured noise level, L_{Aeq}	Comment
First survey, 2 February 2021			
0432 hrs – 0434 hrs	M6	40	Corona noise from overhead power lines servicing the AusNet site contributing to noise level Contribution of corona noise estimated to be approximately 39 dB
0442 hrs – 0447 hrs	M7	37	L_{eq} dominated by traffic on Evans Road No noise from the AusNet site audible at this location nor at any location between 31 and 75 Breens Road during measurement

Measurement time	Measurement location	Measured noise level, L_{Aeq}	Comment
0507 hrs – 0512 hrs	M8	46	L_{eq} dominated by traffic on Thompsons Road No noise from the AusNet site audible at this location
0602 hrs – 0604 hrs	M7	44	L_{eq} dominated by traffic on Evans Road No noise from the AusNet site audible at this location
0609 hrs – 0611 hrs	M9	55	L_{eq} dominated by traffic on Evans Road No noise from the AusNet site audible at this location
0620 hrs – 0622 hrs	M10	54	L_{eq} dominated by traffic on Thompsons Road and South Gippsland Highway No noise from the AusNet site audible at this location
0624 hrs – 0626 hrs	M11	45	L_{eq} dominated by traffic on Thompsons Road and South Gippsland Highway No noise from the AusNet site audible at this location
0630 hrs – 0632 hrs	M12	50	L_{eq} dominated by traffic on South Gippsland Highway No noise from the AusNet site audible at this location
Second survey, 18-19 February 2021			
2219 hrs – 2219 hrs	M9	48	L_{eq} dominated by traffic on Evans Road and rail movements towards the east No noise from the AusNet site audible at this location
2225 hrs – 2230 hrs	M7	44	L_{eq} dominated by traffic on Evans Road and insect noise No noise from the AusNet site audible at this location
2243 hrs – 2248 hrs	M8	48	L_{eq} dominated by traffic on Thompsons Road No noise from the AusNet site audible at this location
2253 hrs – 2258 hrs	M12	46	L_{eq} dominated by traffic on South Gippsland Highway No noise from the AusNet site audible at this location
2301 hrs – 2306 hrs	M11	52	L_{eq} dominated by traffic on Thompsons Road and South Gippsland Highway No noise from the AusNet siteaudible at this location
2310 hrs – 2315 hrs	M10	43	L_{eq} dominated by traffic on Thompsons Road No noise from the AusNet site audible at this location

APPENDIX F NOISE MODEL INPUTS

Table 13: Sound power level data, dB L_W

Description	Worst-case period operation	Height of noise source (m)	Octave band centre frequency, Hz							
			63	125	250	500	1000	2000	4000	A
Battery cooling, front, L_W / m^2	Full 30-minute period at any time 24 hrs	1.25	82	83	85	75	71	71	69	80
Battery cooling, rear, L_W / m^2	Full 30-minute period at any time 24 hrs	1.25	81	83	77	75	72	71	68	78
Inverter (unmitigated), L_W	Full 30-minute period at any time 24 hrs	1.50	70	70	83	84	85	86	79	90
Inverter (mitigated), L_W	Full 30-minute period at any time 24 hrs	1.50	61	61	74	75	76	77	70	81
MV transformer, L_W	Full 30-minute period at any time 24 hrs	2.25	60	72	79	72	61	50	44	73
Power transformer, L_W	Full 30-minute period at any time 24 hrs	2.50	60	72	79	72	61	50	44	73

APPENDIX G DIRECTIVITY CORRECTIONS

Figure 5: Inverter directivity corrections