Dalvui

Battery Energy Storage System

Environmental Noise Assessment

June 2022

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GLOSSARY

A-weighting	Frequency adjustment applied to measured noise levels to replicate the frequency response of the human ear.
dB(A)	A-weighted noise or sound power level in decibels.
Equivalent noise level	Energy averaged noise level.
L_{eq}	Equivalent noise level
Sound power level	A measure of the total sound energy emitted from a source of noise.

1 INTRODUCTION

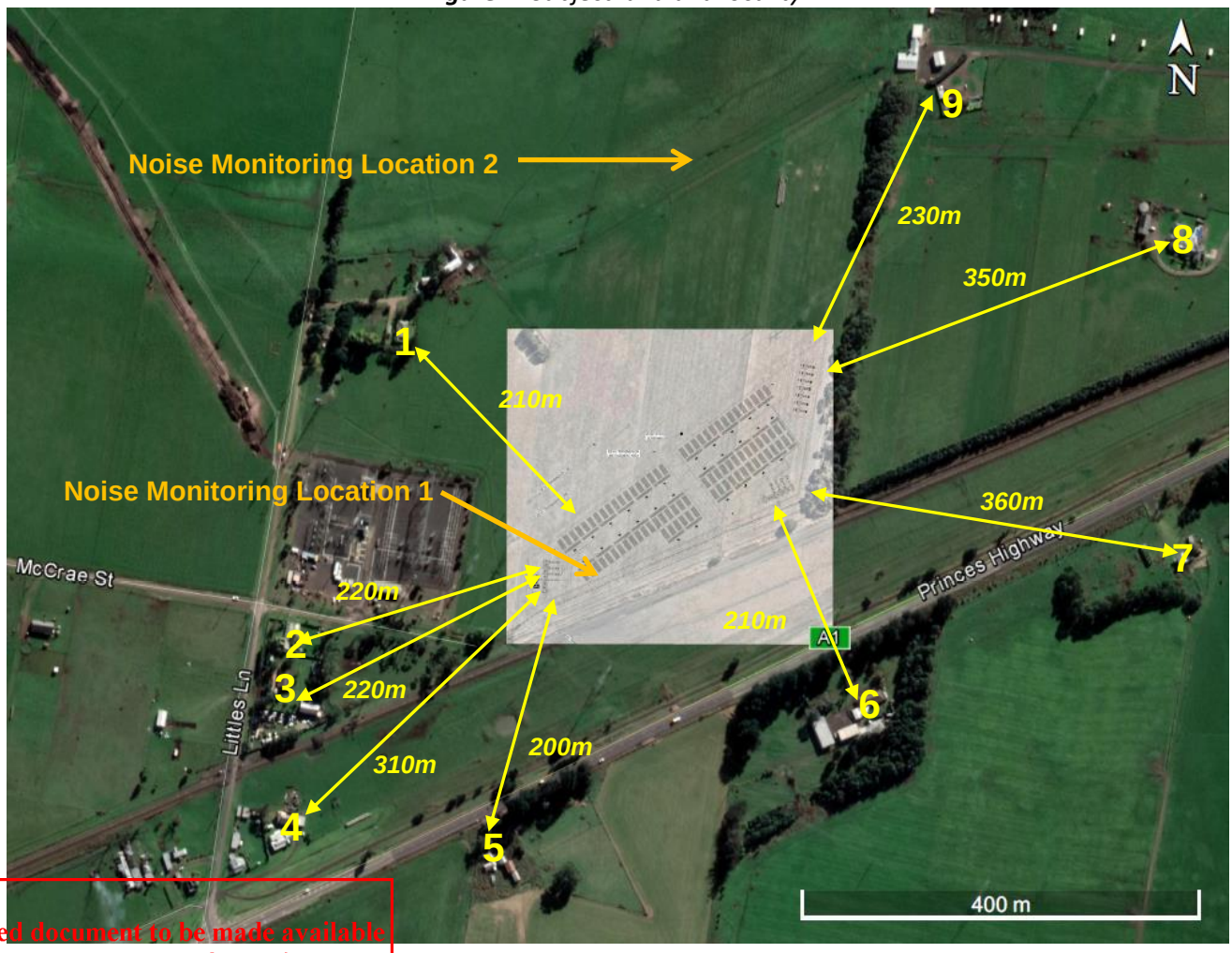
An environmental noise assessment has been prepared for the proposed Dalvui Battery Energy Storage System (**BESS**).

The Dalvui BESS is proposed to be located to the east of the existing Terang Terminal Station on McCrae Street, Terang, Victoria.

This assessment considers the noise at the dwellings surrounding the Dalvui BESS. The assessment has been based on the BESS arrangement detailed in the Aurecon drawing "510875-0000-DRE-CC-0001-1", included as Appendix A.

The location of the Dalvui BESS and the surrounding dwellings (each with a unique identification number for reference in this report) are shown in Figure 1 below.

Figure 1: *Subject land and locality.*



2 CRITERIA

The subject site and residences in the immediate vicinity are located within a Farming zone of the Corangamite Planning Scheme (the **Planning Scheme**). The Planning Scheme has been reviewed and particular regard has been given to the following relevant provisions:

Planning Scheme

Environmental Risks and Amenity

13.05-1S Noise abatement

Objective

To assist the control of noise effects on sensitive land uses.

Strategy

Ensure that development is not prejudiced and community amenity and human health is not adversely impacted by noise emissions, using a range of building design, urban design and land use separation techniques as appropriate to the land use functions and character of the area.

Policy guidelines

Consider as relevant:

- *The noise requirements in accordance with the Environment Protection Regulations under the Environment Protection Act 2017.*

Policy documents

Consider as relevant:

- *Environment Protection Regulations under the Environment Protection Act 2017*
- *Noise Limit and Assessment Protocol for the Control of Noise from Commercial, Industrial and Trade Premises and Entertainment Venues (Publication 1826.2, Environment Protection Authority, March 2021).*

Noise Limit and Assessment Protocol 1826.4

The Planning Scheme references the *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (*the* ***Protocol***) and the *Environment Protection Regulations* (*the* ***Regulations***). The most recent version of the Protocol is *Publication 1826.4* dated July 2021, and the most recent version of the Regulation is dated May 2021.

The Protocol provides guidance in determining noise limits for new and existing commercial, industrial and trade premises in Victoria.

For rural areas, objective noise limits for environmental noise are based on the planning zones in the vicinity of the site, the type of noise source, and the existing background noise level of the environment.

Measurements of the background noise levels were conducted in locations representative of the residences setback at different distances from the Princes Highway. The measurements were made to determine if the area is located within a "background relevant area". The noise monitoring locations are shown in Figure 1 and the results are provided in Appendix B.

Based on the measurements, the average of the background noise levels during the day, evening and night periods have been determined based on the 7 day period of data between 3 and 10 August 2021. Prior to determining the average background noise levels, any periods with the potential to have been adversely affected by wind or rain were removed from the assessment based on data collected at the Bureau of Meteorology Mortlake observation site. The periods that have been removed due to adverse weather are shown by dotted lines in Appendix B.

The background noise level results of the monitoring are provided in Table 1 below:

Table 1: *Average Background Noise Levels.*

Noise Monitoring Location	**Average Background Noise Level, L_{A90}**		
	Day	**Evening**	**Night**
	Monday to Saturday (except public holidays) from 7:00am to 6:00pm	Monday to Saturday, from 6:00pm to 10:00pm and Sunday and public holidays from 7:00am to 10:00pm	10:00pm to 7:00am the following day
1	41 dB(A)	43 dB(A)	42 dB(A)
2	40 dB(A)	40 dB(A)	39 dB(A)

The distance-adjusted level for a utility located in a Farming Zone are summarised in Table 2 below:

Table 2: *Distance Adjusted Level.*

Distance-Adjusted Level for a Utility Located in a Farming Zone		
Day	**Evening**	**Night**
Monday to Saturday (except public holidays) from 7:00am to 6:00pm	Monday to Saturday, from 6:00pm to 10:00pm and Sunday and public holidays from 7:00am to 10:00pm	10:00pm to 7:00am the following day
45 dB(A)	39 dB(A)	34 dB(A)

The noise limits are determined as follows:

- for the day period, the noise limit is the greater of:
  - the distance-adjusted level; or
  - the day background level plus 8 dB.
- for the evening period, the noise limit is the greater of:
  - the distance-adjusted level; or
  - the evening background level plus 5 dB.
- for the night period, the noise limit is the greater of (but not greater than 55 dB(A)):
  - the distance-adjusted level; or
  - the night background level plus 5 dB.

The noise limits have been determined based on the above and are summarised in Table 3 below:

Table 3: *Noise Limits.*

Receivers (as detailed in Figure 1)	**Noise Limits**		
	Day	**Evening**	**Night**
	Monday to Saturday (except public holidays) from 7:00am to 6:00pm	Monday to Saturday, from 6:00pm to 10:00pm and Sunday and public holidays from 7:00am to 10:00pm	10:00pm to 7:00am the following day
2, 3, 4, 5, 6 and 7	49 dB(A)	48 dB(A)	47 dB(A)
1, 8 and 9	48 dB(A)	45 dB(A)	44 dB(A)

3 ASSESSMENT

3.1 Noise Prediction Model

Noise predictions have been made using the ISO 9613-2:1996 "*Acoustics – Attenuation of sound during propagation outdoors*" (**ISO 9613**) propagation model in the 'SoundPLAN' noise modelling program. The ISO 9613 noise propagation model is widely accepted as an appropriate model for ground-based sources and has the ability to take into account relevant influences, including:

- sound power levels of each individual noise source;
- the location and orientation of noise sources;
- separation distances between noise sources and sensitive receptors;
- the influence of barriers;
- influence of the ground;
- directivity of noise source; and,
- atmospheric absorption.

The ISO-9613 model is based on meteorological conditions that are favourable to noise propagation. These conditions correspond to downwind noise propagation or a well-developed moderate ground-based temperature inversion.

For a conservative assessment, the noise model has assumed hard ground for the BESS facility and an average between hard and soft ground in all other areas.

3.2 Proposed Battery Storage Noise Sources

The final make and model of the equipment will be selected through a competitive procurement process should the project gain approval. This assessment has therefore been conducted based on an indicative selection. A further assessment will be made following detailed design to confirm that the final design will comply with the relevant criteria as outlined in this report.

This assessment has considered the noise from the following indicative sources and the site arrangement shown in Figure 2 and Figure 3:

1. 168 *Tesla* Megapacks with the "2h Configuration" (each with 11 fans), shown in the locations marked as yellow in Figure 2;
2. 28 transformers associated with the *Tesla* Megapacks (each with a rating of 7.2MVA), shown in the locations marked as blue in Figure 2;
3. Two power transformers (with a rating of 120MVA), one located in the area marked as orange in Figure 2 and one located within the Terang Terminal Station in one of the locations marked in Figure 3.

Figure 2: *Assumed Noise Sources.*

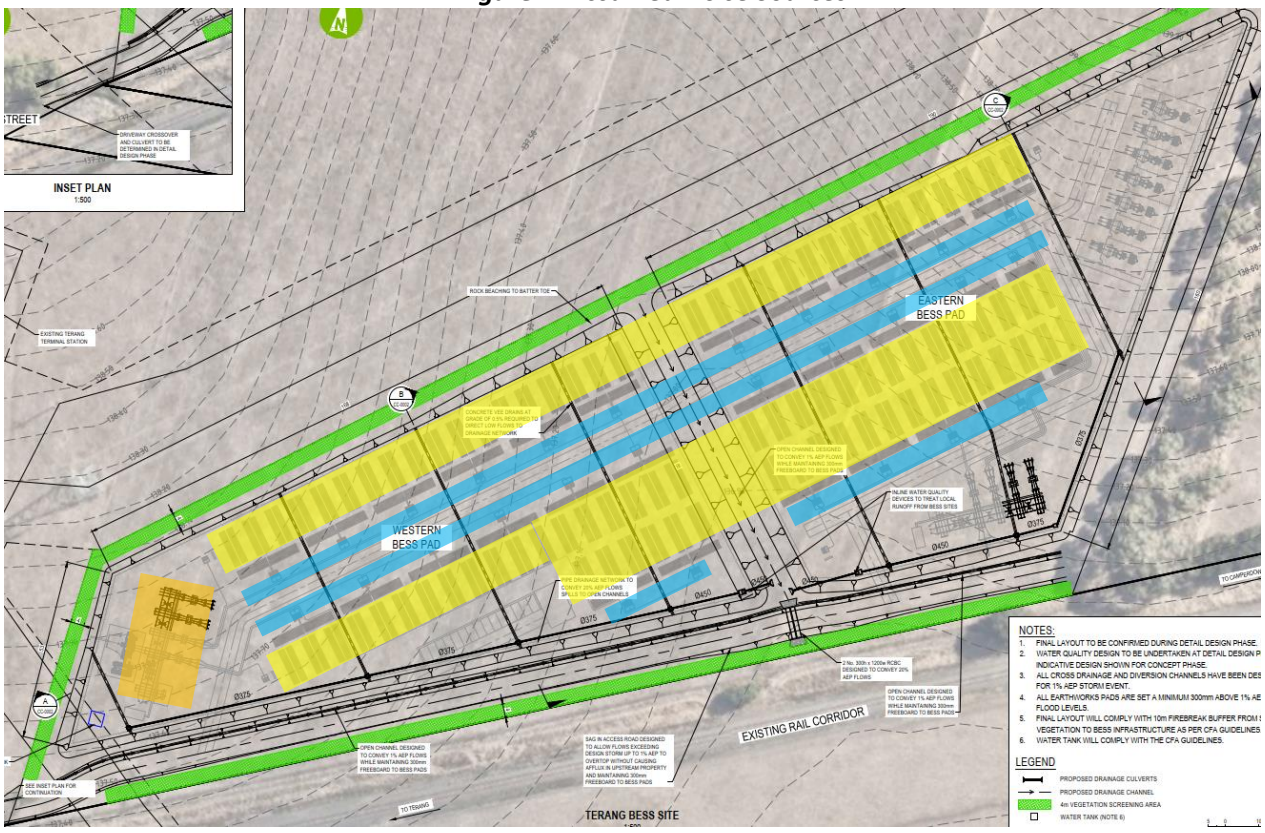
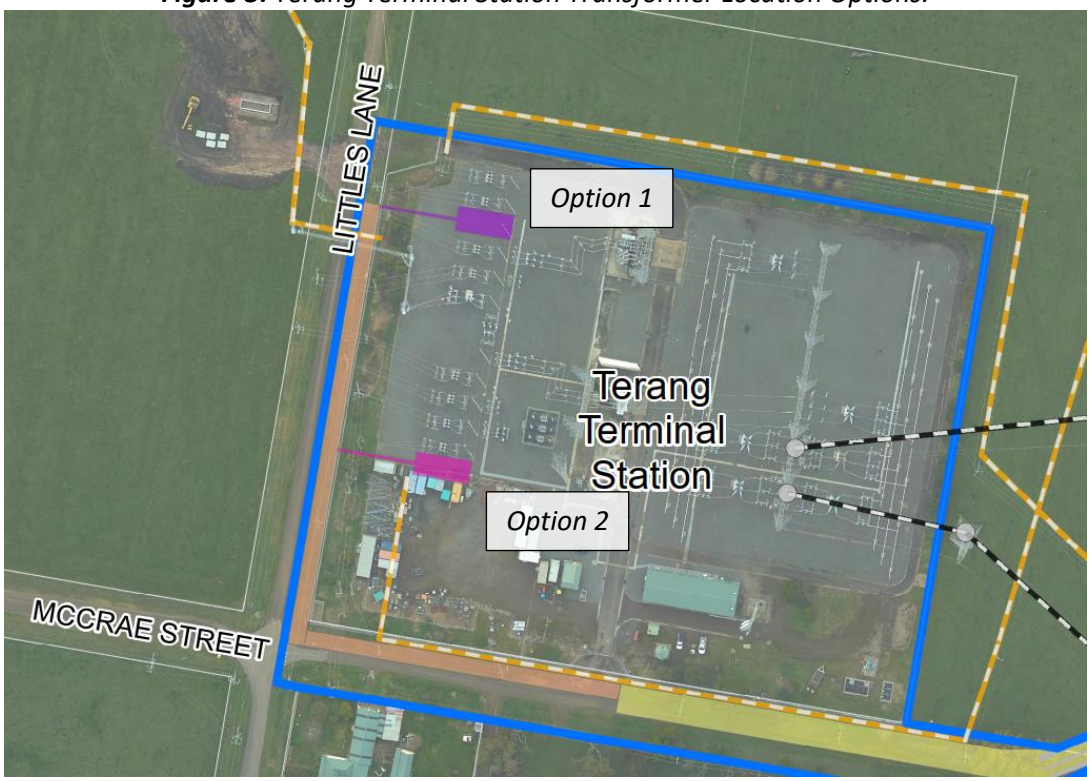


Figure 3: *Terang Terminal Station Transformer Location Options.*



Based on historical meteorological data specific to the Dalvui site, Tesla has indicated that the highest required cooling fan speed is 40%. Notwithstanding, to provide a conservative assessment approach, the noise level has been predicted at residences based on the fans operating at 100% capacity.

The following summarises the input noise data which has been assumed for the assessment:

1. The maximum one third octave band sound power level spectrum for the *Tesla* Megapacks will correspond to 100% fan speed with levels summarised in Table 4.

Table 4: *Tesla Megapacks 100% Fan Speed Sound Power Levels.*

One Third Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW)
100 Hz	67.0
125 Hz	69.3
160 Hz	71.4
200 Hz	70.8
250 Hz	70.4
315 Hz	73.5
400 Hz	85.4
500 Hz	81.7
630 Hz	83.7
800 Hz	88.0
1,000 Hz	79.8
1,250 Hz	86.2
1,600 Hz	83.0
2,000 Hz	84.0
2,500 Hz	81.8
3,150 Hz	80.2
4,000 Hz	79.1
5,000 Hz	81.5
6,300 Hz	79.7
8,000 Hz	73.5
10,000 Hz	68.4
12,500 Hz	61.8
16,000 Hz	55.8
Total	94.8

2. Each of the 7.2MVA transformers associated with the *Tesla* Megapacks will have total sound power level equivalent to the "reduced" level derived from the Australian/New Zealand Standard AS/NZS60076.10:2009, Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD), and a *one third octave band* spectrum that is "typical" of a transformer, as summarised in Table 5.

Table 5: *Megapack Transformer Sound Power Levels.*

One Third Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW)
31.5 Hz	34
40 Hz	39
50 Hz	45
63 Hz	42
80 Hz	48
100 Hz	58
125 Hz	51
160 Hz	60
200 Hz	68
250 Hz	55
315 Hz	56
400 Hz	58
500 Hz	56
630 Hz	53
800 Hz	53
1,000 Hz	49
1,250 Hz	45
1,600 Hz	45
2,000 Hz	45
2,500 Hz	42
3,150 Hz	41
4,000 Hz	41
5,000 Hz	40
6,300 Hz	40
8,000 Hz	38
10,000 Hz	35
12,500 Hz	29
16,000 Hz	20
20,000 Hz	11
Total	**70**

3. The 120MVA power transformers will have total sound power levels equivalent to the "reduced" level derived from the Australian/New Zealand Standard AS/NZS60076.10:2009, Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD), and a *one third octave band* spectrum that is "typical" of a transformer, as summarised in Table 6.

Table 6: *Power Transformer Sound Power Levels.*

One Third Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW) 120MVA
31.5 Hz	51
40 Hz	56
50 Hz	62
63 Hz	59
80 Hz	65
100 Hz	75
125 Hz	68
160 Hz	77
200 Hz	85
250 Hz	72
315 Hz	73
400 Hz	75
500 Hz	73
630 Hz	70
800 Hz	70
1,000 Hz	66
1,250 Hz	62
1,600 Hz	62
2,000 Hz	62
2,500 Hz	59
3,150 Hz	58
4,000 Hz	58
5,000 Hz	57
6,300 Hz	57
8,000 Hz	55
10,000 Hz	52
12,500 Hz	47
16,000 Hz	38
20,000 Hz	28
Total	**87**

3.3 Predicted Noise Levels

Dalvui BESS

The noise level at the surrounding noise sensitive residences has been predicted based on the following:

- the noise propagation model and noise source inputs detailed above;
- the understanding that the *Tesla* Megapacks comprise batteries, inverters and variable speed fans for cooling;
- the Megapacks will operate at the maximum 100% fan speed during the day, evening and night.

Based on the above, the highest predicted noise levels (accounting for the two transformer location options within the Terang Terminal Station) at the closest residences are provided in Table 7 .

Table 7: *Noise Predictions.*

Location	Predicted Noise Level
1	53 dB(A)
2	54 dB(A)
3	54 dB(A)
4	52 dB(A)
5	55 dB(A)
6	53 dB(A)
7	52 dB(A)
8	51 dB(A)
9	53 dB(A)

Cumulative Noise

The Protocol requires the effective noise level from a proposed premises to be determined with regard to the cumulative contribution from existing and approved premises affecting the sensitive area. The assessment therefore also considers the noise from the existing terminal station to the west, and the Terang BESS proposed to the north at 70 Littles Lane.

Based on the *Watson Moss Growcott* report "12574-3.2jg" dated October 2020, prepared for the Terang BESS, it is understood that the noise from the existing terminal station and proposed Terang BESS are as detailed in Table 8.

Table 8: *Other Noise Sources.*

Location	Existing Terminal Station	Proposed Terang BESS
1	24 dB(A)	32 dB(A)
2	28 dB(A)	28 dB(A)
3	<28 dB(A)[1]	<28 dB(A)[1]
4	<24 dB(A)[1]	<32 dB(A)[1]
5	<24 dB(A)[1]	<32 dB(A)[1]
6	<16 dB(A)[1]	<32 dB(A)[1]
7	<16 dB(A)[1]	<32 dB(A)[1]
8	<16 dB(A)[1]	<32 dB(A)[1]
9	<16 dB(A)	22 dB(A)

Note 1: Derived based on conservative interpretation of available data

Based on the above, the cumulative noise level including the Dalvui BESS and transformers is as summarised in Table 9 below.

Table 9: *Cumulative Noise Level.*

Location	Predicted Noise Level from Dalvui BESS	Terminal Station	Terang BESS	Cumulative Noise Level	Most Onerous (Night) Noise Criterion
1	53 dB(A)	24 dB(A)	32 dB(A)	**53 dB(A)**	44 dB(A)
2	54 dB(A)	28 dB(A)	28 dB(A)	**54 dB(A)**	47 dB(A)
3	54 dB(A)	<28 dB(A)[1]	<28 dB(A)[1]	**54 dB(A)**	47 dB(A)
4	52 dB(A)	<24 dB(A)[1]	<32 dB(A)[1]	**52 dB(A)**	47 dB(A)
5	55 dB(A)	<24 dB(A)[1]	<32 dB(A)[1]	**55 dB(A)**	47 dB(A)
6	53 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**53 dB(A)**	47 dB(A)
7	52 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**52 dB(A)**	47 dB(A)
8	51 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**51 dB(A)**	44 dB(A)
9	53 dB(A)	<16 dB(A)	22 dB(A)	**53 dB(A)**	44 dB(A)

The predictions indicate that the noise criteria would be exceeded at all residences without acoustic treatment of the site.

Acoustic Treatment & Mitigated Noise Level

The noise level from the Megapacks can be reduced in order to achieve the noise criteria. The cooling fans are the main noise source and can be attenuated through each of the following measures or a combination of them:

1. Installing attenuators to the inlet and outlet of the Megapack fans;
2. Constructing a barrier around the facility; or,
3. Reducing the noise emitted by the fans.

Predictions indicate that a rectangular and an open circular attenuator on each of the fans can be used to reduce the noise level sufficiently to achieve the noise criteria. Table 10 provides example "Fantech" attenuator details which would achieve the noise criteria.

Table 10: *Example Attenuator Details.*

Location	***Fantech Attenuator Type***	***Insertion Loss***						
		125 Hz	***250 Hz***	***500 Hz***	***1 kHz***	***2 kHz***	***4 kHz***	***8 kHz***
Inlet	RT25A Rectangular Attenuator	2	6	8	11	8	5	5
Outlet	C1-071 Circular Attenuator (Un-Podded)	4	8	14	14	9	7	6

Table 11 provides updated predicted noise levels at each residence with the inclusion of the attenuators.

Table 11: *Cumulative Noise Level with Treatment.*

Location	Predicted Noise Level from Dalvui BESS	Terminal Station	Terang BESS	Cumulative Noise Level	Most Onerous (Night) Noise Criterion
1	44 dB(A)	24 dB(A)	32 dB(A)	**44 dB(A)**	44 dB(A)
2	45 dB(A)	28 dB(A)	28 dB(A)	**46 dB(A)**	47 dB(A)
3	45 dB(A)	<28 dB(A)[1]	<28 dB(A)[1]	**45 dB(A)**	47 dB(A)
4	43 dB(A)	<24 dB(A)[1]	<32 dB(A)[1]	**43 dB(A)**	47 dB(A)
5	46 dB(A)	<24 dB(A)[1]	<32 dB(A)[1]	**46 dB(A)**	47 dB(A)
6	44 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**45 dB(A)**	47 dB(A)
7	43 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**43 dB(A)**	47 dB(A)
8	42 dB(A)	<16 dB(A)[1]	<32 dB(A)[1]	**43 dB(A)**	44 dB(A)
9	44 dB(A)	<16 dB(A)	22 dB(A)	**44 dB(A)**	44 dB(A)

In addition to the above, consideration has been given to construction of a barrier around the facility and restricting the noise of the Megapacks.

A noise reduction in the order of 6 dB(A) (depending on the receiver locations) can be achieved where a 5m high barrier is constructed in accordance with the following:

- a minimum of 0.35 BMT sheet steel ("Colorbond" or similar) that is sealed airtight at all junctions, including the ground; and
- incorporating acoustically absorptive material on the BESS side of the fence that achieve a Noise Reduction Coefficient (NRC) of at least 0.8 (such as insulation [50mm thick/32kg/m^3] covered with perforated material with an open area greater than 15%).

As the noise from the cooling fans controls the overall level, there may be an opportunity to install fans which produce lower noise levels. Typically, larger fans, which operate at a slower speed emit lower noise levels. This is demonstrated by the noise data for Megapacks, which shows a reduction of approximately 10 dB(A) when fans are operating at 40% of full speed.

Noise Character Adjustment

When considering noise impacts on receivers, the Protocol includes adjustment for noise character.

In reviewing the spectral data for the *Tesla Megapacks*, there is a tone which is just detectable and varies in frequency based on the speed of the cooling fans. Therefore, there is the potential for the noise from a single *Megapack* to include the character of tonality as defined under the Protocol. However, as the cooling fans of each of the 168 *Megapacks* operate independently, the fans will be operating at a range of speeds and therefore a tone corresponding to a particular fan speed is unlikely to be detectable at residences.

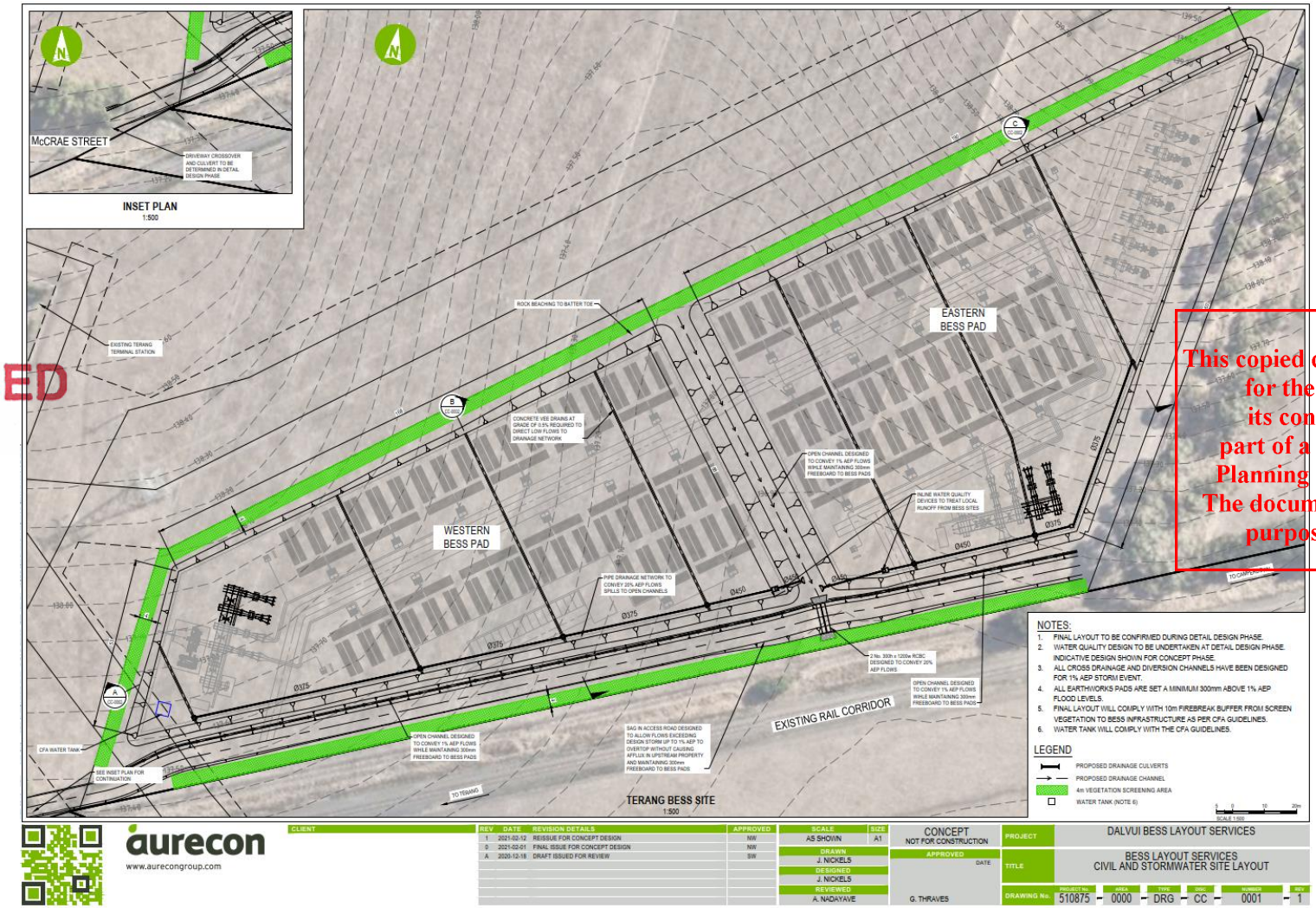
4 CONCLUSION

An environmental noise assessment has been prepared for the proposed Dalvui BESS based on the Tesla Megapack.

The predictions made in this assessment indicate that the noise criteria determined in accordance with the Protocol can be achieved with attenuators on the inlet and discharge of the Megapack cooling fans. The noise criteria could also be achieved with a combination of attenuators, noise barriers and fan selection.

A final noise assessment will be undertaken following detailed design to confirm that the final BESS model and make can comply with the relevant criteria.

APPENDIX A: Proposed Battery Energy Storage System Layout



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APPENDIX B: Noise Monitoring Results