ARUP

Project Echidna

Acoustic Design Report

Reference: Project Echidna-ARP-XX-XX-RP-Y-0004

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1. Introduction

1.1 Background

Project Echidna is a data centre to be located within a site located at 10 Eastern Creek Drive, Eastern Creek. The site will also accommodate two other data centres namely Building 1 and Building 1A, as well as a substation.

Building 1 and Building 1A were approved under a separate Development Application (DA), referred to as SPP-19-00013 DA. The substation will be subject to a separate DA.

Criteria for the whole site was previously set in the approved SPP-19-00013 DA. The criteria are applicable to the whole site which includes noise sources from Building 1A, Building 1, the substation and project Echidna.

In the acoustic assessment that supported the SPP-19-00013 DA, it was unclear if all noise sources had been included or whether any noise criteria allowance remained for Project Echidna noise emissions. Hence, in the noise assessment that was prepared to support the SSDA application for the construction and operation of Project Echidna the design criteria were set 10 dB less than the site criteria as a conservative approach. This approach was to ensure that Project Echidna noise emissions would not result in exceedances to overall site emissions. Noting the conservatism used to derive the Project Echidna criteria (which resulted in conservative noise mitigation measures to be implemented in the design of Project Echidna) it was proposed to re-assess cumulative noise emissions from the site by conducting a detailed assessment of noise emissions from Building 1, Building 1A and the substation during the Project Echidna detailed design. The cumulative noise assessment was proposed to establish if Project Echidna design criteria could potentially be relaxed and consequently if noise mitigations could be reduced and if the site operations could be altered (The client had indicated the desire to conduct generator testing during night-time for Project Echidna). In the State Significant Development Application (SSDA) assessment, it was proposed to present an updated report to the relevant authority prior to Construction Certificate.

Following NSW Department of Planning and Environment (DPE) comments and preliminary noise assessment including noise emissions from Building 1, Building 1A and the substation, the SSDA was updated and an amendment report was attached presenting preliminary cumulative noise emissions from the site. (Refer to Project Echidna, Noise and Vibration Impact Assessment – SSDA dated 7 October 2022 (Referred to as SSDA report)).

Since then the assessment has been refined and this report presents the results and findings of the updated cumulative assessment.

1.2 Purpose of this report

This report presents the results and findings of the cumulative assessment of noise emissions from the site, including noise sources from Building 1, Building 1A, the substation and Project Echidna. This report also presents an assessment of site operations with regards to generator testing.

The assessment has been carried out in accordance with the SEARs requirements and other relevant documents (Refer to Section 2).

As the SSDA is yet to be approved, the acoustic design is contingent on approval and subsequent conditions issued by the authority.

The documentation in this report has been developed to a level of completion equivalent to 100% design development (Tender docs) and considers the following key elements:

- Identification of off-site noise sensitive receivers and applicable design criteria
- Impact of noise sources within site including noise sources from the operation of Building 1 Building 1A, Project Echidna and the substation onto surrounding off-site noise sensitive receivers.

- Review of Project Echidna operations with regards to generator testing

Note, this assessment is limited to off-site environmental noise emissions. Acoustic design of internal office and support spaces is beyond the scope of this assessment.

1.3 Site overview

The site is located at 10 Eastern Creek Drive, Eastern Creek on land zoned as industrial. Datacentre Project Echidna (the proposal) is to be located within the site which will accommodate for two other data centres namely Building 1 and Building 1A, as well as a substation.

Location of Project Echidna, Building 1, Building 1A and the substation are identified on Figure 1 and Figure 2.

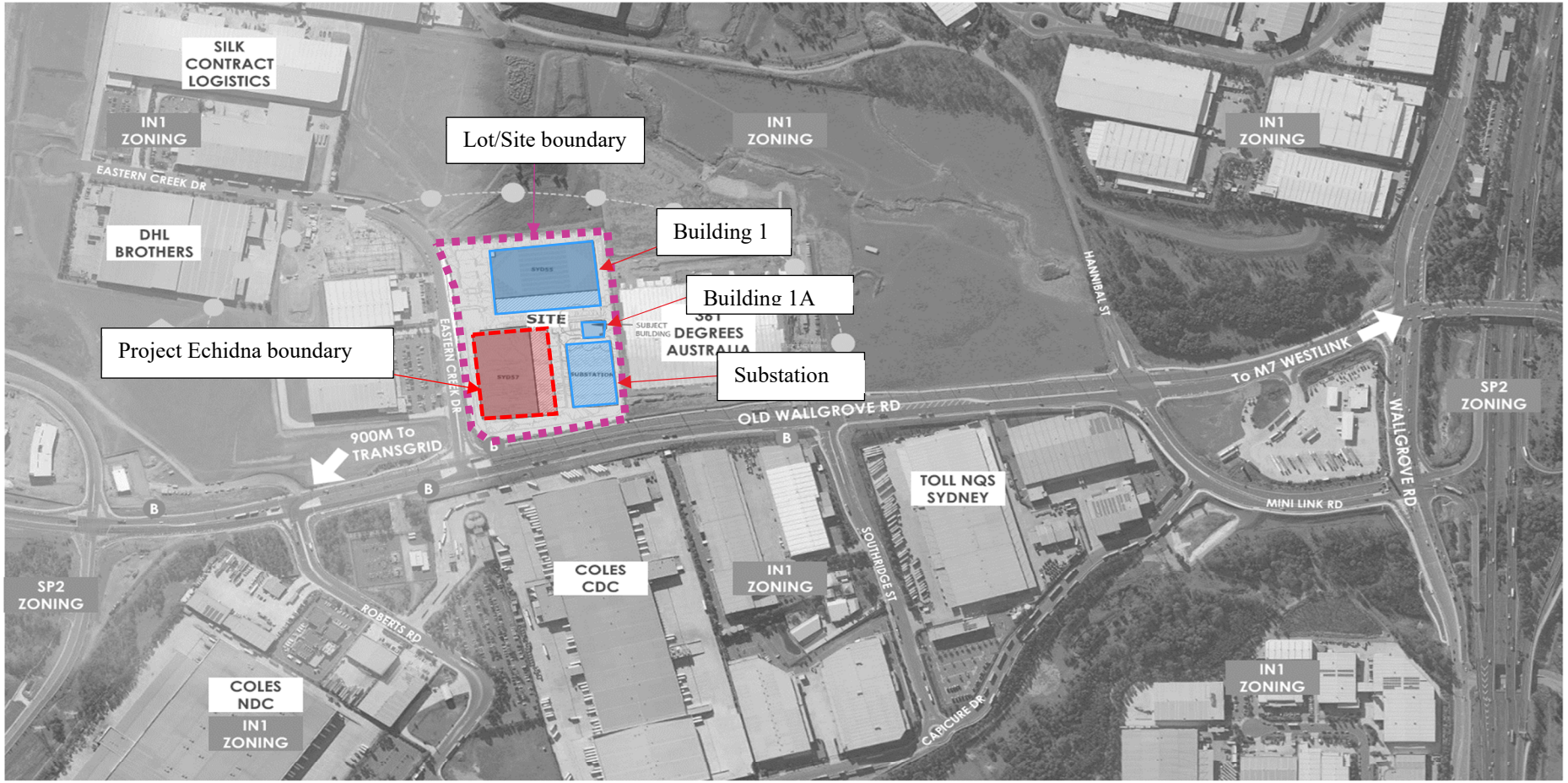

Image Source: SIX MAP

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CONTEXT ANALYSIS

Figure 1: Location context area plan

The proposed data centre, Project Echidna is comprised of the following major relevant components:

- Internal transformers and associated electrical plant.
- Internal air handling units.
- External emergency generators.
- External rooftop plant consisting of exhaust air fans and condenser units.
- Internal Data Halls (DH).
- Loading docks.
- Offices and amenities.

The generators will be operational only during an emergency situation (i.e. power failure) or during regular maintenance and testing.

Figure 2 shows the proposed site plan.

Building 1, located next to Project Echidna is comprised of similar major plant and equipment as Project Echidna.

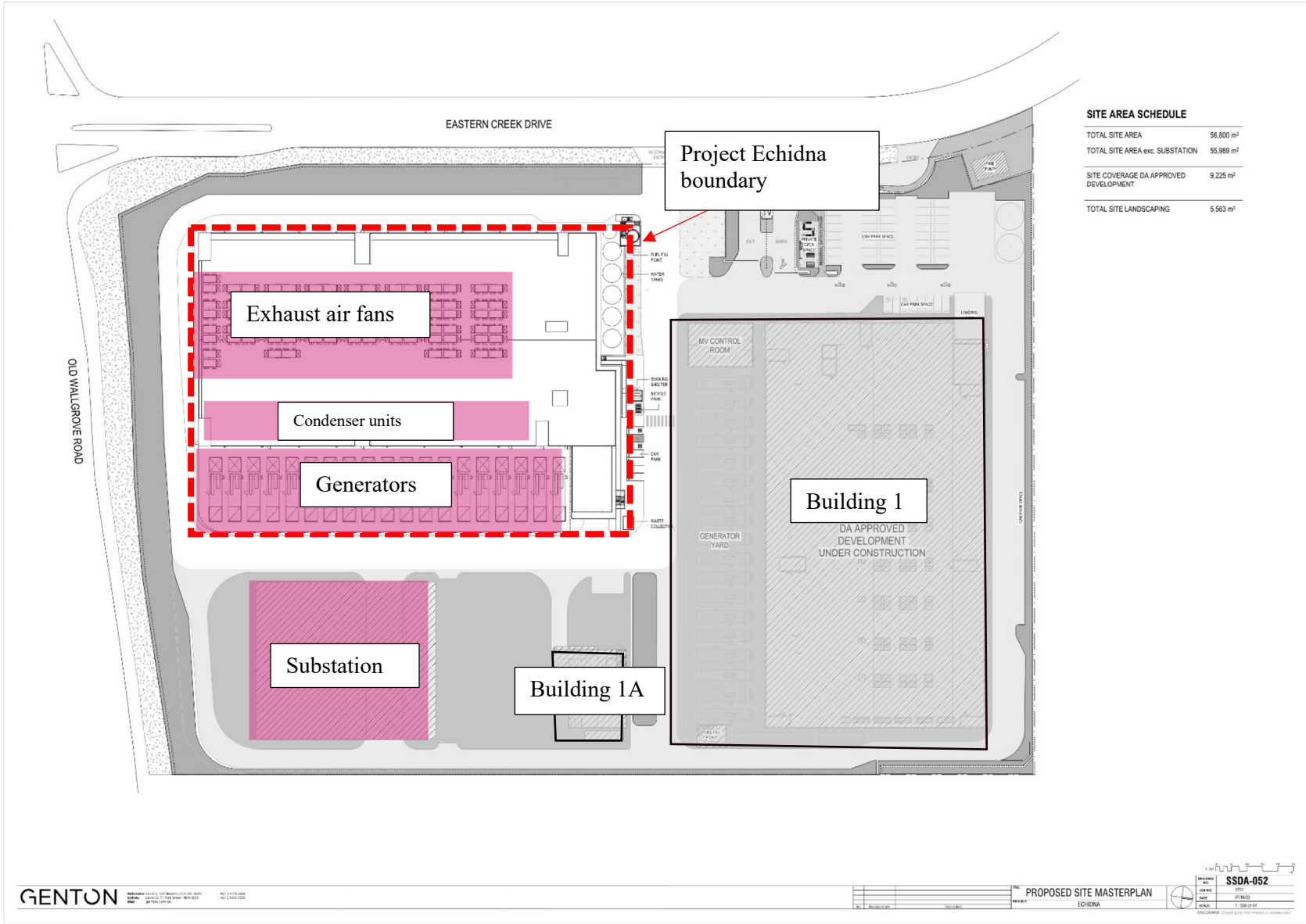

Figure 2: Site Layout

1.4 Architectural drawings

The acoustic assessment has been based on the following architectural drawings prepared by Genton, as outlined in Table 1.

Table 1: Architectural drawings

Drawing Number	Issue	Drawing Name	Date
Project Echidna			
Project Echidna-GEN-00-00L-DR-A-1000	D	Site plan – Ground Floor	17/11/2022
Project Echidna-GEN-00-00L-DR-A-1001	D	Site plan – Level 1	17/11/2022
Project Echidna-GEN-00-00R-DR-A-1002	D	Site plan – Roof level	17/11/2022
Project Echidna-GEN-00-00L-DR-A-2400	D	General arrangement overall plan – Level 1	17/11/2022
Project Echidna-GEN-00-00L-DR-A-2402	D	General arrangement overall plan – Ground level	17/11/2022
Project Echidna-GEN-00-01R-DR-A-2404	D	General arrangement overall plan – Roof	17/11/2022
Project Echidna-GEN-00-00L-DR-A-2650	D	Generator yard details- GA and platform types	17/11/2022
Project Echidna-GEN-00-00M-DR-A-2401	D	General arrangement overall plan- ground level mezz	17/11/2022
Project Echidna-GEN-00-00M-DR-A-2403	D	General arrangement overall plan- Level 1 mezz	17/11/2022
Project Echidna-GEN-00-00M-DR-A-2423	D	Partial plan – Ground level mezzanine- Zone 3	17/11/2022
Project Echidna-GEN-00-XX-DR-A-6210	D	External louvre section details	17/11/2022
Project Echidna-GEN-00-XX-DR-A-6320	D	Typical air plenum corridor & mezzanine details	17/11/2022
Project Echidna-GEN-00-ZZ-DR-A-1200	D	Overall site elevations and sections	17/11/2022
Project Echidna-GEN-01-XX-DR-A-4001	D	Elevations North & East	17/11/2022
Project Echidna-GEN-01-XX-DR-A-4002	D	Elevations South & West	17/11/2022

2. Assessment Requirements and Guidelines

2.1 Assessment requirements

The assessment has been conducted in accordance with the industry specific Planning Secretary's Environmental Assessment Requirements (SEARs) for Data Storage Centres reproduced in Table 2.

Table 2: Industry-specific SEARs (Noise and Vibration) and scope of this assessment

Requirement
Industry – specific SEARs (Noise and Vibration)
Provide a noise and vibration assessment prepared in accordance with the relevant EPA guidelines and Australian/International Standards. The assessment must detail construction and operational noise and vibration impacts (including testing of any back-up power system) on nearby sensitive receivers and structure, and outline the proposed mitigation, management and monitoring measures that would be implemented. **Deliverable:** Noise and Vibration Impact Assessment

2.2 Noise emissions criteria guidelines

The following Acts, Plans, Guidelines and Policies have been considered for this assessment. Those documents are in accordance with the SEARs issued for the project. Additional documents have been reviewed as required.

- NSW Noise Policy for Industry (EPA, 2017) [1]
- Australian Standard AS 1055:2018 Acoustics - Description and measurement of environmental noise [2]
- NSW Road Noise Policy (DECCW, 2011) [3]
- NSW Assessing Vibration: A Technical Guide (DEC, 2006) [4]
- British Standard BS 7385 Part 2 [5]
- British Standard BS 6472 [6]
- German Standard DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure' [7]

3. Assessment locations

Noise and vibration sensitive receivers have been identified in Table 3 and Figure 3. Unattended noise monitoring conducted as part of the SPP-19-00013 DA, relevant to this assessment, has been included in Table 3 and Figure 3.

Table 3: Assessment and noise monitoring locations

Type	ID	Address	Description	Approximate Distance from site boundary
Sensitive receivers				
Residential	R1	39 Farrington St, Minchinbury	Residential dwellings representative of residential properties to the north, south and west of the site.	1700 m
Residential	R2	146 Burley Rd, Horsley Park		1600 m
Residential	R3	3 Cetus Pl, Erskine Park		2500 m
Residential	R4	16 Weaver St, Erskine Park		2600 m
Residential	R5	13 Swamphen St, Erskine Park		3000 m
Residential	R6	10 Agrafe Pl, Minchinbury		2000 m
Residential	R7	168 McFarlane Dr, Minchinbury		2200 m

Residential	R8	58 Burley Rd, Horsley Park		1700 m
Commercial (existing)	C1	1 Eastern Creek Dr, Eastern Creek	Ricoh Australia.	83 m
Commercial (existing)	C2	41 Eastern Creek Dr, Eastern Creek	Bullivants	55 m
Commercial (existing)	C3	45 Eastern Creek Dr, Eastern Creek	Vermeer Australia	53 m
Commercial (existing)	C4	46 Eastern Creek Dr, Eastern Creek	Jay Car	200 m
Commercial (potential)	C5	50 Eastern Creek Dr, Eastern Creek	Potential future commercial	86 m
Industrial (existing)	I1	50 Old Wallgrove Rd, Eastern Creek	ACR Supply	12 m
Industrial (existing)	I2	36 Honeycomb Dr, Eastern Creek	Sydney Mainfreight Warehousing	324 m
Industrial (existing)	I3	3 Roberts Rd, Eastern Creek	Coles CDC	90 m
Unattended monitoring locations[1]				
Unattended	L1	13 Farrington St, Minchinbury	Single storey residence to the north of the site	1900 m
Unattended	L2	146 Burley Rd, Horsley Park	Single storey residence to the south of the site	1600 m

Note_1: As per SPP-19-00013 DA

Figure 3: Site, sensitive receivers and noise monitoring locations

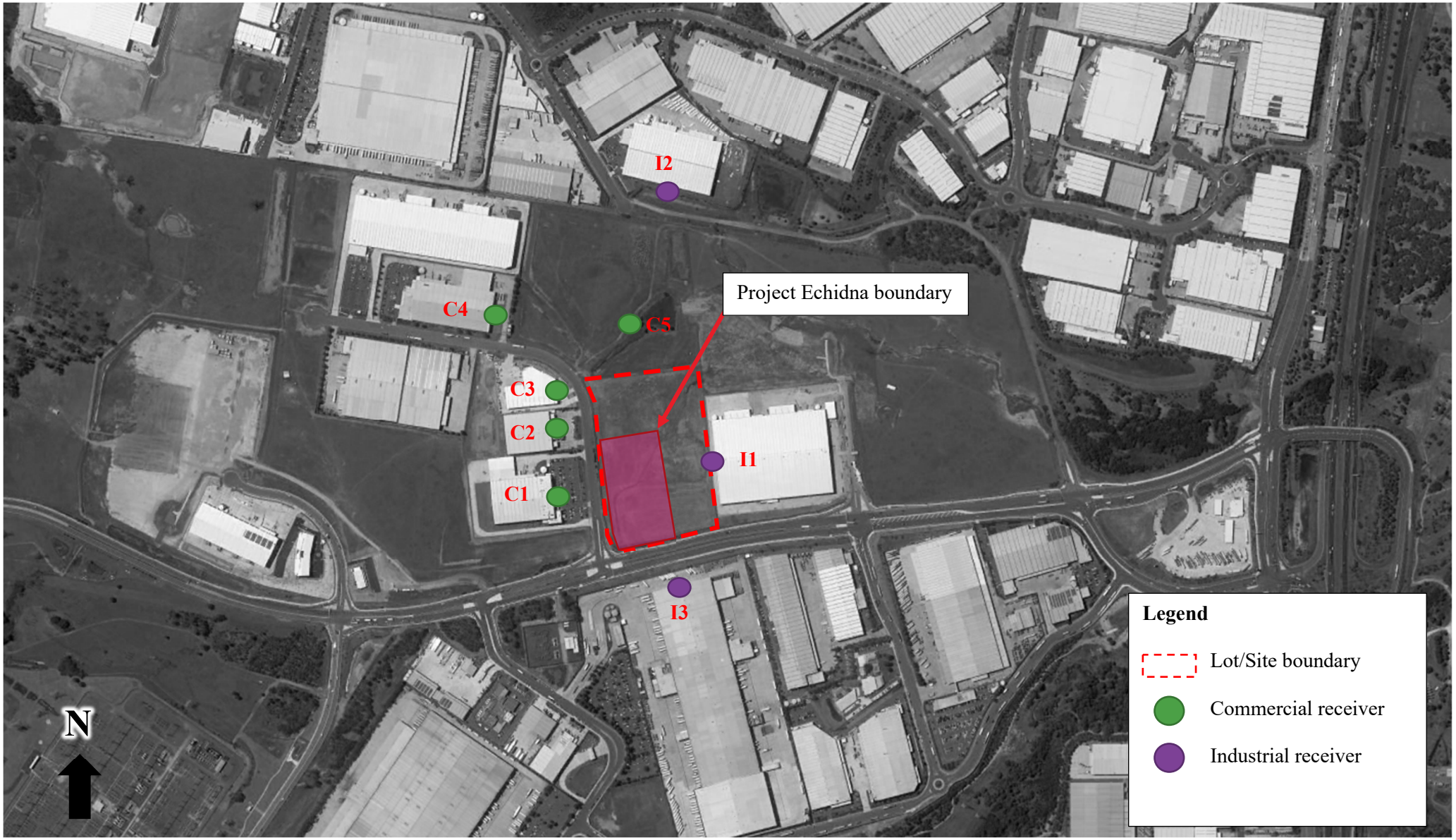

Figure 4: Site and sensitive receivers

4. Existing acoustic environment

Existing background noise levels are required for the establishment of the intrusive noise criteria, applying only to residential locations. All other receivers have fixed criteria applied.

Long-term noise monitoring was previously carried out at locations L1 and L2 (See Table 3 and Figure 3) from 24 May 2019 to 31 May 2019 as part of SPP-19-00013 DA. Results of the noise monitoring are reproduced in Table 4.

Table 4: Long-term noise monitoring results, dB(A)

Location	Time period[1]	Rating background noise levels, dBL_{A90}	Prevailing noise conditions
L1 – 13 Farrington St, Minchinbury	Day	44	Traffic noise from M4 Western motorway, birds chirping and dogs barking.
	Evening	44	
	Night	39	
L2 - 146 Burley Rd, Horsley Park	Day	41	High volume of bird noises, pig farm located to the north of the property and light machinery noise (lawn mowers, grinders etc.) from surrounding properties.
	Evening	42	
	Night	39	

Note:

1_Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

5. Operational noise assessment

5.1 Standard and emergency operations definition

Standard operation was previously defined in the SSDA report and amendment report. However, the definition has been reviewed in this report following several model iterations to determine if night-time generator testing could satisfy criteria. Night-time generator testing is noted as a Client operational objective.

Standard operation is defined in Table 5.

Table 5: Standard operation definition, dB(A)

Standard operations (as defined in the SSDA report)	Standard operations (current)
• **Daytime** | all equipment operating other than the generators and load bank, which will only operate periodically under the following maintenance testing regimes: – Full Load - Only one generator and the load bank operating at 100% load as part of a scheduled testing regime – No Load - Up to three generators being tested concurrently without load banks with no load as part of a scheduled testing regime	• **All periods** | all equipment operating other than the generators and load bank, which will only operate periodically under the following maintenance testing regimes: – Full Load - Only one generator and the load bank operating at 100% load as part of a scheduled testing regime – No Load - Up to three generators being tested concurrently without load banks with no load as part of a scheduled testing regime

• **Evening and night** | all equipment operating except the generators and load bank. Trucks to be operating during daytime hours.	Trucks to be operating during daytime hours.

Criteria for standard operation is in Section 5.2.

Emergency operation is defined as:

- All equipment operating including all generators (except the load bank).

Criteria for emergency operation is in Section 5.3.

5.2 Standard operations noise criteria

Applicable criteria for site noise emissions 'Site Specific Noise Trigger Levels' (SSNTL) were determined in SPP-19-00013 DA in accordance with the Noise Policy for Industry (NPfI) [8] and are reproduced in Table 6 for residential receivers to the North and South of the site and for commercial and industrial receivers.

Background noise at the receivers to the west are likely to be similar to the background noise of the receivers to the south. Criteria for receivers to the west is set to the same criteria that apply to receivers to the south.

The SSNTLs apply to cumulative noise emissions from Building 1, Building 1A, Project Echidna and the substation.

Table 6: NPfI Site Specific Noise Trigger Levels (Normal operations)

Receiver type	Receiver Id	Time Period	Site Specific Noise Trigger Level (SSNTL) $dBL_{Aeq,15min}$	Sleep disturbance L_{Amax}[1]
Residential	R1, R6 & R7	Day	49	-
		Evening	43	-
		Night	38	53
	R2 & R8	Day	46	-
		Evening	43	-
		Night	38	53
	R3, R4 & R5	Day	46	-
		Evening	43	-
		Night	38	53
Commercial	C1 to C5	When in use	63	-
Industrial	I1 to I3	When in use	68	-

Note 1: Sleep disturbance relates to both awakenings and disturbance to sleep stages. The NPfI **[8]** outlines the following noise trigger levels for assessment of night-time noise levels at residential locations:

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

Where these trigger levels are exceeded, a detailed maximum noise level (L_{Amax}) event assessment should be undertaken.

5.2.1 Modifying factors

Table C1 of the NPfI [8] sets modifying factor corrections for annoying noise characteristics such as tonality, dominant low frequency, intermittency or irregularity.

5.2.1.1 Tonal noise

Noise containing a prominent frequency and characterised by a definite pitch.

5.2.1.2 *Low-frequency noise*

Noise with an unbalanced spectrum and containing major components within the low-frequency range (10–160 Hz) of the frequency spectrum.

When assessing low frequency impacts, an initial screening test is first undertaken by evaluating whether the difference in noise levels in C-weighted and in A-weighted are 15 dB or more at the receivers, which identifies the potential for an unbalanced spectrum in which case further assessment is required.

5.2.1.3 *Intermittent noise*

Noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.

5.2.1.4 *Correction for duration*

This is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. Table 7 presents the allowable exceedance of the $L_{Aeq,\ 15\text{-}min}$ equivalent noise criterion for the duration of the event.

Table 7: Adjustment for duration

Allowable duration of noise (one event in any 24-hoour period)	Allowable exceedance of $L_{Aeq,\ 15\text{-}min}$ equivalent project noise trigger level at receptor for the period of the noise event, dB(A)	
	Daytime and evening (7am–10pm)	Night-time (10pm-7am)
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

5.2.1.5 *Maximum correction*

The maximum correction to be applied to the predicted or the measured level where two or more modifying factors are present. The maximum adjustment is 10 dB(A) where the noise contains two or more modifying factors (excluding the duration correction).

5.3 Emergency operations noise criteria

The NPfI [8] sets criteria for Standard Operations. These criteria do not strictly apply to emergency operations, and typically less stringent criteria are adopted, based on the low likelihood of operation under such conditions.

Generator testing is included in the standard operation of the site which is assessed against the NPfI criteria. For emergency operations, the NPfI criteria are typically not adopted as emergency scenarios are considered atypical. Therefore, no acoustic criteria are proposed for emergency operations.

5.4 Modelling methodology

Noise levels have been predicted at the nearest sensitive receivers based on the noise levels and quantities of external plant equipment.

The noise levels have been predicted using SoundPlan 8.1 for both standard and noise-enhancing weather conditions as specified in Table D1 of the NPfI using the Concawe algorithm:

- Standard meteorological condition:
  - Day/evening/night: Stability categories A-D with wind speed up to 0.5 m/s at 10 m.

- Enhanced meteorological condition:
  - Daytime/evening: Stability category A-D with light winds (up to 3m/s at 10 m)
  - Night-time: Stability category A-D with light winds (up to 3m/s at 10 m) and/or stability category F with winds up to 2m/s at 10 m.

  Note, SoundPlan results for Stability category A-D with light winds (up to 3m/s at 10 m) and results for stability category F with winds up to 2m/s at 10 m are similar.

The model includes:

- Receivers listed in Section 2.2
- Noise sources listed in Section 5.5.1
- On-site and surrounding buildings
- Ground terrain and absorption
- For Project Echidna, the model includes the servers assuming a reverberant sound pressure level of 85 dBA. Noise "leakage" from data halls is factored into the calculation of noise break out as per below:
  - Path 1: noise from data hall to plenum then through the dampers to AHU plant room, then noise from AHU plant room to outdoor
  - Path 2: noise from data hall to plenum, to riser then through exhaust fans (GF) /noise from data hall to plenum to exhaust fans (L1)

    Note that the 85 dBA reverberant sound pressure level was taken from measurements conducted within a similar data hall for another project.
- For Building 1, noise "leakage" from data halls has been excluded from the calculation. It was assumed sufficient acoustic treatment was incorporated into the design to ensure noise leakage from data halls does not contribute to overall noise levels in the AHU plant rooms and at the EAFs.

5.5 Noise predictions to off-site receivers

5.5.1 Noise sources

The Project includes the primary mitigated noise sources outlined in Table 8.

The sound power levels and octave band spectra have been provided by manufacturers or estimated based on expected equipment power ratings and past project experience. It is understood that the building envelope will primarily be concrete construction.

Mitigation measures in this section should be read in conjunction with mitigation measures in Section 8, Section 9 and Section 10.

Noise emissions from all plant and equipment (apart from the trucks) are characterised as steady-state sound in accordance with AS1055:2018 [2] i.e., constant noise emissions.

Equipment noise levels are assumed to not exhibit tonal characteristics.

Regarding truck movements within the site, it is anticipated that up to three trucks would be travelling within the site to and from the loading docks per day during daytime hours only. Trucks would enter via Eastern Creek Drive and exit via Old Wallgrove Road. A truck would be on site for a maximum of one hour while being unloaded. The trucks will be turned off while being unloaded.

Table 8: Project Echidna plant and associated sound power levels (L_w) or sound pressure levels (L_p)

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	
Exhaust fan	Manufacturer data (Stulz)	Exhaust	Lw	75	-	84	75	73	63	60	65	66	Point source
		Intake	Lw	91	-	89	86	89	87	82	77	74	Area sources[3]
		Casing	Lw	74	-	73	74	76	64	54	39	31	
Condenser unit	Manufacturer data (Stulz)	-	Lw	75	71	74	69	69	72	68	65	57	Point Source
Air handling unit	Manufacturer data (Dannan)	Inlet	Lw	89	91	102	92	82	79	71	61	62	Area sources[4]
		Outlet	Lw	99	96	103	98	97	93	89	86	86	
	Empirical data	Casing	Lw	68	74	78	71	68	50	45	39	37	
Generators (Full load)[1,2]	-	Enclosure wall	Lp at 1m Indicative dimensions: 9m x 3.7m	75	76	76	79	75	66	57	46	47	Area sources[5]
		Exhaust	Lp at 1m	70	66	66	59	62	67	63	61	55	Point Source (78 dBA Lw)
		Intake louvre	Lp at 1m Indicative dimensions: 4m x 4m	75	79	79	77	59	60	57	55	74	Area sources[5]
		Discharge louvre	Lp at 1m Indicative dimensions: 3.7m x 4m	75	79	79	79	63	61	59	56	73	
Generators (No load)[1,2]	Arup database[6]	Enclosure wall	Lp at 1m Indicative dimensions: 9m x 3.7m	73	75	74	75	73	65	55	38	22	Area sources[8]
		Exhaust	Lp at 1m	68	65	64	55	60	66	61	53	30	Point Source (76 dBA Lw)
		Intake louvre	Lp at 1m Indicative dimensions: 4m x 4m	67	78	77	73	57	59	55	47	49	Area sources[8]
		Discharge louvre	Lp at 1m Indicative dimensions: 3.7m x 4m	69	78	77	75	61	60	57	48	48	

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	
Load bank	Manufacturer data off the shelf loadbank (Parratech)	-	Lp at 3m Indicative dimensions: 3m x 2.5m x 2.6m	85	81	81	87	81	78	77	73	75	Point Source (108 dBA Lw)
Service (heavy vehicles)	Arup database	Vehicle accelerating/moving (assume 5km/h) travelling to/from the loading dock	Lw/m	70	73	69	66	65	67	62	58	52	Line source
		Vehicle near loading dock reversing (assume 5km/h)	Lw/m	64	70	69	60	58	57	59	48	39	Line source
		Vehicle air brake	Lw	106	115	109	105	103	101	97	93	87	Point Source
Data hall	Arup database[7]	Lp reverberant	Lp	84	80	85	79	79	80	78	74	67	-

Notes:

1_Noise emission from the acoustic enclosure shall be free of the tonal, modulated, and impulsive noise (refer to NPfI **[8]**).

2_Sound pressure levels are indicative only, as sound power will be dependent on surface area and size of components

3_Exhaust fan modelled as follows noting that casing dimensions are 4.5 m x 2.4 m x 2.6 m:

- Enclosure (2 long sides, 1 short side, 1 roof). Equivalent Lw of casing is 60 dBA/m^2
- Note: Noise leakage from data hall to plenum to Exhaust Fans and/ noise leakage from data hall to plenum to riser to Exhaust Fans has been included in the calculation.

4_Air Handling Units: 4x to 5x Air handling units are located within a plant room, each plant room services a data hall. There are 4x data halls, therefore 4 plant rooms. An area source for each plant room has been modelled as follows:

- Approximate dimension of a louvre is 24m to 29m x 3m. Equivalent Lw is 55 dBA/m^2.
- Note: Noise leakage from data hall to plenum to AHU plant room then out has been included in the calculation.
- Note: Model includes a directivity factor to the louvre
- Note: Model includes an attenuator at the louvre (see Section 9.1)

5_Generator enclosure modelled as follows:

- Enclosure (2 sides): Each side is approximately 9m x 4m. Equivalent Lw is 77 dBA/m^2
- Intake (1x intake louvre): intake size is approximately 4m x 4m. Equivalent Lw is 77 dBA/m^2
- Discharge (1x discharge louvre): discharge louvre is approximately 3.7m x 4m. Equivalent Lw is 77 dBA/m^2

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	

6_Data based on measurements conducted by Arup for another project

7_ Measurements conducted within a similar data hall for another project

8_ Generator enclosure modelled as follow (no load):

- Enclosure (2 sides): Each side is approximately 9m x 4m. Equivalent Lw is 74 dBA/m^2
- Intake (1x intake louvre): intake size is approximately 4m x 4m. Equivalent Lw is 70 dBA/m^2
- Discharge (1x discharge louvre): discharge louvre is approximately 3.7m x 4m. Equivalent Lw is 72 dBA/m^2

Table 9: Building 1 plant and associated sound power levels (Lw) or sound pressure levels (Lp)

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	
Exhaust fan	As specified in SYD701 DA report.	Exhaust + attenuator	Lw	65	75	71	72	58	42	45	47	47	Point source
		Intake	Lw	92	86	89	92	90	86	83	81	75	Area sources[1]
Condenser unit	As specified in SYD701 DA report.	-	Lw	90	87	87	85	87	87	81	76	70	Point Source
Air handling unit	Max levels specified in Equipment schedule	Inlet	Lw	83	88	95	87	78	73	67	57	55	Area sources[2]
		Outlet	Lw	97	95	102	95	95	92	88	85	82	
	Empirical data	Casing	Lw	66	73	77	68	66	49	44	38	33	
Data hall	Arup database	Lp reverberant	Lp	84	80	85	79	79	80	78	74	67	-

Notes:

1_Exhaust fan modelled as follows noting that casing dimensions are 4.5 m x 2.4 m x 2.6 m:

- Enclosure (2 long sides, 1 short side, 1 roof). Equivalent Lw of casing is 61 dBA/m^2
- Note: Noise leakage from data hall to plenum to Exhaust Fans and/ noise leakage from data hall to plenum to riser to Exhaust Fans has been excluded from the calculation.

2_Air Handling Units: 4x to 5x Air handling units are located within a plant room, each plant room services a data hall. There are 4x data halls, therefore 4 plant rooms. An area source for each plant room has been modelled as follows:

- Approximate dimension of a louvre is 24m to 29m x 3m. Equivalent Lw is 67 dBA/m^2.
- Note: Noise leakage from data hall to plenum to AHU plant room then out has been excluded from the calculation.
- Note: Model includes a directivity factor to the louvre

Table 10: Building 1A plant and associated sound power levels (Lw) or sound pressure levels (Lp)

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	
Condenser unit	Manufacturer data	-	Lw	73	73	76	73	70	68	65	59	52	Point Source
Make-up air unit	SYD701 Mechanical Equipment Schedule	Casing	Lp at 5m Indicative dimensions: 3.7m x 1.7m x 1.4m	51	56	63	55	46	41	35	25	23	Area sources[1]
Transformer (1,500kVA)	Empirical Transformer Lw (IEC60076-10) – Standard Maximum	Forced cooling operation (with load)	Lw	69	71	73	68	68	62	57	52	45	Point source

Note:

1_Make-up air unit: modelled as follows noting that casing dimensions are 3.7 m x 1.7 m x 1.4 m: Equivalent Lw is 63 dBA/m^2

Table 11: Future Substation plant and associated sound power levels (Lw) or sound pressure levels (Lp)

Equipment	Source	Description	Parameter	Overall dB(A)	Octave Band Centre Frequency – Hz, dB								Item modelled as
					63	125	250	500	1 k	2 k	4 k	8 k	
Transformer (40,000kVA)	Empirical Transformer Lw (IEC60076-10) – Reduced Maximum	Natural cooling operation (no load)	Lw	80	83	85	80	80	74	69	64	57	Point Source
Transformer (45,000kVA)	Empirical Transformer Lw (IEC60076-10) – Standard Maximum	Forced cooling operation (with load)	Lw	89	92	94	89	89	83	78	73	66	Point Source
Auxiliary Transformer (315kVA)	Empirical Transformer Lw (IEC60076-10) – Standard Maximum	Forced cooling operation (with load)	Lw	59	62	64	59	59	53	48	43	36	Point source

5.5.2 Operating scenarios

To assess potential noise impacts during operation, three scenarios comprising typical equipment have been developed based on our understanding of the project. These scenarios are considered representative of the noisiest operational activities likely to occur and are described below.

Modelling scenarios are described in Section 5.1 and in Table 12.

Table 12: Modelling scenarios and corresponding plant and equipment quantities

Relevant site	Equipment	Scenarios		
		Normal operation		Emergency operation
		Full Load[1,3]	No Load[2,3]	
Project Echidna	Exhaust fan	96	96	96
	Condenser unit	36	36	36
	Air handling unit	68	68	68
	Generator[3]	1	3	19
	Load bank	1	-	-
	Service (heavy vehicles)	3	3	3
Building 1	Exhaust fan	92		
	Condenser unit	36		
	Air handling unit	68		
Building 1A	Condenser unit	12		
	Make-up air unit	2		
	Transformer (1,500kVA)	1		
Future Substation	Transformer (40,000kV)	1		
	Transformer (45,000kV)	2		
	Transformer (315kVA)	2		

Notes:

1_1 x generator operating at 100% load with load bank at worst case location.

2_ 3 x generators concurrently operating at no load without a load bank.

3_Note that only 1 x generator would be tested within the site at any one time.

5.5.3 Predicted noise levels

Noise predictions for standard operations under standard and enhanced meteorological conditions are presented in Table 13 against the night-time criteria for the site (note that compliance with the night-time criteria will imply that daytime criteria are met).

Noise predictions for emergency operations are presented in Table 14.

Low frequency noise has been assessed in accordance with the modifying factor corrections in Tables C1 and C2 of the NPfI, no exceedances were found and therefore no penalty has been added. Equipment noise levels are assumed to not exhibit tonal characteristics.

Table 13: Standard operation - predicted noise levels

Receiver	Night-time site Criteria LAeq,15min	Standard Operation - Standard weather conditions						Standard Operation – Enhanced weather conditions					
		Non Project Echidna related[1]		Full load[2]		No Load[3]		Non Project Echidna related[1]		Full load[2]		No Load[3]	
		$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?
R1	38	32	Yes	32	Yes	32	Yes	37	Yes	38	Yes	38	Yes
R2	38	30	Yes	32	Yes	31	Yes	36	Yes	38	Yes	37	Yes
R3	38	25	Yes	26	Yes	26	Yes	31	Yes	32	Yes	32	Yes
R4	38	25	Yes	29	Yes	26	Yes	31	Yes	35	Yes	32	Yes
R5	38	24	Yes	28	Yes	25	Yes	30	Yes	34	Yes	31	Yes
R6	38	30	Yes	30	Yes	30	Yes	35	Yes	36	Yes	36	Yes
R7	38	16	Yes	17	Yes	17	Yes	22	Yes	23	Yes	23	Yes
R8	38	17	Yes	31	Yes	19	Yes	23	Yes	38	Yes	25	Yes
C1	63	52	Yes	55	Yes	53	Yes	56	Yes	58	Yes	57	Yes
C2	63	50	Yes	55	Yes	51	Yes	54	Yes	58	Yes	55	Yes
C3	63	51	Yes	56	Yes	51	Yes	55	Yes	59	Yes	55	Yes
C4	63	52	Yes	52	Yes	52	Yes	55	Yes	55	Yes	55	Yes
C5	63	60	Yes	60	Yes	60	Yes	61	Yes	61	Yes	61	Yes
I1	68	58	Yes	66	Yes	59	Yes	60	Yes	68	Yes	60	Yes
I2	68	49	Yes	49	Yes	49	Yes	53	Yes	53	Yes	53	Yes

Receiver	Night-time site Criteria LAeq,15min	Standard Operation - Standard weather conditions						Standard Operation – Enhanced weather conditions					
		Non Project Echidna related[1]		Full load[2]		No Load[3]		Non Project Echidna related[1]		Full load[2]		No Load[3]	
		$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?	$L_{Aeq, 15min}$ dB(A)	Meets Project Criteria?
I3	68	53	Yes	59	Yes	54	Yes	57	Yes	62	Yes	58	Yes

Note_1: Includes noise sources from Building 1, Building 1A and the substation

Note_2: Full load is 1 generator and 1 load bank

Note_3: No load is 1 generator being testing without load

Table 14: Predicted emergency noise levels

Receiver	Emergency – Standard weather conditions $L_{Aeq, 15min}$ dB(A)	Emergency – Enhanced weather conditions $L_{Aeq, 15min}$ dB(A)
R1	32	38
R2	32	38
R3	27	33
R4	27	33
R5	25	31
R6	31	37
R7	19	25
R8	24	31
C1	54	57
C2	52	55
C3	52	56
C4	53	55
C5	60	61
I1	61	63
I2	49	54
I3	56	59

With modelling inputs in Section 5 and mitigation measures as per above and in Section 8, Section 9 and Section 10, results show that overall site criteria are predicted to be met during all periods when the whole site is operating under standard operations (as defined in Section 5.2) which includes generator testing during the night-time.

5.6 On site noise impact from noise generated by the development

Noise impacts from on-site noise sources and existing ambient noise sources should be used to determine administration building envelope performance requirements. Review of on-site noise impacts is excluded from this scope of works.

6. Road traffic noise

Increased traffic generated on the public road network is assessed in accordance with the NSW Road Noise Policy (RNP) [3].

When assessing noise impact using the existing road network, an initial screening test is applied to evaluate whether noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the Project.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) further assessment is required against the criteria in Table 3 of the RNP.

Access to and from the site will be via Eastern Creek Drive and Old Wallgrove Road which is a sub arterial road.

Due to the anticipated low number of vehicles generated by the site (up to 3 trucks per day for Building 1 and Building 1A combined and up to 3 trucks per day for Project Echidna), generated traffic noise is anticipated to comply with RNP.

7. Cumulative noise impact (site + other developments)

Cumulative noise impacts due to emissions from non-site and site related sources are addressed through the establishment of the site criteria.

8. Architectural design

Project specific acoustic treatment recommendations are presented in sections below.

8.1 Building envelope – Plant rooms

Building envelope mitigation strategies are presented in Table 15.

Table 15: Building envelope mitigation strategies

Building envelope component	Mitigation strategy	Minimum Acoustic Performance
Building envelope	The building envelope is proposed to be a minimum of 150 mm concrete. Hence, noise breakout through the walls is anticipated to be negligible compared to noise emissions from externally located plant and equipment and ventilation openings.	$R_w + C_{tr}$ 50 Rw 54
Louvres/attenuator/duct apertures/penetrations	Junctions between louvres/attenuators or duct work penetrations of the building envelope will need to be fully sealed such that the overall building attenuation is not compromised. Louvres shall not cause regenerated noise due to airflow or wind. A backing panel is required to all plant room louvres that are not required as part of the ventilation strategy. The backing panel shall be specified to maintain the overall sound insulation performance of the façade. Proposed construction of panels above the attenuators (sealing off the internal spaces) is a minimum of 2 x 13 mm CFC.	$R_w + C_{tr}$ 37 Rw 40 Overall indicative surface area of panel is 44 m^2
Roller shutter doors	It is understood that: • 2 roller shutter doors are to be installed on the southern façade of the building. Those roller shutter doors open to the corridor between the external façade and the AHU plant room and data halls.	Rw +Ctr 23 Rw 25 Indicative dimensions[1]: 5.6m x 5m
Note: 1_ The performance of the roller shutter doors is dependent on the door dimensions. Should the door dimensions differ significantly, the required performance of the doors should be reassessed.		

8.2 Acoustic sealant

Manufacturer's standard non-sag, permanently resilient, non-hardening, paintable, non-staining latex, polyurethane, or silicone based sealant shall be used. Products shall be effective in reducing airborne sound transmission through perimeter joints and openings in building constructions. The sealant shall be capable of maintaining its elastic properties sufficient to maintain the full sound insulation performance of the lining system during the entire design life.

Recommended products are outlined in Table 16.

Table 16: Acoustic rated sealants

Type	Manufacturer	Name	Specific gravity
Acrylic fire and acoustic rated sealants	HB Fuller	Firesound (VOC Compliant)	1.5
	Promat	Promaseal AN Acrylic Sealant	1.6
	Selleys	ProSeries Fireblock (Low VOC)	1.5
	Sika	Firerate	1.5
	Hilti	CP606	1.5
	Bostik	Firecaulk	1.6
Polyurethane fire and acoustic rated sealants	Bostik	Fireban One (Low VOC)	1.45
	Sika	Firerate PU	1.6

Unless otherwise approved by the acoustic consultant or outlined in manufacturer's data sheets (for acoustic applications), the following is to be adopted:

- Maximum gap width of 10 mm
- Depth of sealant no less than the gap dimension
- Open-cell foam backing rod to be fitted in the cavity behind the sealant
- Apply to both sides of the material/partition/construction containing the gap

8.3 Sealing of service penetrations

All penetration of pipes, ducts, conduit, etc. through acoustic sensitive walls should be made with attention to acoustic detail. All penetrations should be appropriately sized and sleeved, packed and sealed. Each service, duct or pipe etc., should have its own penetration with suitable spacing to allow good sealing.

Typical sealing arrangements for standard and critical pipe, insulated duct and non-insulated duct penetrations are described below.

8.3.1 Standard penetration sealing

For all penetrations through partitions lower than R_w 50 ensure the gap around penetrating ductwork and pipes is less than 15 mm all around the duct including any insulation. The gap shall be packed with acoustic insulation, and moderately compressed during packing. The packing shall be sealed on both sides with an acoustic sealant.

8.3.2 Critical penetration sealing

For all penetrations through partitions R_w 50 or higher the following guidelines shall be adhered to:

Table 17: Critical Sealing of ductwork penetrations

Perimeter Gap	Sealing Details
< 13 mm	Ram pack gap with mineral fibre and seal with non-hardening, silicone based sealant.
13 mm – 25 mm	A close fitting cover plate comprising 13 mm plasterboard, or building board of similar surface mass, shall be bedded in mastic and fitted round the duct on both sides. The joint between cover plate and duct shall be sealed with a non-hardening silicone based sealant.
25 mm – 50 mm	As above but with two layers of 13 mm plasterboard.
> 50 mm	As above but with three layers of 13 mm plasterboard.

Where external thermal insulation with a vapour barrier is applied to the duct, the thermal insulation shall be stopped on either side of the plasterboard but the vapour barrier shall be continuous and pass under the plasterboard.

9. Mechanical services

Building services design shall meet acoustic performance requirements outlined in Section 5.5.1.

Project specific acoustic treatment recommendations are presented in Section 9.1.

9.1 Recommended acoustic treatment

Table 18: Recommended building services acoustic treatment

Location	Item	Indicative acoustic treatment description	Minimum octave band centre frequency insertion loss, dB							
			63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Internal locations along the east and west facade	Air Handling Unit plant room	Attenuator on intake louvre of the plant room	-6	-14	-29	-45	-45	-40	-31	-20
Note: Attenuator regenerated noise level should be at least 10 dB lower than the sound power level Lw exiting the attenuator.										

9.2 Vibration isolation

General vibration treatment recommendations are presented below.

9.2.1 Isolation of equipment

Vibration isolation of mechanical plant and equipment must be considered as part of the internal acoustic design to prevent structure borne noise and vibration impacts in noise sensitive spaces. It is expected that vibration isolation systems will be required. Reference to ASHRAE Application Handbook, Chapter 48, Table 47 should be included in the design of vibration isolation.

9.2.2 Space requirements

Provide 50 mm minimum horizontal clearance between any vibrating equipment and nearby building structure and 50 mm between the underside of a loaded concrete inertia base or structural base and the top of a 100 mm thick concrete housekeeping pad or floor slab.

9.2.3 Inertia base

Base mounted pumps >50 kW should be mounted on isolated concrete inertia bases.

Inertia bases should be at least 150mm thick and should weigh one to two times as much as the equipment they support (including any associated piping, fluid and/or dynamic loads).

9.2.4 Electrical connections to mechanical equipment

Electrical connections to all vibration-isolated equipment, including pumps, fans and transformers, should be with flexible cable and containment. This detail should be described in both mechanical and electrical specifications for co-ordination purposes.

9.2.5 Duct connections

Connect all ductwork to fans, fan casings or fan plena with flexible sleeves.

9.2.6 Pipe connections

Connect all pipework to vibration equipment with flexible connections.

10. Electrical systems

Reference shall be made to the general provisions outlined for mechanical services equipment, in Section 9 regarding vibration control.

Project specific acoustic treatment recommendations are presented in Section 10.1.

10.1 Recommended acoustic treatment

Recommended treatment for the electrical system for Project Echidna is provided in Table 19.

Table 19: Recommended acoustic treatment for electrical systems

Item	Location	Indicative acoustic treatment description
All plant	Site wide	• To meet indicative sound power levels in Table 8 and mitigation measures provided in Section 8 and Section 9.
Generators	Generator yard	• as per Table 8
Mobile loadbank	Generator yard	• as per Table 8

11. References

[1] NSW Environment Protection Authority, “NSW Noise Policy for Industry,” NSW Environment Protection Authority , Sydney, 2017.

[2] S. Australia, “AS1055 Acoustics - Description and measuremnet of environmental noise,” Standards Australia, 2018.

[3] Department of Environment, Climate Change and Water NSW, “NSW Road Noise Policy,” NSW Environmental Protection Authority, Sydney, 2011.

[4] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.

[5] Bristish Standard Institution, “BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration,” Bristish Standard Institution, London, 1993.

[6] Bristish Standards Institution, “BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80Hz),” Bristish Standards Institution, London, 1992.

[7] Deutsches Institut fur Normung, “DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures,” Deutsches Institut fur Normung, Berlin, 1999.

[8] NSW EPA, “NSW Noise Policy for Industry,” EPA, Sydney, 2017.