ARUP

EIS

Project Echidna

Noise and Vibration Impact Assessment - SSDA

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Arup Australia Pty Ltd | ABN 76 625 912 665

Arup Australia Pty Ltd
Level 5
151 Clarence Street
Sydney
NSW 2000
Australia
arup.com

ARUP

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		Name	Cynthia Nguyen Clemence Terraz	Sam Grieve	Sam Grieve
		Signature			
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		Name	Cynthia Nguyen Clemence Terraz	Sam Grieve	Sam Grieve
		Signature			
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			Prepared by	**Checked by**	**Approved by**
		Name	Clemence Terraz	Mathew Simon	Mathew Simon
		Signature			

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1. Introduction

1.1 Key Terminology and Project Details

Table 1: Terminology and Project Details

Term	Definition
Proposal / Project Echidna	Construction of a two-storey data centre comprising of data halls, mechanical and electrical equipment rooms, offices, other ancillary support spaces, and external/rooftop mechanical and electrical equipment.
Proposal GFA	The building has a total GFA of approximately 9,225 square metres comprising two data floors (Ground Floor + Level 1).
Site	The proposal is located at 10 Eastern Creek Drive, Eastern Creek NSW, legally described as Lot 4001, DP 1243178. The site is situated within the Blacktown Local Government Area. The entire site area is approximately 56,800 m^2 and is to accommodate Building 1, Building 1A, a substation and Building 2 (the Proposal).
Concept Design Approval	A previous DA (SPP-19-00013) was approved on site for the industrial development of a Detailed Design Stage 1 and a Concept Design Approval of an outline for Stage 2, which is the subject of this Proposal.
State Significant Development (SSD) Trigger	The data centre building will have a capacity of over 10MW, which triggers the proposal as a State Significant Development under the Schedule 1 of the State Environmental Planning Policy (Planning Systems) 2021.

Arup on behalf of the Proponent is seeking development consent to construct a data centre (the Proposal) at 10 Eastern Creek Drive, Eastern Creek NSW, legally described as Lot 4001 DP 1243178 (the Site). The Proposal involves the construction of a two-storey data centre comprising of data halls, mechanical and electrical equipment rooms, offices, other ancillary support spaces, and external/rooftop mechanical and electrical equipment. The Site is situated within the Blacktown Local Government Area (LGA) on the corner of Eastern Creek Drive and Old Wallgrove Road. Building 1 to the north of the Proposal site is currently under construction. The Proposal's site coverage is approximately 9,225 square metres.

The design of the Data Centre is based on the end-client's reference design as well as applicable Australian Standards and will deliver capacity for approximately 35.2MW of IT equipment. Utility power will be delivered via a dedicated on-site electricity substation (subject to a separate development application), with emergency backup power provided by a combination of lithium-ion battery systems and standby generators. Cooling will be delivered by highly efficient fresh air free-cooling systems in the Winter and evaporative cooling in the Summer to ensure energy consumption is minimised as far as practical.

The two (2) level facility will reach a building height of approximately 25m including all significant plant and rooftop equipment. The facility will include two (2) levels of data hall space and supporting plantrooms, and supporting administrative spaces incorporating secure entry facilities, loading dock, storage, staff offices and the like. The standby generators will occupy an external equipment yard to the west of the main building, and some mechanical equipment will be located at roof level. The site will be served from a private on site substation, located to the west of the proposed data centre building and subject to a separate development application.

Landscaped areas are also proposed, where mature local trees will be used to improve aesthetics and amenity for local businesses.

On-site car parking spaces will be provided for staff and visitors, including disabled and electric vehicle parking. Figure 1 shows the Site and surrounding context. Figure 2 shows a figure of the Site.

1.2 Permissibility and Approval Pathway

Division 4.7 of Part 4 of the EP&A Act covers State significant development (SSD). The Proposal is identified as SSD by virtue of meeting thresholds defined under Schedule 1, Clause 25 of the *State Environmental Planning Policy (Planning Systems) 2021*. Specifically, the Proposal is appropriately classified as a data storage development with a capacity of more than 10 megawatts (see Chapter 4 (Strategic context) for further detail).

The proposed data centre is permissible with consent within a light industrial zone pursuant to the provisions outlined in Section 2.31 of State Environmental Planning Policy (Transport and Infrastructure) 2021.

Given the proposal has a capacity that is greater than 10 MW, the proposal classifies as State Significant Development (SSD) pursuant to the provisions outlined in Schedule 1 of the *State Environmental Planning Policy (Planning Systems) 2021*.

1.3 Development history

The previous planning approvals relevant to the subject SSDA and proposed development include:

- **DA-18-00196:** Consent was granted for the *'Torrens Title subdivision of 1 lot into 1 industrial lot and 1 residue lot'* of Lot 532, DP 1236811 which created the subject lot.
- **DA-18-00938:** On 6 December 2018 consent was granted for *'Bulk earthworks entailing cut and fill across the site to facilitate suitable site levels for future built form (subject to future approval)'*. The associated Construction Certificate is CC-19-00320. These earthworks have been completed on site. The subject development proposed has been designed to respond to these works.
- **DA-18-01592:** On 20 June 2019 consent was granted for the construction of a warehouse and distribution facility comprising 33,250 square metres of GFA, 266 vehicles and site landscaping. Construction of this project has not commenced at this time.
- **DA-20-10387:** On 15 September 2020 consent was granted for the installation of 4 temporary electricity kiosks for interim power supply for an approved data centre.
- **SPP-19-00013:** A previous DA was approved on site for the industrial development of a Detailed Design Stage 1 (Building 1 and Building 1A) and a Concept Design Approval of an outline for Stage 2, which is the subject of this Proposal. It is intended that this SSDA will supersede the existing Concept Design Approval for Stage 2.

2. Project Description

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 2 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 [1]. The substation will be subject to separate DA.

Reference to the SPP-19-00013 DA has been made for this assessment.

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

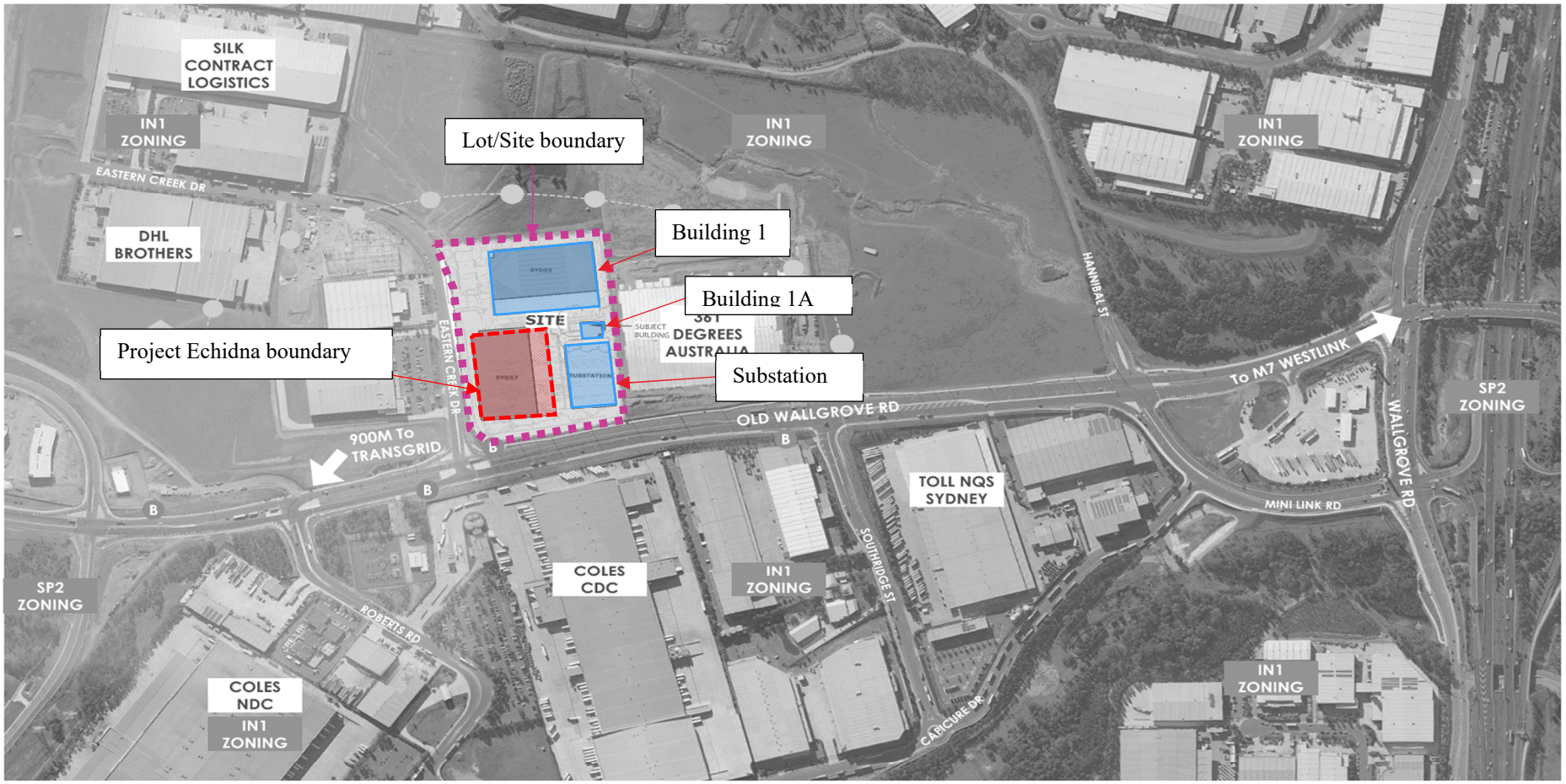

Image Source: SIX MAP

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 monthly maintenance and testing.

Figure 2 shows the proposed site plan.

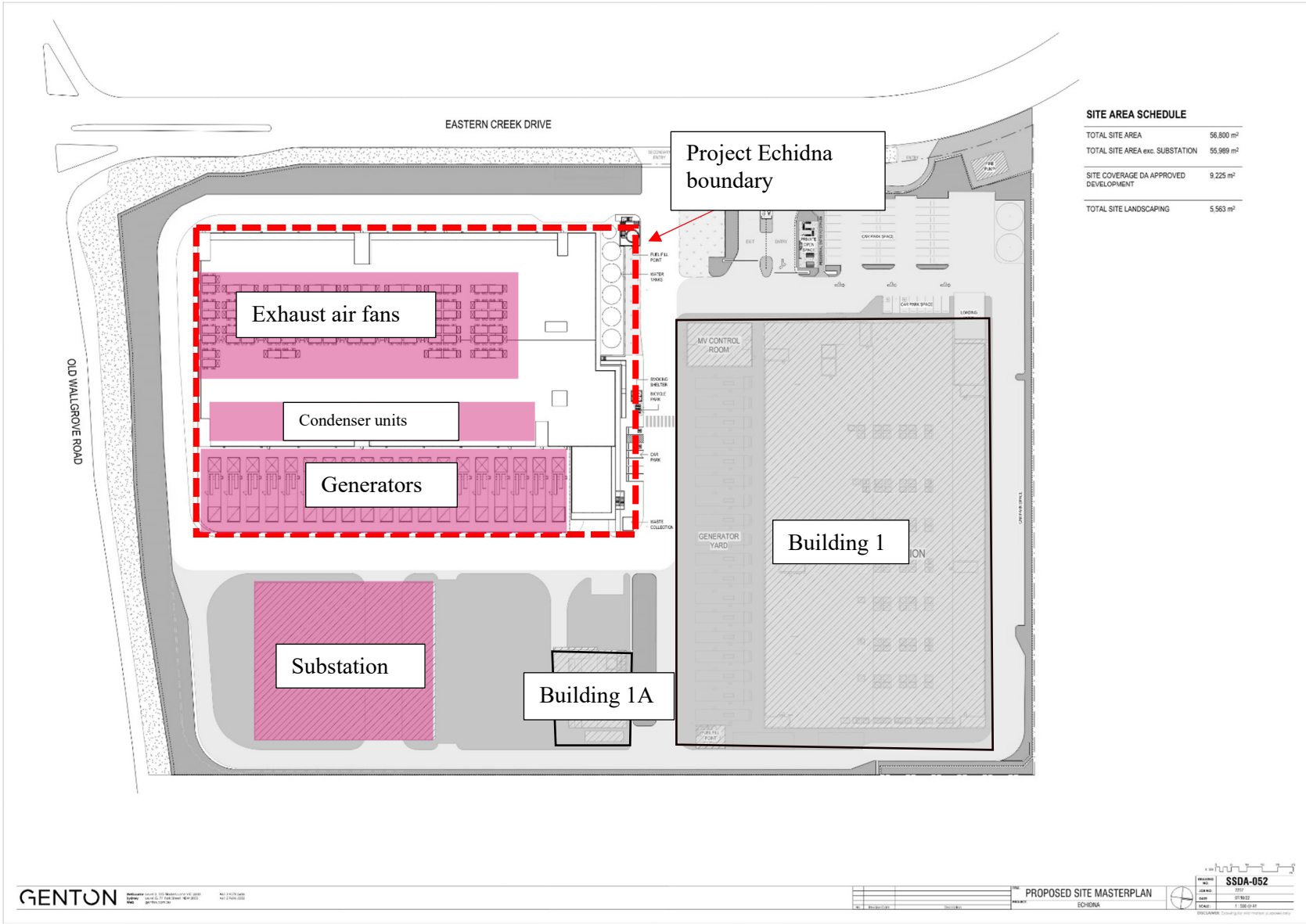

Figure 2: Site Layout

3. Assessment Requirements

The industry specific Planning Secretary's Environmental Assessment Requirements (SEARs) for Data Storage Centres have been reviewed.

The requirements relevant to the acoustic assessment are reproduced in Table 1. Table 1 also includes the scope of this assessment with regards to addressing the industry SEARs.

Table 1: Industry-specific SEARs (Noise and Vibration) and scope of this assessment

Requirement	Confirmation included in the scope of this report
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	This noise and vibration impact assessment has been prepared for the project addressing the Industry-specific SEARs and includes: • Identification of nearby sensitive receivers • Details of noise monitoring in the area • Determination of applicable noise criteria for construction and operation of the project • Determination of major sources of noise for the construction and operational assessment • Preliminary high-level noise and vibration construction assessment • Operational noise assessment for standard and emergency operations. Note that standard operation includes testing of backup generators • Cumulative site noise emissions from the operation of Project Echidna and approved buildings and equipment currently under construction located on the same site (This includes Building 1 and Building 1A, as well as the 132kV substation) • Loading dock operational noise assessment • Assessment of increase in traffic noise on the road network due to project operations. • Identification of conceptual mitigation and management measures for the construction phase to minimise noise and vibration impacts on nearby sensitive receivers • Identification of required mitigation and management measures for the operational phase to minimise noise and vibration impacts onto nearby sensitive receivers

4. Assessment locations

Noise and vibration sensitive receivers have been identified in Table 2 and Figure 3. Unattended noise monitoring conducted as part of the SPP-19-00013 DA [1], relevant to this assessment, has been included in Table 2 and Figure 3.

Table 2: 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 **[1]**

Figure 3: Site, sensitive receivers and noise monitoring locations

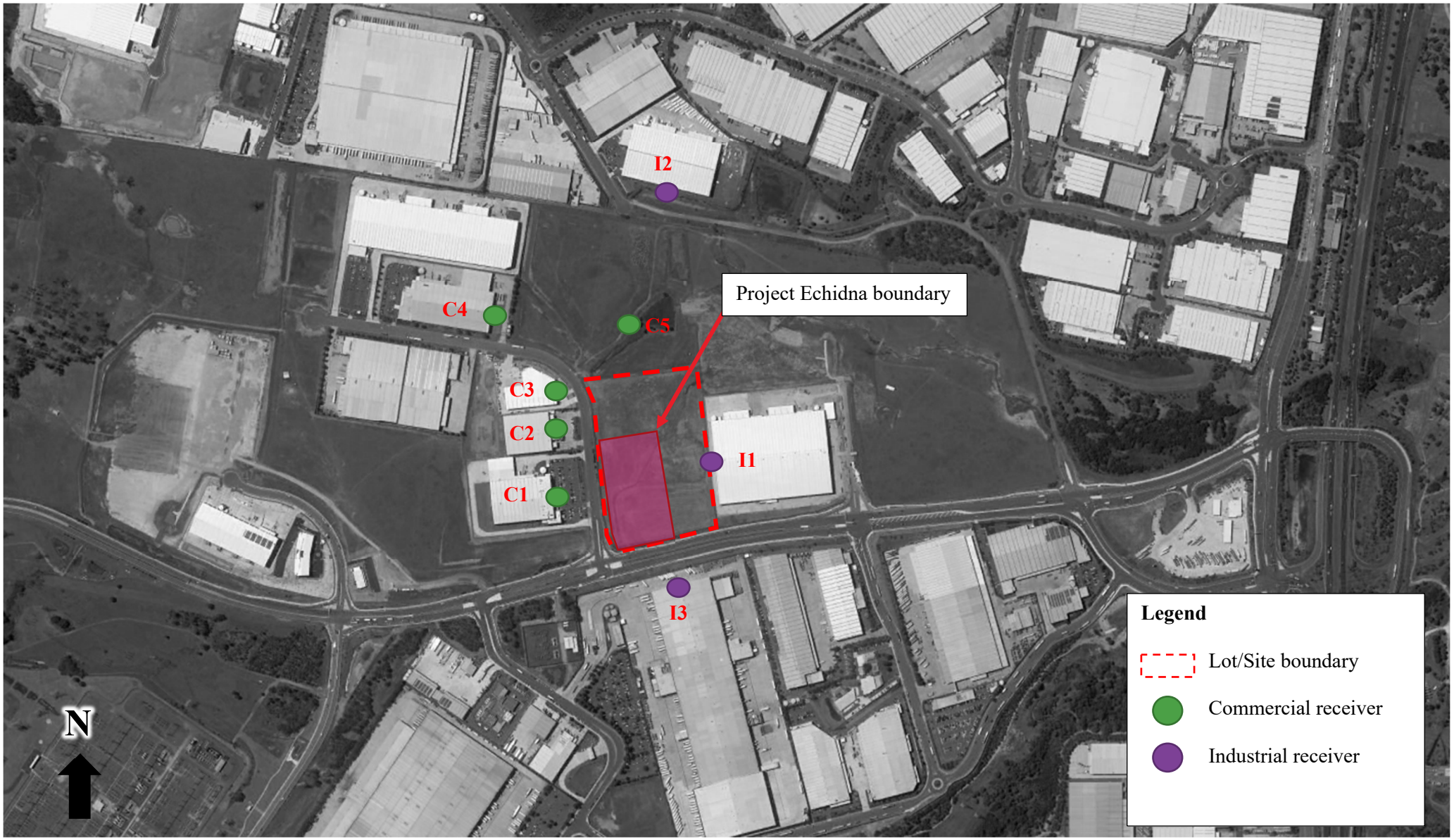

Figure 4: Site and sensitive receivers

5. 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 2 and Figure 3) from 24 May 2019 to 31 May 2019 as part of SPP-19-00013 DA [1]. Results of the noise monitoring are reproduced in Table 3. Details regarding the monitoring has been included in Appendix B.

Table 3: 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

6. Operational noise assessment

6.1 Standard and emergency operations definition

Standard operation is defined as:

- Daytime | all equipment operating other than the generators and load bank, which will only operate periodically under the following testing regimes:
  - Only one generator and the load bank operating as part of a scheduled testing regime
  - Up to three generators being tested concurrently without load banks as part of a scheduled testing regime
- Evening and night | all equipment operating except the generators and load bank.

The Proponent has indicated the desire to conduct generator testing during the night-time period. This scenario will be assessed during detailed design. If criteria can be achieved when testing is conducted during the night-time, this will be documented and presented to the relevant authority prior to Construction Certificate.

Criteria for standard operation is in Section 6.2.

Emergency operation is defined as:

- All equipment operating including all generators.

Criteria for emergency operation is in Section 6.3.

6.2 Standard operations noise criteria

Applicable criteria for site noise emissions Site Specific Noise Trigger Levels (SSNTL) were determined in SPP-19-00013 DA [1] in accordance with the Noise Policy for Industry (NPfI) [2] and are reproduced in Table 4 for residential receivers to the North and South of the site and for the 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.

It is understood, the Building 1 and Building1A noise impact assessments and resulting acoustic design did not allow for future development on the site (e.g. Project Echidna). Additionally, SPP-19-00013 DA did not include noise predictions which could have informed adjustments to the SSNTLs. As such, it is unclear what the Project Echidna and substation SSNTL allowances are.

Therefore, for this assessment, a conservative approach is used, which is to set the criteria for cumulative noise emissions of Project Echidna and the substation to 10 dB less than the SSNTL. This would ensure that emissions from Project Echidna will not contribute to an exceedance of the site criteria.

The SSNTLs are presented in Table 4 as well as the sleep disturbance site criteria and the Project Echidna + substation noise trigger levels. Note that while this assessment is for Project Echidna, the assessment includes the substation noise emissions to assess cumulative noise levels at receivers.

Table 4: 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]	Project Echidna + Substation Noise Trigger Levels $dBL_{Aeq,15min}$
Residential	R1, R6 & R7	Day	49	-	39
		Evening	43	-	33
		Night	38	53	28
	R2 & R8	Day	46	-	36
		Evening	43	-	33
		Night	38	53	28
	R3, R4 & R5	Day	46	-	36
		Evening	43	-	33
		Night	38	53	28
Commercial	C1 to C5	When in use	63	-	53
Industrial	I1 to I3	When in use	68	-	58

Note:

1 Sleep disturbance relates to both awakenings and disturbance to sleep stages. The NPfI **[2]** 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.

Noting the conservatism used to derive the Project Echidna criteria for this assessment (which result in conservative noise mitigation measures to be implemented in the design of Project Echidna), it is 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. This assessment will establish if the Project Echidna design criteria can potentially be relaxed and consequently if noise

mitigations can be reduced and if the site operations can be altered (The client has indicated the desire to conduct generator testing during night-time for Project Echidna).

The detailed design report would include the results and findings of the assessment, including review of detailed noise emissions of Building 1, Building 1A, Project Echidna and the substation. The report would also include all operating scenarios which can be implemented while meeting site emissions criteria at all receivers. The report would be presented to the relevant authority prior to Construction Certificate.

6.2.1 Modifying factors

Table C1 of the NPfI [2] sets modifying factor corrections for annoying noise characteristics such as tonality, dominant low frequency, intermittency or irregularity.

6.2.1.1 Tonal noise

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

6.2.1.2 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.

6.2.1.3 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.

6.2.1.4 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 5 presents the allowable exceedance of the $L_{Aeq,\ 15\text{-}min}$ equivalent noise criterion for the duration of the event.

Table 5: 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

6.2.1.5 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).

6.3 Emergency operations noise criteria

The NPfI [2] 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.

Designing all 19 generators to comply with the NPfI [2] criteria (Project criteria in Section 6.2) is likely to put unnecessary constraints and associated costs on the project and would be considered unreasonable due to the low likelihood of power failure. Furthermore, if power failure were to occur, the duration of an outage is expected to be hours rather than days.

Therefore, no acoustic criteria are proposed for emergency operations.

6.4 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 the standard and the noise-enhancing weather conditions as specified in Table D1 of the NPfI using the Concawe algorithm:

Fact sheet D of the NPfI provides two options to consider meteorological effects:

Option 1: adopt the noise enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur.

Option 2: Determine the significance of noise-enhancing conditions by assessing the significance of temperature inversions during the night time and wind during all periods.

The assessment has been conducted in accordance with Option 1 which does not require to conduct an assessment of the meteorological conditions in the area but use a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night.

Meteorological conditions used in the assessment:

- 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 the results for stability category F with winds up to 2m/s at 10 m are similar (<1 dB difference).

The model includes:

- Receivers listed in Section 4
- Noise sources listed in Section 6.5.1
- On-site and surrounding buildings
- Ground terrain and absorption

6.5 Noise predictions

6.5.1 Noise sources

The Project includes the primary **unmitigated** noise sources outlined in Table 6 with the exception of the generators that are already mitigated; they are assumed to be located within an enclosure and the AHU that includes an attenuator fitted on the inlet.

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, therefore noise breakout from the internal data halls and other spaces is anticipated to be readily controlled. Therefore, the focus of this assessment for the planning stage relates to external equipment.

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 3 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 1 hour while being unloaded. The trucks will be turned off while being unloaded.

Table 6: Unmitigated plant and associated sound power levels (L_w) or sound pressure levels @ 1 m (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	90	-	87	85	87	87	81	76	70	Point Source
Air handling unit	Manufacturer data (Dannan)	Inlet + attenuator	Lw	76	89	91	67	57	55	52	51	63	Area sources[4]
		Outlet	Lw	99	96	103	98	97	93	89	86	86	
	Empirical data	Casing	Lw	86	88	96	86	85	75	64	54	53	
Generators[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
		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	
Substation transformer	Empirical data- AS/NZ60076.10.2019 Assumes reduced maximum	40MVA	Lw	80	83	85	80	80	74	69	64	57	Point Source
	Empirical data- AS/NZ60076.10.2019 Assumes standard maximum	45MVA	Lw	89	92	94	89	89	83	78	73	66	Point Source
		315kVA	Lw	59	62	64	59	59	53	48	43	36	Point Source
Load bank	Manufacturer data off the shelf loadbank (Sephco)	-	Lw	111	107	107	113	108	105	103	99	102	Point Source
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

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	
		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

Note:

1_Noise emission from the acoustic enclosure shall be free of the tonal, modulated and impulsive noise (refer to NPfI **[2]**).

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** 58 **Lw/m^2**

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 70 dBA/m^2. Model also adds a directivity factor to the louvre.**

5_Generator enclosure modelled as follow:

- **Enclosure (2 sides): Each side is approximately 9m x 3.7m. Equivalent Lw is 81dBA/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**

6.5.2 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 6.1 and in Table 7.

Table 7: Modelling scenarios and corresponding plant and equipment quantities

Equipment	Scenarios		
	Normal operation		Emergency operation
	Day	Night	
Exhaust fan	96	96	96
Condenser unit	36	36	36
Air handling unit	68	68	68
Generator	1-maintenance testing[1]	-[2]	19
Substation transformer	5	5	5
Load bank	1-maintenance testing[1]	-[2]	-
Service (heavy vehicles)	3	-	3

Note 1: Note that the client has indicated the desire to test up to 3 generators concurrently without load banks or 1x generator with load bank. The assessment reviewed both scenarios and the results of the worst case scenario being 1x generator tested with load bank is presented in this report.

Note 2: The client has indicated the desire to conduct generator testing during the night-time period. This scenario will be assessed during detailed design. If criteria can be achieved when testing is conducted during the night-time, this will be documented and presented to the relevant authority prior to Construction Certificate.

6.5.3 Predicted noise levels - unmitigated – noise egress

Noise predictions for standard operations under standard and enhanced meteorological conditions are presented in Table 8 and Table 9 for the daytime and the night-time operations respectively.

Noise predictions for emergency operations are presented in Table 10.

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. Assumed equipment noise levels do not to exhibit tonal characteristics.

Table 8: Unmitigated predicted noise levels – standard daytime operation – Standard and Enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Daytime - Standard weather conditions			Daytime - Enhanced weather conditions		
		Predicted level $L_{eq,15min}$ dB(A)	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?	Predicted level $L_{eq,15min}$ dB(A))	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?
R1	49	29	39	Yes	35	39	Yes
R2	46	29	36	Yes	35	36	Yes
R3	46	27	36	Yes	33	36	Yes
R4	46	26	36	Yes	32	36	Yes
R5	46	24	36	Yes	30	36	Yes
R6	49	26	39	Yes	32	39	Yes
R7	49	14	39	Yes	19	39	Yes
R8	46	29	36	Yes	35	36	Yes
C1	58	58	53	No (+5dB)	59	53	No (+6dB)
C2	52	52	53	Yes	54	53	No
C3	48	48	53	Yes	51	53	Yes
C4	46	46	53	Yes	51	53	Yes
C5	40	40	53	Yes	45	53	Yes
I1	66	66	58	No (+8dB)	67	58	No (+9dB)
I2	59	42	58	Yes	47	58	Yes
I3	42	63	58	No (+5dB)	64	58	No (+6dB)

Note:

1_Project criteria accounts for Project Echidna and Substation sources.

2_Exceedances to project criteria are indicated in red.

Table 9: Unmitigated predicted noise levels – night-time operation - standard and enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Night-time - Standard weather conditions			Night-time - Enhanced weather conditions		
		Predicted level $L_{eq,15min}$ dB(A)	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?	Predicted level $L_{eq,15min}$ dB(A))	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?
R1	38	26	28	Yes	32	28	No (+4dB)
R2	38	28	28	Yes	34	28	No (+6dB)
R3	38	27	28	Yes	32	28	No (+4dB)
R4	38	26	28	Yes	32	28	No (+4dB)
R5	38	24	28	Yes	30	28	No (+2dB)
R6	38	25	28	Yes	31	28	No (+3dB)
R7	38	12	28	Yes	18	28	Yes
R8	38	28	28	Yes	34	28	No (+6dB)
C1	63	58	53	No (+5dB)	59	53	No (+6dB)

Receiver	Overall Site criteria $L_{eq,15min\ dB(A)}$	Night-time - Standard weather conditions			Night-time - Enhanced weather conditions		
		Predicted level $L_{eq,15min\ dB(A)}$	Project Criteria[1] $L_{eq,15min\ dB(A)}$	Meets project criteria?	Predicted level $L_{eq,15min\ dB(A)}$)	Project Criteria[1] $L_{eq,15min\ dB(A)}$	Meets project criteria?
C2	63	52	53	Yes	54	53	No (+1dB)
C3	63	48	53	Yes	51	53	Yes
C4	63	46	53	Yes	51	53	Yes
C5	63	40	53	Yes	45	53	Yes
I1	68	60	58	No (+2dB)	61	58	No (+3dB)
I2	68	41	58	Yes	46	58	Yes
I3	68	54	58	Yes	56	58	Yes

Note:

1_Project criteria accounts for Project Echidna and Substation sources.

2_Exceedances to project criteria are indicated in red.

Results in Table 8 and Table 9 show that mitigation measures are required to comply with criteria in Section 6.2.

Predicted levels for the emergency scenario for the unmitigated scenario are presented in Table 10.

Table 10: Unmitigated Predicted noise levels – emergency operation

Receiver	Predicted level, $L_{eq,15min\ dB(A)}$	
	Standard weather conditions	Enhanced weather conditions
R1	27	33
R2	29	35
R3	27	33
R4	27	32
R5	25	31
R6	26	33
R7	16	22
R8	28	34
C1	58	59
C2	52	54
C3	48	52
C4	47	51
C5	41	45
I1	60	61
I2	42	47
I3	56	58

6.5.4 Mitigation measures

Preliminary noise mitigation measures (to be revised during detailed design) include:

- Reselecting quieter equipment
- Installing acoustic louvres to plant room and or installing attenuators to AHU units
- Building solid barriers/partial enclosures around noisy plant

The assessment has been revised considering implementation of the above mitigation measures. Updated noise level predictions are presented in Table 11, Table 12 and Table 13.

The mitigated assessment includes:

- An estimated 10 dB noise reduction of noise emissions from the condenser units – achieved through reselection and oversizing of units
- An estimated 10 dB reduction of noise emissions from the AHUs – achieved through reselection of AHUs + attenuator fitted to the inlet or attenuator fitted at the louvre
- An estimated 13 dB reduction of noise emissions from the load bank – achieved through reselection of unit or partial enclosure.

Further detailed acoustic design will be required to finalise mitigation specifications during the detailed design phase of the project (as per Section 6.2).

6.5.5 Predicted noise levels - mitigated – noise egress

Noise predictions for standard operations (with mitigation measures included) under standard and enhanced meteorological conditions are presented in Table 11 and Table 12 for the daytime and the night-time operations respectively.

Noise predictions for emergency operations (with mitigation measures included) are presented in Table 13.

Table 11: Mitigated predicted noise levels – standard daytime operation – Standard and Enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Daytime – Standard weather conditions			Daytime – Enhanced weather conditions		
		Predicted level $L_{eq,15min}$ dB(A)	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?	Predicted level $L_{eq,15min}$ dB(A))	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?
R1	49	21	39	Yes	28	39	Yes
R2	46	22	36	Yes	29	36	Yes
R3	46	19	36	Yes	25	36	Yes
R4	46	19	36	Yes	25	36	Yes
R5	46	17	36	Yes	23	36	Yes
R6	49	20	39	Yes	26	39	Yes
R7	49	8	39	Yes	14	39	Yes
R8	46	23	36	Yes	29	36	Yes
C1	63	50	53	Yes	51	53	Yes
C2	63	45	53	Yes	47	53	Yes
C3	63	42	53	Yes	45	53	Yes
C4	63	40	53	Yes	44	53	Yes
C5	63	34	53	Yes	39	53	Yes
I1	68	57	58	Yes	58	58	Yes
I2	68	35	58	Yes	40	58	Yes
I3	68	53	58	Yes	55	58	Yes

Notes:

1_Project criteria accounts for Project Echidna and Substation sources.

2_Exceedances to project criteria are indicated in red.

Table 12: Mitigated predicted noise levels – standard night-time operation – Standard and Enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Night time – Standard weather conditions			Night time – Enhanced weather conditions		
		Predicted level $L_{eq,15min}$ dB(A)	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?	Predicted level $L_{eq,15min}$ dB(A))	Project Criteria[1] $L_{eq,15min}$ dB(A)	Meets project criteria?
R1	38	21	28	Yes	27	28	Yes
R2	38	22	28	Yes	28	28	Yes
R3	38	19	28	Yes	25	28	Yes
R4	38	19	28	Yes	25	28	Yes
R5	38	17	28	Yes	23	28	Yes
R6	38	20	28	Yes	26	28	Yes
R7	38	10	28	Yes	13	28	Yes

Receiver	Overall Site criteria $L_{eq,15min\ dB(A)}$	Night time – Standard weather conditions			Night time – Enhanced weather conditions		
		Predicted level $L_{eq,15min\ dB(A)}$	Project Criteria[1] $L_{eq,15min\ dB(A)}$	Meets project criteria?	Predicted level $L_{eq,15min\ dB(A)}$)	Project Criteria[1] $L_{eq,15min\ dB(A)}$	Meets project criteria?
R8	38	22	28	Yes	28	28	Yes
C1	63	50	53	Yes	51	53	Yes
C2	63	45	53	Yes	47	53	Yes
C3	63	41	53	Yes	44	53	Yes
C4	63	39	53	Yes	44	53	Yes
C5	63	34	53	Yes	38	53	Yes
I1	68	55	58	Yes	56	58	Yes
I2	68	34	58	Yes	39	58	Yes
I3	68	48	58	Yes	50	58	Yes

Notes:

1_Project criteria accounts for Project Echidna and Substation sources.

2_Exceedances to project criteria are indicated in red.

Table 12 shows compliance with criteria in Section 6.2 during standard and enhanced weather conditions at all receivers with indicative preliminary mitigation measures included.

Mitigated predicted levels for the emergency scenario are presented in Table 13.

Table 13: Mitigated Predicted noise levels – emergency operation

Receiver	Predicted level, $L_{eq,15min\ dB(A)}$	
	Standard weather conditions	Enhanced weather conditions
R1	24	30
R2	25	32
R3	22	28
R4	21	27
R5	20	26
R6	23	30
R7	15	21
R8	23	31
C1	50	52
C2	46	49
C3	44	47
C4	42	47
C5	37	41
I1	59	60
I2	38	43
I3	53	55

7. 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.

8. Construction noise and vibration

Construction works will be assessed in accordance with the NSW Interim Construction Noise Guideline [4] (ICNG or Guideline).

8.1 Construction noise criteria

The ICNG [4] provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG provides two methods for assessing construction noise, varying typically on the basis of the project duration, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement of background noise levels for determination of noise management levels and prediction of construction noise levels. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

This development is considered to warrant a quantitative assessment.

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 14 and in Table 15 respectively.

Table 14: Construction noise management levels (NMLs) at residential receivers

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

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 15: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)

Note 1: Noise management levels apply when receiver areas are in use only.

8.1.2 Project construction noise targets

Table 16 summarises relevant project construction noise targets for the project. For the residential receivers, the construction noise criteria are set based on the noise measurements results in Section 5.

Table 16: Construction Noise Management Levels – recommended Standard hours

Rec ID	Type	External NML, $dBL_{Aeq\ 15\ minute}$ (Recommended standard hours)	
		Noise affected	Highly Noise affected
R1, R6 & R7	Residential	54	75
R2 & R8	Residential	51	75
R3, R4 & R5	Residential	51	75
C1 to C5	Commercial	70 (when in use)	-
I1 to I3	Industrial	75 (when in use)	-

Note 1_Standard hours are Monday to Friday 7am to 6pm and Saturday 8am to 1pm.

8.2 Construction noise assessment

8.2.1 Hours of work

Construction works are proposed to be conducted during ICNG recommended standard construction hours, outlined in Table 17.

Table 17: ICNG recommended standard hours of construction

Day	ICNG recommended standard hours of construction
Monday – Friday	7am – 6pm
Saturday	8am – 1pm
Sundays or Public holidays	No construction work

8.2.2 Assessment methodology

Noise emissions from construction activities have been assessed to NMLs in Section 8.1.

Noise emissions have been modelled using SoundPlan 8.1 using the Concawe algorithm.

The model included:

- Receivers listed in Section 4
- Noise sources listed in Section 8.2.5
- On-site and surrounding buildings
- Ground terrain and absorption

Equipment, staging, locations and duration are unavailable at this stage of the project. Therefore, assumptions have been made based on similar projects.

The magnitude of construction noise impacts is dependent upon a number of aspects including the intensity and location of activities, the type of equipment used and background noise levels during the construction period.

No mitigation measures have been included in the predictions.

8.2.4 Construction activities

Construction activities likely to be conducted for the project are:

- Activity 1: Site establishment and excavation
- Activity 2: Foundations
- Activity 3: Pavement and road works
- Activity 4: Building construction
- Activity 5: Plant installation and connection

8.2.5 Plant and equipment sources

Equipment sound power levels (L_w) have been determined by reference to AS2436 [5] and the CNVS [6]. The equipment has been assumed to operate concurrently and for durations listed over a 15-minute period (a typical worst-case assumption).

Table 18: Equipment and plant sound power levels

Plant item	Plant item L_w, dBA	Penalty[1], dB	% of use in worse case 15 min	Number of items operational in worst case 15 minute period				
				Activity 1: Site establishment and excavation	Activity 2: Foundations	Activity 3: Pavement and road works	Activity 4: Building construction	Activity 5: Plant installation and connection
Backhoe	108	0	100	1				
Compactor	115	5	100	1		1		
Concrete Pump	109	0	100		1	1	1	
Concrete Pump Truck	113	0	100		1	1	1	
Crane (Franna)	98	0	100				1	
Crane (Tower)	105	0	100				1	
Excavator (30t) + hydraulic hammer	122	5	100	3		1		
Generator (Diesel)	113	0	100	1		1	1	
Grader	115	0	100	1		1		
Jack Hammer	121	5	100			1		
Loader (Front-end) (23t)	112	0	100	1		1		
Pavement Laying Machine	114	0	100			1		
Piling rig (impact)	129	5	100		1			
Roller (Smooth-drum)	107	0	100			1		
Roller (Vibrator)	112	5	100	2				
Scraper	116	0	100	1				
Truck (>20 Tonne)	107	0	100	1	1	1		
Truck (Water Cart)	108	0	100	2		2	1	
Vehicle (Light Commercial e.g. 4WD)	111	0	100	2		2	2	1

Note 1: Penalty applies if equipment has special characteristics in accordance with ICNG [4]

8.2.6 Noise prediction results

Predicted construction noise levels at the surrounding receivers are presented in Table 19.

A maximum range of noise levels have been predicted for receivers located the closest to the site as the construction noise levels at those receivers will vary greatly depending on location of equipment. The lower level assumes that all equipment in Section 8.2.5 is operating concurrently within the site which represents the maximum average noise levels at the receivers throughout the construction period while the upper noise levels in the range represents the maximum noise levels at the receivers when the noisiest piece of equipment operates the closest to the receivers.

It is noted that the predicted construction noise levels are generally conservative and do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the project construction period. In reality the predicted noise levels will vary in intensity and would only be experienced for limited periods of time when works are occurring.

Table 19: Predicted construction noise levels – Residential and non-residential receivers

Residential receiver	NML, $dBL_{Aeq\ 15min}$		Predicted noise level, $dBL_{Aeq(15min)}$.				
	Noise affected – Standard hours	Highly Noise Affected	Activity 1: Site establishment and excavation	Activity 2: Foundations	Activity 3: Pavement and road works	Activity 4: Building construction	Activity 5: Plant installation and connection
R1	54	75	43-49	45-49	41-42	30-33	21-33
R2	51	75	51-54	52-55	49-49	38-40	29-35
R3	51	75	45-45	46-49	43-43	32-34	23-29
R4	51	75	45-47	46-47	43-43	32-34	23-31
R5	51	75	45-47	46-48	42-43	31-33	23-27
R6	54	75	38-39	39-42	36-36	25-27	16-23
R7	54	75	33-35	35-36	31-31	20-21	11-15
R8	51	75	49-50	50-50	46-47	35-38	27-34
C1	70	-	80-83	81-83	78-78	67-68	58-63
C2	70	-	79-80	80-83	77-77	66-68	57-64
C3	70	-	77-80	78-80	75-75	64-65	55-60
C4	70	-	72-74	73-74	70-70	59-62	50-58
C5	70	-	68-72	69-72	65-66	54-56	46-56
I1	75	-	87-96	88-96	85-87	74-80	65-80
I2	75	-	61-63	62-63	58-59	47-50	39-47
I3	75	-	80-83	81-83	78-78	67-68	58-63

Note 1: Proposed future commercial receiver

Note 2: Cells highlighted in grey indicate an exceedance of standard hours NMLs

Results show that the NMLs are predicted to generally comply with criteria at the residential receivers during all phases with a minor exceedance predicted at R2 during activity 1 and activity 2. Predicted levels at residential receivers are below the 75 dBA highly noise affected level.

Results show that for the commercial and industrial receivers near the site, the NMLs will be exceeded. Noise Management measures should be implemented (Refer to Section 8.5).

8.3 Construction traffic assessment

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 Old Wallgrove Road which is a sub arterial road.

Due to the anticipated low number of vehicles generated by the construction of the development, construction traffic noise is anticipated to comply with RNP.

8.4 Construction vibration criteria

The effect of vibration in buildings can be divided into three main categories:

1. **Human perception of vibration**: when the occupants or users of the building are potentially disturbed by vibration**.** Relevant guidance is provided in NSW *Assessing Vibration: a technical guideline* [7]. This document is based on BS 6472:1992 [8].
2. **Effects on building contents**: People can perceive floor vibration at levels well below those likely to cause damage to typical building contents. However, some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

   Note that it is not expected that scientific equipment would be located near the site.
3. **Effects of vibration on structures:** A level of vibration where the integrity of the building or the structure itself may be affected, ranging from cosmetic to major structural damage. The relevant criteria are typically well above the level of vibration which people may consider intrusive. Guidance may be found in AS 2187:Part 2 [9]. BS 7385 Part 2 [10] and DIN 4150 [11] which also has criteria of particular reference for heritage structures and buried pipework.

Further details are included in Appendix C.

8.5 Construction noise and vibration management

Application of all reasonable and feasible mitigation measures should be adopted for the project. The following discusses in-principle management measures.

8.5.1 Construction noise and vibration management plan

For all construction works, the contractor would be expected to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). This plan should include but not be limited to the following:

- Roles and responsibilities
- Noise sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

8.5.2 General

In general, practices to reduce construction noise impacts will be required, and may include:

- Adherence to the standard approved working hours as outlined in the Project Approval.
- Manage noise from construction work that might be undertaken outside the recommended standard hours
- The location of stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers
- Using site sheds and other temporary structures or screens to limit noise exposure where possible.
- The appropriate choice of low-noise construction equipment and/or methods (such as using bored piling instead of impact piling for example)
- Modifications to construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.
- Carry out consultation with the community and surrounding building owners/occupants during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures.

8.5.3 Universal work practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.
- Avoid the overuse of public address systems.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.

8.5.4 Vibration – minimum working distances

With regards to vibration impacts during construction, these will be managed by the Contractor and will depend on the type, size, number and location of equipment used. Preliminary screening criteria are provided in Table 20. Those Recommended minimum working distances for vibration intensive plant are based on international standards and guidance. Table 20 shows that where vibration generating equipment is to be located within a certain distance from a receiver vibration impact may occur.

Regarding the proposed development works, vibration is not expected to impact upon surrounding developments. Notwithstanding, should equipment be located within the minimum working distance, mitigations measures should be implemented such as reselection of low vibration generating equipment and/or vibration monitoring. Should vibration monitoring be conducted, the criteria to be achieved at the location of monitoring would be the criteria in Appendix C.

Table 20: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance			
		Industrial and heavy commercial buildings BS 7385 Line 1 -25 mm/s (See note 1)	**Residential and light commercial buildings** BS 7385 Line 2 - 7.5 mm/s (See note 1)	**Structures unsound** DIN 4150 Line 3 - 3 mm/s	**Human response (OH&E Vibration Guideline)**
Vibratory Roller	> 300 kN (Typically 13-18 tonnes)	8 m	20 m	40 m	100 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	9 m	22 m	44 m	73 m
Vibratory Pile Driver	Sheet piles	9 m	22 m	44 m	73 m
Jackhammer	Hand held	1 m (nominal)	1 m (nominal)	3 m	5 m

Notes:

1_Where vibration might give rise to resonant responses in structures

9. Conclusion

An acoustic assessment has been carried out for the proposed data centre Project Echidna in accordance with the requirements of the industry specific Planning Secretary's Environmental Assessment Requirements (SEARs) for Data Storage Centres.

Project Echidna is to be located on a site containing 2 approved data centres and a future substation. Criteria applicable to the whole site was determined for SPP-19-00013 DA [1] application. As no allowance was made for Project Echidna and the substation noise emissions, a conservative and preliminary noise criteria have been set (i.e. site criteria – 10 dB). This would ensure that emissions from Project Echidna will not contribute to an exceedance of the site criteria.

The operational noise assessment has carried out noise predictions in accordance with the NSW Noise Policy for Industry [2], including consideration of noise-enhancing meteorological conditions.

Indicative noise mitigation measures are provided and demonstrate the Proposal can achieve the adopted project criteria. Further acoustic design will be required during the design development phase to confirm the detailed specification of equipment and mitigation measures.

Noting the conservatism used to derive the Project Echidna criteria for this assessment (which result in conservative noise mitigation measures to be implemented in the design of Project Echidna), it is 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. This assessment will establish if the Project Echidna design criteria can potentially be relaxed and consequently if noise mitigations can be reduced and if the site operations can be altered (The client has emitted the desire to conduct generator testing during night-time for Project Echidna).

The detailed design report would include the results and findings of the assessment, including review of detailed noise emissions of Building 1, Building 1A, Project Echidna and the substation. The report would also include all operating scenarios which can be implemented while meeting site emissions criteria at all receivers. The report would be presented to relevant authority prior to Construction Certificate.

Regarding construction, while specific activities and work schedules are not yet known, a preliminary assessment has been conducted. Criteria has been established in accordance with the NSW ICNG [4] and Assessing Vibration: a technical guideline [12]. Predicted levels indicate that NMLs are likely to be exceeded. Recommendations with regard to mitigation and management measures are also outlined and are expected to be developed further in a formal Construction Noise and Vibration Management Plan, to be prepared prior to commencement of works.

10. References

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

[4] Department of Environment and Climate Change NSW, “Interim Construction Noise Guideline,” Department of Environment and Climate Change NSW, Sydney, 2009.

[5] Australian Standards, “AS2436-2010: Guide to noise and vibration control on construction, demolition and maintenance sites,” Australian Standards, Sydney, 2010.

[6] Transport for NSW, “Construction Noise and Vibration Strategy,” 2019.

[7] Department of Envirnoment and Conservation (NSW), “Assessing vibration - a technical guide,” Department of Envirnoment and Conservation (NSW), NSW, 2006.

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

[9] Australian Standards, “AS2187:2006 Explosives - Storage and Use - Part 2: Use of Explosives,” AS, Sydney, 2006.

[10] British Standards Institute, “BS7385:1993 Evaluation and Measurement for Vibration in Buildings Part 2,” BSI, London, 1993.

[11] Deustsches Institut fur Normung, “DIN4150-3 (2016) Vibrations in buildings - Part 3: Effects on structures, English translation,” DIN-Normen, Berlin, 2016.

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

[13] Department of Environment and Conservation, “Assessing Vibration: A Technical Guideline,” DEC, 2006.

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

[15] UK National Grid, “T/SP/SSW/22 Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties,” UK National Grid, 2006.

Appendix A

Glossary

A.1 Glossary

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background LA90 noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / min$L_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and minLA90,1hour in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain

Sound Pressure Level dB(A)	Example
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L1

The L1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB LA1,15min is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

L10

The L10 statistical level is often used as the “average maximum” level of a sound level that varies with time.

Mathematically, the L10 level is the sound level exceeded for 10% of the measurement duration. L10 is often used for road traffic noise assessment. As an example, 63 dB LA10,18hr is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L90

The L90 statistical level is often used as the “average minimum” or “background” level of a sound level that varies with time.

Mathematically, L90 is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB LA90,15min is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

Leq

The ‘equivalent continuous sound level’, Leq, is used to describe the level of a time-varying sound or vibration measurement.

Leq is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB LAeq. Often the measurement duration is quoted, thus Laeq,15 min represents the dB(A) weighted energy-average level of a 15 minute measurement.

Lmax

The Lmax statistical level can be used to describe the “absolute maximum” level of a sound or vibration level that varies with time.

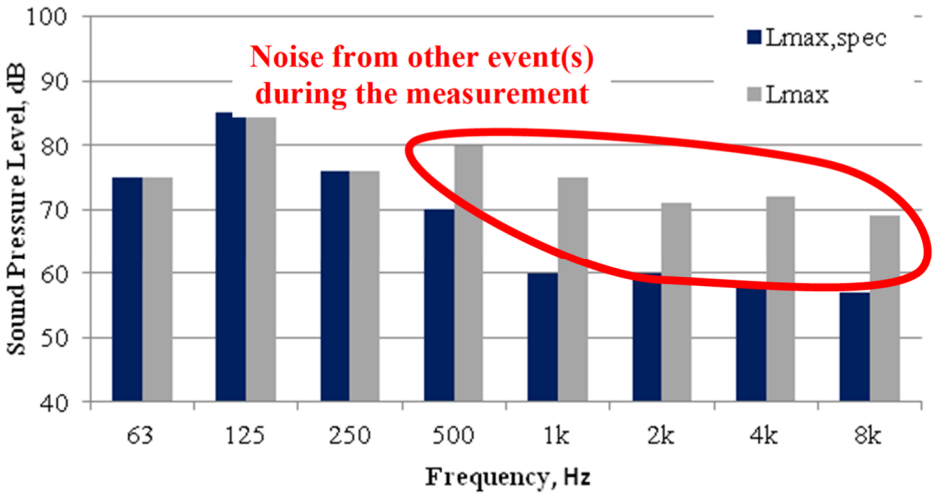
Mathematically, Lmax is the highest value recorded during the measurement period. As an example, 94 dB Lamax is a highest value of 94 dB(A) during the measurement period.

Since Lmax is often caused by an instantaneous event, Lmax levels often vary significantly between measurements.

Lmax spec

Lmax spec is another representation of the highest noise or vibration levels during the measurement period.

Lmax spec is the spectrum of the event that caused the highest overall sound or vibration level during the measurement period is denoted by dB Lmax spec. An example of the relationship between dB Lmax and dB Lmax spec is shown below.



Lmax (see definition above), when measured on an octave band or 1/3 octave band meter, is the spectrum obtained by recording the highest measured value in each band. However, the highest measured values in each band may occur at different times.

Hence, Lmax spec represents a real event, while Lmax is often the mathematical addition of frequency band values from different times and often does not represent a real-world event.

Since Lmax spec is caused by an instantaneous event, Lmax spec levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as “pitch”. Sounds towards the lower end of the human hearing frequency range are perceived as “bass” or “low-pitched” and sounds with a higher frequency are perceived as “treble” or “high pitched”.

Peak Particle Velocity (PPV)

Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure root mean squared (RMS) values; it is common to approximate the PPV based on an RMS measurement.

PPV is commonly used as a vibration criteria, and is often interpreted as a PPV based on the Lmax or Lmax,spec index.

Sound Exposure Level (SEL)

The Sound Exposure Level or Single Event Noise Exposure Level, denoted SEL or LAE, is a measure of the total amount of acoustic energy contained in an acoustic event. The SEL is the constant sound pressure level that would produce in a period of one second the same amount of acoustic energy contained in the acoustic

event. SEL is commonly used to quantify the total acoustic energy contained in transient events such as a vehicle pass-by.

Sound Power and Sound Pressure

The sound power level (Lw) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (Lp) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Sound Reduction Index I

The sound reduction index (or transmission loss) of a building element is a measure of the loss of sound through the material, i.e. its sound attenuation properties. It is a property of the component, unlike the sound level difference, which is affected by the common area between the rooms and the acoustics of the receiving room. R is the ratio (expressed in decibels) of the sound energy transmitted through the building element to the sound energy incident on the building element for a particular frequency.

The weighted sound reduction index, Rw, is a single figure description of sound reduction index across a wider frequency range and is defined in BS EN ISO 717-1: 1997. Rw values are calculated from measurements in an acoustic laboratory. Sound insulation ratings derived from site measurements (which are invariably lower than the laboratory figures) are referred to as apparent sound reduction index (R'w) ratings.

Speech Transmission Index (STI)

STI is a technical index, predictable and measurable using specialised equipment, for assessing speech and vocal intelligibility. STI takes into account the signal/noise ratio of the speech signal and the reverberation of the receiving environment. The higher the value of STI, the higher the expected speech intelligibility.

STI ratings are assigned subjective categories, as follows:

STI Range	Subjective Category
< 0.3	Bad
0.3 – 0.45	Poor
0.45 – 0.6	Fair
0.6 – 0.75	Good
0.8 – 1.0	Excellent

Spectrum Adaptation Terms (C and Ctr)

The terms C and Ctr are spectrum adaptation terms (in dB) that are added to the Rw or Dw value of a partition in order to determine the overall sound insulation rating of a partition for various conditions. The overall performance of the partition is quoted as the sum of the Rw value and the spectrum adaptation terms, e.g. Dw + C 55 dB; Rw + Ctr 60 dB.

C is a spectrum adaptation term used to measure the performance of a partition for medium to high-frequency noise sources, such as speech.

Ctr is a spectrum adaptation term used to measure the performance of a partition for low-frequency noise sources such as traffic noise.

The values of C and Ctr are dependent on the construction of the partition. Because C and Ctr are (usually) negative quantities, they typically increase the Rw requirement of a partition (eg if Ctr is -6 dB, an Rw of 56 dB is required to achieve a rating of Rw + Ctr 50 dB).

Vibration

Waves in a solid material are called "vibration", as opposed to similar waves in air, which are called "sound" or "noise". If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Ambient noise survey conducted as part of SPP-19-00013 [1]

The relevant extracts from the SPP-19-00013 report regarding the noise monitoring survey have been provided below. Those include monitoring locations (Section B.1), methodology, equipment used and results (Section B.2), noise monitoring graphs (Section B.3).

B.1 Monitoring locations

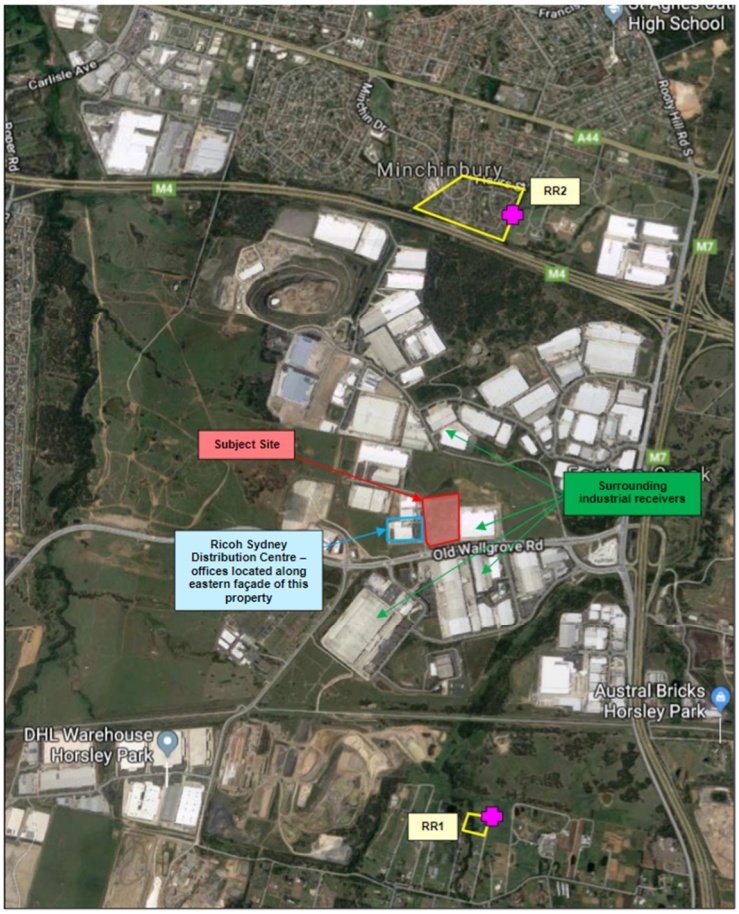


Figure 1 – Overall Site Context Plan

B.2 Ambient noise survey methodology, equipment used and results

3 Ambient Noise Survey

- The ambient environment immediately surrounding the project site is dominated by traffic noise from the high percentage of heavy vehicle movements on the surrounding road network, associated with the surrounding industrial properties.
- Unattended long-term monitoring was conducted at the two residential receiver locations, to quantify the existing acoustic environment.

All monitoring procedures and calculated rating background (RBL), project amenity (ANL) and project intrusiveness noise levels, were conducted in accordance with the requirements of the NSW EPA Noise Policy for Industry and Australian Standard 1055:2018 "*Acoustics – Description and measurement of environmental noise*".

3.1 Measurement Period and Locations

Two noise monitors were used to measure the existing ambient environment at the identified sensitive receiver locations (refer section **Error! Reference source not found.**). Monitoring was conducted between 24th – 31st May 2019, at the following locations, as illustrated in **Error! Reference source not found.**.

- NML 1 – along the northern property boundary of the rural residential receiver at146 Burley Road, Horsley Park.
- NML 2 – along the eastern property boundary of the residential properties along Farrington Street, north of Nicol Place.

Detailed noise monitoring data is attached in Appendix A.

3.2 Prevailing Noise Conditions

The following noise conditions were noted during monitor setup;

- NML 1 – High volume of bird noise (chirping), pig farm located to the north of the property and light machinery noise (lawn movers, grinders etc.) from surrounding properties.
- NML 2 – Traffic noise from M4 Western Motorway, birds chirping and dogs barking.

3.3 Instrumentation

Unattended noise monitoring was conducted using two Acoustic Research Laboratories type EL-316 noise monitors. The monitors were set to record continuously at 15-minute time intervals, in an A-weighted fast response mode. Both monitors were calibrated at the start and end of the monitoring period using a Brüel & Kjær type 4230 calibrator. No significant drift was noted. Calibration information for the two monitors are detailed in the table below.

Table 1 – Noise Monitor Calibration Information

Equipment	Make	Serial	Last Calibration
NML 1	Acoustic Research Labs	878079	1 May 2019
NML 2		878000	12 October 2019

3.4 Meteorological Conditions

Section A4 of the NSW EPA NPfI outlines the following with regards to meteorological impacts on noise monitoring:

Noise monitoring should not be conducted (or the data should be excluded) when average wind speeds (over 15-minute periods or shorter) at microphone height are greater than 5 m/s, or when rainfall occurs.

However, the same section of this policy also outlines that;

Exceptions to this rule are allowed, provided the proponent is able to show that the wind-induced noise on the microphone, and sound levels due to rain, are at least 10 dB below the noise levels (that is, background and/or ambient) under investigation.

Weather conditions during the monitoring period were obtained from the Horsley Park Equestrian Centre AWS (33.8510°S 150.8567°E) located approx. 7km to the south of the subject site. This data was assessed, and periods of inclement weather are highlighted on the detailed logging data attached in Appendix A.

- Rain was noted most of the day on the 5th October and till approx. 9:20am on the 6th October. This data has been excluded in determining the rating background noise levels.
- Some periods of high wind speeds (> 5m/s) were noted, and these data was excluded in determining the rating background noise levels.

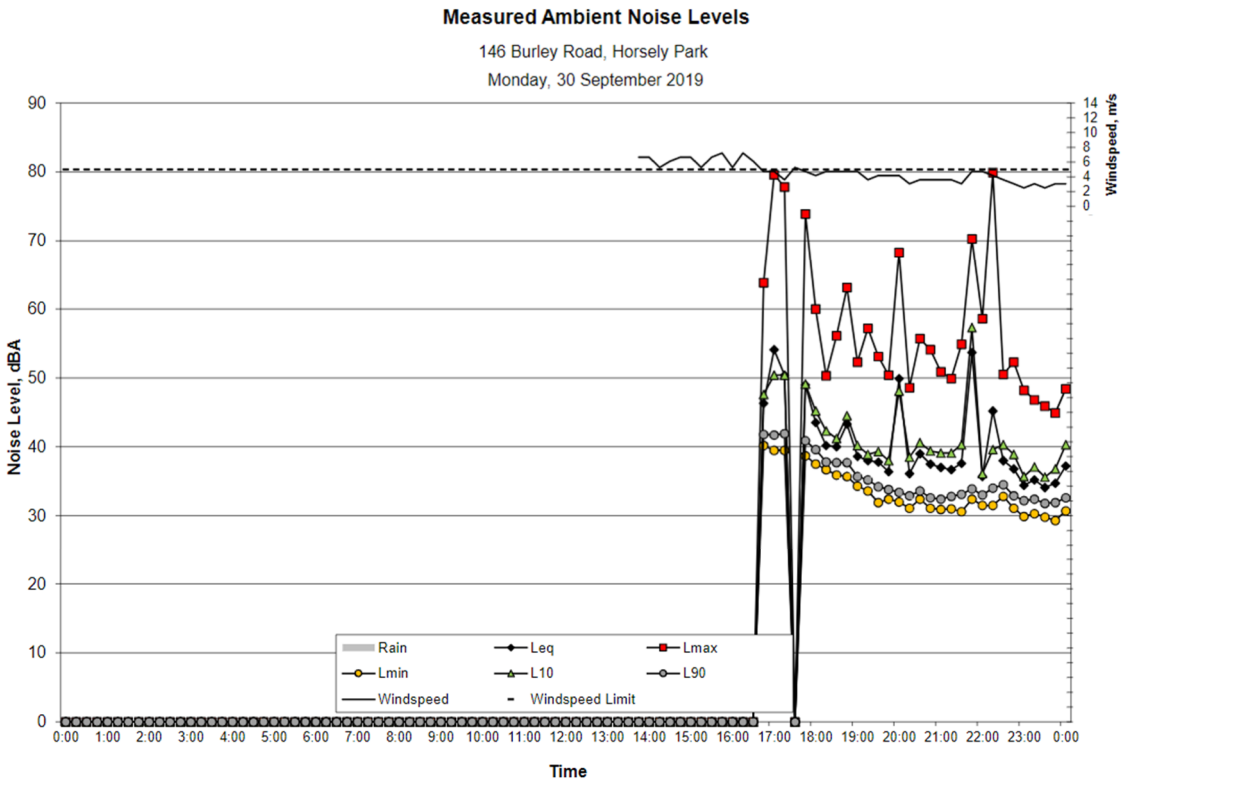
3.5 Measured Background Noise Levels

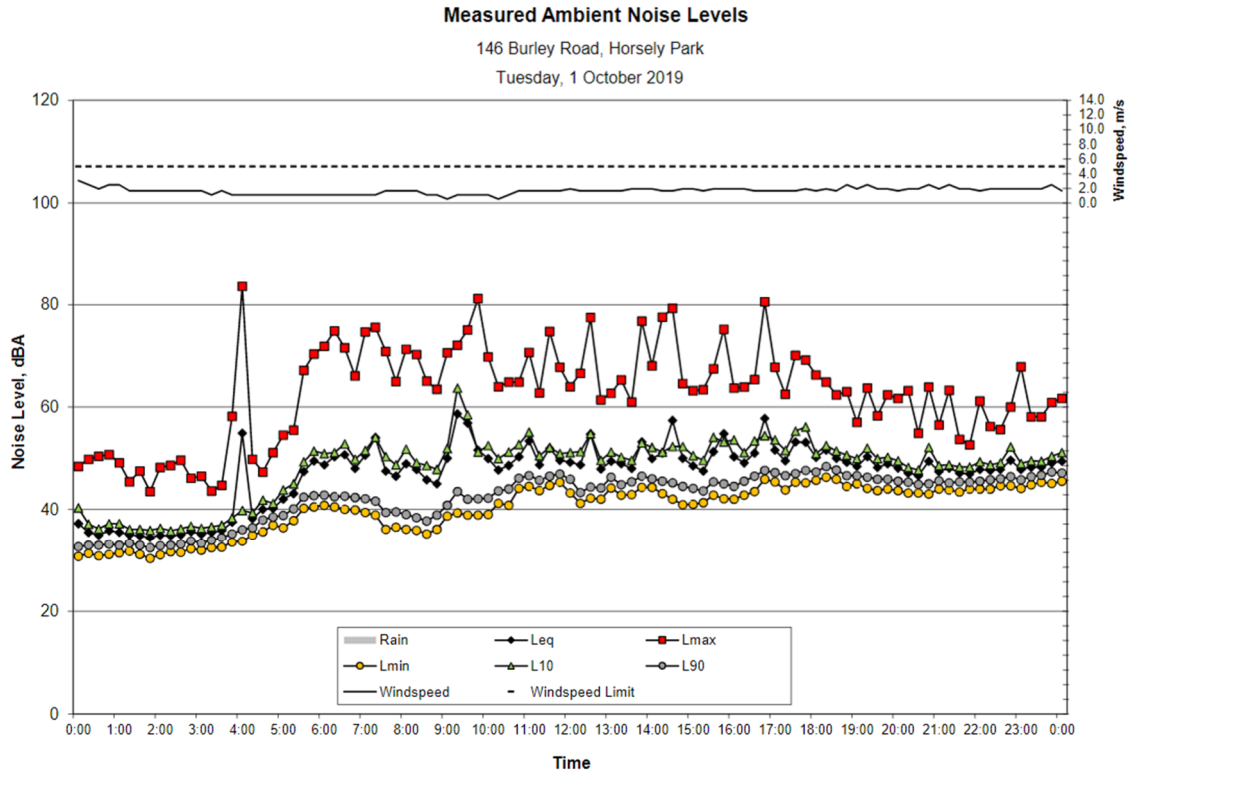
The rating background noise levels (RBL) at the two monitoring locations are detailed below. The RBL's were calculated based on the methodology detailed in fact sheet A of the NSW EPA NPfI.

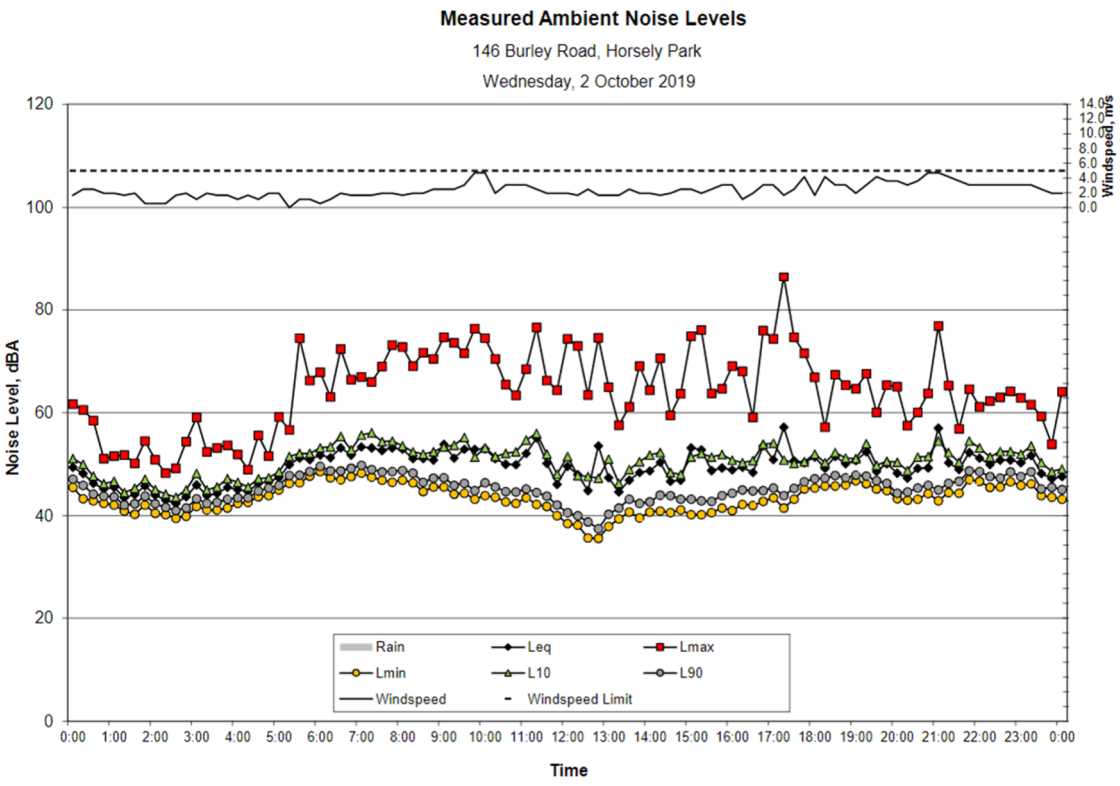
Table 2 – Measured Rating Background Noise Levels

Monitor	Measured Rating Background Noise Level dB(A)$L_{90(period)}$		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
NML 1	41	42	39
NML 2	44	44	39

B.3 Noise monitoring graphs



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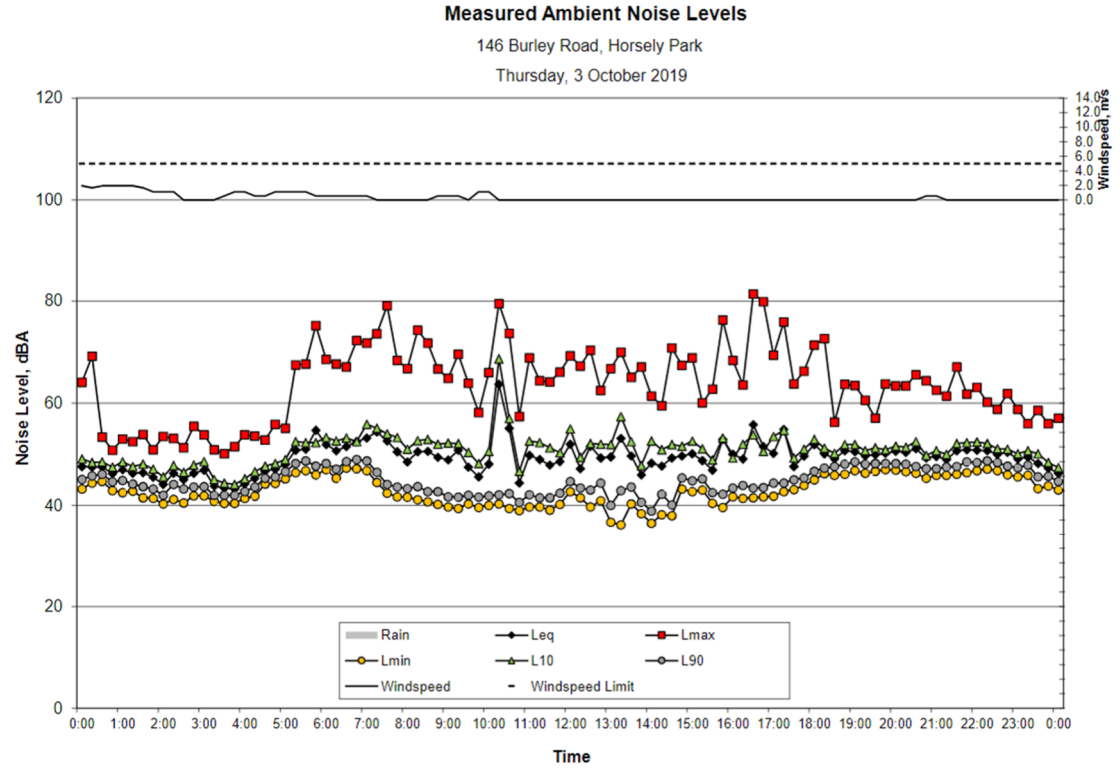
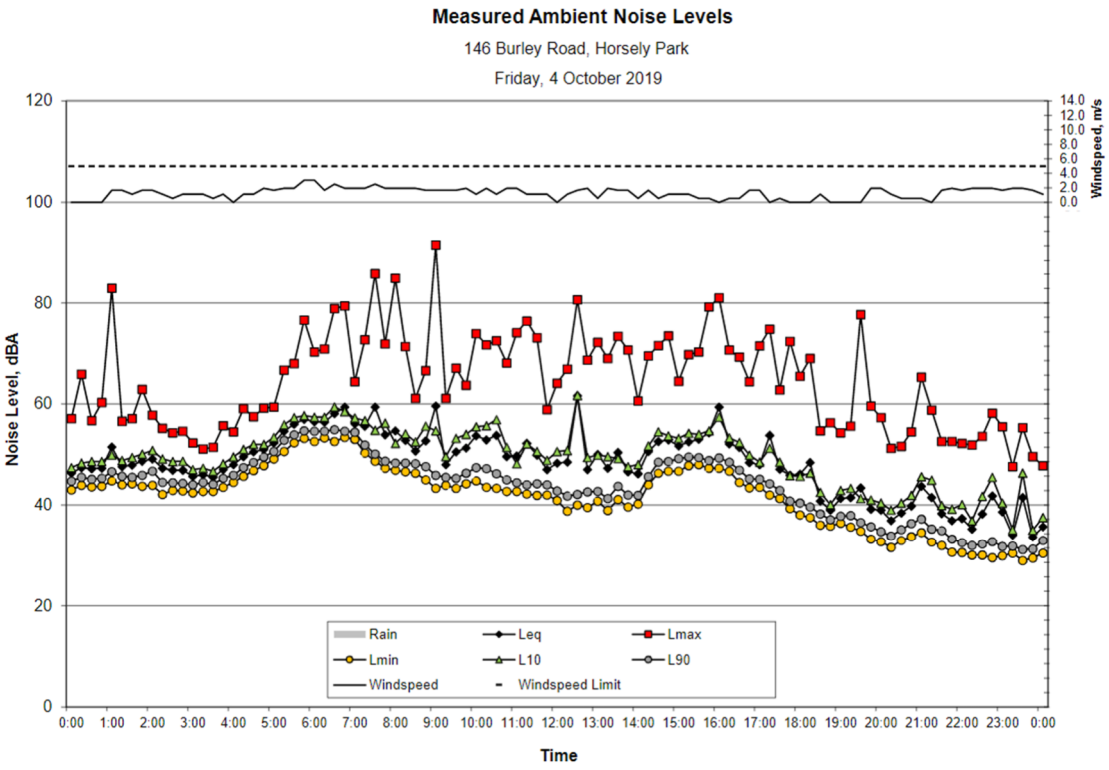
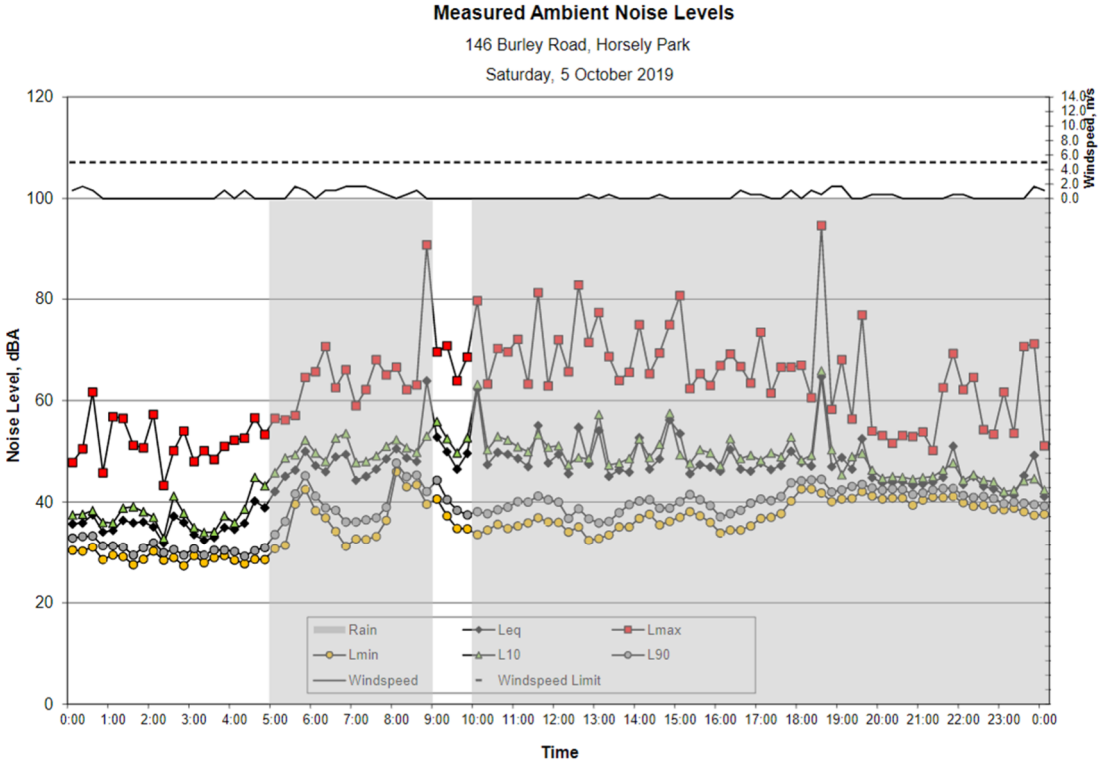
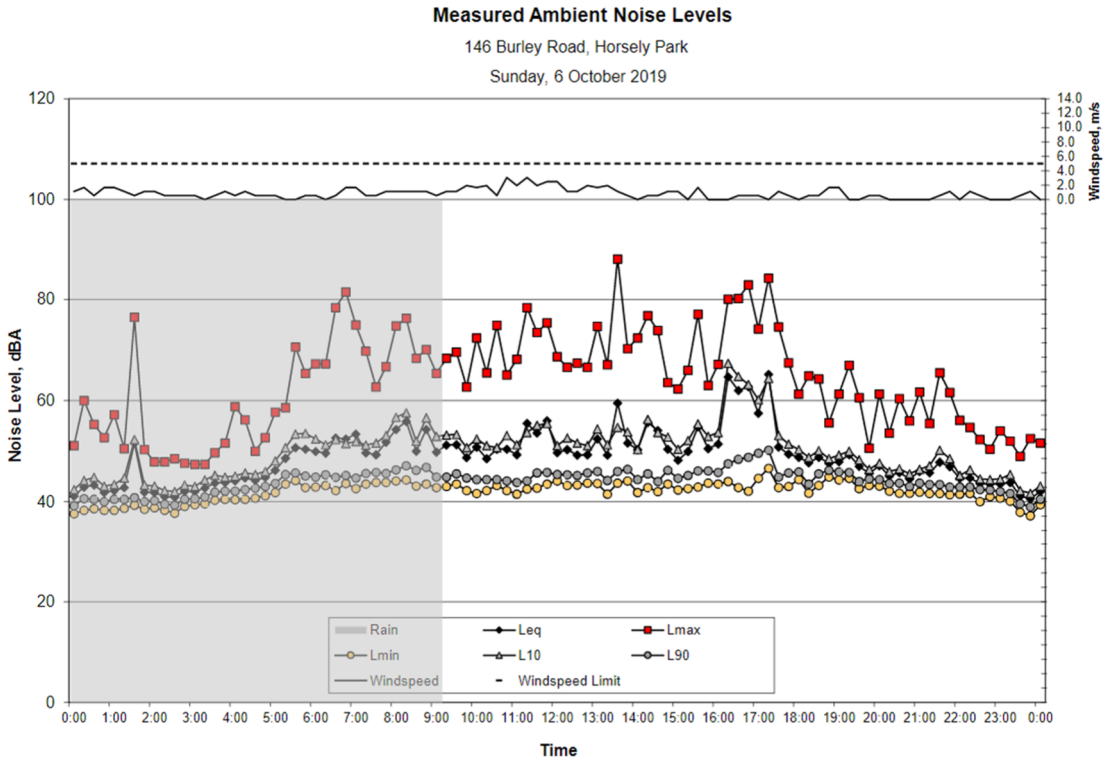
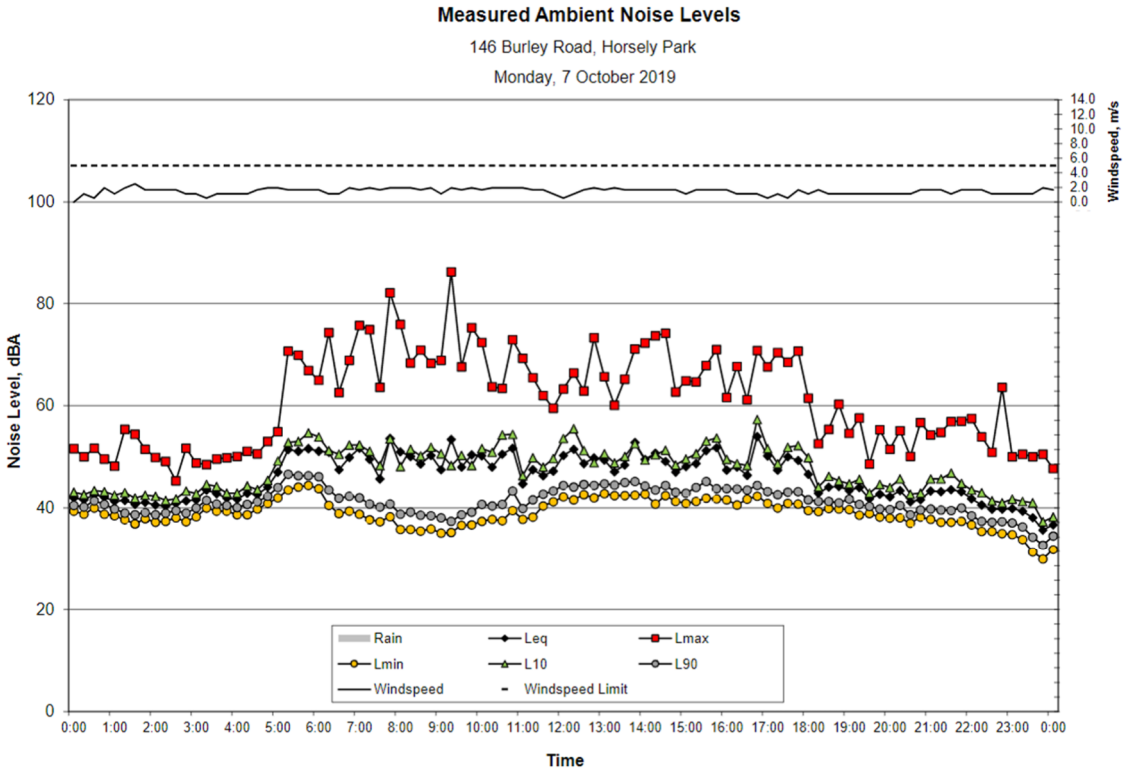
146 Burley Road, Horsely Park
Wednesday, 2 October 2019
Noise Level, dBA
Windspeed, m/s
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit
Time


Measured Ambient Noise Levels
146 Burley Road, Horsely Park
Thursday, 3 October 2019
Noise Level, dBA
Windspeed, m/s
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit
Time


Measured Ambient Noise Levels
146 Burley Road, Horsely Park
Friday, 4 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
146 Burley Road, Horsely Park
Saturday, 5 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
146 Burley Road, Horsely Park
Sunday, 6 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit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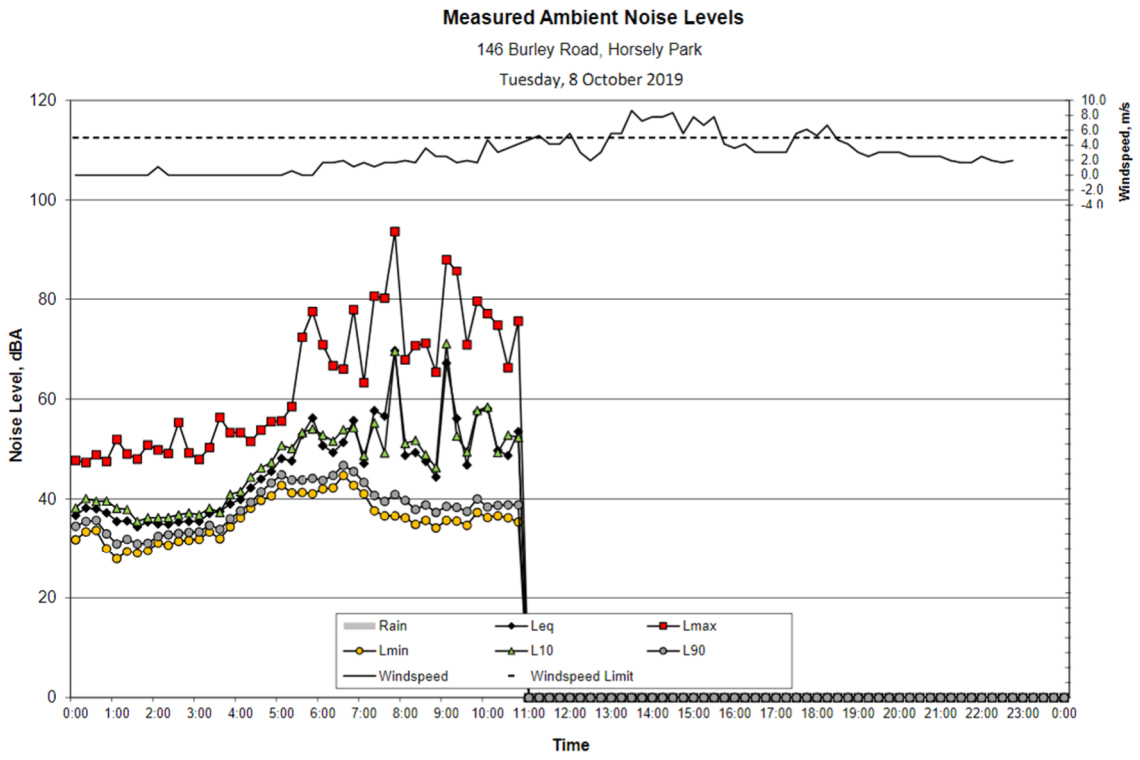
Monday, 7 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit



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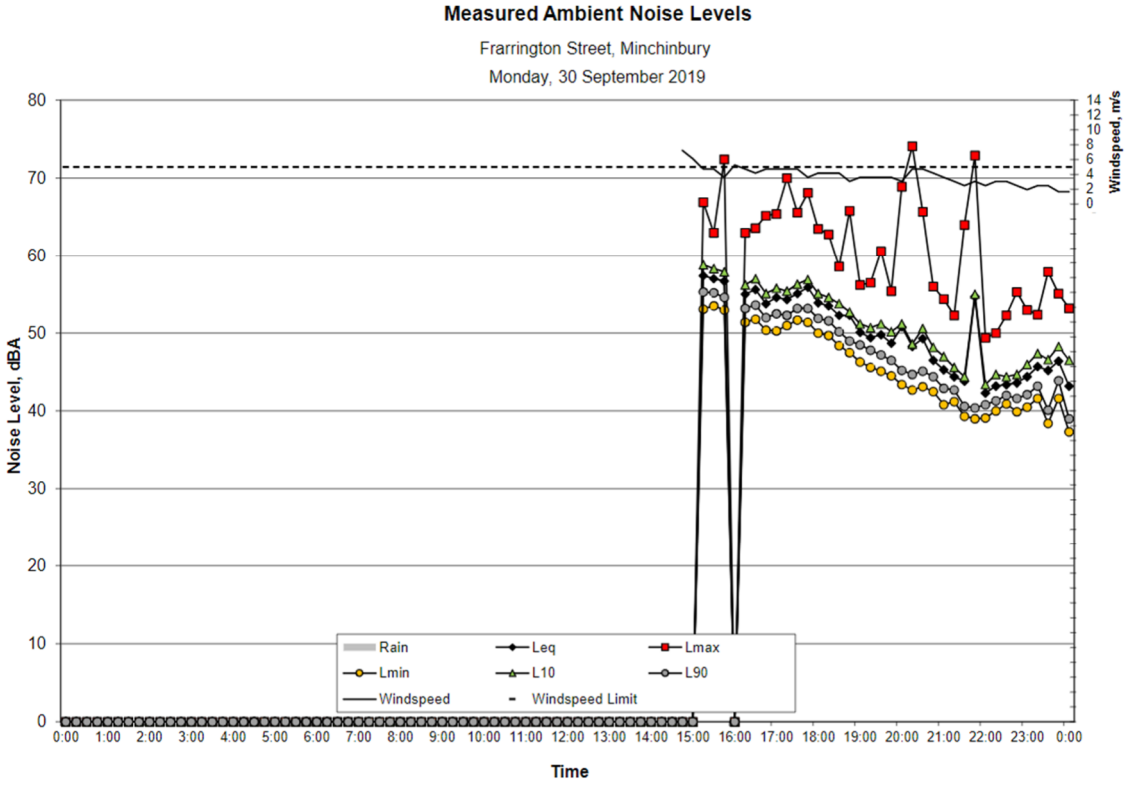

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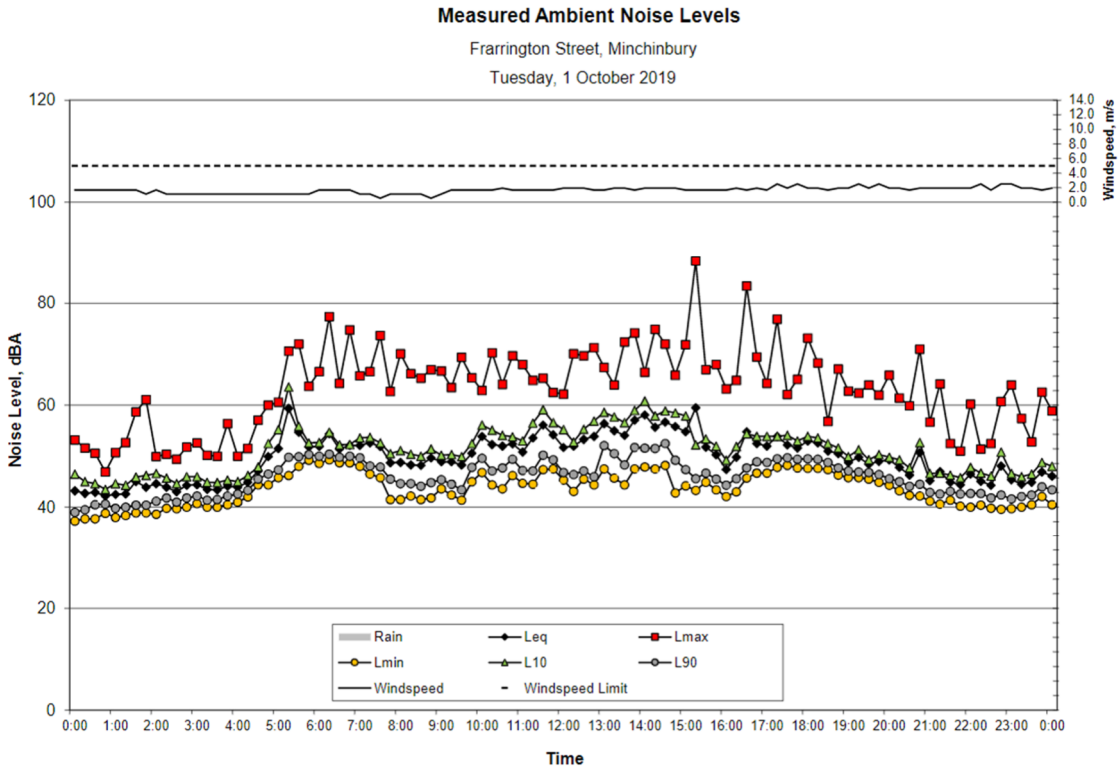

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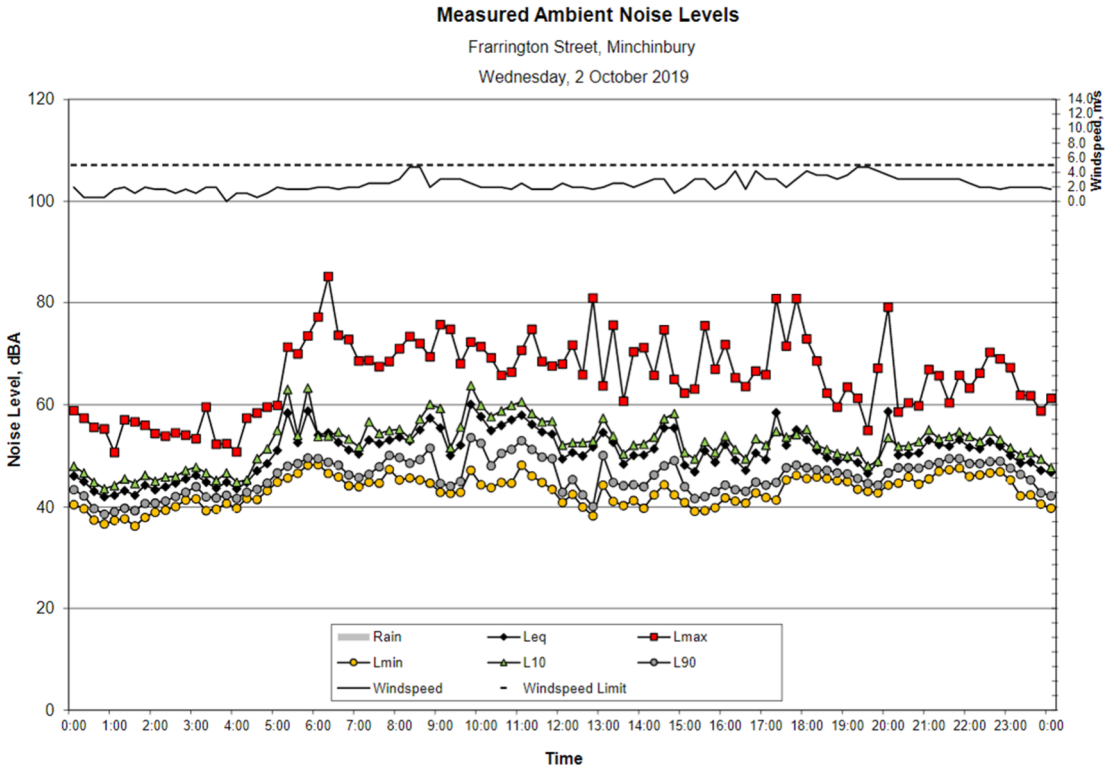

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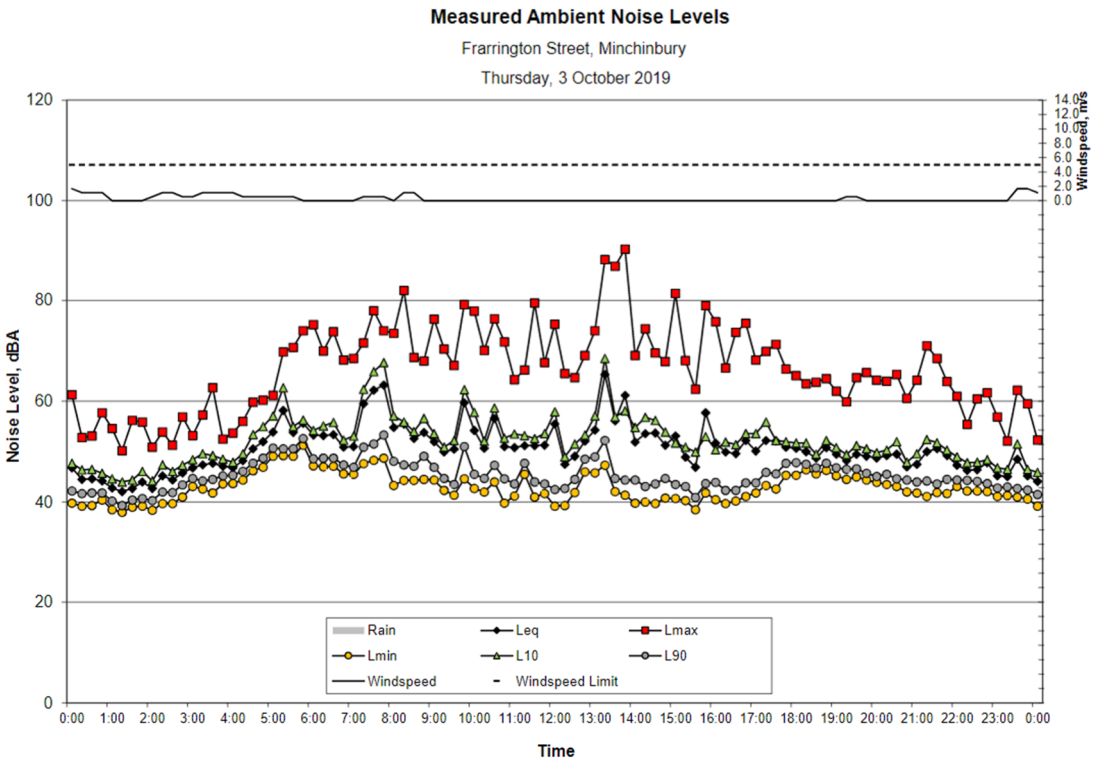
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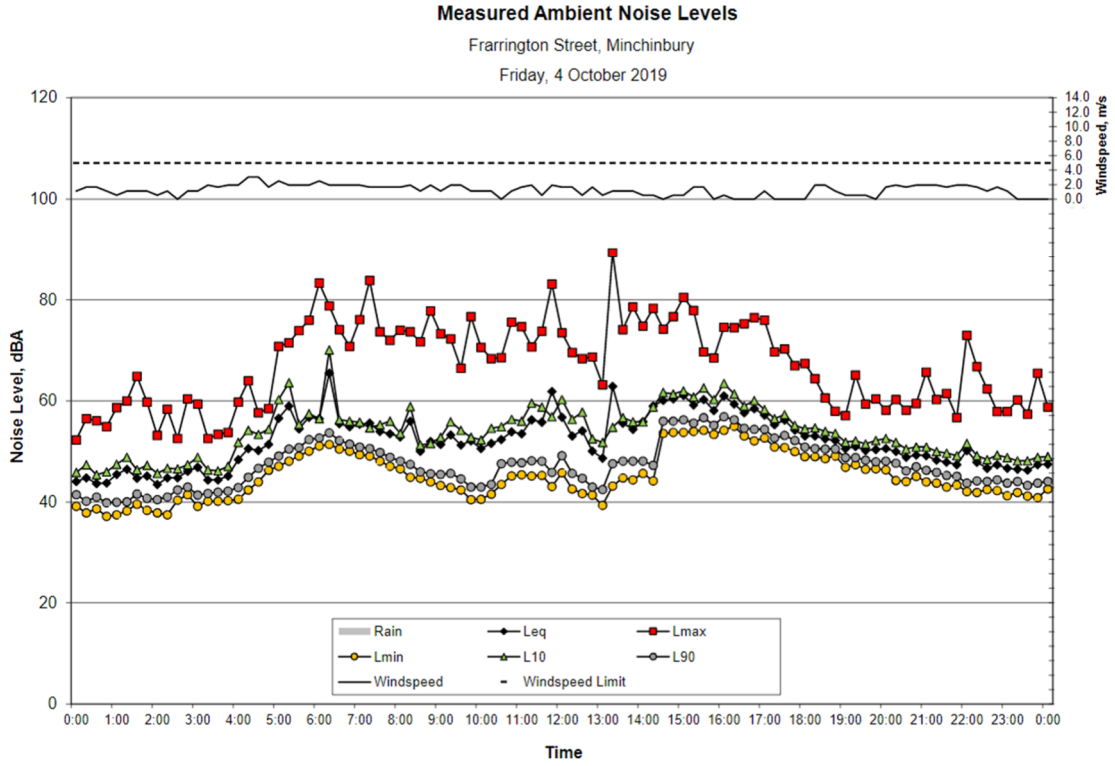
Frarrington Street, Minchinbury
Thursday, 3 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit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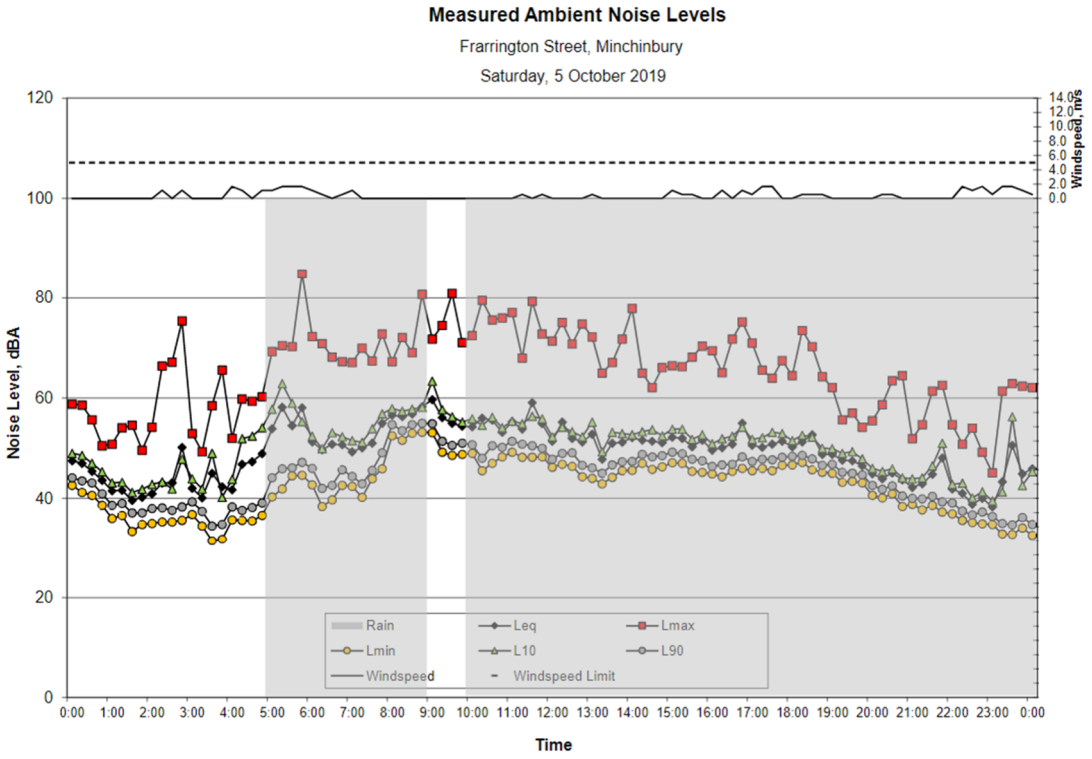
Frarrington Street, Minchinbury
Friday, 4 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit



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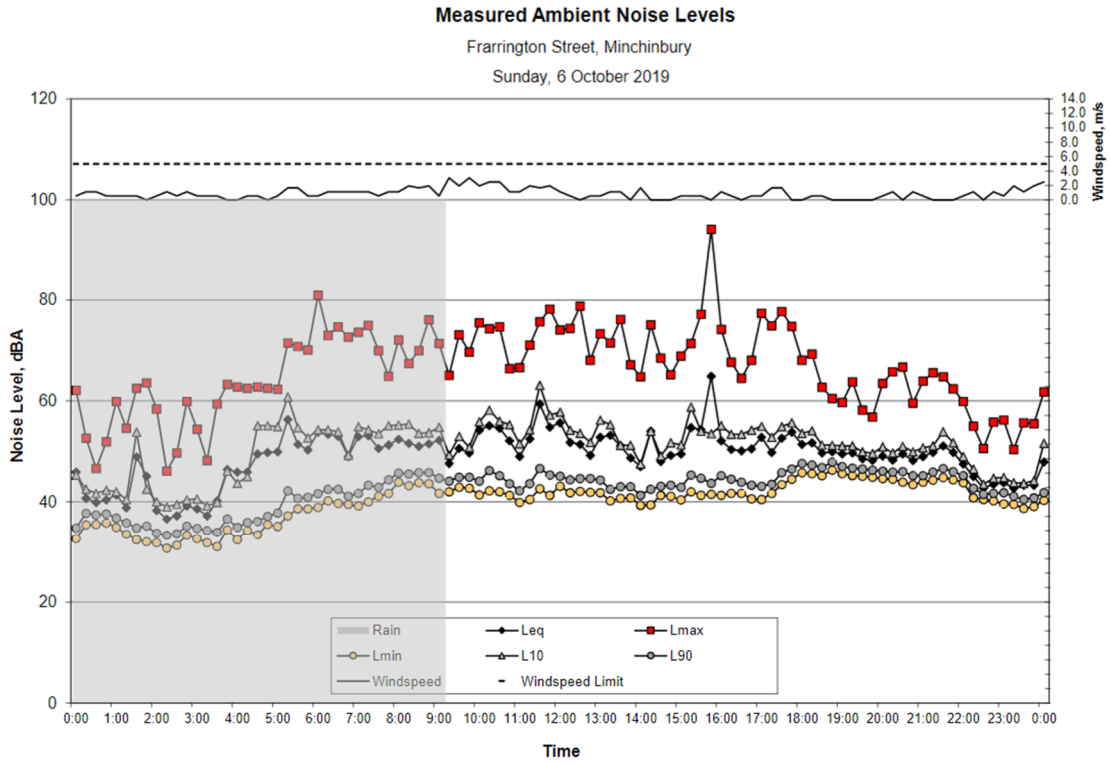

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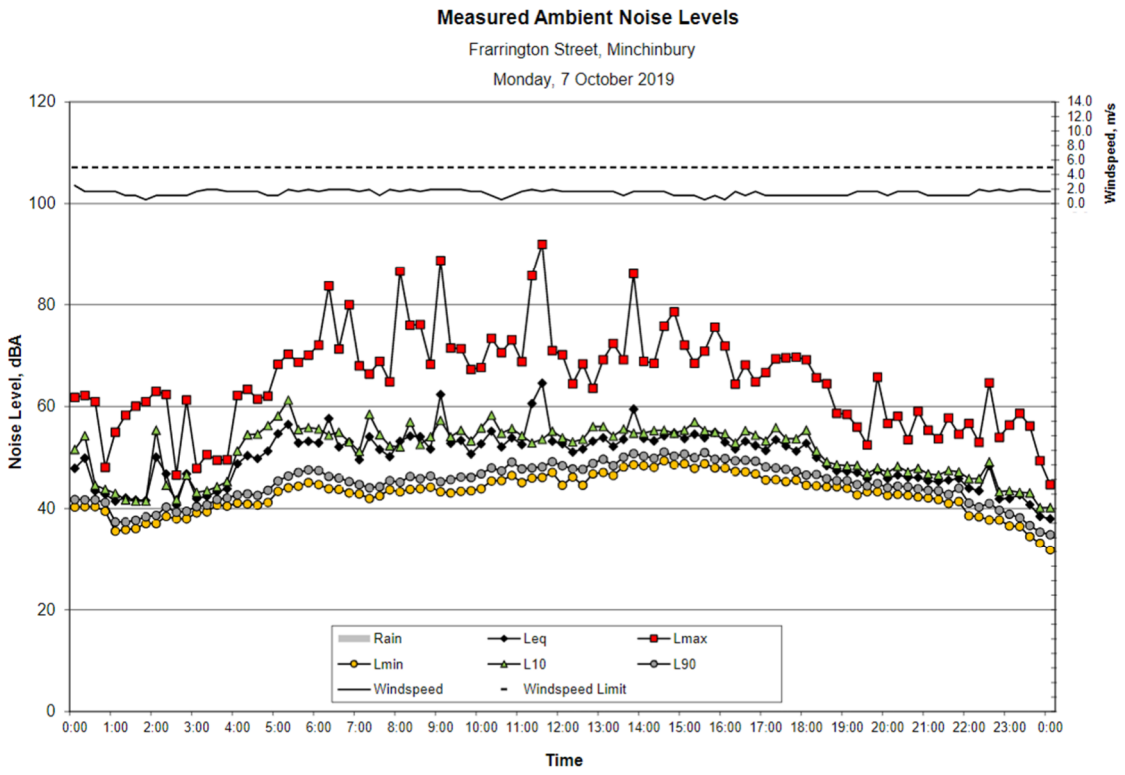
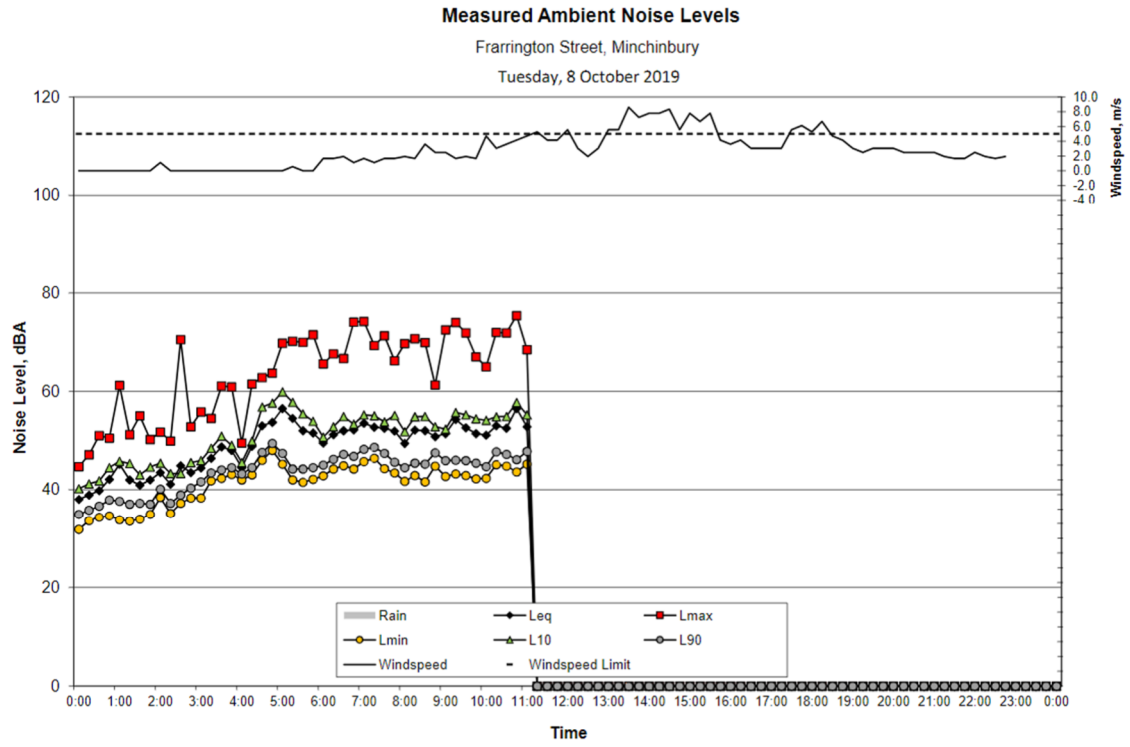

Measured Ambient Noise Levels
Frarrington Street, Minchinbury
Monday, 7 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
Frarrington Street, Minchinbury
Tuesday, 8 October 2019
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

Appendix C

Vibration Criteria

C.1 Vibration Criteria

C.1.1 Disturbance to buildings occupants

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC *Assessing Vibration; a technical guideline* [13]. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 *Evaluation of human exposure to vibration in buildings (1-80Hz)* [14]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 21.

Table 21: Types of vibration - Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 22 reproduces the 'Preferred' and 'Maximum' values for continuous and impulsive vibration from Table 2.2 of the Guideline.

Table 22: Preferred and maximum vibration acceleration levels for human comfort, m/s2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92

Note 1 - Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

Table 23 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration from Table 2.4 of the Guideline. The VDV is dependent upon the level and duration of the vibration episode and the number of vibration episodes occurring during the assessment period; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

Table 23: Acceptable vibration dose values (VDV) for intermittent vibration (m/s1.75)

Location	Daytime[1]		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1- Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

C.1.2 Structural damage

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [14].

C.1.2.1 Standard structures

British Standard 7385 Part 1: 1993, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 and Section 7.4.2 of BS7385-2 sets limits for the protection against the different levels of structural damage and those levels are reproduced in Table 24 below.

Table 24: BS 7385-2 Structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings3	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:

1 - Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

2 - Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

3_Considered to be relevant for the M7 abutment.

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

The guide values in Table 24 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 24 may need to be reduced by up to 50%.

C.1.2.2 Sensitive structures

German Standard *DIN 4150 – Part 3 'Structural vibration in buildings – Effects on Structure'* [11] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed in accordance with BS7385-2. If a heritage building or structure is found to be structurally unsound (following inspection) DIN 4150-3, line 3 as outlined in Table 25, provides a conservative cosmetic damage objective that should be adopted unless alternative limits are justified by a dilapidation or structural survey. The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.

Table 25: DIN 4150-3 structural damage guideline values

Line	Type of structure	Peak component particle velocity (PCPV), mm/s				
		Vibration at the foundation at a frequency of			At horizontal plane of highest floor	In the vertical direction, at floor slabs
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz1	All frequencies	All frequencies
3	Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under a preservation order)3	3	3 to 8	8 to 10	8	202

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.
2. Guideline value might have to be lowered to prevent minor damage
3. Line 1 refer to buildings used for commercial purposes, industrial buildings and buildings of similar design, while Line 2 refers to residential buildings and buildings of similar design and/or occupancy

Note that no sensitive structures have been identified near the site.

C.1.2.3 Buried services

It is not expected that the proposed works will impact upon buried services, however the following is nonetheless provided for guidance.

DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework (see Table 26).

Table 26: Guideline values for short-term vibration impacts on buried pipework

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s
-	High pressure gas pipelines*	75 Monitoring required if predicted above 50. No piling within 15 m of pipeline without detailed assessment.

Notes:

- For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 [11] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

- For Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

* Based on UK National Grid's specification [15]

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

Appendix D

Addendum to SSDA report

Appendix D: Addendum to SSDA report

ARUP

EIS

Project Echidna

Noise and Vibration Addendum to SSDA report

Reference: SSD-47320208

1 | 7 October 2022

Job number

Arup Australia Pty Ltd | ABN 76 625 912 665

Arup Australia Pty Ltd
Level 5
151 Clarence Street
Sydney
NSW 2000
Australia
arup.com

Appendix D: Addendum to SSDA report

ARUP

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Appendix D: Addendum to SSDA report

1. Background

A noise and vibration assessment was prepared to support the SSDA application for the construction and operation of Project Echidna (Refer to Project Echidna, Noise and Vibration Impact Assessment – SSDA dated 6 October 2022 (Referred to as SSDA report)). 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 for 2 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, as a conservative approach for SSDA, Project Echidna design criteria were set 10 dB less than the site criteria. This approach would ensure that Project Echidna noise emissions would not result in exceedances to overall site emissions.

SSDA assessment of noise emissions to nearest receivers from Project Echidna was carried out using modelling software SoundPlan. The SSDA assessment identified nearest receivers, Project Echidna primary noise sources and mitigation measures necessary to comply with Project Echidna design criteria.

The assessment identified the following mitigation measures and associated noise reductions are required:

- An estimated 10 dB noise reduction of noise emissions from the condenser units – achieved through reselection and oversizing of units
- An estimated 10 dB reduction of noise emissions from the AHUs – achieved through reselection of AHUs + attenuator fitted to the inlet or attenuator fitted at the louvre
- An estimated 13 dB reduction of noise emissions from the load bank – achieved through reselection of unit or partial enclosure.

The feasibility of the above noise reductions was discussed with the project team and equipment manufacturers.

In the SSDA report, the following was noted:

> Noting the conservatism used to derive the Project Echidna criteria for this assessment (which result in conservative noise mitigation measures to be implemented in the design of Project Echidna), it is 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. This assessment will establish if Project Echidna design criteria can potentially be relaxed and consequently if noise mitigations can be reduced and if the site operations can be altered (The client has indicated the desire to conduct generator testing during night-time for Project Echidna).
>
> The detailed design report would include the results and findings of the assessment, including review of detailed noise emissions of Building 1, Building 1A, Project Echidna and the substation. The report would also include all operating scenarios which can be implemented while meeting site emissions criteria at all receivers. The report would be presented to the relevant authority prior to Construction Certificate.

Following DPIE comments regarding Project Echidna design criteria (being 10 dB less than site criteria) and questioning the feasibility of the noise mitigation measures, as well as wanting to see a detailed assessment of cumulative noise impacts for the SSDA stage, the aim of this addendum report is to:

- include noise sources from approved buildings and substation into the model

- assess noise emissions from Project Echidna cumulatively with other noise sources with the site against overall site criteria
- re-assess the noise reduction required and mitigation measures to be implemented
- provide noise contours for Project Echidna

Note that this report includes information required to address the immediate requirements for SSDA Stage. A more complete report will be prepared prior to Construction Certificate.

This report is to be read in conjunction with the SSDA report.

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

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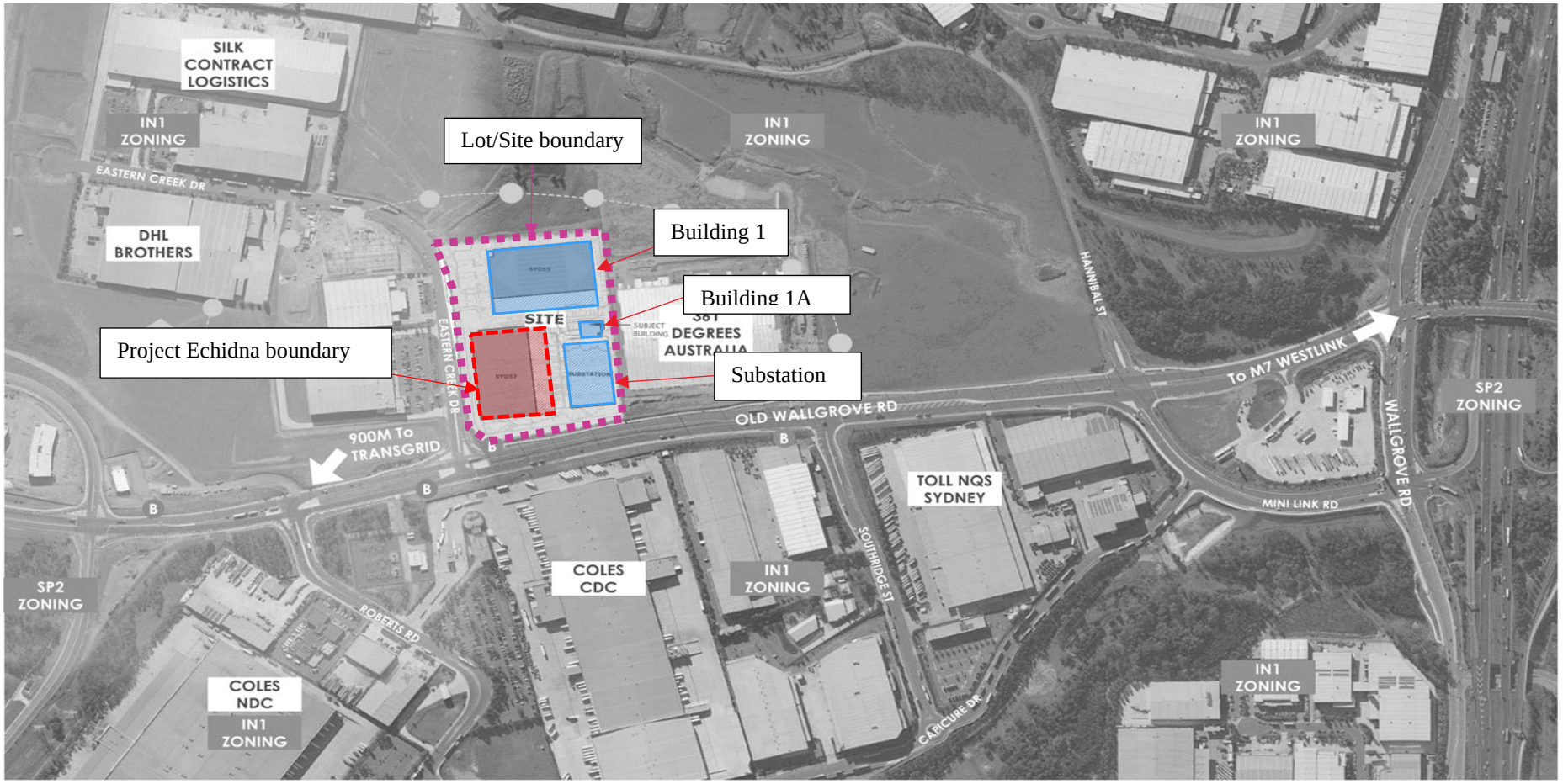

Figure 1: Location context area plan

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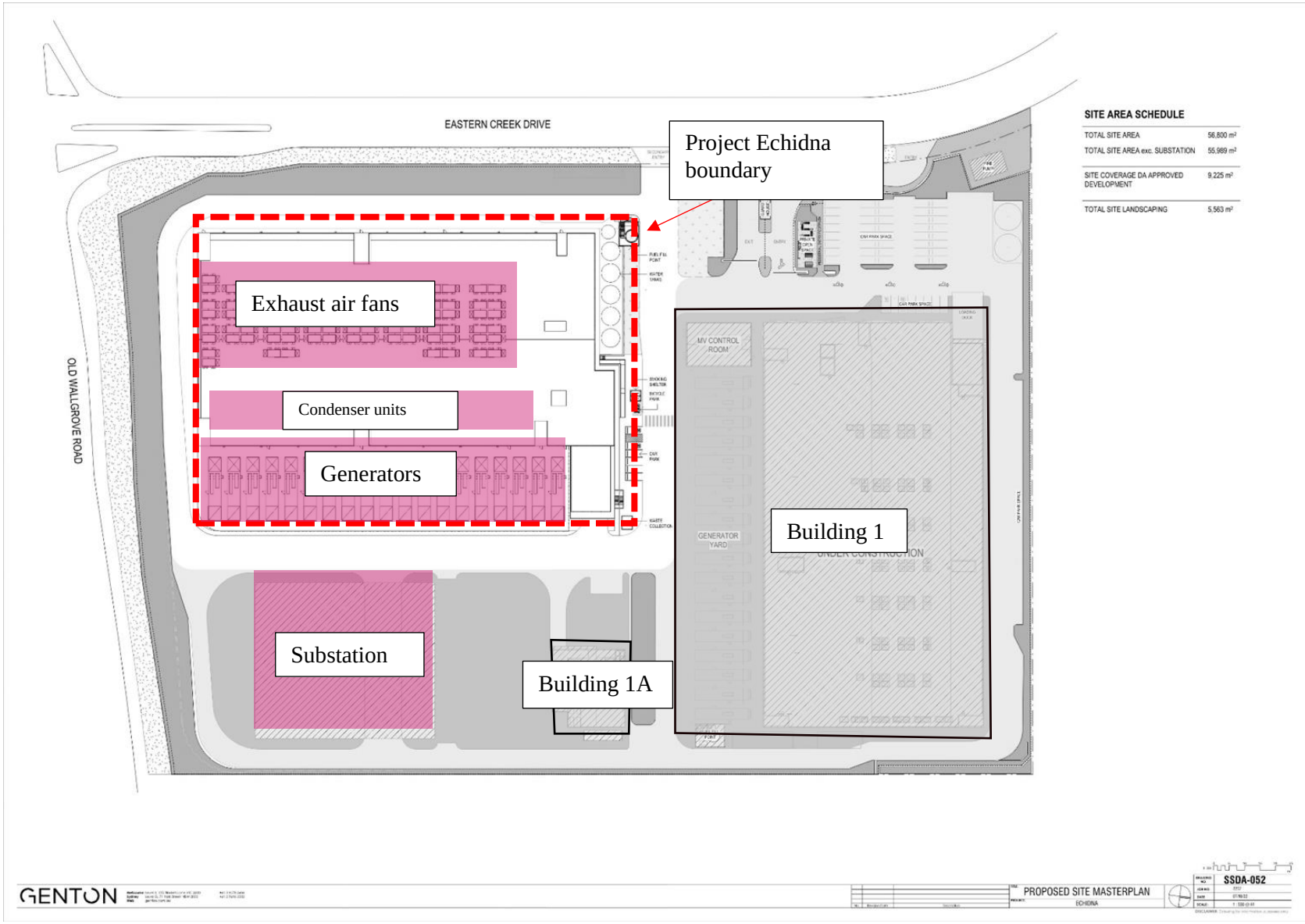

Figure 2: Site Layout

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2. Noise sources

Noise sources for Building 1, Building 1A and the substation have been included in the Soundplan model. The noise sources were provided by the design team.

Noise sources for Project Echidna are shown in Table 6 of the SSDA report. For this assessment, mitigation measures have been implemented following several model iterations. Table 2 and Table 2 present the mitigation measures provided by the design team and equipment manufacturers.

Table 1: Mitigation measures

Equipment	Mitigation measure recommended in SSDA report	Mitigation measure implemented in this report
Condenser unit	Reselection of unit (including oversizing of units)	Units have been reselected to a lower noise generating unit as per recommendation in SSDA report.
AHU	Reselection of AHUs + attenuator fitted to the inlet or attenuator fitted at the louvre	AHU have been reselected. An attenuator is fitted on the inlet and a new casing for the units has been provided as per recommendation in the SSDA report.
Load bank	Reselection of unit or partial enclosure.	The load bank modelled is still an ‘off the shelf’ load bank, however, is quieter than the previous selection presented in Table 6 of the SSDA report. This assessment which includes all noise sources for the site, identified that no further mitigation to the load bank is required when testing Project Echidna’s generators.

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Table 2: Plant and associated noise data

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[2]	Manufacturer data (Stulz)	-	Lw	80	-	77	75	77	77	71	66	60	Point Source
Air handling unit	Manufacturer data (Dannan)	Inlet + attenuator	Lw	72	85	88	64	57	55	52	49	48	Area sources[1]
		Outlet	Lw	99	96	103	98	97	93	89	86	86	
	Empirical data	Casing	Lw	68	74	78	71	68	50	45	39	37	
Load bank[2]	Parratech	Lp at 3 m is 85	Lw	108	104	104	109	104	101	99	96	98	Point Source

Note:

1_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 58 dBA/m^2. Model also adds a directivity factor to the louvre.

2_Spectrum is indicative

3. Predicted noise levels

Noise predictions for standard operations (with mitigation measures included) under standard and enhanced meteorological conditions are presented in Table 3 and Table 4 for the daytime and the night-time operations respectively. Standard operations is defined in Section 6.1 of the SSDA report.

Note, it is assumed only 1 generator and 1 load bank will be operational at any time during the daytime within the site. Two scenarios have been modelled for loadbank operation and generator testing; one to the south and one to the north of the Project Echidna building. Worse case predictions are reported in Table 3.

Table 3: Predicted noise levels – standard daytime operation – Standard and Enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Daytime – Standard weather conditions				Daytime – Enhanced weather conditions			
		Site noise emissions - Predicted level $L_{eq,15min}$ dB(A)				Site noise emissions - Predicted level $L_{eq,15min}$ dB(A)			
		Non Project Echidna related[1]	Project Echidna related	All noise sources	Meets Overall Site criteria?	Non Project Echidna related[1]	Project Echidna related	All noise sources	Meets Overall Site criteria?
R1	49	29	20	32	Yes	35	26	38	Yes
R2	46	27	24	31	Yes	33	30	38	Yes
R3	46	15	18	23	Yes	21	24	28	Yes
R4	46	16	25	28	Yes	21	31	34	Yes
R5	46	19	25	28	Yes	25	31	34	Yes
R6	49	28	19	31	Yes	34	25	37	Yes
R7	49	13	8	17	Yes	19	14	22	Yes
R8	46	27	30	34	Yes	33	36	41	Yes
C1	63	44	47	51	Yes	47	49	53	Yes
C2	63	43	51	54	Yes	46	55	58	Yes
C3	63	44	52	55	Yes	47	56	59	Yes
C4	63	50	39	53	Yes	52	43	55	Yes
C5	63	59	35	62	Yes	60	39	63	Yes
I1	68	55	62	66	Yes	56	64	67	Yes
I2	68	47	34	50	Yes	51	39	54	Yes
I3	68	49	56	59	Yes	52	60	63	Yes

Notes:

1_Includes noise emissions from Building 1, Building 1A and the substation.

2_Exceedances to project criteria are indicated in red.

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Table 4: Predicted noise levels – standard night-time operation – Standard and Enhanced weather conditions

Receiver	Overall Site criteria $L_{eq,15min}$ dB(A)	Night-time – Standard weather conditions				Night-time – Enhanced weather conditions			
		Site noise emissions - Predicted level $L_{eq,15min}$ dB(A)				Site noise emissions - Predicted level $L_{eq,15min}$ dB(A)			
		Non Project Echidna related[1]	Project Echidna related	All noise sources[3]	Meets Overall Site criteria?	Non Project Echidna related[1]	Project Echidna related	All noise sources[3]	Meets Overall Site criteria?
R1	38	29	19	32	Yes	35	25	38	Yes
R2	38	27	21	31	Yes	33	27	37	Yes
R3	38	15	18	22	Yes	21	23	28	Yes
R4	38	16	17	22	Yes	21	23	28	Yes
R5	38	19	15	23	Yes	25	21	29	Yes
R6	38	28	18	31	Yes	34	24	37	Yes
R7	38	13	5	16	Yes	19	11	22	Yes
R8	38	27	20	30	Yes	33	26	37	Yes
C1	63	44	47	51	Yes	47	49	53	Yes
C2	63	43	43	48	Yes	46	45	51	Yes
C3	63	44	40	48	Yes	47	43	51	Yes
C4	63	50	38	53	Yes	52	43	55	Yes
C5	63	59	32	62	Yes	60	37	63	Yes
I1	68	55	45	58	Yes	56	48	59	Yes
I2	68	54	33	56	Yes	56	38	58	Yes
I3	68	47	45	52	Yes	51	48	56	Yes

Notes:

1_Includes noise emissions from Building 1, Building 1A and the substation.

2_Exceedances to project criteria are indicated in red.

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 6.1 of the SSDA report).

Mitigation measures to Project Echidna as per Section 2 should be implemented.

Noise contours for standard operations of Project Echidna have been generated considering enhanced weather conditions and are presented in Appendix A.

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4. Conclusion

This report presents an assessment of all noise sources to be located on the site at 10 Eastern Creek Drive, Eastern Creek. The noise sources include Building 1, Building 1A, a substation and Project Echidna.

This assessment is a follow up from the preliminary assessment conducted for SSDA for Project Echidna. Mitigation measures were previously established in the SSDA report based on the assumption that the whole criteria are taken by other noise sources (i.e. Building 1, Building 1A) on site and no allowance for Project Echidna noise emissions remains. This noise assessment refines the mitigation measures based on noise emissions predicted from Building 1, Building 1A that have been approved and are under construction.

Predicted results for the whole site indicate overall site criteria will be met.

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Appendix A

Noise contours

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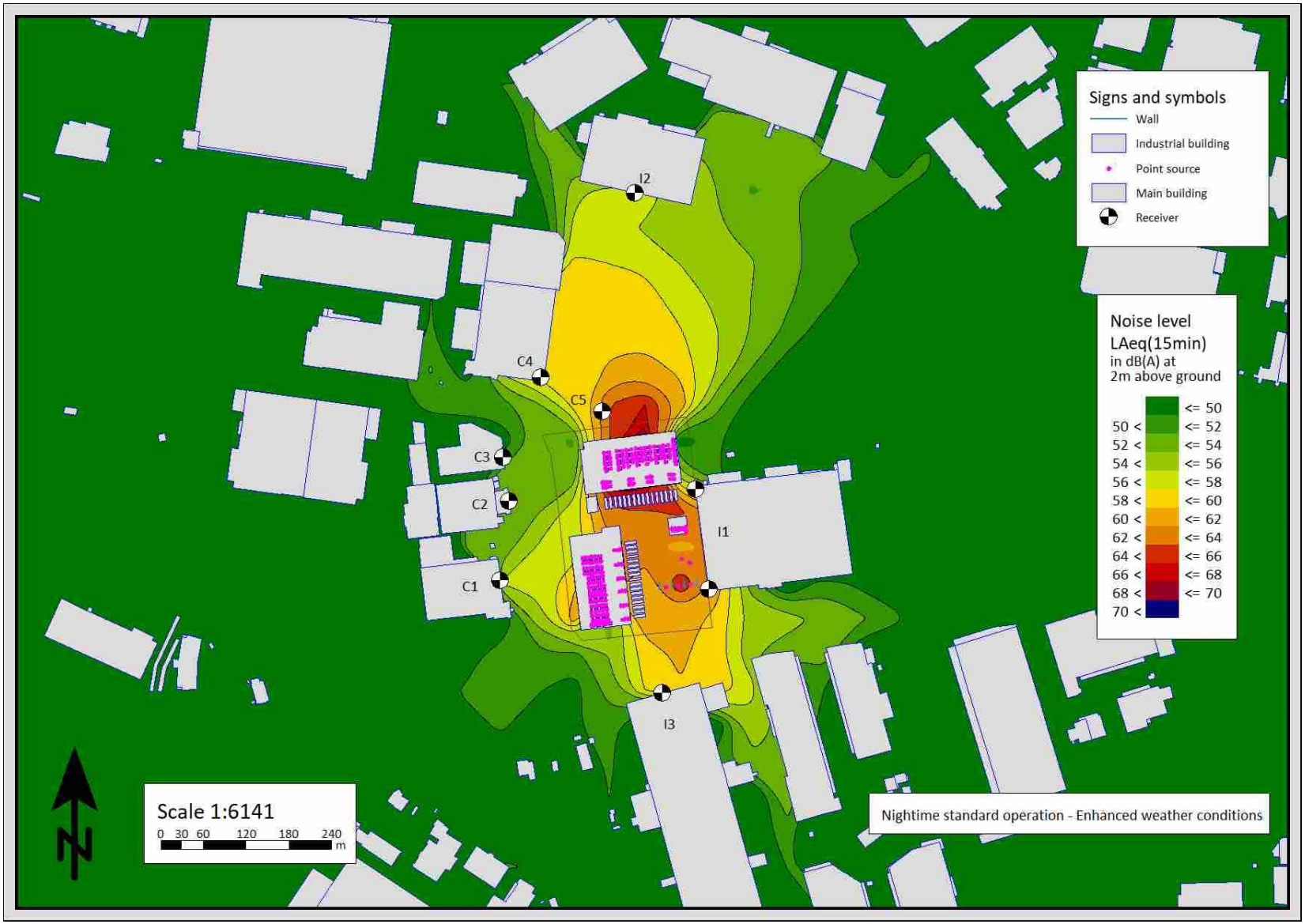
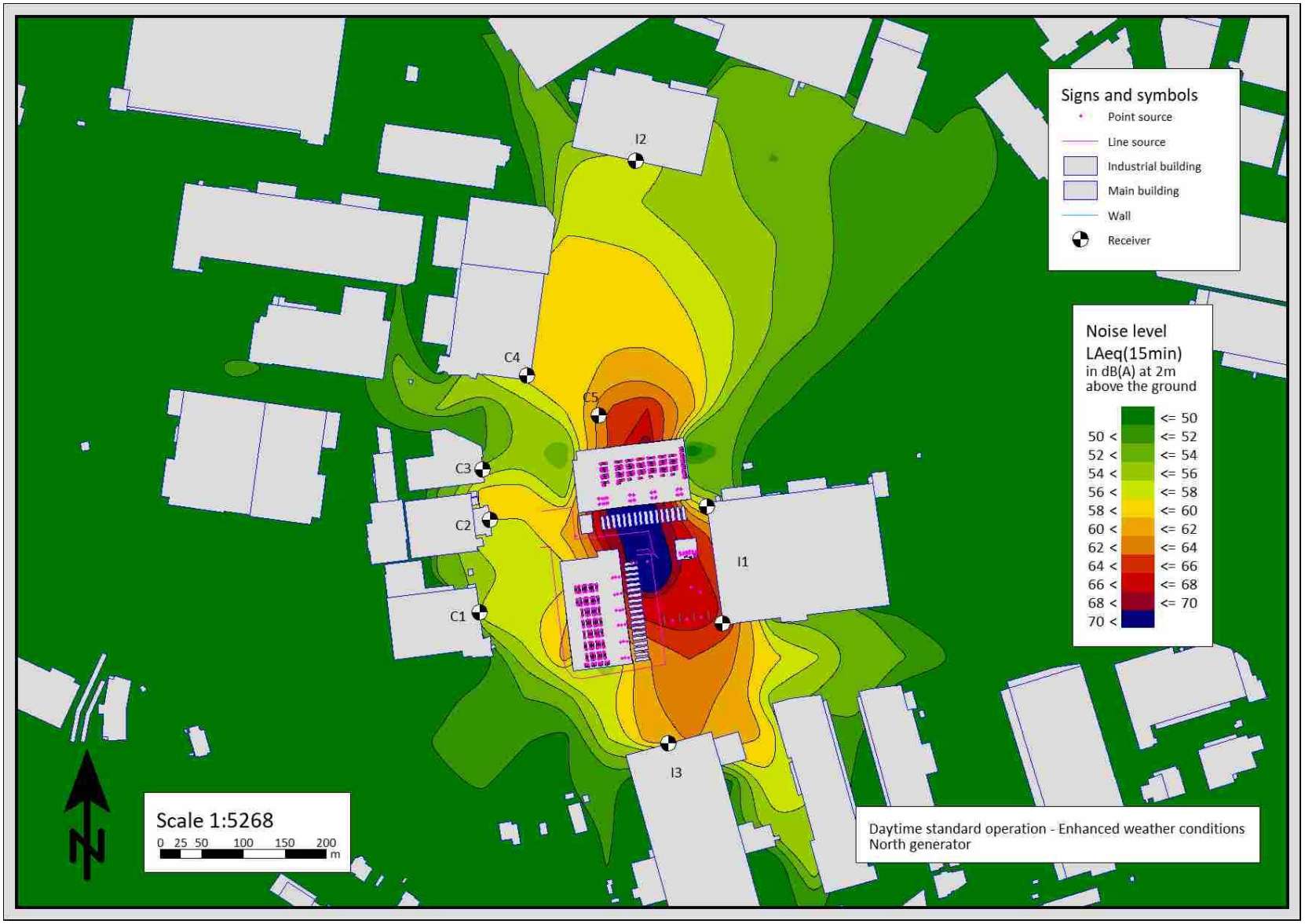
A.1 Night-time standard operation



A.2 Day-time standard operation – North generator



A.3 Day-time standard operation – South generator