RNA Pilot Research and Manufacturing Facility

Construction Noise and Vibration Management Plan

Hindmarsh Construction Australia Pty Ltd

Report Reference: 240258 – RNA Pilot Research and Manufacturing Facility – Construction Noise and Vibration Management Plan – R0
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1 INTRODUCTION

Pulse White Noise Acoustics (PWNA) has been engaged by Hindmarsh Construction Australia Pty Ltd to prepare a site-specific Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of the RNA Pilot Research and Manufacturing Facility. The site is located at the corner of Gymnasium Road and Culloden Road, approximately 13km from the Sydney CBD – 16 Herring Road, Macquarie Park

This CNVMSP has been prepared to satisfy the requirements of B16 of the consent conditions presented to this office given in the Notice of determination – Approval issued for Development Application Number SSD-51811548.

Onsite unattended noise levels have previously been determined for the project by ARUP in the sites Noise and Vibration Impact Assessment submitted as part of the SSD Application, report reference: *289887-00 AC01, Issue8* (dated 6 July 2023). These will be adopted for the purpose of establishing residential Noise Management Levels (NMLs)

A glossary of acoustic terminology used throughout this report have been included in in Appendix A.

1.1 Condition Satisfaction

In addressing the requirements of Condition B16.

Table 1 Condition Satisfaction Table

CEMP Condition Satisfaction Table		
Condition	**Condition Requirements**	**Document/Sub-Plan Reference**
B16	*The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to the following,*	-
	a) Be prepared by a suitably qualified and experienced noise expert;	Refer to Appendix A
	b) Describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);	Refer to section 5.2.
	c) Describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;	Refer to section 5.2.
	d) Include strategies that have been developed with the community for managing high noise generating works;	Refer to section 5.4
	e) Describe the community consultation undertaken to develop the strategies in condition B15(d);	Refer to section 5.4
	f) Include a complaints management system that would be implemented for the duration of the construction; and	Refer to section 5.4
	g) Include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the management measures in accordance with Condition B13(d).	Refer to section 5.2 & 5.3

1.2 Development Overview

In brief the proposed works will entail the following works:

- Health Infrastructure, on behalf of Health Administration Corporation, proposes to construct and operate a single storey (with a mezzanine plant level) RNA (Ribonucleic Acid) Pilot Research and Manufacturing Facility, with works including the following:
    - Site Preparation Works
    - Earthworks
    - Tree Removal
    - Construction of internal road
    - Carpark Alterations
    - Utility works
    - Signage
    - Landscaping

1.3 Site Layout

The Project site is located at 16 Herring Road, Macquarie Park. The development site is a part of a larger lot that is legally described as Lot 70 DP127681 (formerly Lot 220 DP1266103). The development site is bound by gymnasium Road 9private, MQU-owned internal campus road) to the south-west, Cullen Road to the north-west and Talavera Road to the north-east. The area to be developed is known as Lot B04 under the Macquarie University Concept Plan (MP06_0016).

Development surrounding the development site includes:

- To the north-east: The Macquarie University Observatory is located directly adjacent to the site. Beyond this, development comprises a series of buildings associated with the Faculty of Science and Engineering, Macquarie University.
- To the North-west: Culloden Road adjoins the development site to the north-west. Existing development further to the north-west, on the opposite side of Culloden Road, includes a multi dwelling student accommodation development (MQU Village) and residential buildings.
- To the south-east: a cricket pitch is located directly to the south-east of the development site and that main part of the Macquarie University Campus is located beyond this.
- To the south-west: Gymnasium Road adjoins the development site to the south-west. On the opposite side of the Gymnasium Road is the Royal Institute for Deaf and Blind Children Centre of Excellence.

Surrounding the proposed project site are several sensitive receivers, these are summarised below for the project site.

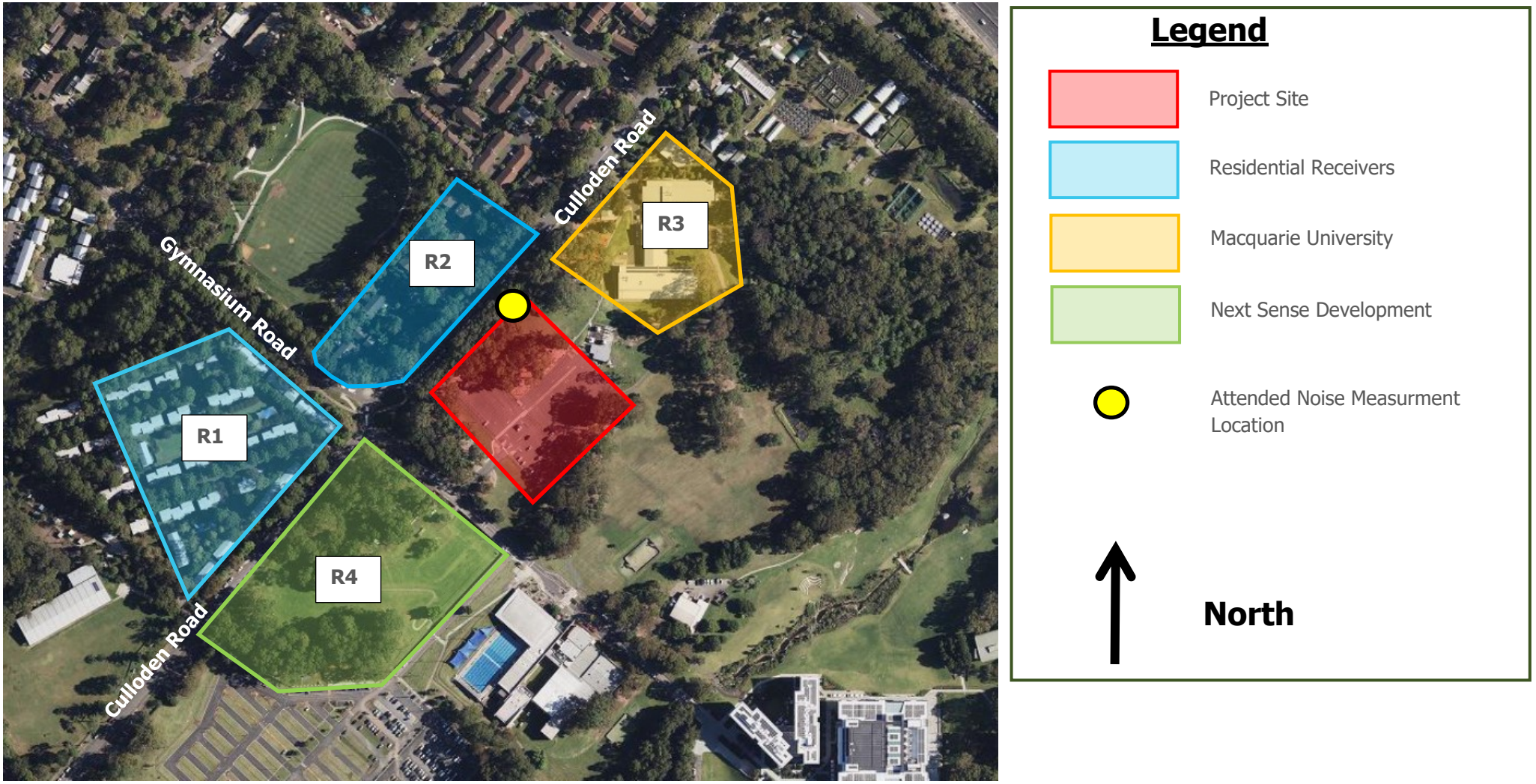
Receiver 1: Located to the north-west of the project site located from 144 – 160 Culloden Road, is located multi dwelling student accommodation as well as residential dwellings. Within this report these receivers will be identified as R1 Receivers.

Receiver 2: Located to the north-east of the project site is located the Macquarie University building for the Faculty of Science and Engineering. This building is located at 205 Culloden Road, Macquarie Park.

Receiver 3: Located to the south and south-west of the project site is located the Royal Institute for Def and Blind Children Centre of Excellence. This development is located at 2 Gymnasium Road, Macquarie Park.

Maps outlining the site location and nearest surrounding receivers as well as attended measurement positions have been provided in the below figures

Figure 1: Site Map, Measurment Location and Surrounding Receivers



2 EXISTINIG ACOUSTIC ENVIRONMENT

Measurements of the existing background noise levels have ben previously conducted by ARUP as part of their Noise and Vibration Impact Assessment submitted as part of the SSD Application, report reference *289887-00 AC01, Issue8* (dated 6 July 2023). Information regarding the monitoring conducted by ARUP is provided below

Figure 2 - Extract from ARUP Noise and Vibration Impact Assessment

2. Existing acoustic environment

2.1 Assessment locations

The nearest most potentially affected off-site land uses surrounding the development have been identified in Figure 3. These receivers have been selected as they are considered to be the most noise-affected. It is anticipated that if the acoustic criteria is achieved at these locations, it follows that the criteria will be achieved at all other locations.

Residential receivers are listed in Table 2. The reasonably most-affected non-residential sensitive receivers are listed in Table 3.

Table 2: Reasonably most affected residential receivers

Receiver ID	Address	No. of floors	Approximate distance to site [m]
R1	146-150 Culloden Rd, Marsfield NSW 2122	1	56
R2	122 Culloden Rd, Marsfield NSW 2122	1	126

Table 3: Reasonably most affected non-residential sensitive receivers

Receiver ID	Name	Address	No. of floors	Approximate distance to site [m]
Commercial				
C1	MU Sport and Aquatic Centre	10 Gymnasium Rd, North Ryde NSW 2109	1	132
C2	Lighthouse Theatre	11 Gymnasium Rd, Macquarie Park NSW 2109	1	187
Educational Facilities				
E1	MU Bioscience Building	205B Culloden Rd, Macquarie University NSW 2109	2	66
E2	MU Observatory	5 Gymnasium Rd, Macquarie Park NSW 2113	1	25
E3	Royal Institute for Deaf and Blind Children (Under construction)	105 Culloden Road and Talavera Road, Macquarie Park NSW 2113	2	82
Active Recreation Area				
AR1	Royal Institute for Deaf and Blind Children – external play area (Under construction)	105 Culloden Road and Talavera Road, Macquarie Park NSW 2113	2	100

Figure 3 - Extract from ARUP Noise and Vibration Impact Assessment (Cont.)

2.2 Noise levels

A noise survey has been conducted to establish criteria for the assessment of operational and construction noise from the RNA Pilot Research & Manufacturing Facility as well as to establish the levels of environmental noise the site is exposed to.

A summary of short-term and long-term measurements are illustrated in Figure 4.

2.2.1 Long term noise monitoring

Noise data has been sourced from the noise monitoring results presented in the "*SSD 8755 Acoustic Report for Modification Application*," prepared by Arup for the Macquarie University Central Courtyard Redevelopment on May 2020 [5]. The noise monitoring was undertaken from 2 March 2020 to 16 March 2020.

Although there has been development in the surrounding area it is not envisioned that the external noise environment has been significantly changed, and would not have decreased since measurements were conducted, resulting in potentially slightly conservative criteria. Therefore, Arup considers it reasonable to use this data to derive acoustic criteria for the development.

It is noted that the noise logger was located within the Macquarie University premises but is considered to be representative of the existing noise environment at the worst-affected receivers as no operational noise was observed from site and noise was dominated by traffic noise from Culloden Road and the nearby M1 motorway.

The long-term noise monitoring methodology and noise level graphs are included in Appendix B.

Table 4 presents the overall single Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period, determined in accordance with the NPfI [3].

Table 4: Long-term noise monitoring results

Location	Time period[1]	Rating background noise levels, dBL_{A90}	Ambient dB_{LAeq} noise levels
L1: Macquarie University Observatory	Day	47	61
	Evening	47	56
	Night	45	59

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
   As required by the NPfI, the external ambient noise levels presented are free-field noise levels. [i.e.. no façade reflection]

2.2.2 Short-term noise monitoring

Short-term measurement data for facility was sourced from the attended noise measurements section presented in the "*RIDBC Centre of Excellence Macquarie University Noise Impact Assessment*," prepared by White Noise Acoustics for the Macquarie University RIBDC Centre of Excellence on October 2020 [6]. The attended noise monitoring was undertaken on 3rd September 2020 at 3:30pm to 4:30pm.

Notwithstanding, an additional short-term measurement was undertaken by Arup on 16th November 2022 to ensure that existing noise levels have not significantly changed. Results indicate that noise levels are comparable to previous measurements and are still appropriate for use in this project.

A summary of the results is presented in Table 5.

Figure 4 - Extract from ARUP Noise and Vibration Impact Assessment (Cont.)

Table 5: Short term monitoring results

Measurement Location	Date and Time	Measured Noise Level (dBA)		Comments
		L_{A90} (15-min)[1]	L_{Aeq} (15min)[2]	
S1: Culloden Road	3 September 2020 at 3:30pm to 3:45pm	46	66	Noise level at the site dominated by vehicle movements on surrounding roadways
S2: Gymnasium Road	3 September 2020 at 3:50pm to 4:05pm	43	62	
S3: Macquarie University Observatory	16 November 2022 at 1:41pm to 2:07pm	48	53	Noise level at the site dominated by traffic noise from Culloden Road and Talavera Road/M1 Motorway. Windy conditions. No mechanical plant/operational noise noted on site.

Note

1. The L_{A90} noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.
2. The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Figure 5 - Extract from ARUP Noise and Vibration Impact Assessment (Cont.)

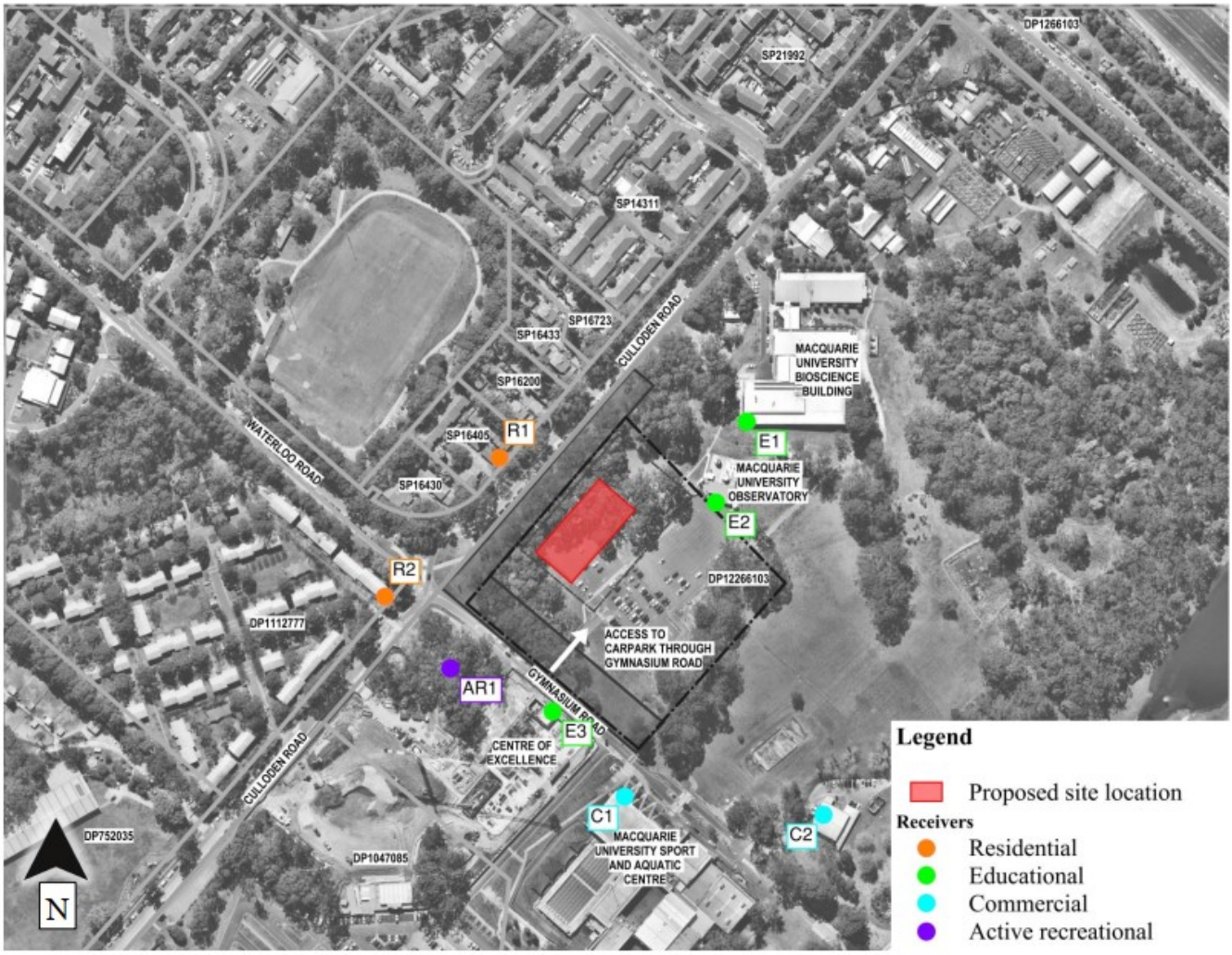


Figure 3: Worst affected noise sensitive receiver locations

Figure 6 - Extract from ARUP Noise and Vibration Impact Assessment (Cont.)

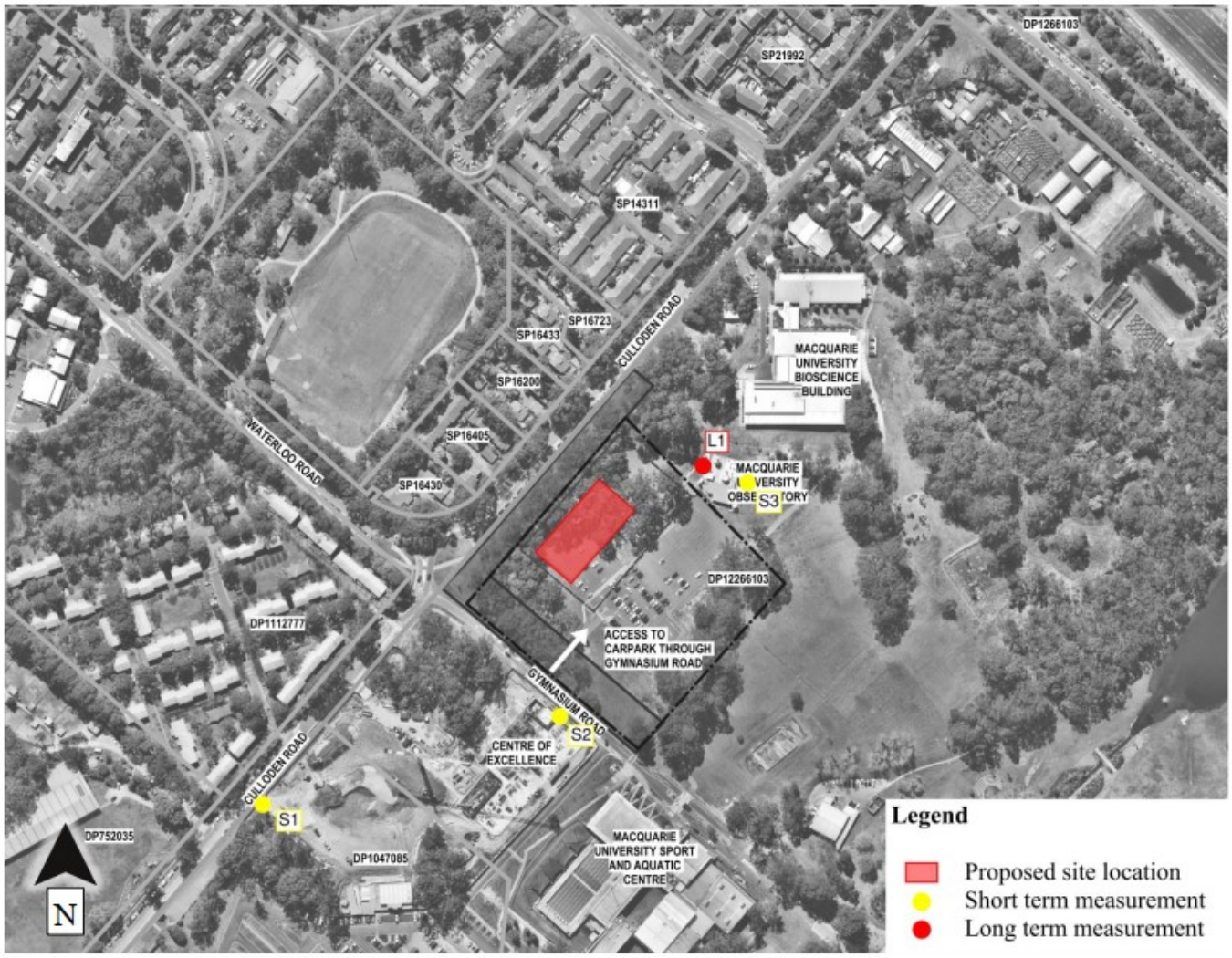


Figure 4: Short-term and long-term measurement location

3 NOISE AND VIBRATION CRITERIA

Relevant noise and vibration criteria for construction activities are detailed below.

3.1 SSD Approval (SSD-51811548) Planning Conditions

Relevant conditions of the consent require the following in relation to construction noise and vibration impacts from the site.

Condition B16 – Construction Environmental Management Plan

The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to the following:

a) Be prepared by a suitably qualified and experienced noise expert;

b) Describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);

c) Describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;

d) Include strategies that have been developed with the community for managing high noise generating works

e) Describe the community consultation undertaken to develop the strategies in condition B16(d);

f) Include a complaints management system that would be implemented for the duration of the construction; and

g) Include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the management measures in accordance with Condition B13(d).

Condition C4, C5, C6, C7 & C8 – Construction Hours

C4 Construction, including the delivery of materials to and from the site, may only be carried out between the following hours:

h) a) between 7am and 6pm, Mondays to Fridays inclusive; and

i) b) between 8am and 1pm, Saturdays.

No work may be carried out on Sundays or public holidays.

C5. Notwithstanding condition C4, provided noise levels do not exceed the existing background noise level plus 5dB, works may also be undertaken during the following hours:

a) between 6pm and 7pm, Mondays to Fridays inclusive; and

b) between 1pm and 4pm, Saturdays.

Condition C6 – Construction Hours

C6. Construction activities may be undertaken outside of the hours in condition C4 and C5 if required:

a) by the Police or a public authority for the delivery of vehicles, plant or materials; or

b) in an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or

c) where the works are inaudible at the nearest sensitive receivers; or

d) for the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or

e) where a variation is approved in advance in writing by the Planning Secretary if appropriate justification is provided for the works.

Condition C7 – Construction Hours

C7. Notification of such construction activities as referenced in condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

Condition C8 – Construction Hours

C8. Rock breaking, rock hammering, sheet piling, pile driving, and similar activities may only be carried out between the following hours:

a) 9am to 12pm, Monday to Friday;

b) 2pm to 5pm Monday to Friday; and

c) 9am to 12pm, Saturday.

Condition C13 – Construction Noise Limits

C13. The development must be constructed to achieve the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures must be implemented and any activities that could exceed the construction noise management levels must be identified and managed in accordance with the management and mitigation measures identified in the approved Construction Noise and Vibration Management Plan.

Condition C14 – Construction Noise Limits

C14. The Applicant must ensure construction vehicles (including concrete agitator trucks but excluding site personnel vehicles) do not arrive at the site or surrounding residential precincts outside of the construction hours of work outlined under condition C4 and C5.

Condition C15 – Construction Noise Limits

C15. The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, the use of 'quackers' to ensure noise impacts on surrounding noise sensitive receivers are minimised.

Condition C16 – Construction Vibration Limits

C16. Vibration caused by construction at any residence or structure outside the site must be limited to:

a) for structural damage, the latest version of DIN 4150-3 (1992-02) Structural vibration - Effects of vibration on structures (German Institute for Standardisation, 1999); and

b) for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: a technical guideline (DEC, 2006) (as may be updated or replaced from time to time).

Condition C17 – Construction Vibration Limits

C17. Vibratory compactors must not be used closer than 30 metres from residential buildings unless vibration monitoring confirms compliance with the vibration criteria specified in condition C16.

Condition C18 – Construction Vibration Limits

C18. The limits in conditions C16 and C17 apply unless otherwise outlined in a Construction Noise and Vibration Management Plan, approved as part of the CEMP required by condition B15 of this consent.

3.2 Construction Noise Criteria

3.2.1 NSW EPA Interim Construction Noise Guideline (ICNG) – DECC 2009

Noise criteria for construction and demolition activities are discussed in the Interim Construction Noise Guideline (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in the table below.

Table 2 NMLs for quantitative assessment at residences

Time of Day	Noise Management Level $L_{Aeq(15minute)}$[1,2]	How to Apply
Recommended standard hours: **Approved Hours of Construction as outlined in the conditions of consent**	"Noise Affected Level" RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15minute)}$ 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 Level" 75 dBA	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: 1. 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. 2. 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 + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

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.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Noise Policy for Industry (EPA 2017).

Note 3 Requirements listed in the table above are in accordance with the Construction Hours listed in Condition C4.

Construction noise levels at other noise receivers are outlined below:

- Construction noise levels within classrooms at schools and other educational institutions is not to exceed 45dB $L_{Aeq,15minute}$, when measured internally.

Based on the measured background noise levels summarised in section 2 and the NMLs outlined above the construction noise criteria to be used in this assessment are listed above.

Table 3 NMLs as basis for the acoustic assessment

Receiver Types		NML, dB $L_{Aeq(15minute)}$
		Standard Hours **Monday to Friday: 7:00am to 6:00pm** **Saturday: 8:00am to 1:00pm**
Residential Receiver	Receiver 1	NAFL: 57+10= 67 HNAL: **75**
Residential Receiver	Receiver 2	NAFL: 57+10=67 HNAL: **75**
University Building	Receiver 3	Noise Management Level: Internal Noise Levels (When in use) 45 dB(A)
Educational Facility Next Sense School	Receiver 4	Noise Management Level: Internal Noise Levels (When in use) 45 dB(A)

3.2.2 Construction Traffic Noise Criteria

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

3.3 Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed. Refer to further discussion in Section 3.3.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 3.3.2.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 3.3.2.

3.3.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled "Assessing Vibration – A Technical Guideline". (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (refer to Table 4).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 5).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 6)

Table 4 Continuous vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
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
		0.04	0.029	0.080	0.058

Table 5 Impulsive vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
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

Table 6 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
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

3.3.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration" (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

3.3.2.1 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 7 and illustrated in Figure 7.

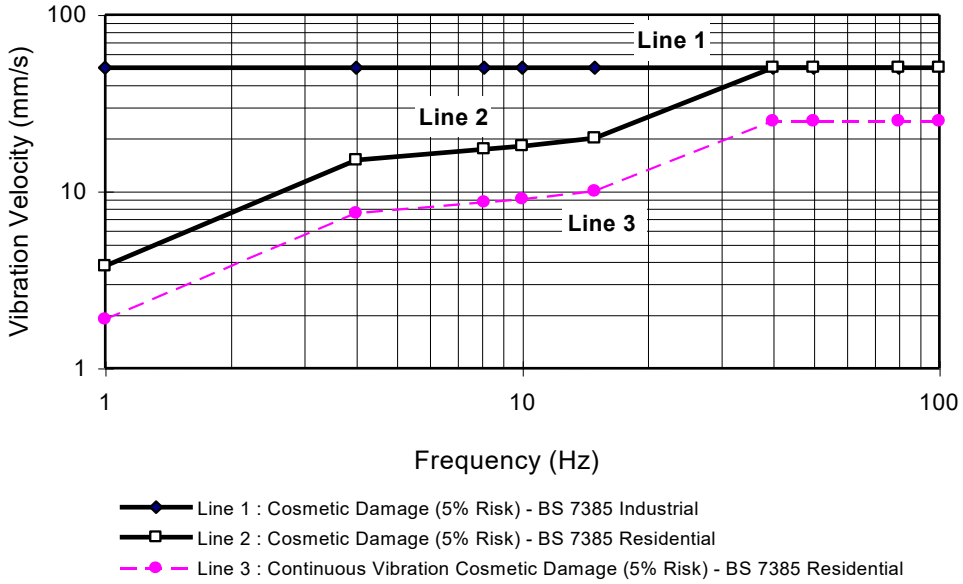
Table 7 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 7	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in Table 7 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 7 may need to be reduced by up to 50% (refer to Line 3 in Figure 7).

Figure 7 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 7, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 7 should not be reduced for fatigue considerations.

3.3.2.2 Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 8. The criteria are frequency dependent and specific to particular categories of structures.

Table 8 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz1	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
Note 4 For frequencies above 100Hz, at least the values specified in this column shall be applied.				

3.4 Ground-Borne Noise Criteria

According to the NSW EPA Interim Construction Noise Guideline (ICNG) 2009, the criteria for ground-borne noise at residences is defined as follows:

- Maximum internal noise levels of 40 dB $L_{Aeq(15mins)}$ between 6:00pm and 10:00pm.

It is noted that the ground borne criteria will apply for construction works undertaken outside of standard hours.

4 NOISE AND VIBRATION ASSESSMENT

4.1 Construction Noise Assessment

Sound power levels have been predicted for the construction tasks identified in the project program. The equipment anticipated for use in each task is based on previous project experience. The sound power levels for the equipment likely to be used for each of the listed tasks are provided in Table 9 below.

Table 9 Summary of predicted sound power levels

Tasks	Equipment	Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Site Establishment Works	Mobile crane	110	113
	Power hand tools	109	
	Semi Rigid Vehicle [1]	105	
Ground Works and Demolition	Excavator	112	118
	Handheld jack hammer [1]	111	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Skid steer	110	
	Power hand tools	109	
Structure	Handheld jack hammer [1]	106	117
	Concrete saw [1]	114	
	Power hand tools	109	
	Welder	101	
	Concrete pump truck	110	
	Concrete agitator truck	108	
Internal Works	Power hand tools	109	109
Common and External Works	Concrete agitator truck	108	117
	Saw cutter [1]	104	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Power hand tools	109	

Note 5 An assumed time correction has been applied, this being 5 minutes of operation in any 15-minute interval.

Table 10 Receiver 1 – Summary of predicted construction noise levels during Standard Hours (BG + 10dBA)

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	55 – 62	58 – 65	Monday to Friday: 7:00am to 6:00pm: 67 Saturday: 8:00am to 1:00pm: 67 Highly Noise Affected Level (Standard Construction Hours): 75	Works undertaken near the site boundary will exceed the BG +10dBA requirement and in some cases the Highly Noise Affected Level of 75dBA for noisy plant items such as hydraulic hammering. It is recommended that several acoustic mitigation measures are implemented. Refer to following sections below.
	Power hand tools		54 – 61			
	Semi Rigid Vehicle		50 – 57			
Ground Works and Demolition	Excavator	118	57 – 64	63 – 70		
	Handheld jack hammer		51 – 58			
	Dump truck		49 – 56			
	Concrete saw		59 – 66			
	Skid steer		55 – 62			
	Power hand tools		55 – 62			
Structure	Handheld jack hammer	117	51 – 58	62 – 69		
	Concrete saw		59 – 66			
	Power hand tools		54 – 61			
	Welder		46 – 53			
	Concrete pump truck		54 – 61			
	Concrete agitator truck		53 – 60			
Internal Works	Power hand tools	109	54 – 61	54 – 61		
Common and External Works	Concrete agitator truck	117	46 – 53	57 - 65		
	Saw cutter		49 – 56			
	Dump truck		49 – 56			
	Concrete saw		50 – 57			
	Power hand tools		54 - 61			

Table 11 Receiver 2 – Summary of predicted construction noise levels during Standard Hours (BG + 10dBA)

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	57 – 67	61 – 70	Monday to Friday: 7:00am to 6:00pm: 67 Saturday: 8:00am to 1:00pm: 67 Highly Noise Affected Level (Standard Construction Hours): 75	Works undertaken near the site boundary will exceed the BG +10dBA requirement and in some cases the Highly Noise Affected Level of 75dBA for noisy plant items such as hydraulic hammering. It is recommended that several acoustic mitigation measures are implemented. Refer to following sections below.
	Power hand tools		56 – 66			
	Semi Rigid Vehicle		53 – 62			
Ground Works and Demolition	Excavator	118	59 – 69	66 – 75		
	Handheld jack hammer		54 – 63			
	Dump truck		52 – 61			
	Concrete saw		62 – 71			
	Skid steer		57 – 67			
	Power hand tools		57 – 67			
Structure	Handheld jack hammer	117	54 – 63	65 – 74		
	Concrete saw		62 – 71			
	Power hand tools		56 – 66			
	Welder		48 – 58			
	Concrete pump truck		56 – 66			
	Concrete agitator truck		55 – 65			
Internal Works	Power hand tools	109	56 – 66	56 – 66		
Common and External Works	Concrete agitator truck	117	48 – 58	60 – 69		
	Saw cutter		52 – 61			
	Dump truck		52 – 61			
	Concrete saw		53 – 62			
	Power hand tools		56 - 66			

Table 12 Receiver 3 – Summary of predicted construction noise levels during Standard Hours

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	61 – 82	64 – 85	(When in Use) Internal Noise level 45	Affected Level of 75dBA for noisy plant items such as hydraulic hammering. It is recommended that several acoustic mitigation measures are implemented. Refer to the following sections below.
	Power hand tools		60 – 81			
	Semi Rigid Vehicle		56 – 77			
Ground Works and Demolition	Excavator	118	63 – 84	70 – 90		
	Handheld jack hammer		57 – 78			
	Dump truck		55 – 76			
	Concrete saw		65 – 86			
	Skid steer		61 – 82			
	Power hand tools		61 – 82			
Structure	Handheld jack hammer	117	57 – 78	69 – 89		
	Concrete saw		65 – 86			
	Power hand tools		60 – 81			
	Welder		52 – 73			
	Concrete pump truck		60 – 81			
	Concrete agitator truck		59 – 80			
Internal Works	Power hand tools	109	60 – 81	60 – 81		
Common and External Works	Concrete agitator truck	117	52 – 73	64 - 85		
	Saw cutter		55 – 76			
	Dump truck		55 – 76			
	Concrete saw		56 – 77			
	Power hand tools		60 – 81			

Table 13 Receiver 4 – Summary of predicted construction noise levels during Standard Hours

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	57 – 65	61 – 68	(When in Use) Internal Noise level 45	Requirement and in some cases the Highly Noise Affected Level of 75dBA for noisy plant items such as hydraulic hammering. It is recommended that several acoustic mitigation measures are implemented. Refer to the following sections below.
	Power hand tools		56 – 64			
	Semi Rigid Vehicle		53 – 60			
Ground Works and Demolition	Excavator	118	59 – 67	66 – 73		
	Handheld jack hammer		54 – 61			
	Dump truck		52 – 59			
	Concrete saw		62 - 69			
	Skid steer		57 – 65			
	Power hand tools		57 – 65			
Structure	Handheld jack hammer	117	54 – 61	65 – 72		
	Concrete saw		62 – 69			
	Power hand tools		56 – 64			
	Welder		48 – 56			
	Concrete pump truck		56 – 64			
	Concrete agitator truck		55 – 64			
Internal Works	Power hand tools	109	56 – 64	56 – 64		
Common and External Works	Concrete agitator truck	117	48 – 56	60 - 68		
	Saw cutter		52 – 59			
	Dump truck		52 – 59			
	Concrete saw		53 – 60			
	Power hand tools		56 – 64			

5 NOISE AND VIBRATION MANAGEMENT PLAN

5.1 Acoustic Management Procedures

5.1.1 Summary of Management Procedures

Table 14 below summarises the management procedures recommended for airborne noise and vibration impacts. These procedures are also further discussed in the report. Hence, where applicable, links to further references are provided in Table 14.

Table 14 Summary of mitigation procedures

Procedure	Abbreviation	Description	Further Reference
General Management Measures	GMM	Introduce best-practice general mitigation measures in the workplace which are aimed at reducing the acoustic impact onto the nearest affected receivers.	Refer to Section 5.5 For noise impact, also refer to Section 5.2 For vibration impact, also refer to Section 5.3
Project Notification	PN	Issue project updates to stakeholders, discussing overviews of current and upcoming works. Advanced warning of potential disruptions can be included. Content and length to be determined on a project-by-project basis.	Refer to Section 5.4
Verification Monitoring	V	Monitoring to comprise attended or unattended acoustic surveys. The purpose of the monitoring is to confirm measured levels are consistent with the predictions in the acoustic assessment, and to verify that the mitigation procedures are appropriate for the affected receivers. If the measured levels are higher than those predicted, then the measures will need to be reviewed and the management plan will need to be amended.	For noise impact, refer to Section 5.2 and Section 5.2.3. For vibration impact, refer to Section 5.3
Complaints Management System	CMS	Refer to Complaint Management System	Refer to Section 5.4
Specific Notification	SN	Refer to Complaint Management System	Refer to Section 5.4
Respite Offer	RO	Offer provided to stakeholders subjected to an ongoing impact.	Refer to Section 5.2.1
Alternative Construction Methodology	AC	Contractor to consider alternative construction options that achieve compliance with relevant criteria. Alternative option to be determined on a case-by-case basis. It is recommended that the selection of the alternative option should also be determined by considering the assessment of on-site measurements (refer to Verification Monitoring above).	Refer to Section 5.5.1 and 5.5.2

The application of these procedures is in relation to the exceedances over the relevant criteria. For airborne noise, the criteria are based on NMLs. The allocation of these procedures is discussed in Section 5.1.2

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The application of these procedures is discussed in Section 5.1.3.

5.1.2 Allocation of Noise Management Procedures

For residences, the management procedures have been allocated based on noise level exceedances at the affected properties, which occur over the designated NMLs (refer to Section 3). The allocation of these procedures is summarised in Table 15 below.

Table 15 Allocation of noise management procedures – residential receivers

Construction Hours	Exceedance over NML (dB)	Management Procedures (see definition above)
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	0 - 10	GMM
	> 10	GMM, PN, V [1], CMS, SN, AC
	≥ 75dBA	GMM, PN, V [1], CMS, SN, AC, RO
Note 6 Verification monitoring to be only undertaken upon complaints received from affected receivers		

Please note the following regarding the allocation of these procedures:

- The exceedances have been estimated as part of the acoustic assessment, and these are summarised in Section 4.1
- The allocation of procedures is based on the assumptions used for noise level predictions (refer to Section 4.1). Consequently, these allocations can be further refined once onsite works are undertaken and further development of the construction program.
- For non-residential receivers (such as educational), management measures are provided in Section 5.2.3.

5.1.3 Allocation of Vibration Management Procedures

Table 16 below summarises the vibration management procedures to be adopted based on exceedance scenarios (i.e., whether the exceedance occurs over human comfort criteria, building damage criteria, or criteria for scientific and medical equipment). Please note these management procedures apply for any type of affected receiver (i.e., for residences as well as non-residential receivers).

Table 16 Allocation of vibration management procedures

Construction Hours	Exceedance Scenario	Management Procedures
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	Over human comfort criteria (refer to Section 3)	GMM, PN, V, RO
	Over building damage criteria (refer to Section 3)	GMM, V, AC, RO

5.2 Site Specific Noise Mitigation Measures

5.2.1 Respite Periods

Predicted noise levels outlined in Section 4.1 indicate that in some cases when works are being undertaken within proximity of receiver boundaries, exceedances above the Noise Management Levels (NMLs) may occur. In addition, in accordance with Condition C8 respite periods are recommended for noisy activities. As such, the following respite conditions are recommended in accordance with Condition C8 or when works extended periods of noisy works are affecting a surrounding receiver above the HNAL of 75dBA. See below.

Table 17 Recommended Respite Periods

Monday to Friday	Saturday
7:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	**8:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)**
9:00am to 12:00pm – C8 listed works permitted.	9:00am to 12:00pm – C8 listed works permitted.
12:00pm to 2:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	**12:00pm to 1:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)**
2:00pm to 5:00pm – C8 listed works permitted.	
5:00pm to 6:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	

Note: Recommended respite periods for noisy works has been formulated in accordance with Condition C8 from the Notice of Determination – Approval.

5.2.2 General Comments

The contractor will, where reasonable and feasible, apply best practice noise mitigation measures. These measures shall include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

In order to minimise noise impacts during the works, the contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

5.2.3 Noise Mitigation Measures for Non-Residential Receivers

Where exceedances have been identified in Section 4, the following mitigation measures are recommended:

- Undertake general mitigation measures as discussed in Section 5.5.
- Issue project updates to tenants in affected premises. The updates can include overview of current and upcoming works, as well as advanced warning of potential disruptions.
- Signage to be posted in order to provide stakeholders information regarding project details, emergency contacts and enquiry contact information.

5.2.4 Alternate Equipment or Process

Exceedance of the site's NMLs should result in an investigation as to whether alternate equipment could be used, or a difference process could be undertaken.

In some cases, the investigation may conclude that the use of other equipment is not possible, however, a different process could be undertaken.

5.2.5 Acoustic Enclosures/Screening

Typically, on a construction site there are three different types of plant that will be used: mobile plant (i.e., excavators, skid steers, etc.), semi mobile plant (i.e., hand tools generally) or static plant (i.e., diesel generators).

For plant items which are static it is recommended that, in the event exceedances are being measured due to operation of the plant item, an acoustic enclosure/screen is constructed to reduce impacts. These systems can be constructed from Fibre Cement (FC) sheeting or, if airflow is required, acoustic attenuators or louvres.

For semi mobile plant, relocation of plant should be investigated to either be operated in an enclosed space or at locations away from a receiver.

With mobile plant it is generally not possible to treat these sources. However, investigations into the machine itself may result in a reduction of noise (i.e., mufflers/attenuators etc).

5.3 Vibration Mitigation Measures

5.3.1 General Comments

As part of the CNVMSP, the following vibration mitigation measures should be implemented:

- Any vibration generating plant and equipment is to be in areas within the site in order to lower the vibration impacts (where feasible).
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of construction plant and equipment; that is, smaller capacity plant, where feasible
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Schedule a minimum respite period in accordance with Condition 8.
- Use only dampened rock breakers and/or "city" rock breakers to minimise the impacts associated with rock breaking works.

5.4 Contingency Plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most construction noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

5.5 General Mitigation Measures (Australia Standard 2436-2010)

As well as the above project specific noise mitigation controls, AS 2436-2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites" sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below, including the typical noise reduction achieved, where applicable.

5.5.1 Adoption of Universal Work Practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevating work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

5.5.2 Plant and Equipment

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics, where feasible.
- Operating plant and equipment in the quietest and most efficient manner.

5.5.3 On Site Noise Mitigation

- Maximising the distance between noise activities and noise sensitive land uses.
- Installing purpose-built noise barriers, acoustic sheds and enclosures around static plant.

5.5.4 Work Scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
- Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

5.5.5 Source Noise Control Strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. In order to minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

5.5.6 Miscellaneous Comments

- Deliveries should be undertaken, where possible, during standard construction hours.
- Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles at site and monitor the profiles in use.
- The use of "quackers" will be used to ensure noise impacts on surrounding noise sensitive receivers are minimised. This will not be implemented where it is deemed the use of quackers (as opposed to standard vehicle notification devices) would compromise the safety of construction staff or members of the public.
- No public address system should be used on site (except for emergency purposes).

6 CONCLUSION

Pulse White Noise Acoustics (PWNA) has been engaged by Hindmarsh Construction Pty Ltd to prepare a site-specific Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of the construction of the RNA Pilot Research and Manufacturing Facility. The site is located at the corner of Gymnasium Road and Culloden Road, approximately 13km from the Sydney CBD – 16 Herring Road, Macquarie Park

This CNVMSP has been prepared to satisfy the requirements of B16 of the consent conditions presented to this office given in the Notice of determination – Approval issued for Development Application Number SSD-51811548.

An assessment of noise and vibration impacts from the required processes to be undertaken during the construction period of the project (including excavation and construction) has been undertaken and suitable treatments, management controls, periodic measurements and community engagement has been detailed in this report.

Providing the recommendations in this report are included in the construction of the site, compliance with the relevant EPA's Interim Construction Noise Guideline Objectives and Condition B16 of the projects Conditions of Consent can be achieved.

For any additional information please do not hesitate to contact the undersigned.

Kind regards,

George Kinezos
Acoustic Engineer
Pulse White Nosie Acoustics

APPENDIX A. ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report:

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
LMax	The maximum sound pressure level measured over a given period.
LMin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
dB (A)	'A' Weighted overall sound pressure level
Sound Pressure Level, LP dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.

Sound Power Level, Lw dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt

APPENDIX B. AUSTRALIAN ACOUSTICAL SOCIETY MEMBERSHIP