8-12 University Avenue, Macquarie University

DA Stage Acoustic Assessment (Main Works)

SYDNEY
A: 9 Sarah St Mascot NSW 2020
T: (02) 8339 8000
F: (02) 8338 8399

SYDNEY MELBOURNE BRISBANE CANBERRA
LONDON DUBAI SINGAPORE GREECE

www.acousticlogic.com.au
ABN: 11 068 954 343

DOCUMENT CONTROL REGISTER

Project Number	20161608.2
Project Name	8-12 University Ave, Macquarie University (Main Works)
Document Title	DA Stage Acoustic Assessment
Document Reference	20161608.2/0205A/R0/TT
Issue Type	Email
Attention To	Cadence

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	5/02/2018	20161608.2/0205A/R0/TT	TT	TT	TT

TABLE OF CONTENTS

Executive Summary

Acoustic Logic Consultancy has been engaged by Macquarie University to undertake an assessment of operational and construction noise and vibration at the proposed development at 8-12 University Ave, Macquarie University.

Noise and vibration has been assessed with reference to relevant EPA guidelines for both operational and construction noise.

The scope of this report has been limited to development that is not owned by Macquarie University. Noise and vibration impacts on buildings that are University assets will be addressed through internal University management procedures.

With respect to excavation and construction noise:

- Analysis indicates that for the nearest development to the site which is not a part of the Macquarie University Campus (an Aged Care facility and apartment development, both approximately 150m south of the site) will generally comply with EPA construction noise and vibration impacts.

- Noise and vibration mitigation strategies to ensure that acoustic impacts are minimised are set out in section 7 of this report.

With respect to operational noise, analysis indicates that:

- Typical noise generating items will be from the use of the loading dock and from external mechanical plant.

- These items are in keeping with typical commercial development, and compliance with EPA operational noise requirements will be achievable through standard acoustic treatments such as in-duct lining, acoustic attenuators or (potentially) noise screens around noisy root top equipment items.

- While it is relatively unlikely that a noise screen would in fact be required to external plant, this would be determined following final equipment selections.

- Noise and vibration mitigation strategies to ensure that acoustic impacts are minimised are set out in section 7 of this report.

1 INRODUCTION

Acoustic Logic Consultancy has been engaged by Macquarie University to undertake an assessment of noise likely to be associated with the proposed development at 8-12 University Ave.

In this report, we will:

- Identify nearby noise sensitive receivers and anticipated operational noise sources with the potential to adversely impact nearby development.
- Identify relevant EPA acoustic criteria (noise and vibration) applicable to the development.
- Review noise emissions and assess them against acoustic criteria.
- If necessary, determine building and/or management controls necessary to ensure ongoing compliance with noise emission goals.

In addition, the report will include an in-principle review of construction noise and vibration.

The acoustic analysis in this report is limited to potential noise impacts on development in the vicinity of the site that is not owned by the University. Noise impacts on university buildings that are Macquarie University assets will be addressed through internal management procedures/agreements.

2 SITE DESCRIPTION AND PROPOSED WORKS

The site is located within the Macquarie University campus, between Macquarie Drive and University Avenue.

The proposed development consists of:

- Excavation of a three level basement car park.
- Construction of two buildings (6-7 storeys each) containing a mixture of office space, retail spaces and educational space.
- A pedestrian link/atrium separating the buildings.

This assessment does not include an early works phase that included site clearing, demolition or services diversion works.

The site is located within the University campus, and as such is bounded by other University buildings (Australian Hearing Hub, Cochlear, Macquarie University Library and English Language Centre, Gumnut Cottage Child Care Centre – see aerial photo below).

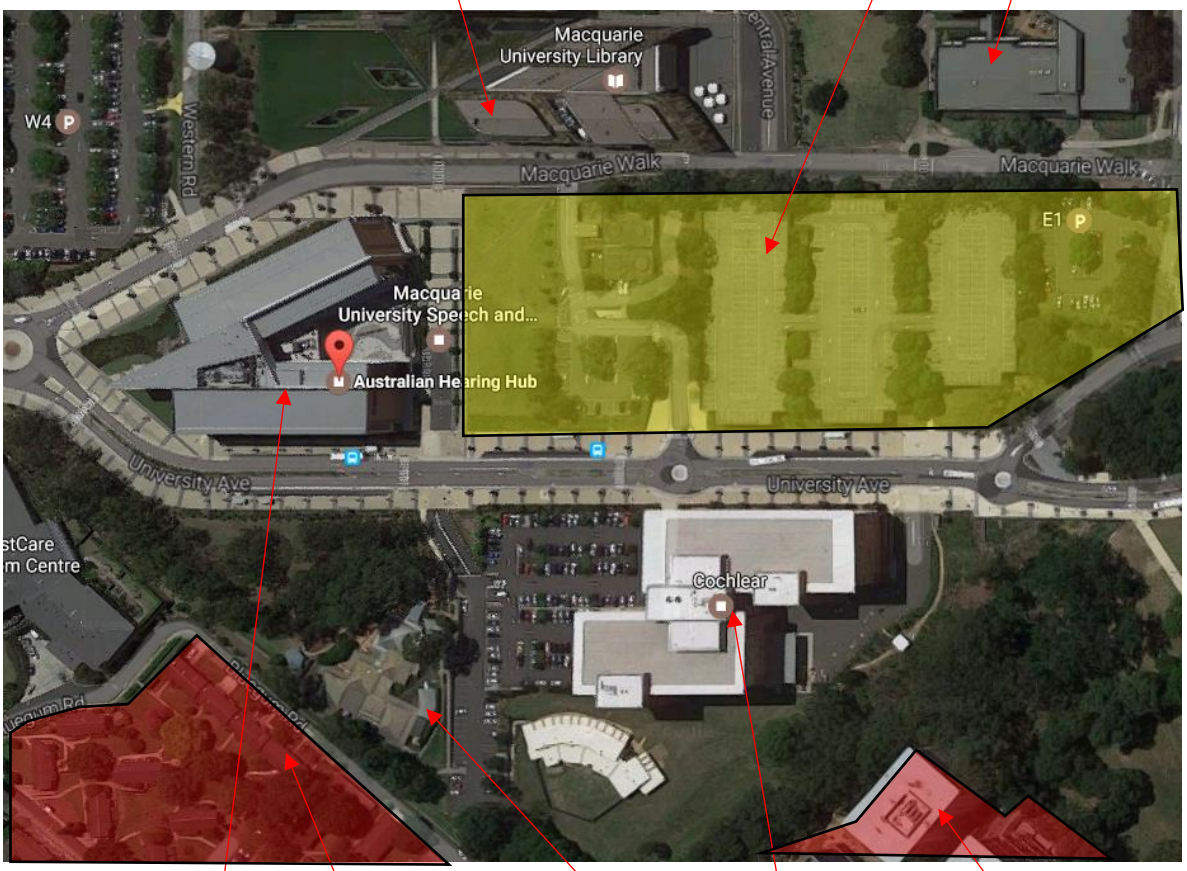
The nearest non-University development is marked in red, below, and consists of:

- Residential apartment development to the south and
- An Aged Care Facility to the south-west.

English Language Centre
(University Owned Building)

Macquarie University Library
(University Owned Building)

Site



Australian Hearing Hub
(University Owned Building)

Aged Care Facility

Gumnut Cottage Child Care Centre
(University Owned Building)

Cochlear (University
Owned Building)

Apartment
Development

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In analysing environmental noise, three-principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the 15 minute period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of environmental noise.

L_1 levels represent is the loudest 1% noise event during a measurement period.

4 SURVEY OF AMBIENT NOISE

Both long term unattended noise logging, and attended noise measurements were conducted to quantify the existing acoustic environmental at the site.

Equipment consisted of Acoustic Research Laboratories monitors set on A-weighted fast response mode. The monitors were calibrated before and after the measurements using a Rion Type NC-73 calibrator. No significant drift was recorded.

Measured noise levels (ambient and rating background noise level) are presented below.

Table 1 – Long Term Noise Logging Data

Location	Time of Day		
	Daytime (7am-6pm)	**Evening (7am-6pm)**	**Night (7am-6pm)**
University Ave	49dB(A)L_{90}	47dB(A)L_{90}	39dB(A)L_{90}

5 NOISE EMISSION CRITERIA

The following noise controls and guidelines are applicable to the site:

- EPA Industrial Noise Policy.
- EPA Road Noise Policy.
- EPA guidelines for sleep arousal (Application Notes to the Industrial Noise Policy)
- EPA Interim Construction Noise Guidelines and Assessing Vibration, A Technical Guideline.

5.1 EPA INDUSTRIAL NOISE POLICY

Noise sources covered by this code will include vehicle noise (generated on the site/loading docks) and mechanical services noise. Both the Intrusiveness and the Amenity criteria (as set out below) must be complied with.

Noise from traffic on public roads are subject to different acoustic criteria (detailed in Section 5.3 of this report).

5.1.1 INP - Intrusiveness Assessment

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels. The criteria are as follows:

Table 2 - EPA Intrusiveness Criteria

Location	Time of Day	Background noise Level - dB(A)L_{90}	Intrusiveness Noise Objective dB(A)$L_{eq(15min)}$ (Background + 5dB)
University Ave	Day Time (7am - 6pm)	49	54
	Evening (6pm - 10pm)	47	52
	Night (10pm - 7am)	39	44

5.1.2 INP - Amenity Assessment

The Amenity criteria set additional criteria based on the land use of the noise sensitive receivers.

Amenity criteria are as follows:

Table 3 -EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A)$L_{eq(Period)}$
Residential development/ Aged Care	Suburban	Day Time (7am – 6pm)	55
		Evening (6pm – 10pm)	45
		Night (10pm-7am)	40

5.2 SLEEP AROUSAL ASSESSMENT

Potential sleep arousal impacts should be considered for noise generated before 7am or after 10pm.

Short duration, intermittent noise events are typically assessed for potential sleep disturbance.

Potential impacts are assessed using the recommended procedure in the Application Notes to the EPA Industrial Noise Policy. As recommended in the Application Notes, when assessing potential sleep arousal impacts, a two stage test is carried out:

- Step 1 - An "emergence" test is first carried out. That is, the L_1 noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. If the noise events are within this, then sleep arousal impacts are unlikely and no further analysis is needed. This is consistent with the Noise Guide for Local Government. The guideline level is set out below.

Table 4 – Sleep Arousal (Emergence Criteria)

Location	Background Noise Level (5am-7am) dB(A)$_{L90}$	Emergence Level dB(A) $L_{1(1min)}$
Residential Apartments/Aged Care Facility	39	54

- Step 2 - If there are noise events that could exceed the emergence level, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night, existing noise sources, etc. This test takes into account the noise level and number of occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory notes of the EPA Industrial Noise Policy, this more detailed sleep arousal test is conducted using the guidelines in the EPA Road Noise Policy. Most relevantly, the Road Noise Policy states:

  For the research on sleep disturbance to date it can be concluded that:

  - *Maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep.*

- *One to two noise events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing significantly.*

The internal noise level guidelines have also been adopted in this assessment.

5.3 NOISE FROM INCREASED TRAFFIC GENERATION ON PUBLIC STREETS

For land use developments with the potential to create additional traffic on public streets the development should comply with the EPA Road Noise Policy.

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at a nearby property.

Table 5 - Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Arterial (Balaclava Road, Herring Road)	Day (7am to 10pm)	60 dB(A)$L_{eq(15hr)}$
	Night (10pm to 7am)	55 dB(A)$L_{eq(9hr)}$

However, if existing noise levels exceed those in the table above, section 3.4 of the Road Noise Policy is applicable, which states that an increase of less than 2dB(A) above existing levels is a minor impact and would be barely perceptible.

5.4 CONSTRUCTION NOISE AND VIBRATION IMPACTS

5.4.1 EPA Interim Construction Noise Guidelines

For residential development impacted by construction noise, EPA guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise effected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise effected level". For residential properties, the "noise effected" level occurs when construction noise exceeds ambient levels by more than:
    - 10dB(A)$L_{eq(15min)}$for work during standard construction hours (7am-6pm Monday to Friday and 8am to 1pm on Saturdays) and
    - 5dB(A)$L_{eq(15min)}$for work outside of standard construction hours.
- "*Highly noise affected level"*. Where noise emissions are such that nearby properties are "highly noise effected", noise controls such as respite periods should be considered. For residential properties, the "highly noise effected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

A summary of EPA recommended noise levels for both residential and other relevant land uses is presented below.

Table 6 – Construction Noise Emission Goals

Location	"Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Residential development/Aged Care	59 (Standard Construction Hours)	75

5.4.2 Construction Vibration

5.4.2.1 Building Damage - German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in table 1.

Table 7 - DIN 4150-3 (1999-02) Safe Limits for Building Vibration

CATEGORY	TYPE OF STRUCTURE	At Foundation at a Frequency of:			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Based on the building types in the vicinity of the site (the Hearing Hub, Cochlear and the University Library building) would be considered as Category 1 with respect to building damage sensitivity.

5.4.2.2 Amenity Impacts

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline.* These levels are presented below:

Table 8 – Construction Vibration Goals

Location	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Continuous Vibration			
Residences	Daytime	0.28	0.56
Impulsive Vibration			
Residences	Daytime	8.6	17

*Vibration impacts on Hearing Hub and Cochlear to be discussed in detail in section 6.5.

6 NOISE/VIBRATION EMISSION ASSESSMENT

An assessment of noise emissions is presented below. The following noise sources are assessed:

- Operational Noise:
    - Car park, vehicle and loading dock noise.
    - Mechanical plant noise
- Construction noise and vibration.

6.1 OPRERATIONAL NOISE

6.1.1 Noise from the Car Park

Noise generated within the basement car park will not be significant, and will be compliant with EPA guidelines at all nearby development.

6.1.2 Noise Generated by additional traffic on public roads

Noise created as a result an increase in traffic on public roads is assessed with reference to the EPA Road Noise Policy.

Primary access/egress to the site is via a driveways on University Ave and Macquarie Drive. These are both roads located within the University campus.

The first public road connections will be at Balaclava Road and Herring Roads. These are both arterial roads and the impact of noise from additional traffic generated by the site will be minimal (less than a 2dB(A) increase collared to existing levels).

6.1.3 Noise from Mechanical plant

Detailed acoustic design of mechanical plant cannot be undertaken at project approval stage, as plant selections and locations are not finalised. However, an indicative assessment of primary plant items is presented below.

Primary plant items will include:

- Cooling towers (assumed to be located on the roof).
- Air handling plant (air handling units, supply/exhaust/outside air fans), located within plant rooms.
- Chillers (located within plant rooms).

With respect to the above, we note:

- Cooling towers
    - In the event that a cooling tower sound power level exceeds 95dB(A), there is potentially an exceedance of Industrial Noise Policy (INP) noise emission requirements at the

residences and aged care facility to the south of the site if roof top cooling towers are not acoustically treated.

- To ensure compliance with INP requirements during day, evening and night time:
  - All cooling towers are to have variable speed drives, to allow for reduced fan speed during periods of low load. Typically, a fan speed of no more than 50% would be expected at night time (in the event they are operated at this time at all).
  - Acoustic screening around the cooling towers will potentially be required to eastern and southern edges of the plant area for 12 University Road, to ensure compliant noise levels at the residential apartments to the south. Alternatively, if the building shell acts as a barrier between the roof top plant and the top floor apartments, further acoustic treatment is not likely to be required.

- Chillers (assumed sound power of 102dB(A)).
  - Water cooled chillers should be located in plant rooms without any external ventilation opening/louvre.
  - Depending on equipment selection, light weight cladding to plant room walls and ceiling will potentially require internal plasterboard sheeting to ensure noise breakout through wall/roof are compliant with INP requirements. Final plant room building shell design to be conducted following final chiller section and plant room location.

- Fans and air-handling units.
  - Air handling units do not typically require extensive acoustic treatment to ensure compliant noise emissions at nearby properties.
  - Air handling unit exhaust and outside air ducting (both of which are typically ducted to outside) are to be acoustically reviewed following layout design by mechanical engineer/contractor to determine whether internal lining to this ductwork is required.
  - Major fans (typically with a sound power over 90(A) – such as kitchen exhaust, major toilet exhaust and major relief air fans) will require acoustic treatment if located externally. This treatment may include internal lining to any external ductwork. Potentially acoustic treatment of fan casing will also be required. Review of all external fans (including internal fans ducted to external locations) must be conducted once selected to ensure compliant noise emissions to external areas are achieved.

Cumulative assessment of both plant noise with other noise sources is recommended when conducting acoustic design of plant items.

Compliance with INP acoustic criteria as set out in Section 5.1 will be achievable, provided that detailed acoustic review of plant items is undertaken once plant is selected, and acoustic treatments similar to those outlined above are adopted.

6.1.4 Loading Docks (Deliveries and Waste Removal)

The loading dock is proposed to be located on the eastern façade of 12 University Ave.

Noise associated with the use of the loading docks will consist of:

- Trucks moving into or out of the loading dock (assume to be articulated/b-double trucks as a worst case).
- Materials Handling (forklift/pallet jack).

Noise generated on the proposed site is assessed with reference to the EPA Industrial Noise Policy. Noise emission predictions are made based on the following data/assumptions:

- Noise levels used in calculations:

Table 9 – Loading Dock Noise Source Data

Noise Source	Noise Level (sound power level)
Truck engine (articulated truck/garage truck at approx 5km/h)	105dB(A)L_{eq}
Materials Handling (pallet jacks or similar)	90dB(A)L_{eq}

- Relative position of noise source and noise receiver, taking into account distance attenuation and noise screening (where appropriate).

Operational noise levels are predicted and assessed against the INP criteria detailed in section 5.2. Noise from both manual handling in the loading dock, and the noise created by the truck as it enters/leaves the site are assessed.

Table 10 - Loading Dock – Noise Impact Assessment

Noise Source	Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Compliance
Truck manoeuvring to/from loading dock	Aged Care Facility	<35dB(A)$L_{eq(15min)}$	Complies – with day/evening/night criteria - tables 2 and 3.
	Residential Development (South of site)	<40dB(A)$L_{eq(15min)}$	Complies – with day/evening/night criteria - tables 2 and 3
Materials Handling (in loading dock)	Aged Care Facility	<35dB(A)$L_{eq(15min)}$	Complies – with day/evening/night criteria - tables 2 and 3
	Residential Development (South of site)	<40dB(A)$L_{eq(15min)}$	Complies – with day/evening/night criteria - tables 2 and 3

*Internal noise level, assuming windows to the centre are closed, standard 4mm glass.

Noise emissions from the loading dock are complaint with Industrial Noise Policy requirements.

6.1.5 Transient Noise Events (Sleep Arousal)

Noise events occurring between 10m and 7am should be assessed for potential sleep disturbance impacts on nearby residents.

Other than the operation of some mechanical plant (discussed above), the site will not typically be used at this time.

6.2 CONSTRUCTION NOISE

With respect to excavation or construction noise, the impacts on nearby development will be dependent on the activity in question and where on the site the activity is undertaken.

Use of bulk excavation equipment (hydraulic hammer, rock-saw) is the loudest activity likely to be associated with the proposed works.

6.2.1 Construction Noise Predictions

Predictions of excavation and construction noise are based the following:

- Assumed sound power of equipment items are follows
    - Dozer - hydraulic hammer/saw attachment (rock excavation): 120dB(A).
    - Rock Ripper (rock excavation): 110dB(A).
    - Dozer – bucket attachment (soil excavation): 105dB(A).
    - Concrete vibrator/slab finishing equipment: 105dB(A).
    - Powered hand tools: 100dB(A)

In the table below, a range of noise levels is predicted, being the noise level predicted when working on the property boundary nearest the noise effected property (worst case scenario) to the noise level when working at the far end of the site.

Table 11 – Excavation and Construction Noise Impact

Location	Target Noise Level (as per table 2)	Activity	Predicted Noise Level
Aged Care Facility (South of site)	59dB(A)L_{eq}	Hydraulic Hammer/Rock Saw Ripper Other equipment	60-65dB(A)L_{eq} 50-55dB(A)L_{eq} <50dB(A)L_{eq}
Residential Development (South of site)	59dB(A)L_{eq}	Hydraulic Hammer/Rock Saw Ripper Other equipment	60-65dB(A)L_{eq} 50-55dB(A)L_{eq} <50dB(A)L_{eq}

6.2.2 Construction Noise - Discussion

With respect to the above, we note:

- Aged care facility and apartment development south of site:
    - A small/moderate exceedance of the 59dB(A) Noise Management Level (as per table 2) is expected when using pneumatic hammers.
    - Given there is an exceedance of the Noise Management Level, EPA practice recommends that reasonable and feasible noise mitigation measures be investigated.
    - In this case, use of a excavator with bucket and roc rippers should be investigated if feasible. If this is found not to be feasible then use of a hammer would still be permitted. As the noise level is still expected to be below 75dB(A) (the EPA Highly Noise Effected Level", respite periods are not warranted.

6.3 CONSTRUCTION VIBRATION

Use of percussive equipment (hydraulic hammers) is the primary vibration generating activity during the demolition process.

Given the distance between the site and the Aged Care facility and residential apartments to the south of the site (more than 150m away), demolition vibration will not exceed with the building damage or human comfort guidelines set out in section 5.2 of this report, regardless of equipment selections and demolition methods.

7 RECOMMENDATIONS

We recommend the following acoustic treatments/management controls to ensure compliance with EPA noise emission guidelines:

- Before commencement of works (once equipment selections and duration of works is known, the main contractor should undertake a detailed construction noise and vibration management plan. Review of the mitigation techniques outlined in section 6 of this report should be done, and implemented where feasible. For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby development is made aware of the time and duration of noise intensive construction processes.

- Use of dozers with bucket and rock rippers should be investigated given they will have reduced noise and vibration impacts compared to hydraulic hammers.

- For at least the initial stages of excavation, vibration monitoring should be conducted to ensure excessive levels of vibration are not achieved. Any vibration monitoring system should allow for rapid feedback to the contractor (for example, SMS notification) in the event that excessive levels are reached.

- With respect to operational noise - Detailed acoustic review of all external plant items should be undertaken following equipment selection and duct layout design. Initial analysis (Section 6.1.3) indicates that with acoustic treatment, all plant items will be capable of meeting noise emission requirements. However this is likely to require:

    - Noise screening (using either a dedicated noise screen or the building shell) for roof top cooling towers.

    - Acoustic lining of external ducting for major external fans.

    - Upgrade of plant room wall/roof construction for any plant room housing generators or water cooled chiller plant.

    - Detailed acoustic review of external louvres for any plant room to determine whether acoustic louvres/attenuators are required.

8 CONCLUSION

Noise emissions associated with the proposed excavation and construction works at 8-12 University Ave have been assessed with reference to relevant EPA construction noise and vibration guidelines.

Noise and vibration impacts on nearby non-University owned development has been reviewed with respect to potential acoustic impacts.

Provided that the recommendations in section 7 of this report are adopted, noise and vibration impacts from the proposed Early Works will be generally compliant with EPA construction noise and vibration guidelines.

Please contact us if you have any queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Thomas Taylor