Redevelopment of UNSW Cliffbrook Campus
45-51 Beach Street, Coogee
State Significant Development Submission (SSD 8126)

Acoustic Report for the Redevelopment of UNSW Cliffbrook Campus
45-51 Beach Street, Coogee

www.jhaservices.com Ph: (02) 9437 1000
Sydney | Brisbane
Level 23, 101 Miller St, North Sydney NSW 2060

CONTENTS

Document Control Sheet

Title	Redevelopment of UNSW Cliffbrook Campus 45-51 Beach Street, Coogee
Project	State Significant Development Submission (SSD 8126)
Description	Acoustic Report for State Significant Development at 45 Beach St Coogee
Key Contact	CP

Prepared By

Company	JHA
Address	Level 23, 101 Miller Street, North Sydney NSW 2060
Phone	61-2-9437 1000
Email	@jhaengineers.com.au
Website	www.jhaservices.com
Author	JM
Checked	RO
Authorised	CP

Revision History

Issued To	Revision and Date								
Elizabeth Carpenter	**REV**	B							
FJMT Architects	**DATE**	08/05/17							

1. EXECUTIVE SUMMARY

JHA have been engaged by Francis-Jones Morehen Thorp Architects (FJMT) to prepare an environmental noise impact report for the State Significant Development of the proposed Cliffbrook Campus redevelopment, located at 45 Beach Street, Coogee 2034 NSW.

This report addresses the NSW Critical State Significant Infrastructure Standard Secretary's Environmental Assessment Requirements (SEARs) 2015, NCC Building Code of Australia 2016 and the NSW Environment Protection Authority (EPA) Industrial Noise Policy (INP) 2000 requirements pertaining to the environmental noise impact of the proposed development, in particular on the noise impact of the development at the nearest affected residences.

On-site noise measurements and long-term noise monitoring were conducted to quantify the existing acoustical conditions for the area to be developed and the noise criteria have been determined for the development to comply with current regulations and requirements.

Construction noise predictions have been developed using the following documents issued by the NSW EPA:

- Interim Construction Noise Guideline (2009)
- Assessing Vibration: A Technical Guideline (2006)

The predicted noise and vibration impact from construction work is quantified and presented, vibration and airborne noise generating sources are identified and potential noise impact on adjoining residences is detailed. Preventive measures and mitigation strategies are proposed to minimise construction noise from affecting the surrounding community.

This report also includes an assessment for the noise impact of the various activities within the proposed development on neighbouring properties including:

- Noise emissions from occupants and guests engaged in outdoor recreational activities
- Noise from mechanical plant, carpark and general property maintenance
- Noise from traffic entering and leaving the carpark
- Use of the premises outside of normal hours of operation.

2. PROJECT DESCRIPTION

2.1 Development Information

UNSW is undertaking a renewal of its Cliffbrook campus to create a bespoke residential and educational retreat.

- The proposed development is comprised of 3 buildings, one new building and two existing buildings (Building CC1 and Building CC3) to be refurbished.
- The new campus will primarily accommodate the UNSW Australian Graduate School of Management (AGSM) residential program. It will provide 50 participant bedrooms, 2 staff bedrooms, 1 on-site manager bedroom, supporting amenities and a customised suite of learning spaces.
- The design will be empathetic to the highly sensitive heritage fabric, adjacent environment, the unique outlook and neighbourhood amenity.
- A carefully selected team of consultants and experts have been tasked with the design and delivery of this unique facility.
- The new campus will align with the University's 2025 Strategy to establish UNSW as Australia's global university, providing world-class environments to deliver distinctive educational experience

The Cliffbrook retreat will predominantly cater for the AGSM's Masters of Business Administration (MBA) residential candidates and Executive Education short course residential candidates. The site will also be used for UNSW activities such as internal management courses and strategy retreats for the University's faculties and divisions.

The site is divided into two zones: an Educational Establishment Zone, and a Private Recreational Zone that forms part of a Foreshore Protection Area. Building development is permissible on the Educational Establishment Zone and smaller, sympathetic structures are permitted on the remainder of the site.

2.2 Site Description

The proposed development site is located at 45 Beach Street, Coogee 2034 NSW, at the corner of Beach Street and Battery Street.
This campus, with the historic Cliffbrook House, surrounding buildings and coastal reserve is an important part of Coogee's history.

Nearest affected receivers located at 1 & 2 Gordons Avenue and 10 Battery Street, Coogee are shown in Figure 1 below (Circled yellow). Figure 2 below shows the ground floor plan of the proposed development.

Figure 1 Aerial View of the Site with Existing Buildings, Nearest Affected Receiver Locations at Nos.1 & 2 Gordons Avenue and No.10 Battery Street

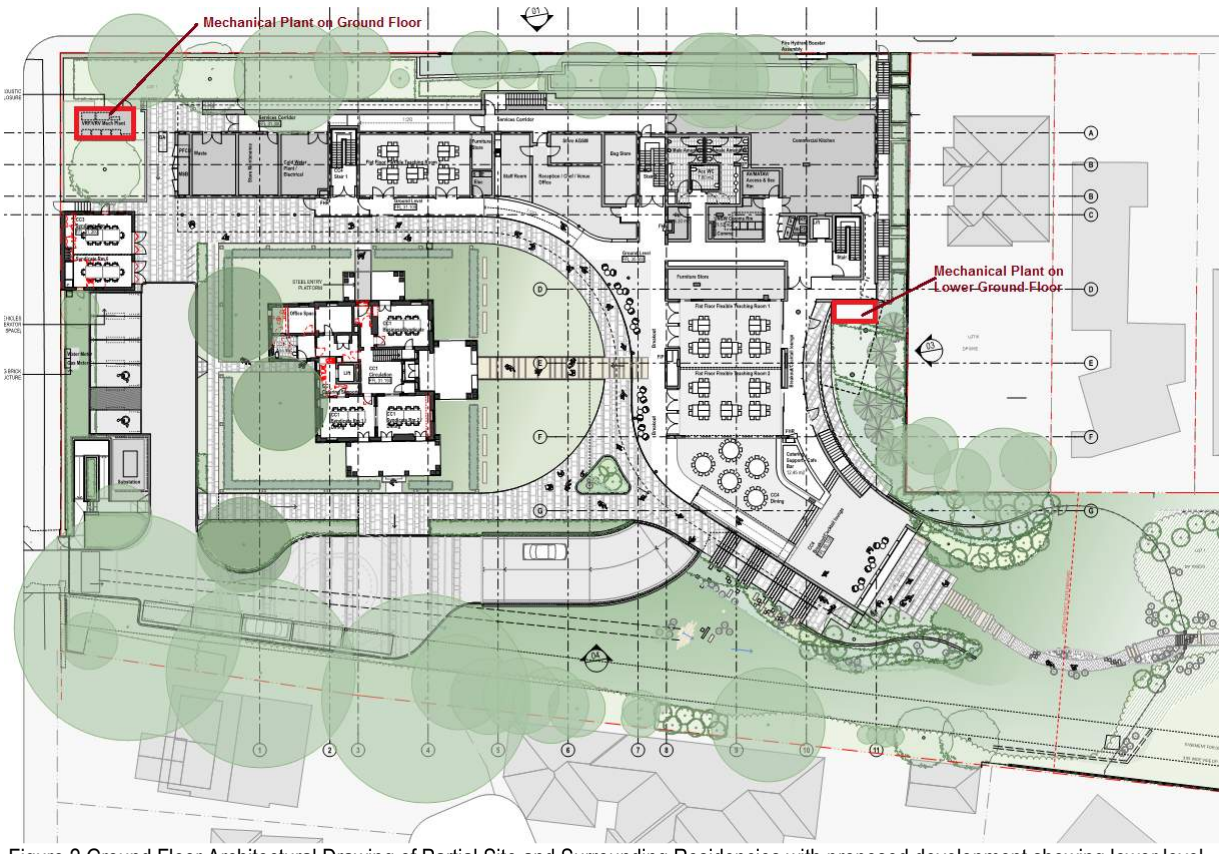


Figure 2 Ground Floor Architectural Drawing of Partial Site and Surrounding Residencies with proposed development showing lower level mechanical plant.

2.3 Land Zoning from Randwick LEP 2012

The site is partly zoned SP2 Infrastructure Educational Establishment and RE2 Private Recreation. Figure 3 below, extracted from Randwick Local Environment Plan (LEP) 2012. The property is surrounded by a mix of low and medium density residential, public and private recreational areas.

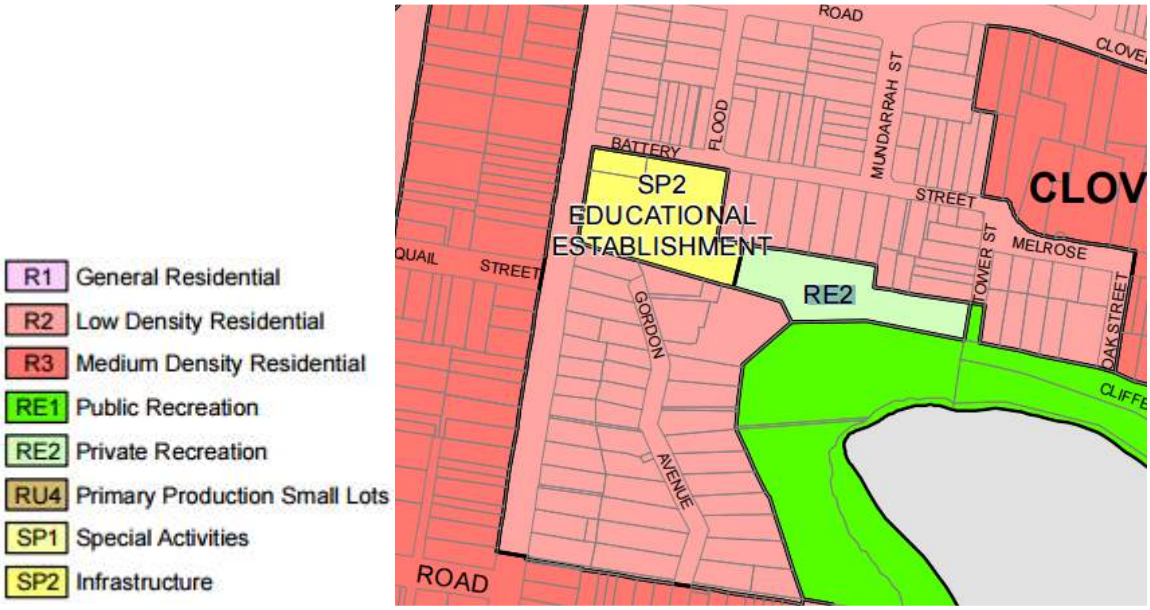


Figure 3 Randwick LEP 2012 Zoning Map

2.4 Aircraft Noise

The campus location is outside of the Australian Noise Exposure Forecast (ANEF) 2033 affected zones, as shown on the map below, and as such will not require aircraft noise assessment as per the current development requirements. However it should be noted that due to the close proximity of the proposed development location to the 20 ANEF contour, aircraft noise can potentially be heard when the east-west runway is in operation. This will be addressed in the design development phase.

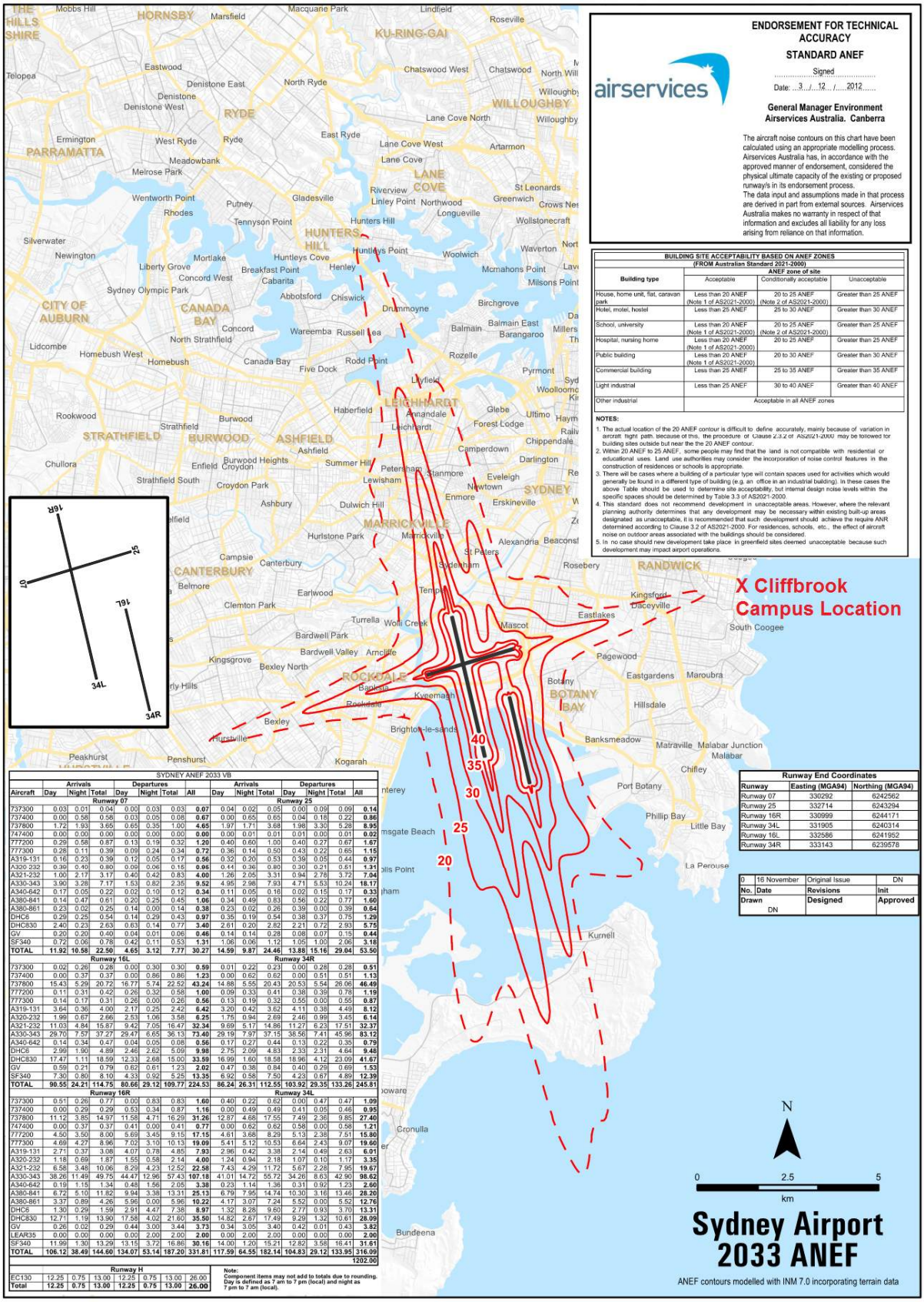


Figure 4 ANEF 2033 Contours Map showing the Cliffbrook Campus location.

3. APPLICABLE NOISE CRITERIA

3.1 Proposed Hours of Operation

The proposed hours of operations are to be dictated by the venue's usage and are as follows:

AGSM Programs:
Classes will typically run Monday to Sunday between 8am and 5pm daily. Some evening classes will resume after meals until 9pm.

UNSW Seminars:
Monday – Sunday: 8:00am – 10:00pm

On site management:
Ground floor windows to the eastern parts of the building to the breakout lounge and the lower ground floor doors to the gym and syndicate rooms are to be shut at 10pm.
All external areas surrounding the immediate buildings to the mid external fence will not be in use after 10pm. The eastern recreational land will not be in use after 9pm.
An on-site manager is on site at all hours and throughout the year.

Maintenance, cleaning and other back of house operations:
Monday – Sunday: 5.00am – 10:00pm.

3.2 NSW Industrial Noise Policy

The NSW Industrial Noise Policy (INP) (2000) assessment procedure for industrial noise sources consists of two components.
They are:

- Controlling intrusive noise impacts in the short term for residences
- Maintaining noise level amenity for particular land uses for residences and land users.

The intrusiveness of an industrial noise source is considered acceptable if the continuous (energy average) A-weighted level of noise from the source measured over a 15-minute period does not exceed the background noise level measured in the absence of the source by more than 5dB. The Rating Background Level (RBL) is the background level used for the assessment purposes and the $L_{A90,\ 15minute}$ measure as recommended in Table 3.1 of the INP is used in the determination.
To limit the continuing increases in noise levels and maintain noise level amenity, the INP has set recommended and maximum noise for the various land usages. The criteria for amenity noise applicable to this Development Application are as follows.

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)	
			Acceptable (ANL)	Recommended Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45

Table 1 INP Recommended Noise Levels

4. EXISTING NOISE ENVIRONMENT

4.1 Existing Noise Levels at Residential Boundaries

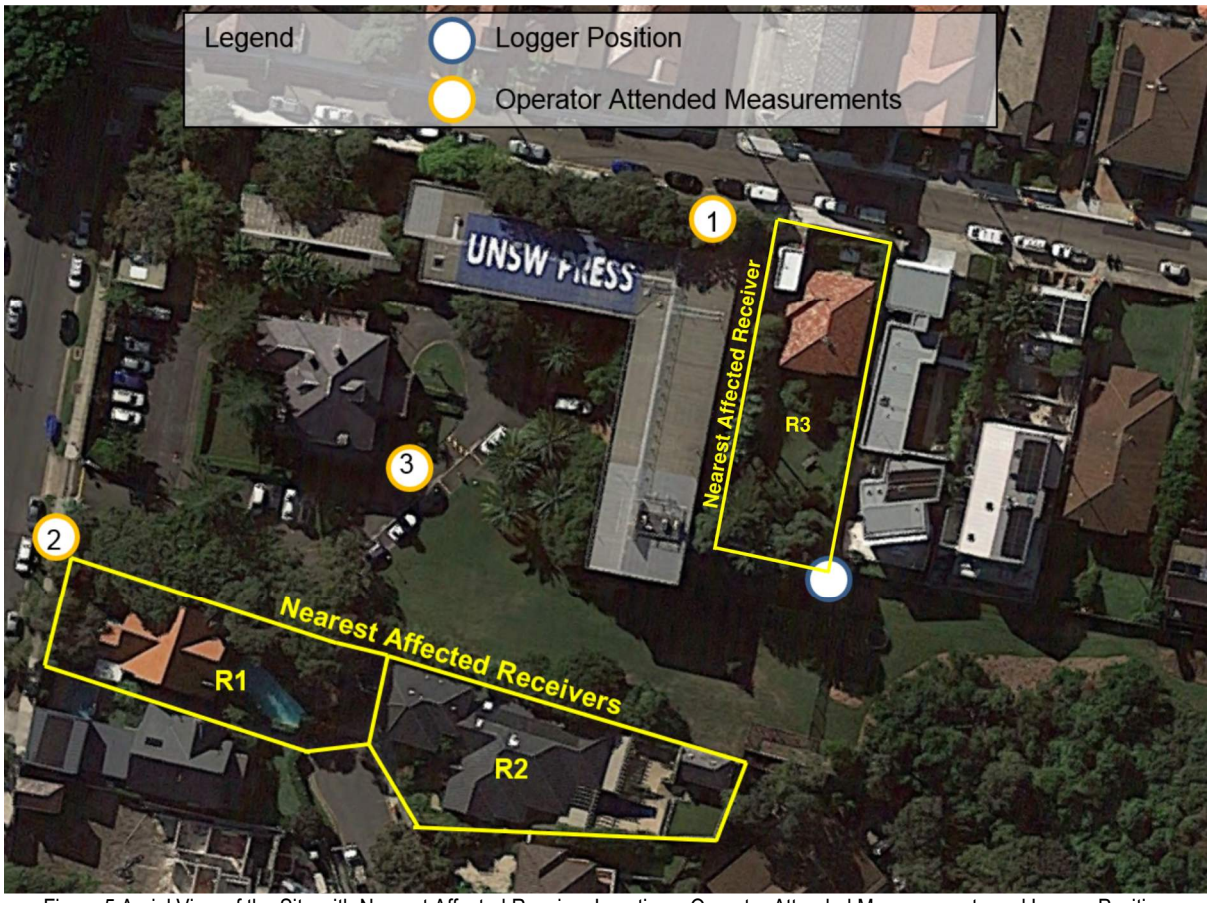


Figure 5 Aerial View of the Site with Nearest Affected Receiver Locations, Operator Attended Measurements and Logger Position

4.1.1 Long Term Noise Monitoring

To determine the intrusive noise criteria in accordance with the INP, long term noise logger monitoring and short term (15-minutes) operator attended noise measurements were conducted at the proposed development site. Automatic logging noise measurements were performed at the site to document the existing acoustic environment, including traffic noise.

Long term noise monitoring with a Rion NL-52 Type 1 noise logging sound level meter were conducted between Wednesday 3rd of February 2016 and Thursday 11th of February 2016 at Logger location shown in Figures 1 and 2 above. The sound level meter was calibrated before and after the measurements using a Bruel & Kjaer Acoustic Calibrator. No calibration deviations were recorded. Detailed results of the logger measurements are shown in Appendix B.

Figure 6 Noise Logger located at the boundary with 12 Battery St

The results of the automatic logging measurements and the site notes are tabulated below:

Start Date and Time	End Date and Time	Logging Period	Assessment Period	$L_{A90,15min}$ dB	$L_{Aeq,15min}$ dB	Logger Location
19/04/2016 at 11.45 AM	27/04/2016 at 1.00 PM	15 min intervals	Day Period	50	53	At boundary with 12 Battery Street
19/04/2016 at 11.45 AM	27/04/2016 at 1.00 PM	15 min intervals	Evening Period	47	48	At boundary with 12 Battery Street
19/04/2016 at 11.45 AM	27/04/2016 at 1.00 PM	15 min intervals	Night Period	45	45	At boundary with 12 Battery Street

Table 2 Results for Long Term Noise Monitoring

The LA90 rating background noise levels were determined using the methodology as described in Section 3.1 of the NSW INP.

4.1.2 Operator Attended Noise Measurements

Figure 7 Operator Attended Measurement at Location 2 on Beach Street

Figure 8 Operator Attended Measurement at Location 1 on Battery Street

Operator attended noise measurements and long term sound logging measurements were performed on site to document the existing acoustic environment, including traffic noise.

Operator attended noise measurement survey was conducted with an integrating Type 1 sound level meter and windshield. Measurements were taken continuously and the microphone was set to receive direct frontal sound and facing the direction of sound emission.
The survey was conducted with the following instruments:

NTI Precision Integrating Octave Band Sound Level Meter, Type XL2 with 1/3 Oct band filter unit, which conforms to applicable standards of IEC 61672-1:2002-05 CLASS1 & IEC 60651 TYPE1.

The sound level meter calibration was verified before and after the measurements using a Bruel & Kjaer Acoustic Calibrator. No calibration deviations were recorded.

The operator attended noise measurements were performed on Thursday 4th of May 2016 between 10.30 am and 11.30 am and Friday 4th of February 2017 between 12.00pm and 1.00 pm. Results are presented in Table 3 below.

Date	Time	Duration	LAeq	LAF90	Location	Notes
04/05/2016	10.46 AM	15 min	52	42	1	Traffic Noise
	11.05 AM	15 min	55	42	2	Traffic Noise
04/02/2017	12.43 PM	15 min	57	42	3	Traffic Noise

Table 3 Operator Attended Measurements Results and Corresponding Locations

4.2 Noise Criteria at the nearest Residential Boundary

The NSW INP requires that any noise generated by the proposed development must be acoustically treated so that:

(a) "The emission of noise associated with the use of the premises including the operation of any mechanical plant and equipment shall comply with the following criteria:
   (i) The LAeq,15minute noise level emitted from use must not exceed background noise level LA90,15minute by more than 5dB when assessed at boundary of any affected residence.
   (ii) The LAeq,15minute noise level shall be adjusted for modifying factors in accordance with Part 4 of the environmental Protection Authority (EPA) NSW Industrial Noise Policy."

Based on the above measurements and assessment in accordance with the NSW INP shown in Table 4.2, the criteria for the project intrusiveness and amenity noise criteria (in bold) at the front boundary of the nearest affected residence at 1 & 2 Gordons Avenue, and 10 Battery Street Coogee is shown in Table 4 below:

Time of Day	Intrusiveness Criterion	Amenity Criterion
Day	**58 $L_{Aeq,15min}$** (53+5)	60 $L_{Aeq, Day}$
Evening	53 $L_{Aeq,15min}$ (48+5)	**50 $L_{Aeq, Evening}$**
Night	50 $L_{Aeq,15min}$ (45+5)	**45 $L_{Aeq, Night}$**

Table 4 Noise Criteria at Nearest Affected Receiver at 1 & 2 Gordons Ave and 10 Battery St, Coogee

5. NCC BCA CLASSIFICATION AND COMPLIANCE REQUIREMENTS

5.1 BCA Classification

Zone	BCA class
Educational Establishment Zone (i.e. educational section)	9b
Private Recreational Zone (i.e. residential section)	3

Table 5 BCA Classification of the buildings on the development site

5.2 BCA Noise Criteria Requirements for Class 3

The following is the BCA requirements for building elements in class 3 buildings.

5.3 F5.2 Determination of airborne sound insulation ratings

A form of construction required to have an airborne sound insulation rating must:

(a) have the required value for weighted sound reduction index (R_w) or weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements; or

(b) comply with Specification F5.2.

5.4 F5.3 Determination of impact sound insulation ratings

(a) A floor in a building required to have an impact sound insulation rating must:

(i) have the required value for weighted normalised impact sound pressure level with spectrum adaptation term ($L_{n,w}$ + CI) determined in accordance with AS/ISO 717.2 using results from laboratory measurements; or

(ii) comply with Specification F5.2

(b) A wall in a building required to have an impact sound insulation rating must:

(i) for a Class 2 or 3 building be of discontinuous construction; and

(c) For the purposes of this Part, discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

(i) for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and

(ii) for other than masonry, there is no mechanical linkage between leaves except at the periphery.

5.5 F5.4 Sound insulation rating of floors

(a) A floor in a Class 2 or 3 building must have an $R_w + C_{tr}$ (airborne) not less than 50 and an $L_{n,w}$ + CI (impact) not more than 62 if it separates:

(i) sole-occupancy units; or

(ii) a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

5.6 F5.5 Sound insulation rating of walls

(a) A wall in a Class 2 or 3 building must:

(i) have an R_w + C_{tr} (airborne) not less than 50, if it separates sole-occupancy units; and

(ii) have an R_w (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

(iii) comply with F5.3(b) if it separates

(A) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

(B) a sole-occupancy unit from a plant room or lift shaft.

(b) A door may be incorporated in a wall in a Class 2 or 3 building that separates a sole occupancy unit from a stairway, public corridor, public lobby or the like, provided the door assembly has an Rw not less than 30.

5.7 Wall R_w Ratings

Partition and floor specifications will be included in the detailed design stage, and it should be noted that for compliance with NCC BCA the following is required for new internal walls:

- Internal walls separating sole-occupancy units from other sole-occupancy units are to have airborne sound insulation rating not less than R_w 50.
- Internal walls separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like shall have airborne sound insulation rating not less than R_w 50.
- Any internal wall separating a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or a sole-occupancy unit from a plant room or lift shaft shall be of discontinuous construction.
- Plumbing and duct work between residences and mechanical services will be insulated so that the background noise levels in residences are compliant with noise criteria specified in AS 2107 and NCC BCA.

5.8 Floor Ratings

Partition and floor specifications will be included in the detailed design stage, and it should be noted that for compliance with NCC BCA the following is required for new floors:

5.9 Airborne sound insulation - R_w

Floors shall have an R_w + C_{tr} (airborne) rating not less than 50 if it separates sole-occupancy units; or a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like.

5.10 Impact sound insulation – L_{nw}

Floors shall have an $L_{n,w}$ + CI (impact) rating not more than 62 if it separates sole-occupancy units; or a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like.

5.11 Recommended Glazing

To ensure sufficient insulation of external noise for the amenity of the occupants it is recommended that minimum 6mm float glass is used for the external glazing assembly of the new buildings. Note: the frames and acoustic seals must not degrade the performance of the glazing. The design $R_w + C_{tr}$ rating for 6mm float glass is 29.

5.12 Recommended Doors

Doors separating a sole occupancy unit from a stairway, public corridor, public lobby etc. must have an R_w not less than 30. This rating includes the frame, seals and keyholes, which must not degrade the acoustic performance of the door assembly.

6. NOISE AND VIBRATION FROM THE PROPOSED DEVELOPMENT

6.1 Road Traffic Noise

The additional road traffic noise resulting from the proposed development will be mainly generated from the movement of traffic in and out of the carpark and car parking activity noise. The proposed driveway into the underground carpark is located approximately 4 metres from the residence at 2 Gordons Avenue, Coogee.

The noise from the proposed underground carpark is not likely to impact on the adjoining properties at number 1 and 2 Gordons Avenue, Coogee. There are 5 parking spaces proposed alongside the boundary of 2 Gordons Avenue. In total there will be 10 external car parking spaces, including the existing 5 parking spaces (2 disabled and 3 service vehicles) at street level located near the Beach Street boundary.

6.2 Rail Traffic Noise

The proposed development site is not affected by rail traffic noise.

6.3 Mechanical Plant Noise

The proposed development will have two plant rooms at the ground and lower ground floors as shown in Figure 2 above. The proposed roof top plant area are shown in the Figure 9 below. Where required, following detailed acoustic modelling, the plant will be acoustically treated to achieve the noise criteria as described in Table 4 'Noise Criteria at Nearest Affected Receiver at 1 & 2 Gordons Ave and 10 Battery St, Coogee' above.

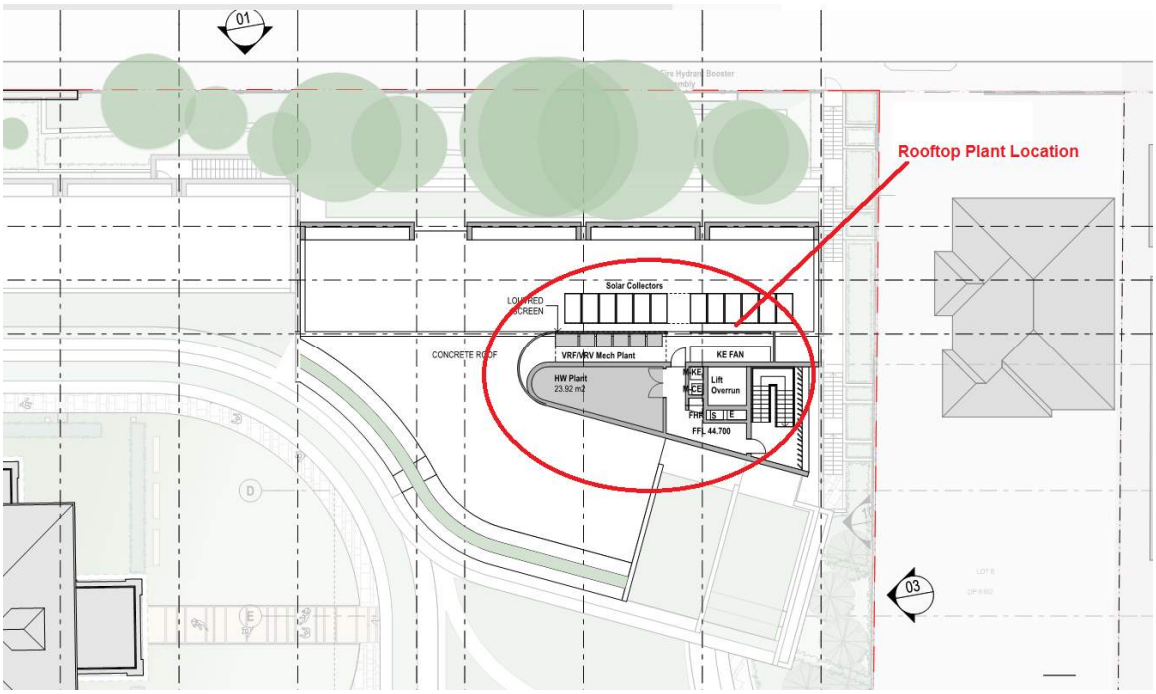


Figure 9 Proposed rooftop plant location

6.4 Vibration from Development

No vibration generating equipment that will impact on the neighbouring residences and properties will be used at the proposed development, except during the construction phase.

7. NOISE COMPLIANCE AND MANAGEMENT PLAN

To ensure the ongoing good relationship with our immediate neighbours, UNSW will implement several control methods to minimise noise emissions including:

- Noise policy
- On-going monitoring
- Signage
- Noise complaints register

7.1 Noise Policy

The following policy will form part of all staff's induction process to ensure awareness and be kept on site for referral at all times. It is the responsibility of UNSW staff onsite to:

- Be aware of the permissible noise limits and operating times for the area and ensure that these limitations are complied with
- No music to be played, or excessive noise generated, prior or after the designated operating times
- Locate speakers away from more sensitive areas if applicable
- Ensure all doors are kept shut for internal amplified noise
- Keep doors shut during event activity to reduce the amount of noise that can be heard from the venue after 10pm.
- Be prepared to discuss any issues that may arise with affected parties and seek an amicable resolution or compromise wherever possible
- Request participants to leave the campus quietly and respect the quiet enjoyment of the neighbouring residences.

7.2 On-going monitoring

To ensure UNSW is continually aware of the noise emissions of the Cliffbrook Campus, UNSW will at random monitor and measure the external noise with a sound pressure level meter during sound sensitive activities. All recordings will be kept on file for a minimum of 12 months. The ongoing monitoring will enable UNSW to proactively adjust the levels used as guides for background music and managing the noise generated by participants.

It is proposed to undertake acoustic readings at the first residence and conference extending past 10.00pm to manage the noise levels and provide guidance for future reference.

7.3 Signage

As the venue management team it is UNSW duty to notify all participants that their actions upon leaving Cliffbrook Campus may have an effect upon surrounding residents. UNSW will ensure that 'Please respect your neighbours by leaving quietly' signage is located at all exit points.

7.4 Noise Complaints Register

Cliffbrook Campus will implement and maintain a Noise Complaints Register; the register will enable UNSW to react and investigate all noise complaints and inform the complainant of the action taken to address the complaint.

If a neighbour wishes to make a complaint regarding noise compliance, a Noise Complaint Form will be made available from the facility's reception and given to the complainant and upon completion is to be handed to the manager for both parties to sign. Complaints will also be added to the Noise Complaints Register if received via phone or email. Upon receiving a complaint an investigation into the matter will been conducted and the complainant will then be contacted by the on-site Manager.

7.5 Point of Contact and Management of noise complaints

It is recommended that Cliffbrook Campus develop and publish a Noise Management Policy for the benefit of the nearby residences likely to be affected by the noise from the development following occupancy. The Noise Management Policy shall formalise the University's objective as good neighbours and willingness to communicate with its neighbours, and informing the neighbours of future activities and events likely to increase the noise levels at the residence. The neighbouring residents shall also be provided with a contact name and contact number of a Cliffbrook Campus on-site manager who can be contacted regarding noise issues emanating from the campus.

8. CONSTRUCTION NOISE AND VIBRATION CONTROL

8.1 Noise and Vibration Regulations and Approval Conditions for the Construction Works

Construction site operators must comply with construction noise and vibration control requirements of the NSW statutory requirements and the conditions set out in the NSW Critical State Significant Infrastructure Standard Secretary's Environmental Assessment Requirements (SEARs) 2015.

The Protection of the Environment Operations Act 1997 (NSW) Act is the key piece of environment protection legislation, and the Protection of the Environment Operations (Noise Control) Regulation 2008 (NSW) provides for inspection and testing of noise emissions.

The "Interim Construction Noise Guidelines" (2009) published by the NSW Environment Protection Authority (EPA), deals with the assessment of noise from construction activities and advises on best practice approaches to minimise noise impacts. It is aimed at managing noise from construction works regulated by Office of Environment and Heritage, and is used to set statutory conditions in licences or other regulatory instruments.

The "Assessing vibration: A Technical Guideline" (2006) published by the NSW EPA, is based on guidelines contained in BS 6472-1992, and presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. It does not address motion sickness, occupational vibration, blasting vibration effects or vibration-induced damage to buildings or structures.

General guidelines on Construction Noise and Vibration criteria and management are shown in Appendix A.

8.2 Hours of Construction Works

The following are the permitted construction hours as recommended in the Redevelopment of UNSW Cliffbrook Campus Redevelopment (SSD 8126) Preliminary Construction Management Plan.

Monday to Friday: 7.00am to 6.00pm

Saturday: 7.00am to 5.00pm

Sundays and Public Holidays: No work permitted.

9. COMMUNITY ENGAGEMENT DURING CONSTRUCTION

9.1 Neighbouring Community Engagement

The most impacted community during the construction phase of the UNSW Cliffbrook Campus redevelopment are the occupants at 1 & 2 Gordons Avenue, and 10 Battery Street, Coogee.

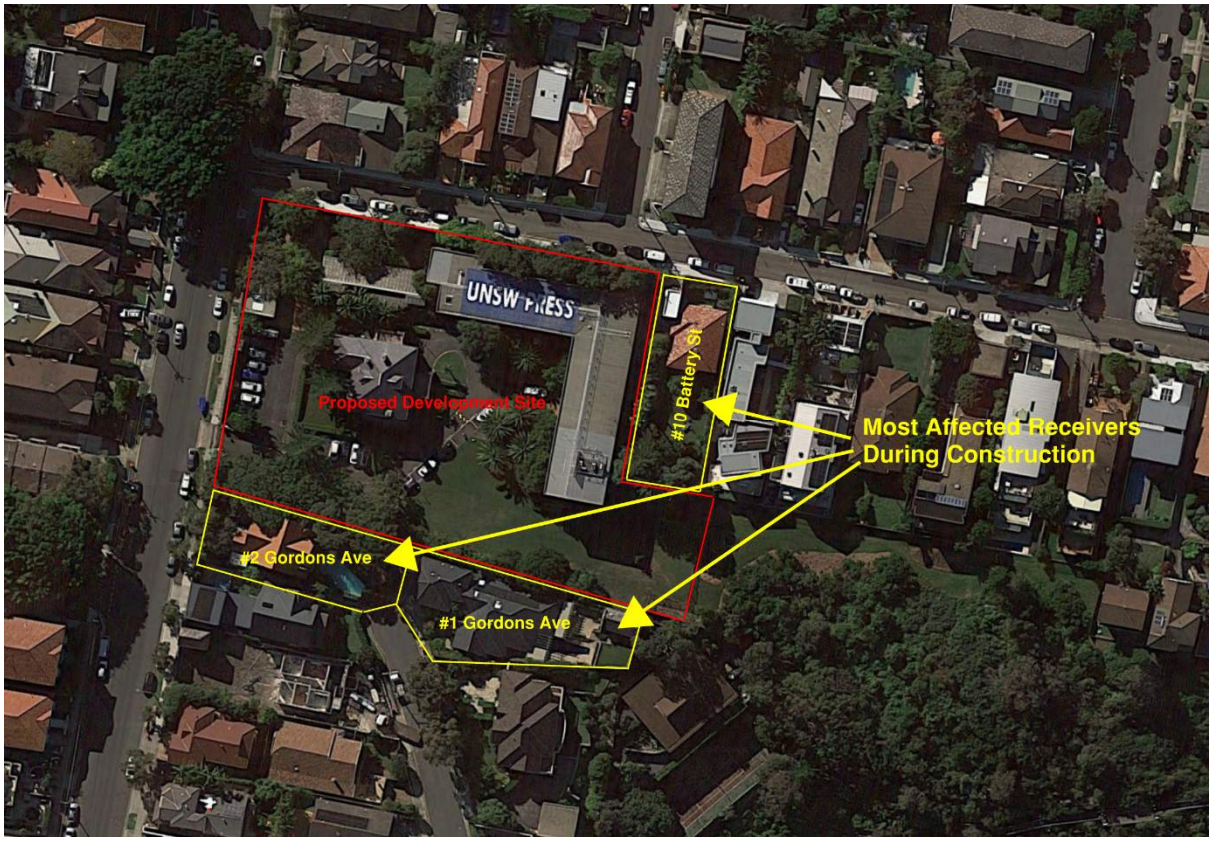


Figure 10 Most Affected Receivers during the Construction Phase

From a community point of view, there is a need for a range of actions and processes which are required by the guidelines of the Secretary's Environmental Assessment Requirements (SEARs) guidelines for the construction works that aim to reduce noise and vibration impacts from the construction activities while encouraging community involvement.

As a project moves towards the construction phase, further details normally become available on the planned work methods, scheduling, location of plant and equipment.

For the UNSW Cliffbrook Campus redevelopment construction works, contact with the nearest affected community is desirable once approval has been given to commence works and should be undertaken prior to any work beginning. The type of community engagement should relate to the likelihood and extent of noise and vibration impacts from the construction works.

The aim of community engagement is to:

- Establish good working relationships between the development owner (UNSW), builder, the community and other stakeholders in relation to the construction project
- Receive feedback on the project's environmental performance, discuss community concerns and identify opportunities for the resolution of community complaints and concerns

- Gain advice on how best to communicate relevant information on the project and its environmental performance to the broader community
- Work cooperatively towards outcomes of benefit to the project, immediate neighbours and the local and regional community.

The UNSW Contractor shall nominate the construction site manager as a community liaison officer for the project as a point of contact for the community regarding issues related to the construction of the development, including issues relating to noise and vibration. Any formal complaints received regarding noise and vibration matters at the construction site shall be passed on to the UNSW Contractor for the complaints to be addressed and resolved.

9.2 Keeping the Noise Affected Community Informed

Being up-front with the noise affected community from the outset can assist in transferring information to the affected community. An example of being up-front is to present noise and vibration related information on the construction works to noise affected community before commencing works.

9.3 Dealing with Community and Public Complaints during Construction

Complaints from the community and public can arise when accidental or unintentional noise and/or vibration are generated due to unforeseen circumstances or error of judgement made by the construction team. The community and public generally understand when this happens once or not too often. The complaints must be handled in a serious and respectful way. The complaints should be recorded and logged in a noise and vibration complaints log book and followed up by the construction site manager.

Following resolution of the noise or vibration problem, the complainant should be informed of the remedial actions taken before the complaint can be recorded as being resolved.

10. CONSTRUCTION WORK SCHEDULE AND TRAFFIC MANAGEMENT

The construction work schedules and proposed construction traffic routes to minimise noise intrusion into neighbouring residential properties will be confirmed following engagement of a builder for the project.

The builder will be required to provide a construction programme for the works, from site establishment and site works to practical completion. The noisy phases will be monitored so as to avoid and minimise potential complaints from neighbouring and other affected properties.

The builder will be required to provide construction traffic routes, proposed frequency of vehicular movements and the estimated total gross weights of the vehicles to assess the traffic generated noise in the vicinity of the development. Traffic noise will be monitored where potentially noisy construction traffic movement periods could cause complaints to arise from the affected residential properties.

11. TRAINING

The site manager shall implement appropriate training and induction in the requirements of this construction noise management plan. All employees, contractors and utility staff working on site will undergo site induction training which includes Environmental Due Diligence Training. The induction will address:

- This Construction Noise Management Plan
- The existence of noise legislation and what this means for the project, i.e. OEH and Noise Management Levels
- Delivery hours and locations.
- Reporting and recording environmental incidents related to noise and vibration.
- Noise and vibration minimisation measures.
- The importance of regular maintenance noise and vibration generating plant.

Records will be kept of all personnel undertaking the site induction and training, including the contents of the training, date and name of trainer/s.

Key staff will undertake more comprehensive training relevant to their position and/or responsibility. This training may be provided as “toolbox” talk training.

12. CONCLUSION

The NSW Critical State Significant Infrastructure Standard Secretary's Environmental Assessment Requirements (SEARs) 2015 and the NSW Industrial Noise Policy (INP) 2000 requirements pertaining to the environmental noise impact on the proposed development at 45 Beach Street, Coogee, in particular on the noise impact of the development at the nearest affected residence has been addressed.

The noise impact from the proposed development including the following activities has been addressed:

- Noise emissions from outdoor recreational activities
- Noise from mechanical plant, carpark and cleaning and maintenance issues
- Noise from traffic entering and leaving the underground carpark

The recommended noise mitigation management strategies including glazing, noise barriers and noise management strategies have been provided for the proposed development to meet the criteria outlined in the SEARs 2015 and the NSW EPA Industrial Noise Policy (INP) 2000.

Detailed design of the building glazing, envelope and acoustic barriers will be provided in the design development phase.

13. APPENDIX A – CONSTRUCTION NOISE AND VIBRATION MANAGEMENT GUIDELINES

The following section addresses the site specific construction noise and vibration criteria, measurement procedures and the various noise levels of construction equipment likely to be used at the site.

13.1 Recommended Standard Hours for Construction Work

The hours for construction work shall be as described in Paragraph 8.2 above.

Section 2.2 of the EPA "Interim Construction Noise Guideline" (2009) specifies categories of work that might be taken outside the standard hours. The categories relevant to this project are:

- The delivery of oversized plant or structures that police or other authorities determine requires special arrangements to transport along public roads.
- Emergency work to avoid loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services and/or consideration of worker safety do not allow work within the standard hours.

13.2 Airborne Construction Affecting Nearby Properties

Table 8 below shows an extract from Table 2 of Section 4.1.1 of the EPA "Interim Construction Noise Guideline" (2009) which sets out the management levels for construction noise at residences and nearby properties. The determination of the Rated Background Noise Level (RBL) is shown in Appendix B.

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected 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 $L_{Aeq\ (15\ min)}$ 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 75 dB(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: 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.

Table 6 Extracted from Table 2 of Section 4.1.1 of the EPA "Interim Construction Noise Guideline (2009)".

The Interim Construction Noise Guideline (2009) notes that there may be some community reaction to noise from major construction projects where this is more than 10 decibels above the background noise level for work during the daytime. This recognises that construction noise is generally temporary with the community having a slightly higher tolerance for it.

The best management practices involve adopting particular operational procedures that minimise noise while retaining production efficiency. Some common noise reduction strategies include:

- Changing the activity to reduce the noise impact or disturbance (e.g. reorganising the way the activity is carried out).
- Choosing a suitable time — schedule noisy activity to less sensitive times of the day. There are sensitive times of the day for different people, for example, residences during evenings, night and weekends. Where several noisy pieces of equipment are used, their operation should be scheduled to minimise impacts.
- Keeping neighbours informed of a planned noisy activity, its duration and the reasons for the activity. Neighbours may be more accepting of temporary noise if they know when and why the noise is happening, and how long it will last.
- Educating staff and contractors about noise and quiet work practices. This could include signage, for example, some construction sites have signs reminding contractors to consider neighbours and be quiet, and to not start noisy work too early (e.g. before 7.00 am).

Noise can be controlled in the transmission path by using separation distances, barriers and sound absorptive materials.

- Increasing the separation distance (distance attenuation) between the noise source and receiver reduces the noise level. As a rule of thumb, each doubling of the distance from a noise source equates to a reduction of sound pressure level of 6 dB (the inverse square law). This does not apply close to a loud noise source.
- Careful site selection for a new noisy activity can help minimise noise impacts where it is possible to provide adequate separation distances.
- Barriers are most effective when they are located close to the noise source and block the line of sight between the source and receiver. The amount of noise reduction achieved depends on the height and mass of the barrier and the frequency of the noise (barriers are less effective for low-frequency noise). Noise barriers should have no gaps. Use of absorptive material on the side of the barrier facing the noise source can also help to reduce noise levels by reducing noise reflections. Trees or other vegetation do not provide an effective noise barrier. Some limited attenuation may be gained where trees are densely planted but little attenuation is achieved for low frequencies.
- Sound-absorptive materials reduce the level of reflected sound. They are porous materials such as glass fibre, wool and mineral wool. Thin layers are capable of absorbing only high frequencies, whereas thicker layers can absorb a wider frequency range.

13.3 Equipment Noise Levels for the Proposed Construction works

The construction activities associated with the proposed development will consist of various plant and equipment as detailed above. The sound power levels of the noisy plant and equipment likely to be used during the construction works are provided below, listed from high to low.

Plant	Sound Power Level dBW	Estimated Sound Pressure Level dB(A) at	
		7m	18m
Bulldozer	114	89	81
Excavator	108	83	75
Rotary Hoe	109	84	76
Mobile Crane	104	79	71
Concrete Truck	109	84	76
Angle Grinder	109	84	76
Concrete Pump - 120 mm diameter / 50 bar	112	87	79
Sheet metal forming (grinding, hammering)	105	80	72
Concrete Saw	116	91	83
Crawler Cranes	98	73	65
Mobile Crane	98	73	65
Rotary Boring Drill Rig	107	82	74
Site Cranes	104	79	71
Dump Truck	108	83	75
Front End Loader	112	87	79
Excavator	107	82	74
Piling - Vibrating	108	83	75
Concrete Saw	113	88	80
Compressor	100	75	67
Bobcat	103	78	70
Hand Tools	90	65	57
Jackhammer	105	80	72

Table 7 Typical construction equipment & sound pressure levels at 7 metres in dB(A). Noise levels at larger distances can be extrapolated

The sound power levels for the plant and equipment presented in the above table are based on maximum levels given in "AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites" and cross-checked with our measured levels on past projects.

13.4 Noise Criteria at the Nearest Affected Neighbouring Properties

Distance between the boundary at 1 & 2 Gordons Avenue and 10 Battery Street and the closest building, which will undertake redevelopment work is 7 metres.
Typical noise levels from construction machinery are presented in Table 9.

13.5 Temporary Sound Barrier Walls

It is recommended that a temporary sound barrier wall be erected enclosing the construction site, along all boundaries to block the direct line of sight between the noise generating activities on site and adjoining buildings, in particular the property boundaries at 1 & 2 Gordons Avenue and 10 Battery Street.

The height of the barrier shall be a minimum of 2.4 metre high and constructed using steel posts and 19mm thick plywood. The barrier shall be erected prior to commencement of demolition and earthworks.

13.6 Vibration Criteria Objectives

The management objective for the site is to limit vibration from construction activities so as to avoid building damage and human discomfort associated with the construction works. It is noted that buildings in the vicinity of development are residential. Vibration impacts on the buildings and their occupants should be considered for the assessment of structural damage and human annoyance, respectively.

13.7 Vibration Sources

Typical vibration levels from construction plant equipment most likely to cause significant vibration are summarised in the table below.

Activity	Typical ground vibration
Bulldozers/ Excavators	Typical ground vibration from bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m and at distances greater than 20m, vibration levels are usually below 0.2mm/s.
Jack Hammers	Typical ground vibrations from jack hammers are generally greater than 5mm/s at distances of 1m and no more than 2mm/s for distances of 5m or more.
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration in the range 0.01-0.2mm/s at the footings of buildings located 10-20m from a roadway. In general ground vibration from trucks is usually imperceptible in nearby buildings.

Table 8 Typical ground vibration generated by construction plant

Therefore, vibration management strategies implemented on site shall consider these items of plant and construction activities involving these items of plant.

13.8 Vibration Criteria

The following criteria are considered applicable when assessing vibration emission levels from the construction works.

The effects of ground vibration on buildings near construction sites may be broadly defined by the following three categories:

1. Disturbance to building occupants - Vibration in which the occupants or users of the building are inconvenienced or possibly disturbed,
2. Effects on building contents - Vibration where the building contents may be affected, and,
3. Effects on building structures - Vibration in which the integrity of the building or structure itself may be prejudiced.

In general, vibration criteria for human disturbance (1) are more stringent than vibration criteria for effects on building contents (2) and building structural damage (3). Hence, compliance with the more stringent limits dictated by Category 1, would allow for compliance to be achieved for the other two categories.

Category 1 – Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to the EPA's *'Assessing Vibration; a technical guideline'*, published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*.

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

*'**Continuous** vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*

***Impulsive** vibration is 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.*

***Intermittent** vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.*

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

Preferred and maximum values for continuous and impulsive vibration are defined in below in Table 11 extracted from "Table 2.2 of the guideline" and the values for residential type buildings are reproduced below.

Location	Assessment period[1]	Preferred values		Maximum values	
		z axis	x & y axis	z axis	x & y axis
Continuous vibration					
Residences	Daytime (7am-10pm)	0.010	0.0071	0.020	0.014
Impulsive vibration					
Residences	Daytime (7am-10pm)	0.30	0.21	0.60	0.42

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

Table 9 Preferred and Maximum Weighted RMS Values for Continuous and Impulsive Vibration Acceleration (m/s2) 1-80Hz

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation.

The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline.

Preferred and maximum VDV values are defined in Table 12 below extracted from "Table 2.4 of the guideline" and VDV values for residential type buildings are reproduced below.

Location	Daytime (7am-10pm) [1]		Night-time (10pm-7am) [1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Residences	0.20	0.40	0.13	0.26

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

Table 10 Preferred and Maximum VDV Values

13.8.1 Buffer Distances for Vibration Control

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (i.e. dimensions, materials, type and quality of construction and footing conditions).

The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyance caused and the strains induced in structures.

As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific, below are some indicative minimum 'buffer' distances determined for some common construction plant with data available from recent projects, which assist to avoid human discomfort in terms of perceptible (or tactile) vibration during daytime construction hours:

Plant Item	Recommended Minimum Buffer Distance (m)
CFA (Continuous Flight Auger) Piling rig	10
Excavators	10
Jack hammers	5

Table 11 Recommended Minimum Buffer Distances for Construction Plant

From the above table it can be seen that the nearest receivers are less than 10m from the site, and as such, vibration may cause discomfort to occupants during piling activities.

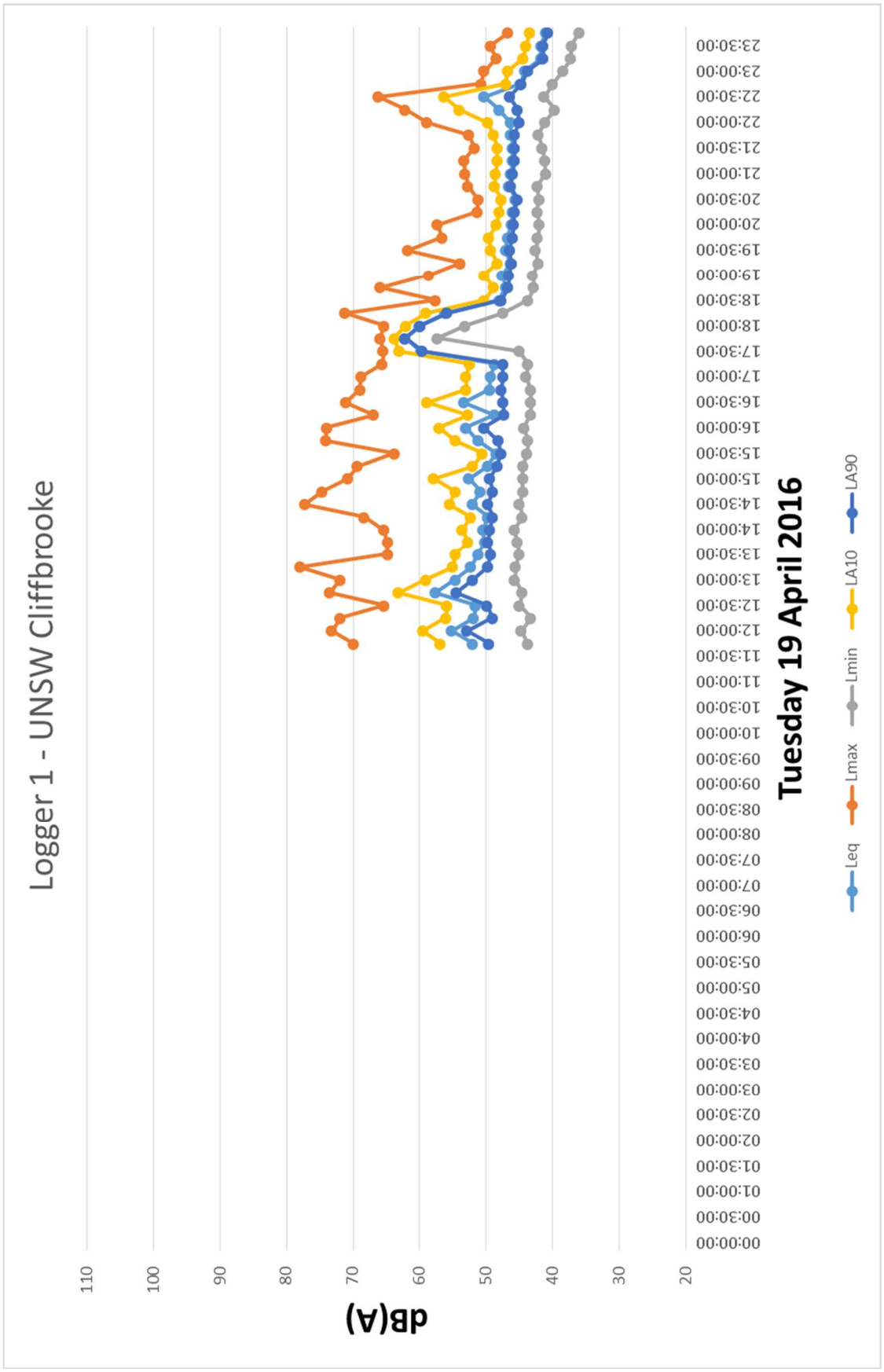
Therefore, site specific buffer distances should be determined for piling activities once vibration emission levels are measured from the piling rig prior to the commencement of its regular use on site.

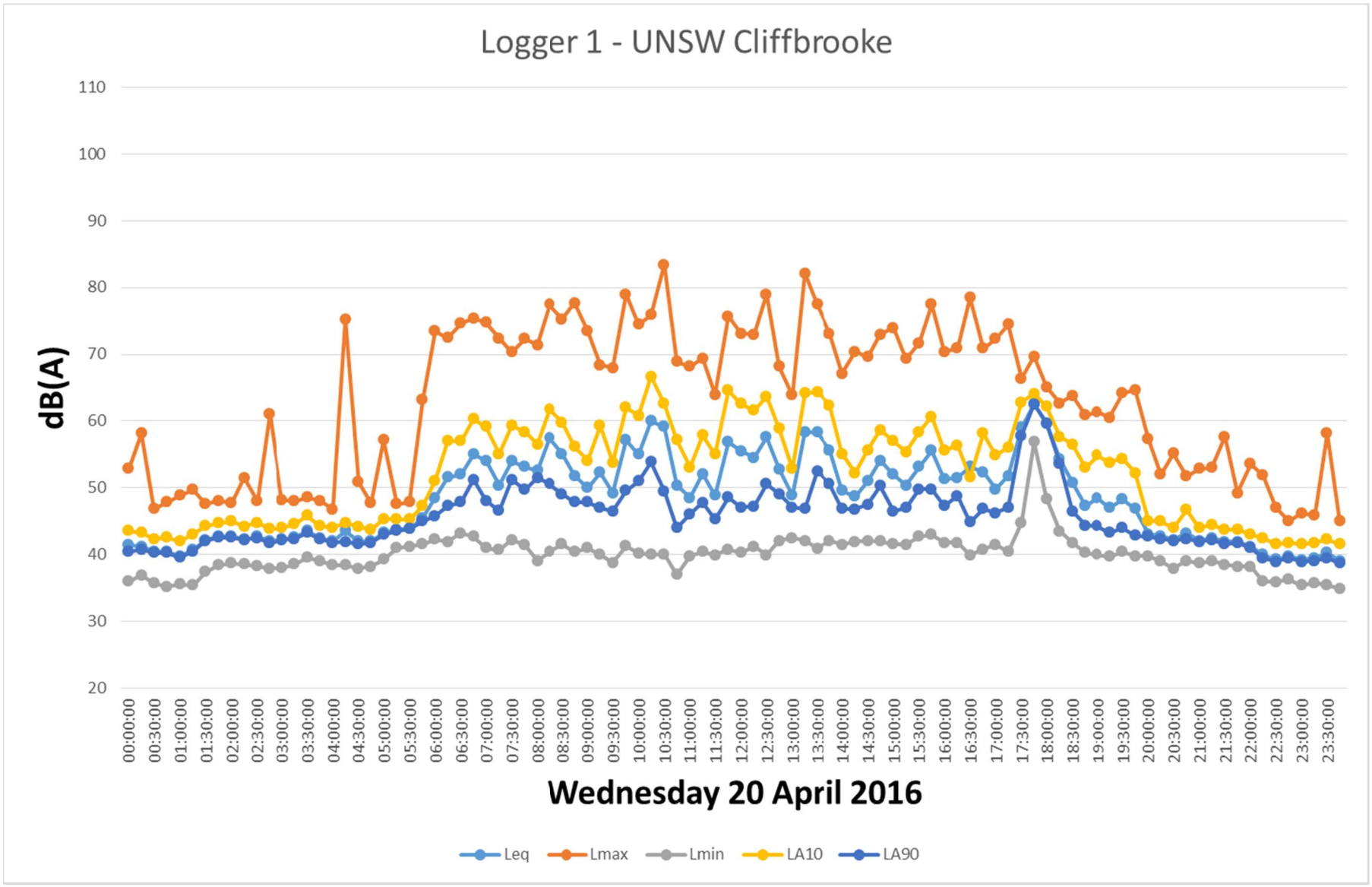
13.8.2 Vibration Management Measures

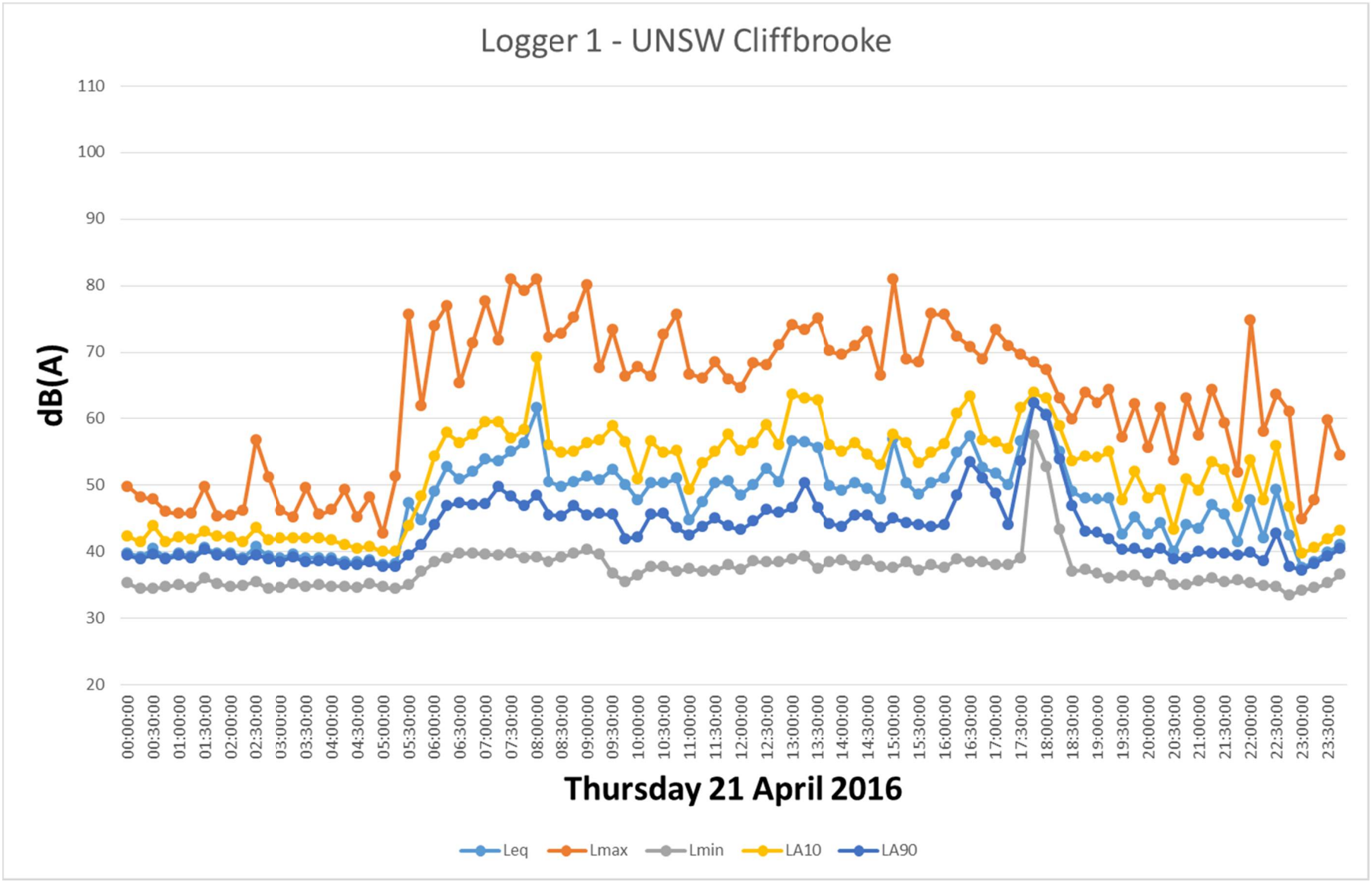
Further to buffer distances, to ensure vibration impacts are minimised during the construction period, the following vibration management control measures are provided:

1. The proper implementation of a vibration management plan is required to avoid adverse vibration disturbance to affected occupancies. Consultation with occupants and property owners is recommended and should be aimed at providing a communication path directly to the contractor.
2. A management procedure will be implemented to deal with vibration complaints. Each complaint will be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences
3. Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller units, establishment of safe buffer zones and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

14. APPENDIX B – LOGGER GRAPHS




Logger 1 - UNSW Cliffbrooke
dB(A)
110
100
90
80
70
60
50
40
30
20
00:00:00
00:30:00
01:00:00
01:30:00
02:00:00
02:30:00
03:00:00
03:30:00
04:00:00
04:30:00
05:00:00
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00
08:00:00
08:30:00
09:00:00
09:30:00
10:00:00
10:30:00
11:00:00
11:30:00
12:00:00
12:30:00
13:00:00
13:30:00
14:00:00
14:30:00
15:00:00
15:30:00
16:00:00
16:30:00
17:00:00
17:30:00
18:00:00
18:30:00
19:00:00
19:30:00
20:00:00
20:30:00
21:00:00
21:30:00
22:00:00
22:30:00
23:00:00
23:30:00
Wednesday 20 April 2016
Leq
Lmax
Lmin
LA10
LA90


Logger 1 - UNSW Cliffbrooke
dB(A)
110
100
90
80
70
60
50
40
30
20
00:00:00
00:30:00
01:00:00
01:30:00
02:00:00
02:30:00
03:00:00
03:30:00
04:00:00
04:30:00
05:00:00
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00
08:00:00
08:30:00
09:00:00
09:30:00
10:00:00
10:30:00
11:00:00
11:30:00
12:00:00
12:30:00
13:00:00
13:30:00
14:00:00
14:30:00
15:00:00
15:30:00
16:00:00
16:30:00
17:00:00
17:30:00
18:00:00
18:30:00
19:00:00
19:30:00
20:00:00
20:30:00
21:00:00
21:30:00
22:00:00
22:30:00
23:00:00
23:30:00
Thursday 21 April 2016
Leq
Lmax
Lmin
LA10
LA90