Report

Acoustics Services – Noise and Vibration Impact Assessment

TAFE NSW CONSTRUCTION CENTRE OF EXCELLENCE
Gray Puksand

CONFIDENTIAL

Revision: 4.0 - Revised version
Issued: 10 March 2021

Norman Disney & Young
A TETRA TECH COMPANY

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This report has been prepared to accompany a detailed State Significant Development Application (SSDA) SSD_ 8571481 for the development of an educational facility at the TAFE Nepean Kingswood Campus, located at 2-44 O'Connell Street, Kingswood (the site). The legal description of the site is Lot 1 in DP 866081. The site comprises a rectangular lot with an area of approximately 23 hectares.

The purpose of this report is to address key noise and vibration impacts during both construction and operation of the facility. This report shall not be relied upon as providing any warranty or guarantee of the building, its services or equipment.

Specifically, the SSDA seeks development consent for the construction and operation of the TAFE NSW Construction Centre of Excellence (TAFE CCoE) a multi-level, integrated educational facility designed to accommodate specialised training and education for construction-related TAFE NSW courses (the project).

The TAFE CCoE will be a new learning environment with an emphasis on flexibility and adaptability, to encourage cross-disciplinary collaboration, industry engagement and educational excellence. On 27 February 2019, the NSW Government announced the delivery and associated funding for the CCoE.

The proposed development is classified as State Significant Development (SSD) on the basis that it falls within the requirements of clause 4, Schedule 19 of the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP), being 'development for the purpose of a tertiary institution… that has a capital investment value of more than $30 million'.

The Minister for Planning, or their delegate, is the consent authority for the SSDA and this application is lodged with the NSW Department of Planning, Industry and Environment (NSW DPIE) for assessment.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) issued for the project. Specifically, this report has been prepared to respond to the following SEARs:

SEARS	Report Sections
Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimize and mitigate the potential noise impacts on surrounding occupiers of land.	5.7, 5.7.1, 5.7.2, 5.8, 5.9, 7
Identify and assess operational noise, including consideration of any public address system, mechanical services (trade equipment, air conditioning plant), use of facilities for events, and outline measures to minimize and mitigate the potential noise impacts on surroundings occupiers of land.	5.1, 5.2, 5.2.1, 5.3, 5.4, 5.5, 5.6, 7

1 INTRODUCTION

NDY has been engaged by Gray Puksand to undertake a Noise Impact Assessment as part of the Development Approval for TAFE NSW Construction Centre of Excellence, located on 2 – 44 O'Connell Street, Kingswood, approximately 5 km east of the Penrith CBD and 2 km east of Nepean Hospital. This report was prepared to assess the noise and vibration impacts of the proposed development and to determine feasible and reasonable treatment options.

1.1 Required and Recommended Design Standards

This report has been written with reference to the following mandatory and recommended documents, which set out various acoustic criteria for residential buildings.

Required:

- New South Wales Noise Policy for Industry (NSW EPA NPfI)
- New South Wales Interim Construction Noise Guideline (NSW EPA 2020) Assessing vibration: a technical guideline
- NSW Department of Environment & Climate Change (DECC), Interim Construction Noise Guideline, 2009
- DEFRA 2005 Data base, including the existing construction noise database on BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration control on construction and open sites Part 1 Noise and Part 2 Vibration
- German Standard DIN 4150-3:1999
- NSW Transport Roads & Maritime Services Construction Noise and Vibration Guideline, 2016
- Penrith Local Environmental Plan 2010 and Development Control Plan 2014
- NSW Department of Planning, Development near rail corridors and busy roads – Interim Guideline, 2008
- AS / NZS 2107:2016 Acoustics, Recommended design sound levels and reverberation times for building interiors
- Response to request for input into the Secretary's Environmental Assessment Requirements (SEARS) for TAFE NSW Western Sydney Construction Hub SSD 8571481, dated 04.08.2020
- TAFE NSW Western Sydney Construction Hub (SSD 8571481) Secretary's Environmental Assessment requirements (SEARS), dated 06.08.2020

1.2 Information Sources

- Gray Puksand, TAFE NSW Construction Centre of Excellence, Concept Design Report, October 2020
- Gray Puksand preliminary architecture plans, rev. A., Issue for SSDA, dated 19.12.2020.
- Draft mechanical concept sent on 04.12.2020
- Draft selection for Sprinkler pump sent on 8.12.2020
- Traffix, Transport and Accessibility Impact Assessment, dated March 2021.

1.3 Authority

Authority to undertake this report was provided by Barry Hackett of Gray Puksand Ltd on 07.10.2020.

1.4 Authors

This report was prepared by Victoria Rastelli, accredited engineer part of the New Zealand Acoustical Society and part of the Association of Australian Acoustical Consultants. Quality assurance was made by Cameron Walbran, M.A.A.S member of the Australian Acoustical Society.

1.5 Revision History

Revision	Date Issued	Comment
1.0	11th December 2020	Draft Noise and Vibration assessment Report
2.0	18th December 2020	Noise and Vibration assessment Report – revised
3.0	28th January 2021	Noise and Vibration assessment Report – updated
4.0	March 10th 2021	Issued for State Significant Development Application

2 SITE DESCRIPTION

The project will provide for the multi storey construction of a number of teaching and administrative facilities in the new construction centre of excellence. The construction hub is located in the north eastern part of the campus, along the eastern boundary to take advantage of adjacencies with the neighbouring Western Sydney University Campus.

TAFE already has existing buildings and activity along O'Connell Street and with open field spaces to accommodate sports, parking and drainage. The construction hub will comprise 2storey construction (2 storey addressing WSU, 3 storey addressing TAFE NSW Campus) with internal workshops, café, learning areas, amenities, storage in the lower ground, amenities, industry engagement and staff kitchen in the upper ground level and level 1.

This new building is expected to host industry events, product launches, engagements with TAFE, graduation ceremonies, no loud music events are expected to be hosted, therefore these events will not have implications on noise on the adjacent receivers.

The Multi-Trades and Digital Technology Hub Building will be operational during semester time periods only. The proposed operating hours for the Multi-Trades and Digital Technology Hub Building are:

- Monday to Thursday: 7.00am to 10.30pm.
- Friday: 7.00am to 7.00pm.
- Saturday: 8.00am to 5.30pm.
- Whenever possible, power tools / construction plant used in the outdoor workshops shall be operated only between 7am to 6 pm.

The development includes an additional carpark and provides services for a projected 3,500 student enrolment, encompassing various construction disciplines. The building capacity is around 1,000 Students simultaneously at maximum occupancy. There is a staff terrace adjacent the main staff workplace on the L3 north west corner and a small outdoor work area on the south east corner enabling roof access.

The new carpark will intent to have 16 car parking spaces for students and staff.

- The building comprises a lower ground, upper ground and level 1
- Primary site access via O'Connell Street to the west and a possible secondary access from the WSU campus to the east
- Built environment of the existing campus can partially shield the noise emissions to the south and west boundaries
- A generator (proposed size of 300kVA) and a sprinkler fire pump (149kV) are envisaged for this development
- The mechanical strategy will be basically to use a mix of cassette units and fan coil units with VRV / VRF Outdoor units, heat rejection of condensed water via geothermal ground sources (no cooling towers), condenser water pumps. Dust extraction systems and exhaust fans for workshops and inline fans.

Main receivers from the project are:

- East side, approximately 50 m from site, WSU Werrington South Campus building / 536 m residential area (Redwood Place)
- South east side approximately 200 m from site, a future potential residential area (partially shielded by T and P existing TAFE buildings)

- West side, approximately 400m from site, O'Connell Street residential area (partially shielded by U, K, L, I, H, G, L M, B, C, E and N existing TAFE buildings)
- North side, approximately 150 m from site, a future residential area south St Charbel Boulevard (on the opposite site of the 6 lane Great Western Highway).

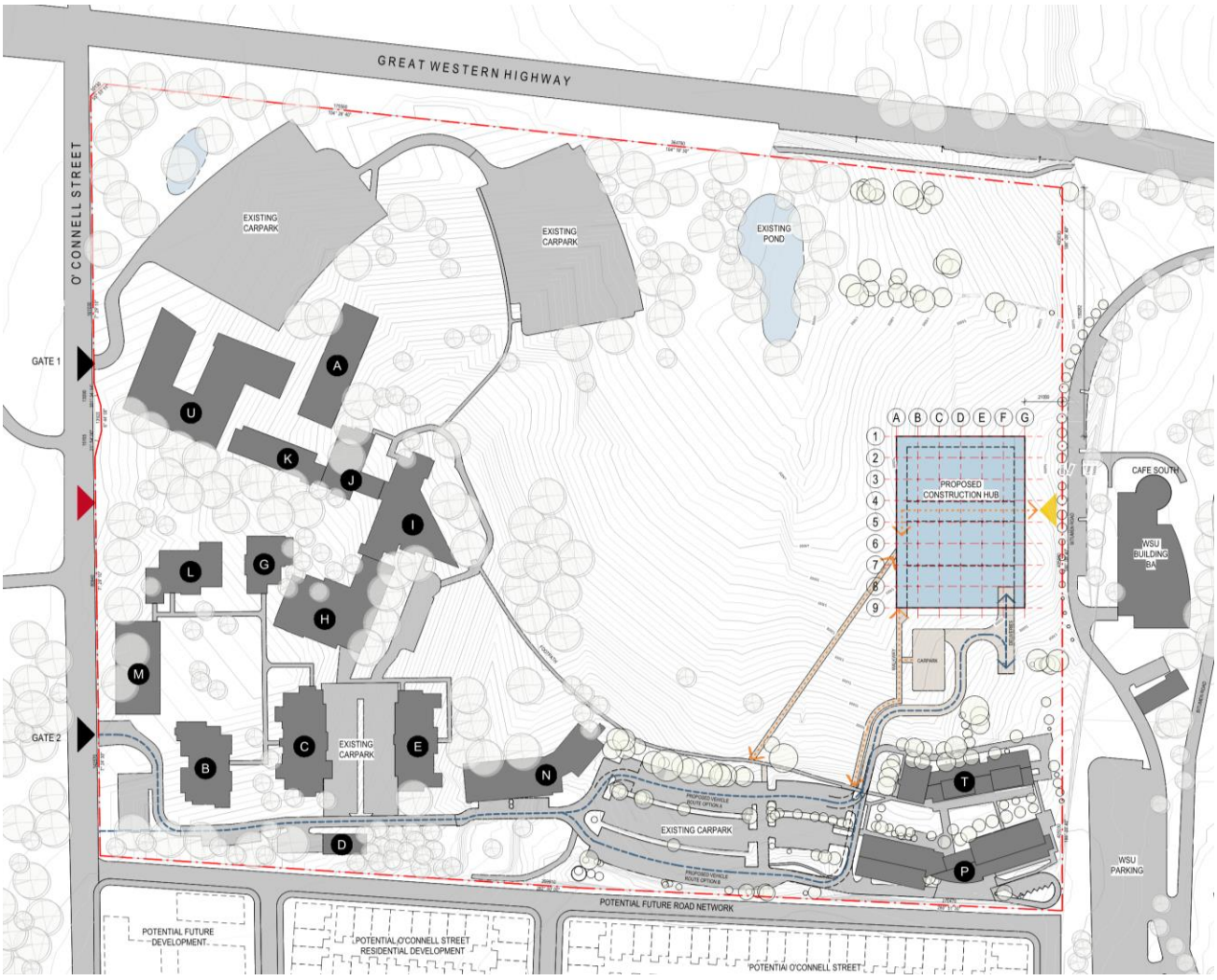

Figure 2-1 Project location / general

3 METHODOLOGY

This report was prepared under the below methodology:

- ✓ Consultation with local plans and planner consultants to define the best places to install acoustic loggers that will record background noise levels
- ✓ Weather conditions were noted throughout the measurement periods and noise measurements were discarded where weather conditions were not suitable for noise monitoring (i.e. rain and/or wind speed > 5 m/s). Noise measurements were performed in accordance with Australian Standards AS1055 and AS2702.
- ✓ The equipment used to measure the background noise levels were NL-42EX NL Series Logging Kit with 512 MB SD Card, windshield, 12V 26-amp SLA Battery, 4 piece mic set, EC-04, USB SD Card. Loggers were left for 10 days of data retrieve.
- ✓ A comprehensive liaison was made with the architects and the services consultants, particularly with the mechanical, electrical and fire consultants to understand the project and the general noise sources.
- ✓ This report considers any likely cumulative impacts from surrounding development (acoustics).
- ✓ Includes mitigation measures that are required to address impacts resulting from the proposal, from construction noise and vibration emission and operative noise emissions.

4 ACOUSTIC CRITERIA

4.1 Secretary's Environmental Assessment requirements

It is our understanding that TAFE NSW Western Sydney Construction Hub (SSD 8571481) Secretary's Environmental Assessment requirements (SEARS), request to consider the following regarding noise and vibration:

- ✓ Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimize and mitigate the potential noise impacts on surrounding occupiers of land.
- ✓ Identify and assess operational noise, including consideration of any public address system, mechanical services (trade equipment, air conditioning plant), use of facilities for events, and outline measures to minimize and mitigate the potential noise impacts on surroundings occupiers of land.

4.2 Penrith Local Environmental Plan 2010

According to Map 13 of Penrith Local Environmental Plan 2010, the construction hub is located on an SP2 Educational Establishment zone next to and E2 (environmental conservation) zone to the west, R3 (medium density residential) zone to the North, west and south, B2 (local centre) zone to the south, B7 (Business park) zone to the north and East and R2 (low density residential) zone to the far east.

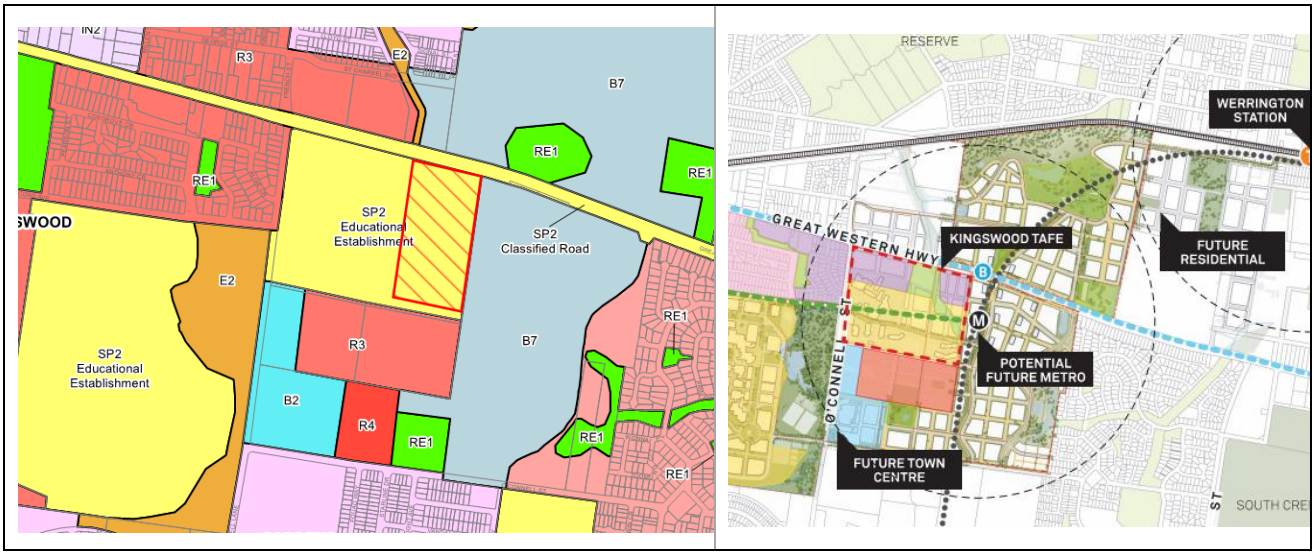

Figure 4-1 Project location zoning

4.3 Noise Policy for Industry

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs.
- Evening: 1800 to 2200 hrs.
- Night-time: 2200 to 0700 hrs.

The measured background (L_{A90}) and equivalent continuous (L_{Aeq}) noise levels during these defined time periods. The L_{A90} noise levels presented are *Rating Background Levels* (RBLs), being the median of the background L_{A90} (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24-hour period during the noise survey.

The L_{Aeq} noise levels presented are the logarithmic average of all the L_{Aeq} samples taken in each of the daytime, evening and night-time periods.

4.3.1 Amenity and Intrusiveness Criteria

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW. The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background (L_{A90}) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5 dB(A).

- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equalled to recommended amenity noise level minus 5dB(A).

  A +3dB(A) to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The NPfI recommends “Intrusive noise levels are only applied to residential receivers (residences).

4.4 Determination of Project Specific Trigger Levels (PSTL)

Following a review of the data, the project and surrounding area zoning, the following site-specific noise levels were adopted for this study, as shown in Table 4-2. It is to be noted that these locations were previously agreed with the planning team:

- Logger 1: 7B O’Connell Street (R3)
- Logger 2: South carpark (next to R3)
- Logger 3: WSU East boundary (B7)
- Logger 4: 9 Redwood Place (R2)
- Logger 5: 14 St Charbel Boulevard (R3)

Figure 4-2 Project location of monitoring

Figure 4-3 Project location of monitoring

Amenity criteria per zoning in accordance with NPfI Table 2.2 is as per below:

Table 4-1 Amenity noise levels per zoning (Extract of Table 2.2 NPfI)

Location	Average Noise Level - L_{Aeq}		
	Day (0700-1800)	Evening (1800-2200)	Night (2200-0700)
Logger 1, 2 and 5 R3 zone	55	45	40
Logger 3 B7 Zone	70	70	70
Logger 4 R2 zone	55	45	40

Table 4-2 Baseline noise data for the proposed development

Location	Average Noise Level - L_{Aeq}			Rated Background Noise Level RBL		
	Day (0700-1800)	Evening (1800-2200)	Night (2200-0700)	Day (0700-1800)	Evening (1800-2200)	Night (2200-0700)
Logger 1: 7B O'Connell Street	58	65	56	41	41	35
Logger 2: South carpark	49	64	58	41	41	38
Logger 3: WSU East boundary	60	64	56	43	41	39
Logger 4: 9 Redwood Place	51	64	54	39	41	35
Logger 5: 14 St Charbel Boulevard	59	64	55	44	41	35

As shown in tables above, the intrusiveness criteria were deemed to be the most conservative criteria, and hence the following project trigger levels were at the residential receivers.

Table 4-3 Project trigger levels

Period	Amenity criteria*	Intrusiveness**	Project Trigger Levels
Logger 1			
Day (0700-1800)	(55-5)+3 = 53 dB(A)	RBL+5 = (41+5)=46 dB(A)	**$L_{Aeq(15min)}$ 46 dB(A)**
Evening (1800-2200)	(45-5)+3 = 43 dB(A)	RBL+5 = (41+5)=46 dB(A)	**$L_{eq(15min)}$ 46 dB(A)**
Night (2200-0700)	(40-5)+3 = 38 dB(A)	RBL+5 = (35+5)=40 dB(A)	**$L_{eq(15min)}$ 40 dB(A)**
Logger 2			
Day (0700-1800)	(55-5)+3 = 53 dB(A)	RBL+5 = (41+5)=46 dB(A)	**$L_{Aeq(15min)}$ 46 dB(A)**

Period	Amenity criteria*	Intrusiveness**	Project Trigger Levels
Evening (1800-2200)	(45-5)+3 = 43 dB(A)	RBL+5 = (41+5)=46 dB(A)	$L_{eq(15min)}$ **46 dB(A)**
Night (2200-0700)	(40-5)+3 = 38 dB(A)	RBL+5 = (38+5)=43 dB(A)	$L_{eq(15min)}$ **43 dB(A)**
Logger 3			
Day (0700-1800)	(70-5)+3 = 68 dB(A)	RBL+5 = (43+5)=48 dB(A)	$L_{Aeq(15min)}$ **48 dB(A)**
Evening (1800-2200)	(70-5)+3 = 68 dB(A)	RBL+5 = (41+5)=46 dB(A)	$L_{eq(15min)}$ **46 dB(A)**
Night (2200-0700)	(70-5)+3 = 68 dB(A)	RBL+5 = (39+5)=44 dB(A)	$L_{eq(15min)}$ **44 dB(A)**
Logger 4			
Day (0700-1800)	(55-5)+3 = 53 dB(A)	RBL+5 = (39+5)=44 dB(A)	$L_{Aeq(15min)}$ **44 dB(A)**
Evening (1800-2200)	(45-5)+3 = 43 dB(A)	RBL+5 = (41+5)=46 dB(A)	$L_{eq(15min)}$ **46 dB(A)**
Night (2200-0700)	(40-5)+3 = 38 dB(A)	RBL+5 = (35+5)=40 dB(A)	$L_{eq(15min)}$ **40 dB(A)**
Logger 5			
Day (0700-1800)	(55-5)+3 = 53 dB(A)	RBL+5 = (44+5)=49 dB(A)	$L_{Aeq(15min)}$ **49 dB(A)**
Evening (1800-2200)	(45-5)+3 = 43 dB(A)	RBL+5 = (41+5)=46 dB(A)	$L_{eq(15min)}$ **46 dB(A)**
Night (2200-0700)	(40-5)+3 = 38 dB(A)	RBL+5 = (35+5)=40 dB(A)	$L_{eq(15min)}$ **40 dB(A)**
*Determined from NSW Noise Policy for Industry 'Table 2.2' ** Determined from Loggers results			

4.5 Construction Noise and Vibration Criteria

4.5.1 Interim Construction Noise Guideline

The NSW Interim Construction Noise Guideline was developed by the NSW-Department of Environment & Climate Change DECC, NSW which incorporates the EPA. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

The guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

It is expected that the length of the construction works associated with the development would be more than 3 weeks and therefore a quantitative method has been used for this assessment.

Table 4-4 set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the

'highly noise affected management level' which is >75dBA. Affected properties above 75 dBA will require community consultation and a Construction Noise & Vibration Management Plan (CNVMP).

Table 4-4: Noise at Residences using Quantitative Assessment

Recommended Hours	Time of Day	External Management Level $L_{eq,15min}$ [dBA]
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise Affected RBL + 10
		Highly noise affected 75
Note: Noise Levels apply at the boundary that is most exposed to construction noise and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most affected point within 30m of the residence.		

4.5.2 Noise Management Levels

Noise Management Levels (NML) associated with the construction works on the project site are presented in Table 4-5.

Table 4-5: Construction Noise Management Levels, $L_{eq\ 15min}$

Receivers	Recommended Hours	Period	RBL $L_{A90,15mins}$ [dBA]	External Noise Management Level [dBA]
Logger 1: 7B O'Connell Street (400 m from site)	All Hours (Standard Construction Hours)	When in use	46 dB(A)	(46+10) =56 dB(A) (noise affected) 75 dB(A) (highly noise affected)
Logger 2: South carpark (200 m from site)	All Hours (Standard Construction Hours)	When in use	46 dB(A)	(46+10) =56 dB(A) (noise affected) 75 dB(A) (highly noise affected)
Logger 3: WSU East boundary (50 m from site)	All Hours (Standard Construction Hours)	When in use	48 dB(A)	(48+10) =58 dB(A) (noise affected) 75 dB(A) (highly noise affected)
Logger 4: 9 Redwood Place (536 m from site)	All Hours (Standard Construction Hours)	When in use	44 dB(A)	(44+10) =54 dB(A) (noise affected) 75 dB(A) (highly noise affected)
Logger 5: 14 St Charbel Boulevard (150 m from site)	All Hours (Standard Construction Hours)	When in use	49 dB(A)	(49+10) =59 dB(A) (noise affected) 75 dB(A) (highly noise affected)

Table 4-6: Noise at Sensitive Land Use (other than residences)

Land Use	External Management Level, $L_{eq,15min}$ [dBA] (applies when properties are being used)
Commercial premises	70
Passive Recreation area	60

4.5.3 Construction Vibration Criteria

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration and the possibility of them being disturbed or annoyed.
- Vulnerability of the building structures to vibration induced damaged.
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

4.5.3.1 Human Response to Vibration

Humans are very sensitive to vibration, and they can be disturbed, annoyed and have their work activities interfered with if the levels are too high. The Interim Construction Noise Guideline references *"Assessing Vibration: a technical guideline"* (Vibration Guideline) issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration. The Vibration Guideline provides vibration criteria for continuous, impulsive and intermittent vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The criteria are discussed in more detail in the following sections.

4.5.3.2 Continuous and impulsive vibration (1-80 Hz)

According to the Vibration Guideline for continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted root-mean-square acceleration values and results are to be compared against the following preferred and maximum values given for each orthogonal axis. The frequency weightings as per BS6841:1987 (reproduced in Appendix B3 of the guideline) are to be applied to the RMS measurement values (1-80Hz).

The criteria in the Vibration Guideline are derived from the limiting values of the assessment curves and multiplying factors from BS 6472:1992 (the curves are no longer referenced in the superseded version of the standard BS 6472:2008). We have assumed hotels will be assessed as per the criteria for residences.

Table 2.2 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s²) 1–80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
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
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

The Vibration Guideline notes "*Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short-term duration. An example is a construction or excavation project.*"

4.5.3.3 Intermittent vibration (1-80 Hz)

According to the Vibration Guideline for intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV). Acceptable values of vibration dose are given as follows. We have assumed hotels will be assessed as per the criteria for residences.

Table 2.4 Acceptable vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.
Source: BS 6472–1992

4.5.3.4 Structural Response to Vibration - German Standard DIN 4150-3:1999

The German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading. Referenced on the NSW Department of Environmental and Conservation. Assessing Vibration: a technical guideline.

The response of a building to vibration is affected by several factors that include its type of foundation, the underlying ground conditions, its construction and the state of the building. Please note the construction vibration limits are designed to ensure the structural integrity of nearby buildings and are not for human comfort. the limits are well above perceptibility.

According to DIN 4150 short term vibration refers to vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated. Long-term vibration refers to all types of vibration not covered by the definition of 'short-term vibration'. The criteria for short-term and long-term vibration are listed in the following.

4.5.3.5 Guideline Values for evaluation of short-term vibration - DIN 4150-3:1999

The vibration limits of table 1 in DIN 4150-3:1999 (replicated in Table 4-7 below refer to the evaluation of the effects of short-term vibration on structures.

The criteria are the peak particle velocities (pp.) measured on any foundation or uppermost full storey of any building not related to the site and are listed in the Table 4-7 below.

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty that structural damage will not occur at any point or to any equipment inside the building. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, such as failures within the core structures, however, further investigations are necessary. Conversely, exceeding the limits does not necessarily lead to damage.

Table 4-7: DIN 4150-3 Construction Vibration Limits – Short Term

Type of Structures	Guideline values for vibration velocity (mm/s)			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50 Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, **Industrial building** and building of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

4.5.3.6 Guideline Values for evaluation of long-term vibration - DIN 4150-3:1999

The vibration limits of table 3 in DIN 4150-3:1999 refer to the evaluation of the effects of long-term vibration on structures.

The criteria are the peak particle velocities measured on the uppermost full storey of any building not related to the site and are listed in Table 4-8 below.

According to the standard, *exceeding the values listed below does not necessarily lead to damage*.

If a building is subject to harmonic vibration, then maximum values can occur in floors other than the top floor, or in the foundation. The values given also apply in these cases.

Table 4-8: DIN 4150-3 Construction Vibration Limits – Long Term

Type of Structures	Guideline values for velocity, vi, in mm/s of vibration in horizontal plane of highest floor, at all frequencies
Buildings for commercial purposes, Industrial building and building of similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	2.5

5 NOISE AND VIBRATION IMPACT ASSESSMENT

5.1 Mechanical plant Noise Emissions

Based upon the current building design and layout, it is proposed on the mechanical concept design that the to use a mix of cassette units and fan coil units with VRV / VRF Outdoor units, heat rejection of condensed water via geothermal ground sources (no cooling towers), condenser water pumps. Dust extraction systems and exhaust fans for workshops, roof mounted and inline fans.

Main noise emissions to the boundaries from mechanical plant would be:

- ✓ VRF Outdoor units (estimated units type REQYST)
- ✓ Exhaust fans / dust extraction fans / fume extract fans for workshop
- ✓ Stair pressurization fans / smoke extraction fans (only to work during an emergency / tests only to be done during day time)
- ✓ Water pumps (noise is low in comparison with the rest of the mechanical plant)

For preliminary purposes, we have modelled noise levels to the nearest affected residential and commercial boundaries, derived from a preliminary selection of the above equipment.

5.2 Estimated noise emissions from mechanical plant

For the mechanical plant a critical – preliminary scenario was modelled estimating 4 ODU units working simultaneously with an approximate total of 950,000 Btu/h and three extraction fans working in normal conditions with a total 14 kW. For emergency operations the plant was estimated to work in conjunction with a stair pressurisation fan with an airflow of 9 m^3/s SPF fan and a smoke extractor fan with an airflow of 28m^3/s.

For the noise control measures the ODU plant had no acoustic considerations, the extraction fans and the emergency fans were modelled with 1.5 m internal duct lining with min. 50 mm acoustic insulation. Expected total noise from mechanical plant are given below:

Table 5-1: Predicted noise levels from mechanical plant room equipment

Equipment	SPL noise levels over Octave Bands in Hz								
	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	dBA
ODU units	73	72	71	68	63	60	55	48	**70**
Fans	82	78	74	71	70	69	68	67	**76**
Emergency fans	92	90	92	85	85	85	80	73	**91**
Total	93	90	92	85	85	85	80	73	**91**

Notes:

- ✓ Internally lined duct lined with acoustic insulation correction applied to all fans only if necessary / pending on the review for final equipment selection
- ✓ Emergency fans are rotated 90 degrees so they would face the western boundary (where receivers are located more than 400 m and partially shielded by university buildings).
- ✓ Acoustic recommendations are only preliminary and pending on the review for final equipment selection

Considering the above, typical worst-case noise emissions at the nearest affected receiver are presented below in **Table 5-2**. As shown predicted noise levels for typical worst-case scenario were compliant with the noise criteria at the WSU boundary (50 m) and also the residential boundaries (150 m).

Table 5-2: Predicted noise levels from mechanical plant room

Equipment	SPL noise levels over Octave Bands in Hz								
	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	dBA
Total normal operation at 50 m	48	45	41	37	33	32	32	31	**41**
Total normal operation at 150 m	39	35	31	27	24	23	23	22	**31**
Total Emergency operation at 50 m	52	47	46	37	36	36	32	25	**43**
Total Emergency operation at 150 m	43	37	37	28	26	27	23	16	**34**

All the above levels meet the project trigger levels at all times as depicted in Section 4.4, on the two critical receivers. The water pumps type SEC CWP and SEC CT are much quieter than the rest of the mechanical plant, their noise is masked by the rest of the plant, we do not believe they need any acoustic treatment.

5.2.1 Fume extraction fans

A prevision was made for workshop extraction fans, a preliminary model was selected for the workshops with 5.12 m3/s airflow and the below noise levels and recommended treatment to mitigate the noise to the boundaries:

Table 5-3: Predicted noise levels from fume extraction fans

Equipment	SPL noise levels over Octave Bands in Hz								
	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz	dBA
Outlet sound data (SPL at 3 m)	88	90	85	85	84	80	77	74	**88**
IL of Rectangular Acoustic attenuator 0.6 m long	3	6	10	18	28	26	15	12	
Propagation loss at 50m	33	33	32	32	31	31	31	31	
Total	52	51	43	35	25	23	31	31	**40**

Notes:

- ✓ Recommended attenuator is only preliminary, will only be installed if necessary, pending on the review of the final equipment selection
- ✓ The Multi-Trades and Digital Technology Hub Building will be operational until 10.30 pm.

5.3 Electrical generator emissions

For this building it is envisaged to use an electrical generator that will operate during emergency (and will be tested only during daytime), the generator intended to be used is a Stamford HSW-280 T5 Model or similar with standard soundproofing, 309 Kva, 1500 RPM, turbocharged with an expected sound pressure level of 68 +/- 2,3 dBA measured at 7 m distance.

As depicted in Section 2, critical noise receivers for this building are WSU university at 50 m and residential areas at 150 m (south, future residential area) and 200 m (North current residential area). Propagated noise levels of the electrical generator are predicted to be in the order of 40 dBA at 50 m and 30 dBA at 150 m. These levels are below the project trigger levels as depicted in Section 4.4.

5.4 Fire pump Noise

There is provision for a diesel fire pump room located on the ground floor. Sprinkler pumps are used in case of emergency and for regular tests, however these situations are not expected to occur for long periods of time. We understand there is not yet a final selection of the sprinkler pump, however the typical characteristics are as follows:

- Pump: Diesel type, Engine 33kW, speed 3,000 RPM
- Exhaust pipework and gas exhaust critical attenuator: 50mm diameter, approx. 10m max distance.
- Ventilation extraction fans and fresh air supply fans if required
- Dimensions and weight: approx. 1m long, 0.5 m wide, 1 m tall, 200 kg
- Similar diesel pumps report a sound pressure level of 107 dBA at 3m

Our preliminary and conservative estimations of the noise (Sound Power levels) generated by this equipment is maximum 113 dBA inside the plant room and 116 dBA on the exhaust with the estimated levels as per the below table:

Table 5-4: Estimated sound power levels for the diesel sprinkler pump

Diesel Fire Pump noise levels	Max Sound Power Levels (dB) over Octave Frequency Bands (Hz)								Overall Level dB(A)
	63	125	250	500	1k	2k	4k	8k	
Inlet + casing	95	101	101	100	103	102	97	89	**107**
Exhaust	112	118	114	106	102	96	86	78	**109**

To control noise emissions to the adjacent areas, a preliminary allowance is made for the below proposed measures:

- Allowance for Rw 55 walls with internal strapping and insulation
- Allowance for an Rw 45+ roof (precast or lightweight ceiling)
- Internal absorption to walls and internal surfaces to reduce reverberation.
- Acoustic solid core door Rw 36 - 39 with acoustic seals
- Acoustic louvers or attenuators (to satisfy the cooling air requirements) might be allowed by the design
- Attenuator for ventilation fans (fresh air supply fan and hot air extraction fan)
- Acoustic muffler to exhaust gasses.
- Pump settings to be tested only during day time hours.
- The pump room will be partially protected by a retaining wall structure, this might reduce the final required acoustic treatment.
- Nominated acoustic attenuation as per above is preliminary and will be reviewed once final selection is done, being required only if the developed design option triggers this.

Noise propagation to external spaces from the exhaust (critical noise source) and from the inlet + casing noise can be controlled with the proposed configuration and the distance propagation to the critical receiver (WSU spaces) and a suggested critical absorptive muffler as per below:

Table 5-5: Estimated exhaust attenuator specifications and distance propagation losses

Diesel Fire Pump noise levels	Static insertion losses (dB) over Octave Frequency Bands (Hz)								Overall Level dB(A)
	63	125	250	500	1k	2k	4k	8k	
Suggested exhaust Muffler or similar	11	25	37	43	43	34	17	11	
Outdoor propagation to critical receiver (50 m)	42	41	40	39	39	38	38	38	
Final noise from exhaust (day time test)	58	51	36	23	19	23	30	28	**39**

The above recommendations will be finalized once a selection for the sprinkler pump is done. We believe with proper noise control design for the plant room the operation of the sprinkler pump will meet the recommended comfort levels for closest areas and the boundary requirements.

5.5 Outdoor building uses

5.5.1 Outdoor Balcony

The building comprises a small rooftop terrace on Level 1, on the north West façade, shielded to the nearest receivers in the East boundary (WSU building) by the north roof plant, the access stairs and the building façade above the double height industry engagement area located on the upper ground . We note that the use of the outdoor balconies could have the potential outdoor congregation space. For preliminary planning purposes we have assumed a typical worst-case social event using the following assumptions:

- 20 persons on the outdoor balcony, with 50% (or 10 persons) speaking in raised voice at any given time;
- Assumed staged voice sound power level of L_w=74 dB(A) (as per AS2822-1985 Staged Vocal Effort, 66 dB(A) at 1m);
- Total crowd sound power level of Lw84 dB(A) (or 74dB(A) + 10 x log (10) persons);
- Typical distances of 50m to the nearest affected building on the East (WSU building);
- Shielding by the TAFE plant and building façade estimated to be 10 dB;

Predicted Noise levels are summarised below in Table 5.1.

Table 5-6: Predicted Balcony Noise Levels, dB(A) at the nearest affected receivers.

Location	Predicted balcony Noise	PNTL	Complies Yes/No
Day	40	44	**Yes**
Evening		46	**Yes**
Night		40	**Yes**

Based upon these preliminary findings, the use of the balcony spaces for open air use should not exceed the project trigger levels.

5.5.2 Industry Engagement areas / Auditorium areas

On level 1 and upper ground level there are two Industry engagement areas with indoor selected enclosed rooms. There are no envisaged events with music for these Industry engagement areas, therefore we do not consider this as a relevant noise source to impact on the closest receivers.

A PA system will be used for the industry engagement areas and also for the auditorium, these spaces have glazed and non – glazed façade, even if windows can be opened during an event (no music events as stated above), the noise of these events propagated into the closest receiver (50 m away) is predicted to be well below the project trigger levels at all times.

5.5.3 Outdoor covered workshops

On ground level there is a civil sandpit and an outdoor covered workshop and, on both sides, external workshop storage areas (with concrete facades) shielding the noise to the closest receivers at the East boundary (WSU building).

According to DEFRA 2005 database and NSW Transport Roads & Maritime Services Construction Noise and Vibration Guideline, critical noise from the outdoor workshop (with a forklift and hand held tools) on the South façade of the building can be estimated as 81 dBA inside the workshop.

Considering that the external workshop storages provide a partial barrier attenuation and the distance of 50m to the critical receiver (WSU building), we estimate workshop noise emission levels of approximately 41 dBA at the WSU building. This estimated noise level meets the PTNL levels at all times.

5.5.4 Operational Car Park Noise

Based upon the data provided in the Traffix Traffic Assessment it is stated that the new carpark will have a total provision for 16 car parking spaces. The building will also use the current carpark of the existing TAFE campus located south to the new building. Expected peak car park demand will occur between 11 am – noon and it is expected that in the worst-case scenario the carpark demand will be for maximum 277 spaces.

To assess the noise impacts of site related noise emissions the following assumptions were made:

- It was conservatively assumed that all car spaces would be full during a typical peak hour period, - hence for a typical 15-minute assessment period, 25% of on-site car movements will occur i.e. 69 car movements in 15 minutes;
- Entry and exit points are via Gate 1 (O'Connell Street Northern access) and Gate 2 (O'Connell Street Northern access), at typical distances of 50m to the nearest affected receiver on the East.
- Typical event time of 15 seconds, assuming 90m traverse at 15km/h;
- Using a typical vehicle L_{Amax} of 65 dB(A) measured at 8m traversing a carpark

  where: SEL = L_{Amax} + 10 log ((0.5 x (t2-t1)) / t_{ref}) and:

  - *tref = 1 second;*
  - *N = no. events and in period T;*
  - *T = total time period under consideration in seconds which is 15 minutes, or 900 seconds;*
  - *(t2-t1) = duration of single event in seconds (t=15)*

During a critical peak usage for the car park during the Day, predicted carpark noise levels propagated into the closest receiver is less than 40 dBA, which do not exceed the project trigger levels for day, evening and night times.

5.6 General noise from students

Noise generated by students (increased campus capacity) coming inside and outside the new building will be negligible to the nearest receivers.

5.7 Summary operative noise sources and Project Trigger levels

The following table summarises the expected noise level (dBA) for the critical receivers (50 m) for operative sources in comparison with the Project trigger levels to identify any possible exceedances:

Table 5-7: Summary of operative noise sources and project Trigger Levels

Noise source	Expected noise level	PNTL	Exceedance Y/N Critical receiver (50 m)
Mechanical Plant – Normal operation	41 / 38 (night)	Day 44 dBA / Evening 46 dBA / night 40 dBA	Y / Night time with reduced operation
Mechanical Plant – Emergency operation	43		Y / no testing during night time
Fume extraction fans	40		Y
Electric generator	40		N
Fire pump	39		N
Outdoor building uses – Balcony	40		N
Outdoor building uses – Outdoor workshop	41		N
Carpark noise	40		N
Students noise / PA system in Auditorium and industry engagement areas	Negligible		N

Notes:

- Mechanical plant reduced operating condition during night time assumes less number of extraction fans and ODU units operating. In the critical scenario we estimate a noise in the critical receiver of 38 dBA (this meets the project PTNL levels).
- Expected exceedance only occur during night time. And can be controlled:
    - Emergency operation tests will not be conducted during night time (no exceedance)
    - Mechanical plant during night time will not be working on a normal 100% operation, therefore it is not expected to exceed the night criteria (estimated night time operation in the critical receiver is 38 dBA)

5.8 Construction Noise

5.8.1 Construction Plant Noise Levels

At the time of writing, the proposed construction plant and equipment for the project remains subject to further development. For preliminary assessment purposes and based on previous experience on similar projects, we have assumed that the following plant and equipment will be used in the Excavation, Structural / Piling Works and fitout phases.

These plant items are summarised below in Table 5-8. Estimated operating distances to the receivers are: 50m, 150 m, 200 m, 400 m and 536 m, with predicted construction noise emissions presented in Section 0 below.

Table 5-8: Typical External Noise Levels of Demolition and Construction Machinery/Activity

Item #	Activity /Machinery	Source and reference number	Leq Sound Pressure Level at 10m (dBA)
Excavation and Demolition			
1	Tracked excavator, 30 t, 170kW	BS 5228 – 1:2009 Table C2 Ref 16	75
2	Articulated dump truck 23 t, 187 kW	BS 5228 – 1:2009 Table C4 Ref 2	78
3	Wheeled Loader 184 kW, 23 t	BS 5228 – 1:2009 Table C10 Ref 17	84
4	Dozer 28 t	BS 5228 – 1:2009 Table C2 Ref 11	79
5	Tracked mobile crane 132 Kw / 55 t	BS 5228 – 1:2009 Table C3 Ref 29	70
Structural / Piling Works			
6	Tracked excavator, 30 t, 170kW	BS 5228 – 1:2009 Table C2 Ref 16	75
7	Articulated dump truck 23 t, 187 kW	BS 5228 – 1:2009 Table C4 Ref 2	78
8	Large Piling rig 110 t / 10 m deep / 450 mm – 900 mm diameter max	BS 5228 – 1:2009 Table C3 Ref 17	76
9	Concrete mixer discharging with concrete Pump 26 Ton / 7 m3 + 22m boom	BS 5228 – 1:2009 Table C4 Ref 28	75
10	Tracked mobile crane 132 Kw / 55 Ton	BS 5228 – 1:2009 Table C3 Ref 29	70
Fit out Works			
11	Concrete mixer discharging with concrete Pump 26 Ton / 7 m3 + 22m boom	BS 5228 – 1:2009 Table C4 Ref 28	75
12	Handheld cordless nail gun (15 to 50 mm nails)	BS 5228 – 1:2009 Table C4 Ref 95	73
13	Diesel Generator	BS 5228 – 1:2009 Table C4 Ref 78	66
14	Tower Crane 88 Kw / 22 t	BS 5228 – 1:2009 Table C4 Ref 48	76
15	Diesel scissor lift 24 Kw / 6 t	BS 5228 – 1:2009 Table C4 Ref 59	78
16	Dust suppression unit trailer	BS 5228 – 1:2009 Table C4 Ref 91	57

Notes:

- ✓ NSW DECC 2009 Construction noise Guideline quotes on Appendix B Equipment Noise levels, the DEFRA 2005 database, which includes the above referenced BS 5228 – 1:2009 noise levels.

- ✓ According to the geotechnical consultant, the contractor will probably not require any rock breaking equipment.

5.8.2 Predicted Construction Noise

Based upon the above plant sound power levels, predicted construction noise levels for the various works phases are presented below in Table 5-9. As shown construction noise levels during all phases (excavation, structural works and fitout phases) were predicted not to exceed 75 dB(A). Under the ICNG, this situation does not require the construction noise to be managed as part of a construction noise and vibration management plan.

In addition, during fit out works it is anticipated that noise levels will have less noise impact. Recommended construction noise management measures have been provided in Section 7.5 of this report.

Table 5-9: Predicted construction noise $L_{eq,15min}$

Receivers	Recommended Hours	Period	Predicted Construction Noise Level	External Noise Management Level.
Excavation Phase				
50 m affected (WSU building east boundary)	Monday - Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	70 dB(A)	58 dB(A)(noise affected) 75dB(A) (highly noise affected)
150 – 200 m affected (residential north boundary) * or potential future south residential boundary			64 – 62 dB(A)	75dB(A) (highly noise affected)
> 400 m affected (residential west and east boundaries)*			56 dB(A)	75dB(A) (highly noise affected)
Structural Works Phase				
50 m affected (WSU building east boundary)	Monday - Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	70 dB(A)	58 dB(A)(noise affected) 75dB(A) (highly noise affected)
150 – 200 m affected (residential north boundary) * or potential future south residential boundary			62 – 60 dB(A)	75dB(A) (highly noise affected)
> 400 m affected (residential west			55 dB(A)	75dB(A) (highly noise affected)

and east boundaries)*				
Fit out Phase				
50 m affected (WSU building east boundary)	Monday - Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	70 dB(A)	58 dB(A)(noise affected) 75dB(A) (highly noise affected)
150 – 200 m affected (residential north boundary) * or potential future south residential boundary			60 – 57 dB(A)	75dB(A) (highly noise affected)
> 400 m affected (residential west and east boundaries)*			51 dB(A)	75dB(A) (highly noise affected)

Notes:

- ✓ *NB: 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. A minus 30 m correction was done to the distances in these cases to meet this clause.
- ✓ Residential zone on the north is located opposite site of the 6 lane Great Western Highway, probably this area will not be affected by the construction or operational noise of this development.
- ✓ Future residential zone on the south is only a potential residential receiver, will not likely be affected by the noise of this development.
- ✓ Above calculation considers all plant working 100% of the time on each construction phase (worst case scenario)
- ✓ Above calculation does not consider any perimeter hoarding or acoustic screen

5.9 Summary of construction noise sources and Project Trigger levels

The following table summarises the expected noise level (dBA) for the critical receivers (50 m) for construction sources in comparison with the maximum allowed construction noise levels to identify any possible exceedances:

Table 5-10: Summary of construction noise sources and project Trigger Levels

Noise source	Expected noise level	PNTL	Exceedance Y/N
Excavation Phase	70 dBA	75 dBA Highly affected	N
Structural Phase	70 dBA		N
Fit out phase	70 dBA		N

5.10 Preliminary Vibration Assessment

It is important to note that construction vibration levels depend on several factors. These include the activity, the machine, the geology of the ground and the distance between the building and the source. Surface works are expected to have a lower vibration impact than ground compacting/breaking works.

Compliance with vibration limits is expected based on ensuring ground compacting equipment is selected to adherer to minimum safe working distances. While these magnitudes do not predict cosmetic/structural damage, it is anticipated that human response/comfort would be impacted at these distances. The current RMS Construction Noise and Vibration Guideline sets safe working distances for vibrating plant and equipment. These are summarised below in Table 5-11. As shown the use of large hydraulic hammers would not be recommended for these works. Hence it is recommended that the use of smaller rock breakers and hand held jackhammers are used for activity close to the nearest affected residential receivers.

Table 5-11: RMS Plant Vibration Safe Operating Distances - *Construction Noise and Vibration Guideline 2016*

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	2 m

Piling activities vibration estimations are included below, using Table E.1 Empirical Predictors for groundborne vibration arising from mechanized construction works of the BS 5228 – 2.2009-part II Vibration

Table 5-12: Percussive and Vibratory Piling estimated vibration levels as per Table E.1 of the BS 5228 – 2.2009

Equipment	Vibration level PPV (mm/s) Vibratory Piling (extraction of casing)	Vibration level PPV (mm/s) Percussive piling	Source
Piling: Critical cases, located at 50 m from WSU building	2.4 mm/s	0.3 mm/s (very stiff soil) / 0.1 mm/s (cohesive soil)	Table E1. BS 5228-2:2009
Piling: Standard cases, located at 150 m from residential boundary	0.5 mm/s	Negligible impact	Table E1. BS 5228-2:2009

Notes:

- ✓ As confirmed by Geotechnical consultant, it is not anticipated that vibratory piling will occur on this development, vibration levels are estimated to be low and we do not anticipate this being a problem even for the critical receiver.
- ✓ BS 5228:2009 recommends that for vibrations over 1.0mm/s affected residents should be given prior warning and explanation as to the cause of the vibration.
- ✓ Vibratory piling is not recommended for the East boundary (near WSU building)
- ✓ These levels were calculated (based on kv=33.3% / δ = 1.4 steady state operations) considering a pile depth of 10 m, and horizontal separations as shown above, and a medium to dense granular soils (worst case scenario).

6 ROAD NOISE INTRUSION

The main cumulative impact from the surrounding environment to consider for this project is the current road noise intrusion. As per Table 3.1 of Development Near Rail Corridors and Busy Roads – Interim Guideline, for Non-residential buildings (educational institutions), recommended maximum internal noise level is 40 dBA. According to AS / NZS 2107:2016, the recommended internal noise level for these type of learning spaces and engineering workshops is 45 dBA

The north façade of the development is located at 156 m from the Great Western Highway with learning spaces and workshops adjacent the facade. A critical noise level of 64 dBA for evening time was estimated based on the noise loggers' results (Refer to Table 4-2), using a line noise source propagation to model the Great Western Hwy into the critical façade of the Construction Centre (North façade located at 156 m from the Hwy).

We understand the building façade will be comprised of precast panels (minimum 100 mm thick) and glazed curtain wall. We recommend installing the glazing types listed in **Table 6-1** in order to meet the internal noise requirements. Other glazing options with similar lab rated transmission loss values may be suitable as well but need to be reviewed by NDY.

Based upon current assessment for the project it is recommended that 6.38 mm single laminated glazing or 6 mm / 12 mm / 6 mm double glazing will be suitable for the acoustic requirements of this project. The external noise intrusion into the workshop areas was analysed based on the glazing areas and room sizes, assuming a maximum ceiling height of 2.8 m for single height workshop and 4.8 m for double height workshop.

Table 6-1: Façade construction specification

Glazing Type	Required Minimum Field Transmission Loss (dB) over Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
6.38 mm Laminated glass	18	24	29	31	36	33	38
6 mm / 12 mm / 6 mm	26	22	23	30	32	32	38

Note that is important that we have test data from the manufacturer of the final approved glazing. Glazing to the facade is assumed to be sealed, as ventilation and cooling/heating will be provided mechanically.

6.1 Glazing Framing

All framing housing glazing will need to be constructed to such a standard that the sound insulation performance of the glazing is not significantly degraded.

A high-quality aluminium framing section is recommended to ensure that the performance of the selected glazing is not compromised by sound leakage via the framing section itself nor the perimeter seals. We recommend one of the following framing products:

- 39mm OAW Suite, supplied by Framerite, Nebulite, etc.
- 48mm Atlantic Suite, supplied by Nebulite.
- Thermosash Delta Suite

7 RECOMMENDATIONS

Based upon the findings in this report, the following recommendations to mitigate noise impacts during operation and during construction are provided below.

7.1 Mechanical Plant Noise

It is understood that the development will include mechanical plant and HVAC equipment which will be located on level 1 plant room space (south side of the building). At this stage, the detailed design and selection of mechanical plant is still to be finalised.

Please refer to Section 7.1, It is anticipated that HVAC equipment will be able to meet the project trigger levels. Treatment as recommended in Section 7.1 can be combined with any of the following options:

- Selection of low noise units;
- Strategic location of equipment away from most sensitive receivers;
- Building shielding;
- Distance attenuation;
- Duct internal acoustic lining (as recommended);
- Acoustic barriers (if exceed the above recommendations).
- Limited operating regime during the night time, expected levels are below the project trigger levels as depicted in Section 4.4. Final condition will be calculated as the project progresses and the final selection of equipment is made.

For preliminary purposes a limiting aggregate sound power level of Lw 88 dB(A) in normal operating condition and Lw 102 dB(A) in emergency operating condition is recommended to achieve the NPfI requirements at the nearest affected residential locations at night.

7.2 Generator Noise

The electrical generator will operate during emergency (and will be tested only during daytime), the generator intended to be used is a Stamford HSW-280 T5 Model or similar with standard soundproofing with an expected sound pressure level of 68 +/- 2,3 dBA measured at 7 m distance. Propagated noise levels of the electrical generator are predicted to be in the order of 40 dBA at 50 m and 30 dBA at 150 m. These levels are below the project trigger levels as depicted in Section 4.4

7.3 Fire Pump Noise

To control the noise from the diesel sprinkler pump we have proposed minimum construction standards and noise mitigation measures that will be detailed as the project progresses such as wall and ceiling constructions, allowance for internal absorption and attenuators, louvers and mufflers if necessary. Expected levels are below the project trigger levels as depicted in Section 4.4

7.4 Workshop Noise

Workshops are located far from the closest receivers; therefore, we anticipate that no stringent noise considerations for the façade and glazing are required. This will be updated as the project progresses. It is anticipated during detailed design of the workshops that reverberation control treatments will be reviewed to reduce reverberant noise build-up within the workshops. Acoustic rated walls and attenuators on extraction fans are likely to be required.

In addition to this, we propose that the outdoor workshops limit their operation between 7 am to 6 pm, therefore we anticipate that their noise emissions will meet the project trigger levels as depicted in Section 4.4

7.5 Construction Noise and Vibration

The findings of this assessment have determined that construction works, which is undertaken during standard hours will not exceed the Highly Noise Affected criteria of 75dB(A) or greater during construction works. Hence it is anticipated that a construction noise and vibration management plan will not be required for these works.

The findings have proposed that construction noise is managed through feasible and reasonable noise mitigation measures, outlined in the NSW Interim Construction Noise Guideline and Australian Standards 2436-2010. Additional site and noise management practices have been provided below for guidance purposes.

7.5.1 Construction Noise and Vibration Management Plan

Predicted construction noise levels were determined not to exceed the 'Highly Noise Affected' noise levels, which have been specified in the Interim Guide for Construction Noise (ICNG). However the Interim Guide for Construction Noise (IGCN) list a number of typical best practice measures which can be used to reduce construction related impacts. In addition, Australian Standards 2436-2010 provides best practice measures to mitigate construction noise and vibration.

The following recommendations should be also considered in the development of a construction noise and vibration management plan for the site, when details of the contractor works methodology become finalised.

7.5.1.1 General/Site Management Issues

- All employees, contractors and subcontractors are to receive an environmental induction and should instruct all persons at the site with regard to all relevant project specific and standard noise mitigation measures, including but not limited to permissible hours or work, limitation of high noise generating activities, location of nearest affected noise receivers, construction employee parking areas, designated loading/unloading areas and procedures, site opening/closing times (including deliveries) and environmental incident procedures.
- A dedicated person will form a point of contact for dissemination of general information regarding site operations. Contact persons will also be defined to receive comment or complaints from the community.

7.5.1.2 Construction Activities and Mitigation

The following general construction noise source control measures may be required:

- During extended construction hours, less intrusive works will be scheduled to be carried out and/or works will be carried out away from sensitive receivers;
- Avoid unnecessary revving of engines and turn off plant that is not being used/required;
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms;
- Where possible, avoid using tonal reverse alarm outside standard construction hours;
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously;
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to day period;
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling;

- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors;
- Use less noise intensive equipment where reasonable and feasible;
- Where practical fixed plant should be positioned as far as possible from the sensitive receivers;
- Use temporary site buildings and material stockpile as noise barrier;
- Employ the use of solid barrier plywood hoardings if required;
- Where practical, a partial enclosure shall be used to minimise noise levels.

7.5.1.3 Construction Noise Controls

General/ Work Practices:

- Avoid unnecessary revving of engines and turn off plant that is not being used/required.
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
- Where possible, avoid using tonal reverse alarm outside standard construction hours.
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to daytime period.
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors.
- Use less noise intensive equipment where reasonable and feasible.

Use and sitting of equipment/activities:

- Where practical fixed plant should be positioned as far as possible from the sensitive receivers.

Enclosures:

- Use temporary site buildings and material stockpile as noise barrier.
- Employ the use of solid barrier plywood hoardings if required.
- Where practical, a partial enclosure shall be used to minimise noise levels.

7.5.1.4 Construction Vibration Controls

Structural Damage:

- Use lower impact or low tonnage equipment – use of small rock breakers.
- Maintain safety distance between construction plant and building, to be determined during detailed design stage.

Human Annoyance:

- Scheduling the use of vibration causing equipment at the least sensitive time of the day.
- Sequencing operations so that high vibration causing activities to do not occur simultaneously.

8 OUTSTANDING IMPACTS

As per section 7 above, after installing the noise and vibration mitigation measures proposed in this report, no outstanding impacts from the development are expected.

9 CONCLUSION

A noise impact assessment was undertaken for the proposed TAFE NSW Construction Centre of Excellence, located on 2 – 44 O'Connell Street, Kingswood

Noise and vibration emissions to receivers were assessed on this report. However, it is anticipated that the construction and operating noise emissions can mitigated through the distance attenuation, shielding by a series of existing TAFE NSW Buildings and the natural topography of the site, use of acoustic treatment on mechanical plant and sprinkler plant room when necessary.

The selection of mechanical plant and equipment is yet to be finalised. However, based on the information that we have, and our estimations included in sections above, it is anticipated that noise emissions to the boundary can be controlled using standard engineering measures outlined in this report. Limiting aggregate sound power levels have been provided to facilitate mechanical plant detailed design.

General conclusions are listed below:

- ✓ Events hosted at this building are not expected to have loud music, this will not impact the surrounding areas.
- ✓ Loggers were placed in all critical locations, as agreed with the project planning team. Rated background levels and project trigger levels are in accordance with each receiver zone and are representative of the noise receivers.
- ✓ Mechanical plant (fans + ODU units), generator and sprinkler pump sizing and general acoustic treatment was done considering the critical scenario liaising with the mechanical consultant of the project.
- ✓ Smoke extract fans, stair pressurization fans, electrical generator only operating during emergencies and tested during day time, outlets rotated to the west boundary. Also an allowance of internal duct lining with acoustic insulation for all fans, pending to the final selection of the equipment.
- ✓ Model for all mechanical plant working simultaneously, including normal and emergency operation, meet the project trigger levels.
- ✓ Mechanical plant will work on a less stringent operating regime during night time.
- ✓ Preliminary findings suggest that the operation of the workshops will not require an extensive acoustic design for the façade, it is anticipated that absorptive finishes will be reviewed during detailed design, to reduce reverberant noise levels inside the workshops and treatment for extraction fans potentially.
- ✓ Outdoor workshops will limit their operation to day time.
- ✓ Preliminary acoustic treatment was calculated for the fume extract fans to meet the project trigger levels at the critical receiver (acoustic attenuators, pending to the final selection of the equipment).
- ✓ Water pump noise is relatively low in comparison with the rest of the mechanical plant, we do not expect they will require any acoustic treatment.
- ✓ A general allowance of acoustic treatment was made for the fire sprinkler pump room (considering internal absorption lining, acoustic door, walls and roof construction and a gas muffler), the fire pump room is only to be tested during day time.
- ✓ The electric generator intended to be used is a soundproof cabin and complies with the project trigger levels in the critical scenario at all times. If the selection changes, it might require acoustic mitigation measures.
- ✓ Construction noise levels were predicted for the critical scenarios (50 m, 150 - 200 m and 400 m): considering all plant working 100% of the time on each construction phase (worst case scenario) without any perimeter hoarding or acoustic screen and considering the 30 m correction to receivers that are located more than 30 m distance from the construction. All predicted noise levels are below 75 dBA, therefore there is no need for a Construction Noise and Vibration Management plant.

- ✓ Construction vibration calculations in the most onerous activity (piling works) were done considering both cases percussive and vibratory piling and also considering cohesive an very stiff soils, vibration levels. Vibratory piling is not recommended for the East boundary (near WSU building)
- ✓ Additional recommendations are given if mechanical plant exceeds the estimated levels using Strategic location of equipment away from most sensitive receivers, building shielding and acoustic barriers or louvers.
- ✓ The findings of this assessment have determined that construction works, which is undertaken during standard hours will not exceed the Highly Noise Affected criteria of 75dB(A) or greater during construction works. Hence it is anticipated that a construction noise and vibration management plan will not be required for these works.
- ✓ Additional recommendations to mitigate construction noise should be also considered in the development of a construction noise and vibration management plan for the site, when details of the contractor works methodology become finalised.
- ✓ Estimated noise levels from the new carpark and the increase in the use of the existing TAFE carpark that also service the Construction Centre of Excellence, do not exceed the project trigger levels for day, evening and night times.
- ✓ Noise generated by students (increased campus capacity) coming inside and outside the new building is negligible to the nearest receivers.
- ✓ A PA system will be used for the industry engagement areas and also for the auditorium, these spaces have glazed and non – glazed façade, even if windows can be opened during an event (no music events as stated), the noise of these events propagated into the closest receiver (50 m away) is predicted to be below the project trigger levels at all times.

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