dwp

design worldwide partnership

22nd January 2020

The Planning Secretary
Department of Planning, Industry & Environment
320 Pitt Street
Sydney, NSW 2000

Attention: Megan Fu
Project: Nihon University Newcastle Campus - SSD 9787
Re: Conditions of Consent C11

Dear Megan,

Reference is made to SSD 9787 Conditions of Consent C11 in relation to the Construction Noise and Vibration Management Sub-Plan requirements for the development.

Please find attached a copy of the Construction Noise and Vibration Management Sub-Plan prepared by the contractor Built Pty Limited. The document addresses the construction noise and vibration management of the development during the construction processes. A copy of the plan has been forwarded to the Certifier.

Should you require further clarification on document please feel free to contact either Katherine Daunt or Edward Clode at dwp Australia Pty.

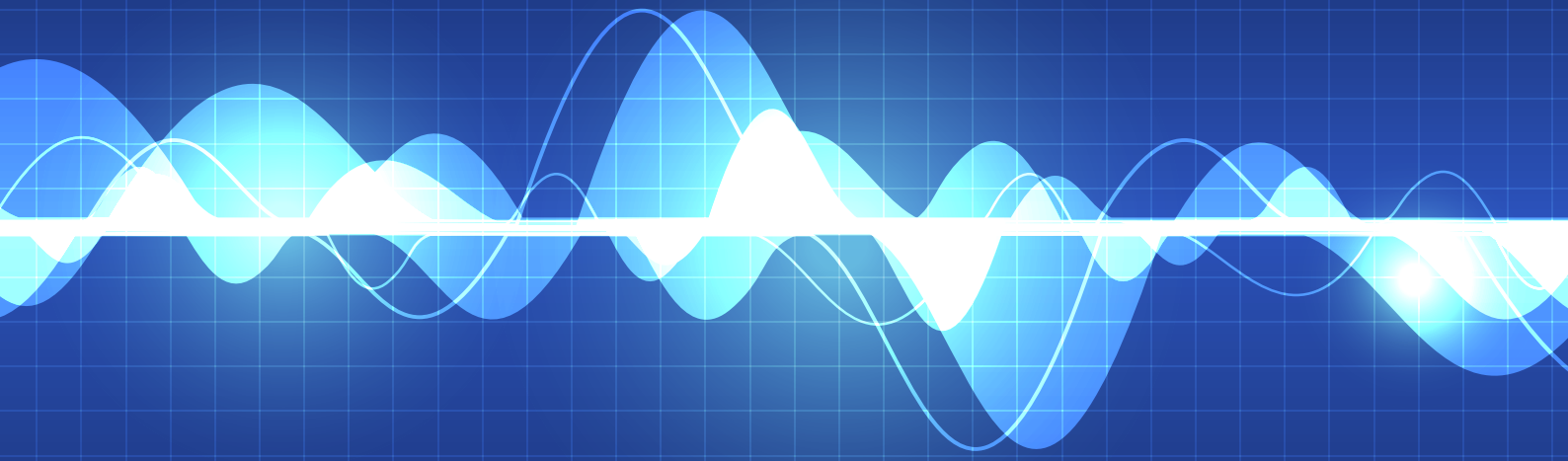
Yours sincerely,

Edward Clode
Design Director
Registered Architect – NSW ARBN 4100
Email: edward.c@dwp.com
File: 17-0347_A-d01-20_let
Encl.: EMM Appendix 23 Noise and Vibration Plan v1-0

Nihon University - Newcastle Campus

Noise and Vibration Assessment - Operational and Construction

Prepared for Azusa Sekkei
May 2019



EMM
creating opportunities

EMM
creating opportunities

Servicing projects throughout Australia and internationally

SYDNEY
Ground floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 1, 146 Hunter Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 10, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE
Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
187 Coventry Street
South Melbourne VIC 3205

PERTH
PO Box 8155
Fremantle WA 6160

CANBERRA
PO Box 9148
Deakin ACT 2600

Noise and Vibration Assessment - Operational and Construction

Nihon University - Newcastle Campus

Prepared for Azusa Sekkei
May 2019

EMM Newcastle
Level 1, Suite 6, 146 Hunter Street
Newcastle NSW 2300

T 02 4907 4800
F 02 4907 4899
E info@emmconsulting.com.au

www.emmconsulting.com.au

Noise and Vibration Assessment - Operational and Construction

Nihon University - Newcastle Campus

Report Number

H190015 RP#1

Client

Azusa Sekkei

Date

1 May 2019

Version

v1-0 Final

Prepared by

Lucas Adamson
Acoustic Consultant
1 May 2019

Approved by

Katie Teyhan
Associate
1 May 2019

Table of Contents

Appendices

Tables

Figures

1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged by Azusa Sekkei on behalf of Nihon University Group to prepare a construction noise and vibration assessment (CNVA) to support a development application (DA) for the Newcastle Nihon University campus and associated 108 bed student accommodation at 9 Church Street, Newcastle NSW (the project).

This report presents an assessment of potential construction and operational noise and vibration impacts from the proposed development on the surrounding community and provides recommended mitigation and management measures. The assessment has been guided by the following:

- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry* (NPfI);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*;
- Standards Australia – AS 1055-2018 *Acoustics - Description and measurement of environmental noise*;
- Australian Standard AS 2436-2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*; and
- State Environmental Planning Policy (Infrastructure) 2007.

Several technical terms are required for the discussion of noise and vibration. These are explained in Appendix A.

2 Project and site description

2.1 Project description

The proposed development is to be located at 9 Church Street, Newcastle. The site currently comprises of three buildings formerly used as the Newcastle Courthouse .

The site will be redeveloped into the proposed Nihon University Newcastle campus with an associated 108 bed student accommodation. The proposal will involve the adaptive reuse of the State listed heritage building known as the Courthouse. The proposed development will comprise the following elements:

- demolition of the Administration Building (east wing) and Supreme Court Building (west wing);
- change of use and minor internal alterations to the former Courthouse to a 'Community Building' to be utilised by both students and the general public for educational purposes;
- construction of two new 4-storey buildings consisting of a 108 bed 'Residential Building' (east wing) and 'Education Building' (west wing);
- service vehicle access from Church Street along an existing eastern boundary driveway;
- ground level car parking; and
- associated ground and rooftop landscaping.

The proposed works will include demolition, excavation and construction activity associated with the development. The broad construction methods and schedule are summarised in Table 2.1

Table 2.1 Broad construction methods and schedule

Project timing	Likely activities
3 months approx.	Demolition of existing structures
6 months approx.	Piling and bulk excavation (heavy machinery and truck movements) Rock cutting and hammering for foundation piles and footings
18 months approx.	Structural works including formwork, reinforcement and concrete pouring. Façade treatments consisting of aluminum and glass panels, face brick work, precast concrete panels. Concrete pumping and placing, grinding/cutting
12 months approx.	Internal fit-out - dry wall construction, services and various fit-out trades
6 months approx.	Civil works such as roads, pavement and landscaping

Notes: Please note that the above project timing is indicative only and may vary depending on approval, regulation, weather, etc.

2.2 Site description

With an overall area of approximately 5,194m², the majority of the site is occupied by existing buildings with a driveway entry on the eastern side of the property, leading to an at-grade carpark area in the rear south-eastern corner. The site is bounded by Church Street to the north, Newcastle Police Station to the east and James Fletcher

Hospital to the south and west. Figure 2.1 shows the boundary of the proposed development and surrounding land uses.

The nearest noise-sensitive receptors potentially affected by noise from the subject site are residences on Church and Bolton Streets (located to the north of the project site) and adjacent commercial businesses. The nearest residences are located approximately 20 m from the northern boundary of the subject site while the nearest commercial properties are approximately 5-10 m from the eastern, southern and western boundaries of the site.

2.3 Construction hours

Construction works are proposed during the following hours:

- 7:00 am – 6:00 pm, Monday to Friday;
- 8:00 am – 1:00 pm, Saturday; and
- No works to be undertaken on Sundays or public holidays.

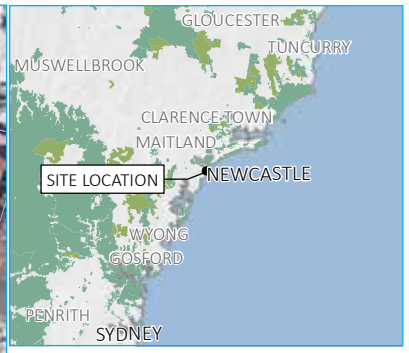
2.4 Assessment locations

The nearest noise-sensitive receptor locations are residences located on Bolton and Church Streets, approximately 20 m north of the site. Representative assessment locations considered in the noise assessment are listed in Table 2.1 and are shown in Figure 2.1.

Table 2.2 Assessment locations

ID	Receptor Type	Description / Address
R1	Residential	Residence, 58 Bolton Street, Newcastle
R2	Commercial	Grand Hotel, 32 Church Street, Newcastle
R3	Residential	Residence, 30 Church Street, Newcastle
R4	Commercial	Newcastle Police Station, 1 Church Street, Newcastle
R5	Hospital	James Fletcher Hospital, 72 Watt Street, Newcastle
R6	Hospital	James Fletcher Hospital, 15 Church Street, Newcastle

The assessment locations represent those most likely to be affected by the project. Adherence with noise criteria at these locations would indicate that noise criteria will be met at other surrounding noise-sensitive locations.



KEY

- Subject site
- Cadastral boundary
- Assessment location
- Noise monitoring location

Source: EMM (2019); DFSI (2017); GA (2011)

0 50 100

GDA 1994 MGA Zone 56

N

\\emmsvr1\EMM\Jobs\2019\H190015 - Newcastle Courthouse Biodiversity\GIS\02_Maps\N001_AssessmentAndMonitoringLocations_20190418.mxd 18/04/2019

Noise monitoring and assessment locations

Nihon University – Newcastle campus
Noise and vibration management plan
Figure 2.1

EMM creating opportunities

2.5 Existing ambient noise environment

Short-term operator attended noise monitoring was conducted to establish the existing ambient noise environment surrounding the proposed development site. The location of monitoring was selected to record background and ambient noise levels at locations representative of receptors potentially most-affected by noise from the proposed development. The operator attended noise monitoring location (L1) can be seen in Figure 2.1.

A Brüel & Kjær 2250 Type 1 sound analyser (s/n 2759405) was used to conduct 15-minute attended measurements and record 1/3 octave frequency and statistical noise indices. The sound analyser was calibrated before and on completion of the survey using a Brüel & Kjær Type 4230 calibrator (s/n 1276091). Attended measurements were conducted in accordance with Australian Standard (AS) 1055-2018 *Description and Measurement of Environmental Noise,* Parts 1, 2 and 3. The instrumentation's calibration certificates are provided in Appendix C.

Where possible throughout each survey, the operator has quantified the contribution of each significant noise source. This was done by matching audible sounds with the response of the analyser (where applicable) and/or via post-analysis of data.

Meteorological conditions throughout each survey period were generally calm and clear with no winds above 5 m/s at microphone height or rain events.

Table 2.3 presents the results of the attended noise measurements, description of the ambient noise environment and quantification of existing noise levels at nearby residences.

Table 2.3 Attended noise monitoring summary

Location	Date	Start time	Period[1]	L_{Aeq}	L_{A90}	L_{Amax}	Comments
L1 Corner of Bolton & Church Streets	17/4/19	11:52	Day	58	49	80	Urban hum (nearby fans, pumps, etc.) and distant traffic noise consistent. Car passbys frequent. Bird noise, aircraft noise, pedestrian noise and wind in trees occasional.
	17/4/19	21:45	Evening	56	45	75	Urban hum (nearby fans, pumps, etc.) and insects consistent. Distant traffic, car passbys and nearby hotel noise frequent. Resident noise, pedestrian noise and dog barking occasional.
	17/4/19	22:15	Night	55	45	71	Urban hum (nearby fans, pumps, etc.) and insects consistent. Distant traffic and car passbys frequent. Pedestrian noise occasional.

Notes: 1. The daytime is 7 am to 6 pm; evening 6 pm to 10 pm; night-time 10 pm to 7 am. On Sundays and Public Holidays, the daytime is 8 am to 6 pm; evening 6 pm to 10 pm; night-time 10 pm to 8 am.

Results of operator-attended noise surveys indicate that road traffic and, to a lesser extent, existing commercial operations are the main contributors to ambient noise levels in the vicinity of the site.

3 Construction noise and vibration guidelines

3.1 Interim Construction Noise Guideline

The ICNG provides guidelines for the assessment and management of noise from construction works.

The ICNG suggests the following time restriction for construction activities where the noise is audible at residential premises which are consistent with those proposed for the subject development:

- Monday to Friday 7.00 am–6.00 pm;
- Saturday 8.00 am–1.00 pm; and
- No construction work is to take place on Sundays or public holidays.

Table 3.1 is an extract from the ICNG and provides noise management levels for residential receivers for both recommended standard construction hours and outside of these periods. These time restrictions are the primary management tool of the ICNG.

Table 3.1 ICNG residential criteria

Time of day	Management level $L_{Aeq,15\ minute}$	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 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 $L_{Aeq,15\ minute}$ 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	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: i) 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; and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Table 3.1 ICNG residential criteria

Time of day	Management level $L_{Aeq,15\ minute}$	How to apply
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

In summary, the ICNG noise level goals for activities during standard construction hours are 10 dB above the existing background levels. Table 3.2 is an extract from the ICNG and provides noise management levels for other land uses.

Table 3.2 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15\ minute}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC, 2009).

The construction noise management levels (NMLs) for this assessment presented in Table 3.3 have been developed using the noise monitoring data provided in Section 2.5 and in accordance with the ICNG.

Table 3.3 Construction noise management levels

Receiver	Period	Representative RBL, dB(A)	NML[1], $L_{Aeq,15\ minute}$, dB
Residential - west (nearest potentially affected)	Recommended standard hours	49	Noise affected: 59 Highly noise affected: 75
Offices, retail outlets	When in use	N/A	70
Neighbouring industrial premises	When in use	N/A	75
Classrooms	When in use	N/A	45 (Internal)/55 (External)
Hospital wards and operating theatres	When in use	N/A	45 (Internal)/55 (External)
Places of worship	When in use	N/A	45 (Internal)/55 (External)

Table 3.3 Construction noise management levels

Receiver	Period	Representative RBL, dB(A)	NML[1], $L_{Aeq,15\ minute}$, dB
Active recreation areas	When in use	N/A	65
Passive recreation areas	When in use	N/A	60

Notes: 1. External noise levels, except where noted.
N/A = not applicable.

3.2 Human comfort – Assessing vibration a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC, 2006) is based on guidelines contained in BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz).

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 3.4.

Table 3.4 Examples of types of vibration (from Table 2.1 of the guideline)

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, intermittent nearby 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 these would be assessed against impulsive vibration criteria.

Continuous and intermittent vibration is expected to be most relevant to this project. Relevant criteria for these types of vibration are described in the following sections.

3.2.1 Continuous vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to continuous vibration (1-80Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 3.5 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 3.5 Criteria for exposure to continuous vibration

Place	Time	RMS velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.1	0.2
Residences	Daytime	0.2	0.4
	Night-time	0.14	0.28
Offices	Day or night-time	0.4	0.8
Workshops	Day or night-time	0.8	1.6

Notes: 1. RMS = root mean square velocity.
2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

3.2.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer *section 2.4.1* of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for intermittent vibration are reproduced in Table 3.6.

Table 3.6 Acceptable vibration dose values (VDV) for intermittent vibration (m/s $^{1.75}$)

Location	Daytime		Night-time	
	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	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

Notes: 1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.
2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The Guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

3.3 Structural vibration criteria

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 "*Explosives - Storage and Use - Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2*" be used as they are "applicable to Australian conditions".

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3.7 and graphically in Figure 4.1.

Table 3.7 Transient vibration guide values - minimal risk of cosmetic damage

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

The standard states that the guide values in Table 3.7 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3.7 may need to be reduced by up to 50%.

Sheet piling activities (for example) are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

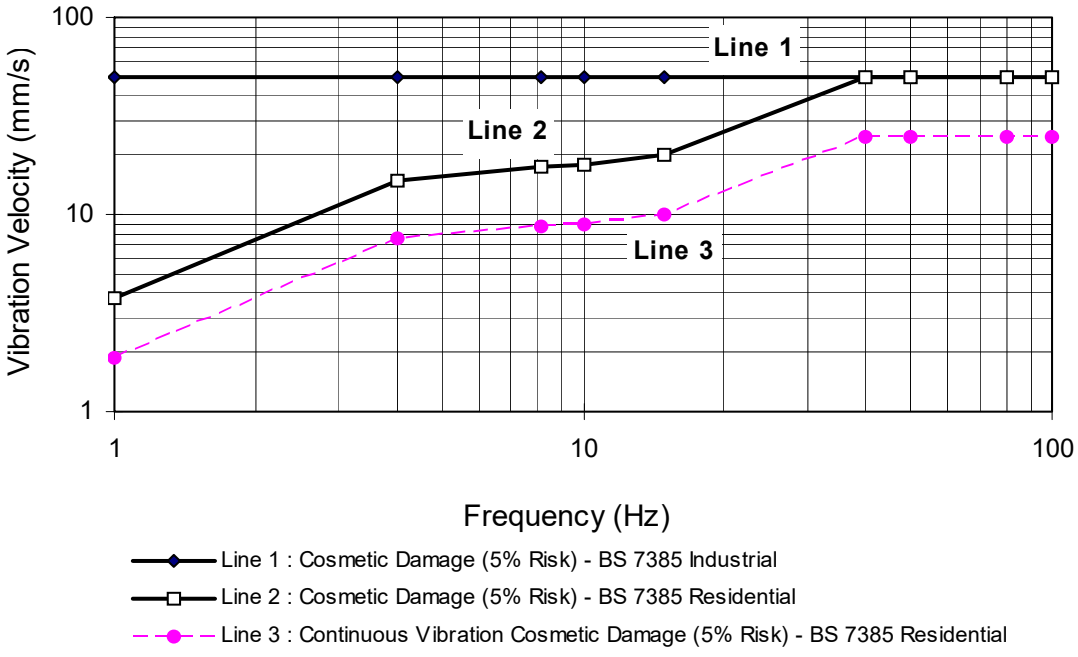


Figure 3.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz. The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than

twice those given in Table 3.7, and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 3.7 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 3.7.

It is noteworthy that extra to the guide values nominated in Table 3.7, the standard states that:

> "Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."

Also that:

> "A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."

4 Operational noise criteria

4.1 Noise Policy for Industry (NPfI)

The Noise Policy for Industry (NPfI) (EPA, 2017) provides guidelines to establish appropriate noise goals for industrial-type developments. The objectives of noise trigger levels for industrial-type noise are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides two separate noise trigger levels: intrusiveness and amenity. The fundamental difference being intrusiveness noise levels apply over 15 minutes in any period (day, evening or night), whereas the amenity noise levels apply to the entire assessment period (day, evening or night).

Noise goals, referred to as project noise trigger levels (PNTL), are generally equal to the lower of the derived intrusiveness and amenity criteria.

4.1.1 Intrusiveness noise levels

The intrusiveness noise trigger levels require that $L_{Aeq,15\ minute}$ noise levels from the site during the relevant operational periods do not exceed the RBL by more than 5 dB.

Table 4.1 presents the intrusive noise level determined for the site based on the adopted RBLs. It is noted that intrusive noise levels are only applicable at residential assessment locations.

Table 4.1 Project intrusiveness noise levels

Assessment location	Adopted RBL, dB				Project intrusiveness noise level dB, $L_{Aeq,15\ minute}$			
	Day	Evening	Night	Morning Shoulder	Day	Evening	Night	Morning Shoulder
All residential	49	45	45	47	54	50	50	52

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays; Morning Shoulder: 6 am to 7 am.

4.1.2 Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial-type noise and exclude road or rail noise. Where the measured existing industrial noise approaches recommended amenity noise level, it needs to be demonstrated that noise levels from new industry will not contribute to existing industrial noise such that amenity noise levels are exceeded.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level for new industrial developments is the recommended amenity noise level (outlined in Table 2.2 of the NPfI) minus 5 dB.

Nearest residential assessment locations to the site have been categorised in the NPfI urban amenity category. As per the definitions provided in the NPfI, residential assessment locations were classified as "urban" since they were deemed to be in and area that *"is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources"*.

To standardise the time periods for the intrusiveness and amenity noise levels, the NPfI assumes that the $L_{Aeq,15\ minute}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 dB, unless robust evidence is provided for an alternative approach for the particular project being considered.

The corresponding project amenity noise levels for the site are given in Table 4.2 based on the methodology provided in the NPfI (EPA, 2017).

Table 4.2 Project amenity noise levels

Assessment location	Indicative area	Time period	Project amenity noise level dB, $L_{Aeq,15\ minute}$ (Recommended amenity noise level minus 5 dB)
All residential areas	Urban	Day	58
		Evening	48
		Night	43
		Morning Shoulder	51
Industrial premises	All	When in use	68
Commercial premises	All	When in use	63
School classroom[2]	All	Noisiest 1-hour period when in use	30 (internal) 40 (external)
Place of worship	All	When in use	35 (internal)
Hospital ward	All	When in use	30 (internal) 45 (external)
Active recreation area	All	When in use	53

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays; Morning Shoulder: 6 am to 7 am.

2. As per NPfI notes, the acceptable noise level for school classrooms may be increased to $L_{Aeq,1\ hour}$ 40 dB (internal) where affected by existing industrial noise sources.

4.1.3 Project noise trigger level

The project-noise trigger level (PNTL) is the lower of the calculated intrusive or amenity noise level and is provided in Table 4.3 for all assessment locations.

Table 4.3 Project noise trigger levels

Assessment location	Period[1]	Intrusive noise level dB, $L_{Aeq,15\ minute}$	Amenity noise level dB, $L_{Aeq,15\ minute}$	Project noise trigger level (PNTL), dB
Residential (R1, R3)	Day	54	58	54 $L_{Aeq,15\ minute}$
	Evening	50	48	48 $L_{Aeq,15\ minute}$
	Night	50	43	43 $L_{Aeq,15\ minute}$
	Morning Shoulder	52	51	51 $L_{Aeq,15\ minute}$
Commercial (R2, R4)	When in use	n/a	63	63 $L_{Aeq,15\ minute}$
Hospital (R5, R6)	When in use	n/a	45	45 $L_{Aeq,15\ minute}$

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.

5 Construction noise assessment

5.1 Typical construction equipment

The construction noise impact assessment has adopted equipment noise emission values obtained from the EMM noise database for plant used on similar projects.

Table 5.1 summarises typical equipment items, sound power level and quantities adopted in the noise modelling for each proposed phase of works.

Table 5.1 Typical construction equipment

Equipment	Quantity (worst case per 15-minute period)	Sound power level per item, $L_{Aeq,15\ minute}$ (dB)[1]
Demolition and earthworks		
Piling rig	1	116
Excavator including rock-hammer	1	120
Excavator	2	105
Compactor	1	106
Dozer	1	108
Roller (up to 20T)	1	107
Truck & Dog	2	104
Structural works		
Concrete trucks	3	108
Concrete pumping	1	110
Crane	1	99
Internal fit-out and civil works		
Concrete trucks	3	108
Crane	1	99
Hand tools	Numerous	102
Generator	1	99

Notes: 1. Plant has been assumed to operate continuously in any 15-minute period.

5.2 Construction noise modelling method and results

Construction noise levels have been predicted to the nearest noise-sensitive receivers assuming attenuation due to distance only.

Construction equipment has been modelled at possible locations nearest to and furthest away from the nearest residence to represent the range of noise levels that may be experienced over the relevant periods. Indicative noise predictions are provided in Table 5.2 for each phase of construction activity.

Table 5.2 Construction noise predictions

Representative receiver	Distance	Indicative predicted noise level $L_{Aeq,15\ minute}$	Construction noise goal $L_{Aeq,15\ minute}$
Nearest residences (to north)	20-105 m	Demolition and earthworks 74-88 dB Structural works 66-81 dB Internal fit-out and civil works 66-80 dB	Noise affected: 59 dB (Recommended standard hours) Highly noise affected: 75 dB
Commercial	5-105 m	Demolition and earthworks 74-100 dB Structural works 66-93 dB Internal fit-out and civil works 66-92 dB	70 dB (when in use)
Hospitals	5-105 m	Demolition and earthworks 74-100 dB Structural works 66-93 dB Internal fit-out and civil works 66-92 dB	55 dB (when in use)

Predicted construction noise levels presented in Table 5.2 are typical of construction works of this nature in close proximity to residential and commercial neighbours. Therefore, as would be expected, construction noise levels are likely to be above the recommended noise goals at times during all stages of proposed activity. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings it is likely that actual construction noise levels would be less than those predicted for much of the time. Notwithstanding, the proponent will actively manage construction noise from the site. Further advice and discussion are provided in Section 7 in this regard in accordance with the requirements of the ICNG.

6 Construction vibration assessment

It is not yet known exactly what methods and/or vibration generating equipment will be utilised for the project. As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 6.1. The safe working distances are quoted for both "Cosmetic Damage" (refer British Standard BS 7385) and "Human Comfort" (refer British Standard BS 6472-1).

Table 6.1 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory Roller	<50kN (Typically 1-2 tonnes)	5 m	15 to 20 m
	<100kN (Typically 2-4 tonnes)	6 m	20 m
	<200kN (Typically 4-6 tonnes)	12 m	40 m
	<300kN (Typically 7-13 tonnes)	15 m	100 m
	>300kN (Typically 13-18 tonnes)	20 m	100 m
	>300kN (>18 tonnes)	25 m	100 m
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: From Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.

The safe working distances presented in Table 6.1 are indicative only and will vary depending on the particular item of plant and local geotechnical conditions.

In relation to human comfort response, the safe working distances in Table 6.1 relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, as discussed in BS 6472-1.

The nearest residences are located approximately 20 m from the northern boundary and the nearest hospital and commercial premises are located approximately 5 m from the eastern and southern boundaries.

To predict the level of vibration that may occur at nearby structures is complex and therefore in the first instance the guide values presented in Table 6.1 should be followed. It is possible that some vibratory activities will occur within relatively close distance of nearby structures, roads and rail corridors and therefore management of vibration levels will be required. For example, if a large hydraulic hammer is operated within 22 m of a surrounding structure, then there is potential for cosmetic damage goals to be exceeded and therefore triggering the need for management. Construction vibration management measures are presented in Section 7.

7 Operational noise assessment

The proposal includes rooftop terraces, a cafeteria (and associated outdoor terrace), mechanical plant, car parking and service areas, all of which have the potential to produce noise impacts to the surrounding area. Potential noise impacts have been assessed and are described in the following sections.

7.1 Industrial noise (Mechanical plant)

Mechanical plant selections (e.g. air-conditioning units and exhaust fans) have not been made at this stage of the development and is to be finalised during the detailed design of the project. Notwithstanding, plant areas will be located internally (ie in a basement) or on the roof level. Assuming the use of conventional plant equipment and noise mitigation methods such as the selection of equipment based on quiet operation and appropriate use of enclosures, localised barriers, acoustic attenuators and acoustically treated ductwork, it is expected that criteria defined in Section 4.1.3 will be met.

During the detailed design stage an assessment of external mechanical plant and equipment will be undertaken with reference to the relevant noise criteria defined in Section 4.1.3.

7.2 Traffic noise (Parking and service vehicles)

Noise levels from cars and service vehicles (small rigid vehicles and commercial vans) arriving and leaving the site have been assessed. There is a service driveway located on the east of the site (adjacent to the Newcastle police station), and the semi-underground carpark is accessed by a driveway to the west of the heritage building.

Garbage collection is proposed to occur on the street, immediately adjacent to the service driveway entrance, up to 3 times per week. This is proposed to occur outside of standard business hours to limit the impacts on the road network. As garbage collection would typically occur only three times per week, it is not considered representative of the typical operation of the development.

The development's semi-underground car park will provide 20 car parking, one motorcycle and 22 bicycle spaces. All staff and students are expected to reside on site, and as such, will not need to travel to and from the site to attend the facility. Additionally, it is very unlikely that any staff member (or student) would have access to a vehicle.

For the assessment of the semi-underground car park, it has been conservatively assumed that 20 vehicle movements would occur in the on-site parking facilities in a one-hour peak period (ie five vehicle movements in a 15-minute period). This is consistent with assumptions outlined in Section 3.2 of Better Transport Futures *Traffic & Parking Assessment Report* dated 21 March 2019.

Site servicing is predicted to occur on an as needs basis and, as such, it is difficult to predict the frequency of vehicles using the service driveway at the east of the site. Notwithstanding, for the assessment of noise from the service driveway, four service vehicle movements have been conservatively assumed to occur in a one-hour peak period (ie one service vehicle movement in a 15-minute period).

As the semi-underground car park and service driveway are located at either end of the development, it is unlikely that cumulative impacts from these noise sources would occur. Due to this, and based on the above traffic assumptions, noise emanating from the use of the semi-underground car park is expected to provide a worst-case scenario regarding traffic noise. Further, site servicing (including garbage collection) of the proposed development would be similar in nature and commensurate with the numerous commercial, retail and residential uses surrounding the site and as such, the acoustic impacts arising from this are considered to be negligible.

To quantify the level of noise that may be received at the nearest residential premises, the $L_{Aeq,15minute}$ noise level resulting from a typical number of noise events generally associated with car parking and pick-up/drop-off activities

(ie cars moving, cars starting and doors slamming) was calculated. The predicted noise level due to onsite vehicle activity is $L_{Aeq,15minute}$ 47 dB at the nearest residential locations. This is well below the most stringent (ie night-time) PNTL of $L_{Aeq,15minute}$ 50 dB and as such, traffic noise from the development is unlikely to cause impacts at surrounding residences.

7.3 Cafeteria and rooftop terrace noise

The cafeteria (and associated outdoor terrace) is to be located on the ground floor and will be open between the hours of 6:30am to 10:00pm, 7 days per week. The cafeteria will be managed by Nihon University and noise from the outdoor areas would be appropriately managed to ensure there is minimal disturbance to nearby residents

The rooftop terraces, located on the fourth floors, will be accessible to students between the hours of 7:00am to 9:00pm, 7 days per week. The proposed roof-top terraces will be available for use by students only and will not be open to the general public. The terraces are intended to provide spaces for students to study, relax or meet with friends, rather than as an area for hosting events or large groups. In order to attenuate any noise impacts that may arise, 1.5-metre-high glazed balustrades are proposed to surround the rooftop terraces.

Noise levels from the cafeteria and roof-top terraces have been modelled using Brüel and Kjær Predictor noise prediction software. 'Predictor' calculates total noise levels at assessment locations from the concurrent operation of multiple noise sources. The model has considered factors such as:

- the lateral and vertical location of plant;
- source to assessment location distances;
- ground effects;
- atmospheric absorption;
- topography of the site and surrounding area; and
- applicable meteorological conditions.

Predicted noise levels over a typical worst case 15-minute scenario were modelled and assessed for comparison against the relevant PNTLs.

Source levels adopted for student noise are presented in Table 7.1. This sound power level has been adopted based on data available in published documents and EMM measurements.

It is worth noting that there are many factors which influence the magnitude of student noise, including number of people and mix, their behaviour, age, demographic and the level of background noise, just to name a few. Therefore, it is difficult to apply a typical sound power level based on number of people alone. Conservative sound power levels have been adopted to account for potential high student noise levels.

Table 7.1 Student octave band centre frequency noise levels

Description	Assessed student noise levels ($L_{Aeq,15\ minute}$), Hz									Overall, dB
	31.5	63	125	250	500	1000	2000	4000	8000	
Student noise (approx. 20 students)	-	66	77	77	83	86	80	71	-	89

For the purpose of this assessment it has been assumed that 20 students are located in each of the rooftop terraces and the internal and external areas of the cafeteria (ie 80 students in total). Predicted noise levels from the site at the nearest boundary of all assessment locations are provided in Table 7.2. It is of note that many of the current surrounding land uses are commercial premises with similar operations and operating hours. Therefore, the level and profile of noise emanating from the premise is expected to be similar in nature to the surrounding ambient environment. It is expected that changes to the noise level and profile will be negligible at the residences surrounding the site.

Table 7.2 Predicted student noise levels

Location	Assessment period	Predicted noise level, $L_{Aeq,15\ minute}$, dB	Project noise trigger level, $L_{Aeq,15\ minute}$, dB	Exceedance, dB
R1	Day	45	54	Nil
	Evening	45	48	Nil
	Morning Shoulder	45	51	Nil
R2	Day	48	63	Nil
	Evening	48	63	Nil
	Morning Shoulder	48	63	Nil
R3	Day	48	54	Nil
	Evening	48	48	Nil
	Morning Shoulder	48	51	Nil
R4	Day	44	63	Nil
	Evening	44	63	Nil
	Morning Shoulder	44	63	Nil
R5	Day	36	45	Nil
	Evening	36	45	Nil
	Morning Shoulder	36	45	Nil
R6	Day	41	45	Nil
	Evening	41	45	Nil
	Morning Shoulder	41	45	Nil

The assessment identified that the $L_{Aeq,15\ minute}$ noise levels from the project are predicted to satisfy the relevant project noise trigger levels at all assessment locations, during all assessment periods. As such, it is unlikely the nature of sound emissions from the proposed development will cause any community response or noticeable change in the surrounding acoustic environment.

8 Mitigation and management

As provided in Section 6, it is likely that noise levels will be above the relevant noise management levels at times during the likely construction activities. It is also possible that vibration levels generated at the project site during construction could be above the relevant human comfort and structural vibration criteria.

Section 8.1 provides site-specific noise and vibration mitigation and management measures that will be implemented at the site and the subsequent sections provide further good practice recommendations in this regard.

8.1 Site-specific mitigation and management for construction noise

The following measures should be implemented at the site with the aim of reducing construction noise and vibration levels below the relevant goals:

- Construction hours will be restricted to the standard hours recommended in the ICNG;
- Information should be provided to neighbours before and during construction through media such as letterbox drops, meetings or individual contact.
- The use of a site information board at the front of the site, with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include after-hours emergency contact details.
- The use of existing structures, temporary site buildings and materials stockpiles as noise barriers, where practicable.
- Where practicable, place as much distance as possible between noisy plant or equipment and residences and other sensitive land uses.
- Minimise the number of plant items operating concurrently when in close proximity to surrounding receivers.
- Minimise the need for vehicle reversing for example, by arranging for one-way site traffic routes.
- Noise and vibration monitoring should be adopted as a management strategy throughout the construction works. The purpose of monitoring would be to validate background noise levels, the construction noise predictions and to confirm that the noise and vibration levels from individual items of equipment are not excessive. Ideally, monitoring would be undertaken at the commencement of works and during (or soon after) any significant change in activity. Further information regarding the proposed monitoring program is provided in Section 9.

8.2 Adoption of general noise & vibration management practices (AS 2436-2010)

AS 2436-2010 *"Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below.

8.2.1 Universal work practices

These include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- developing routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoiding the use of equipment that generates impulsive noise;
- minimising the movement of materials and plant and unnecessary metal-on-metal contact;
- minimising truck movements; and
- scheduling respite periods for intensive works as determined through consultation with potentially affected neighbours (eg a daily respite period for a minimum of one hour at midday).

8.2.2 Plant and equipment

Additional measures for plant and equipment include:

- choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- using temporary noise barriers (in the form of plywood hoarding or similar) to shield intensive construction noise activities from residences;
- operating plant and equipment in the quietest and most efficient manner; and
- regularly inspecting and maintaining plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

8.2.3 Work scheduling

- scheduling activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events;
- scheduling work to coincide with non-sensitive periods;
- scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive;
- planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers;
- optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours;

- designating, designing and maintaining access routes to the site to minimise impacts;
- include contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling; and
- high vibration generating activities should only be carried out in continuous blocks, with appropriate respite periods as determined through consultation with potentially affected neighbours.

8.3 Operational noise mitigation and management

The following measures are proposed to be implemented at the site with the aim of ensuring operational noise levels remain below the relevant goals:

- 1.5-metre-high glazed balustrades around both roof-top terrace areas;
- students will have access to the roof-top terraces between the hours of 7:00am to 9:00pm only (ie no night-time use);
- the cafeteria is proposed to operate between the hours of 6:30am and 10:00pm (ie no night-time operations);
- the mechanical plant areas for the development are proposed to be located internally or on a rooftop level; and
- rooftop mechanical plant areas are to be enclosed or surrounded with appropriate acoustic barriers.

9 Construction noise and vibration monitoring

To maximise the effectiveness of management strategies to minimise construction noise and vibration emissions, a monitoring program will be developed to guide, manage, quantify and control emissions from construction activities. Where monitoring results indicate exceedances of the relevant noise and vibration goals, additional feasible and reasonable mitigation measures and controls would be considered to minimise impacts to nearby sensitive receivers. Details of the monitoring program will be finalised at a later stage when more detail is known about construction methodology and schedule.

9.1 Objectives

After the commencement of acoustically significant activities or where complaints are received, monitoring should be conducted to quantify construction noise and vibration levels and to verify these levels within the community.

The objectives of the monitoring program would be as follows:

- assess construction noise and vibration levels against relevant goals, with consideration given to non-site related ambient and background noise and vibration at the time of measurements;
- identify potential noise and vibratory sources and their relative contribution to impacts from construction activity;
- specify appropriate intervals for monitoring to evaluate, assess and report the relative contribution due to construction activity;
- outline the methodologies to be adopted for monitoring construction noise and vibration, including justification for monitoring intervals or triggers, weather conditions, monitoring location selection and timing; and
- incorporate noise and vibration management and mitigation strategies outlined in this plan.

9.2 General noise measurement procedures

The noise measurement procedures adopted for the project shall be in accordance with AS 1055-2018*Acoustics - Description and Measurement of Environmental Noise*.

All acoustic instrumentation used in the monitoring of construction should comply with the requirements of IEC 61672.1-2004 and carry current NATA or manufacturer calibration certificates. All instrumentation will be programmed to record statistical noise level indices in 15 minute intervals which include the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{Amin} and the L_{Aeq}.

Instrument calibration shall be checked before and after each measurement survey, ensuring a valid variation in calibrated levels not exceeding ±0.5 dB(A).

9.3 Noise monitoring

Noise monitoring will be undertaken by a suitably qualified acoustic specialist or suitably qualified and trained environment officer.

Noise monitoring will be carried out at the complainant and/or nearest sensitive receiver/s.

Where ambient noise is a significant feature of the noise environment at the monitoring location, and the relative construction noise contribution cannot be directly quantified, intermediate monitoring locations may be selected so that the construction noise is clearly audible above the background noise level. Using this methodology, $L_{Aeq,15\ minute}$ noise levels can be estimated to the receiver using distance attenuation calculations, and compared with relevant construction noise goals.

9.4 Operator attended noise surveys

Operator attended noise measurements will be conducted at the potentially most affected receiver locations or representative thereof, relevant to the construction activities at the time of monitoring. Attended noise measurements are conducted to quantify noise emissions and estimate the $L_{Aeq,15\ minute}$ noise contribution from construction activities with respect to the overall level of ambient noise. Importantly, the background and ambient noise levels at that time and in the absence of site contribution must also be quantified.

The operator shall quantify and characterise noise levels from both extraneous (non-site) and construction noise sources over a period of 15 minutes for representative potentially affected receivers.

For each 15-minute attended noise monitoring period, the following information should be recorded:

- name of monitoring personnel;
- monitoring location;
- dates and times that monitoring began and ended at each location;
- height of the microphone above the ground and, if relevant, distances to building facades or property boundaries;
- quantitative meteorological data such as wind speed (including the height above ground at which the measurement was taken), wind direction and humidity;
- qualitative meteorological information such as cloud cover, fog or rainfall;
- instrument type and calibration details before and after the monitoring period;
- the $L_{Aeq,15\ minute}$ noise level for the 15 minute period;
- statistical noise level descriptors over the 15 minute interval: L_{Amin}, L_{A90}, L_{A10}, L_{A1} and L_{Amax};
- notes that identify the noise source that contribute to the maximum noise levels (L_{A1} or L_{Amax}) and noise sources that contribute to the overall noise environment or for periods of time when a specific noise source is audible presented on a run-chart of the recorded noise levels;
- an estimate of the noise contribution from the construction or from other identifiable noise sources;

- measurements in one-third octave bands from 10 Hz to 8 kHz inclusive (or a broader range of bands) for the 15 minute interval;
- any other data suitable for assessing the relative contribution of site-generated noise to the overall noise being measured;
- notes that identify the noise source that contributed to the overall noise environment; and
- recommendations or comments (where considered appropriate).

9.5 General vibration monitoring procedures

The level of vibration produced by construction activities depends on a number of factors, many of which are site specific. It is recommended, prior to significant vibration-generating activities, such as piling or vibratory compaction, that a series of trials be carried out to determine likely vibration levels from typical plant at the nearest potentially affected receiver(s). The likelihood of vibration levels exceeding the criteria (outlined in Section 4) will be able to be determined from these results.

Continuous vibration monitoring may also be required during significant vibration generating activities if the risk of damage or annoyance, as determined from trial monitoring results, is high. If initial vibration measurement trials conclusively demonstrate negligible vibration levels within close working distances, then additional monitoring may not be required, unless otherwise warranted for risk management purposes.

Supplementary vibration monitoring may also be carried out in response to complaints received from the neighbouring properties.

9.6 Vibration monitoring

Vibration monitoring will be undertaken by a suitably qualified specialist or suitably qualified and trained environment officer.

The vibration monitor should be generally installed at the nearest foundation point of the sensitive structure to the vibration generating works. In the event of a complaint, the monitoring shall also be carried out at the complainant location.

The monitoring equipment should be capable of recording the appropriate parameters to provide assessment against the relevant vibration goals.

The monitoring system should also be fitted with an auditory or visual alarm system (or similar) which will trigger when vibration levels approach and/or reach the nominated structural vibration criteria. This will also indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection etc.).

9.7 Reporting

A report will be prepared outlining the results of monitoring and how exceedances (where relevant) were managed. A site layout, outlining the locations of construction equipment and monitoring locations, is to be included in the monitoring reports.

9.8 Training

All personnel involved in noise and vibration monitoring will be adequately trained and up to date with relevant measurement standards, methodologies and product technology with respect to noise and vibration measurements.

10 Community consultation and complaints handling

A programme to engage in active community consultation and maintain positive relations with local residents and commercial neighbours will be implemented in order to minimise complaints by addressing their concerns.

With regard to potentially offensive noise events associated with construction activities, AS 2436 – 1981 provides the following:

> If noisy operations must be carried out, then a responsible person should maintain liaison between the neighbouring community and the contractor. This person should inform the public at what time to expect noisy operations and also inform the contractor of any special needs of the public.
>
> Consultation and cooperation between the contractor and his neighbours and the removal of uncertainty and rumour can help to reduce the adverse reaction to noise.

The same approach can be taken to events likely to cause high levels of vibration at a nearby sensitive receiver.

In order to effectively manage any requests for information or respond to any public concerns in relation to the proposed construction activities and site operation, the following systems shall be maintained:

- The proponent will supply the relevant governing authorities with the names and appropriate contact numbers for the site construction manager during the construction period and one other senior staff member.
- An emergency after hours contact phone number will be put in place to allow contact with the proponent in relation to any environmental matter including those concerned with noise and vibration issues. This phone number will be clearly displayed on the fence surrounding the construction site.
- The proponent will use a complaint handling system to monitor environmental noise and vibration complaints. All information relating to such complaints will be kept in a register. The register will include but not be restricted to the following information:
    - Date and time of complaint;
    - Complainant details (ie full name, address and contact details);
    - Nature and source of complaint;
    - Action taken; and
    - Follow-up with complainant.
- The complaint register will be made available to any relevant regulatory authority upon request.
- The proponent will endeavour to respond to any complaint within one working day of its receipt.

Response measures, which would be adopted following complaints regarding noise and/or vibration, would include:

- Identify the source that has caused the complaint. This would be done by consultation with the complainant and/or by conducting a noise and/or vibration survey to quantify the level of disturbance.

- Reassess the mitigation and management techniques employed at the site to reduce the impact of the source in question. Particular attention should be given to the scheduling of activities and the siting of equipment used on site.

- Following the adoption of additional or alternative mitigation, a further noise and/or vibration survey would be conducted at the complainant's location to demonstrate the effectiveness of the mitigation strategy.

11 Conclusion

EMM has prepared a noise and vibration assessment (NVA) to support a development application (DA) for the proposed Newcastle Nihon University campus and associated 108 bed student accommodation at 9 Church Street, Newcastle NSW (the project).

As would be expected with typical construction works of this nature and in proximity to neighbours, predictions indicate that construction noise levels are likely to be above the noise management levels without mitigation at times during proposed construction activity. This is common for such situations. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings and commercial spaces it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, the proponent will actively manage construction noise from the site.

The guide values presented in Table 6.1 should be followed to minimise the potential impact from vibration at nearest neighbours. It is possible that some vibratory activities will occur within close proximity to nearby structures and therefore management of vibration levels will be required.

Given the limited noise emissions during operations, noise levels are expected to satisfy the NPfI noise trigger levels at all assessment locations, during all assessment periods. Further, it is unlikely the nature of operational noise emissions from the proposed development will cause any community response or noticeable change in the surrounding acoustic environment.

Recommendations have been provided regarding work practices to be considered to minimise noise and vibration from the project.

Appendix A

Glossary of acoustic terms

A number of technical terms are required for the discussion of noise. These are explained in Table A.1.

Table A.1 Glossary of acoustic terms

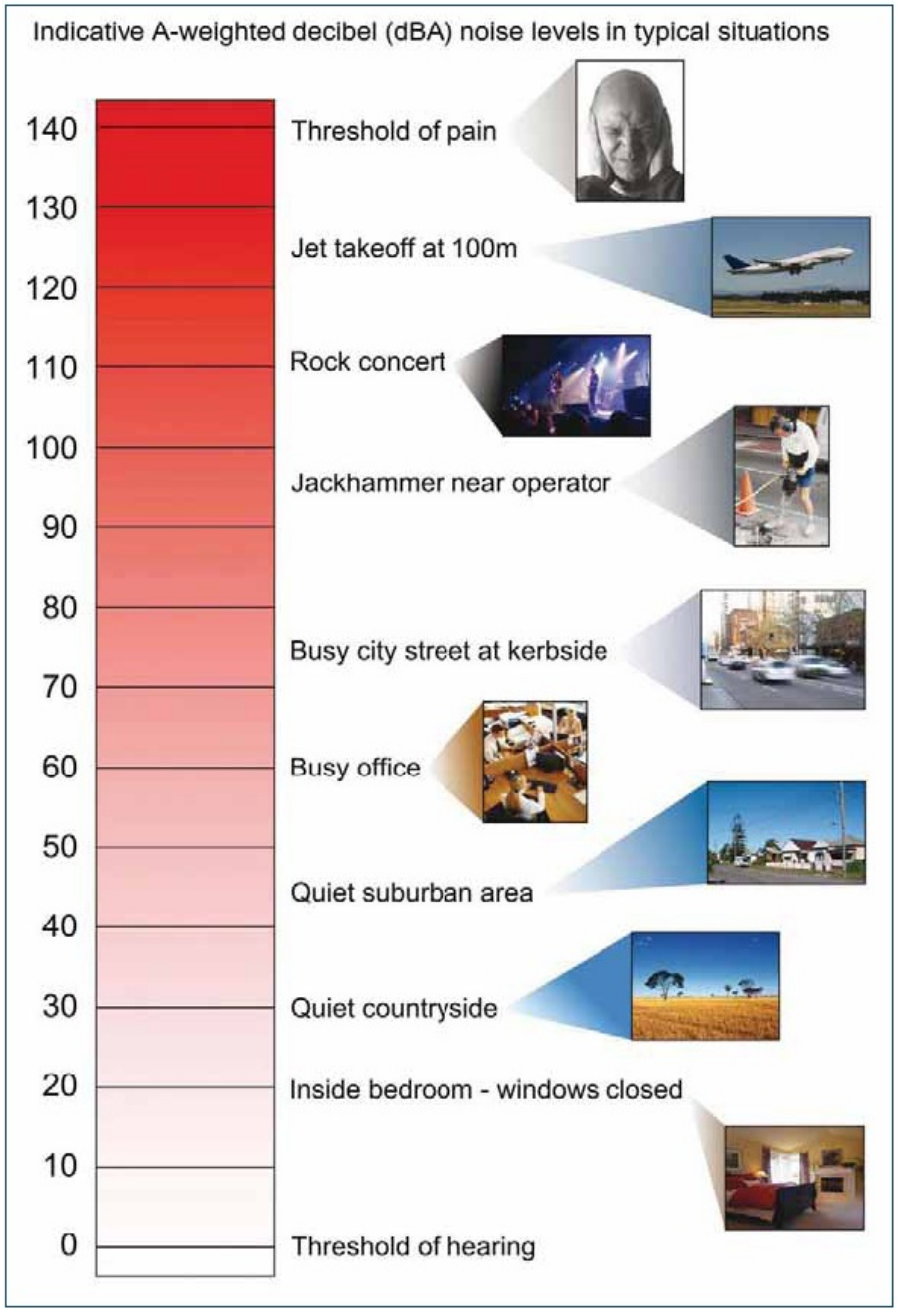
Term	Description
ABL	The assessment background level (ABL) is defined in the NPfI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
DECC	The NSW Department of Environment, Climate Change
ICNG	Interim Construction Noise Guideline
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{eq,15\ minute}$ descriptor refers to an L_{eq} noise level measured over a 15-minute period.
L_{Amax}	The maximum root mean squared sound pressure level received at the microphone during a measuring interval.
NPfI	Noise Policy for Industry
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

It is useful to have an appreciation of decibels, the unit of noise measurement. Table A.2 gives an indication as to what an average person perceives about changes in noise levels:

Table A.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
1 to 2	typically indiscernible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

Examples of common noise levels are provided in Figure A.1.



Source: NSW Road Noise Policy (DECCW 2011)

Figure A.1 Common noise levels

Appendix B

Architectural drawings

EXISTING DRIVEWAY CROSS-OVER TO REMAIN

CHURCH STREET

EXISTING KERB CROSSING TO REMAIN

EXISTING STREET TREES TO REMAIN

EXISTING DRIVEWAY CROSS-OVER TO REMAIN

Width of street : 20,115

BOUNDARY LINE OF STREET

CARS

MAIN PEDESTRIAN ENTRY

DELIVERIES

ZEN GARDEN

No.9
LOT 1
D.P. 1199904
5,191 m2

RL 34.90

VOID

MECH. AREA

RL 38.40

RL 38.10

Easement for Services Variable width

Easement for Services 1.7m wide

Restriction on the use of Land 3m wide

Easement for Drainage 3m wide

RIGHT OF FOOT WAY 2.51m wide

Easement to Permit Encroaching Structure to Remain 0.05m & 0.75m wide

BOUNDARY

BOUNDARY

5,600 | 8,400 | 7,000 | 150 | 2,580 | 4,080 | 150 | 9,000 | 9,000 | 9,000

21,000 | 2,730 | 31,520 | 4,230 | 27,000

1,250 | 150 | 1,100 | 8,000 | 8,000 | 8,000 | 40,000 | 8,000 | 8,000 | 8,000 | 40,000 | 8,000 | 150 | 1,100 | 1,250

X A1 X A2 X A3 X A4 X B1 X B'1 X B'2 X C1 X C2 X C3 X C4

Y A6 Y A5 Y A4 Y A3 Y A2 Y A1 Y C6 Y C5 Y C4 Y C3 Y C2 Y C1

EDUCATION BUILDING

PUBLIC BUILDING

RESIDENTIAL BUILDING

AZUSA SEKKEI Architects,Engineers & Consultants

dwp

moir

Cardno Shaping the Future

marline BUILDING SERVICES ENGINEERS MECHANICAL . ELECTRICAL . HYDRAULIC . FIRE . ENERGY

Planner

Nihon University
Australia Newcastle Campus Project

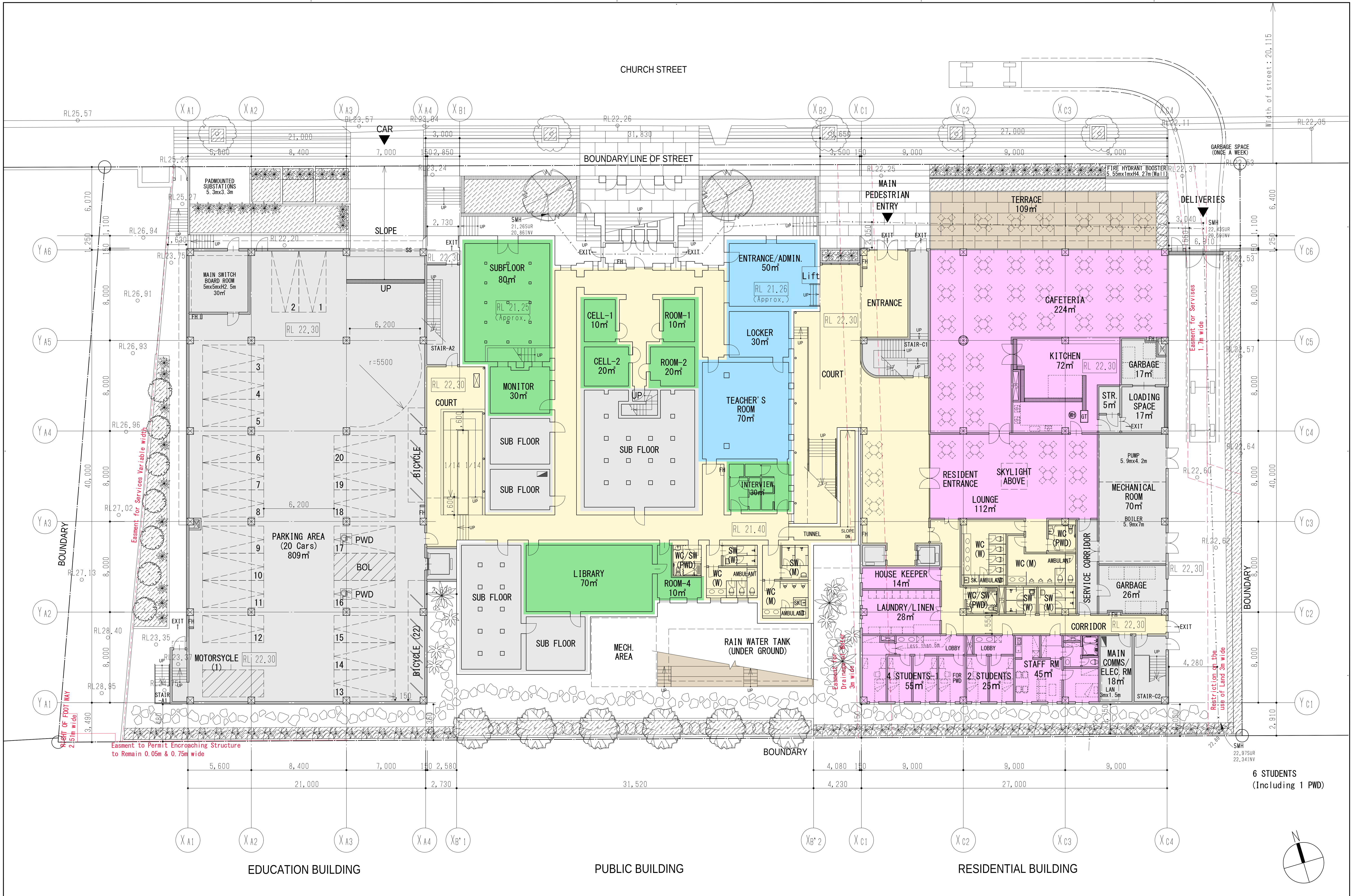
Site Plan

Scale 1/A1:150 A3:300

Date 2014 - 12 - 14

Drawing No. A — 107

No



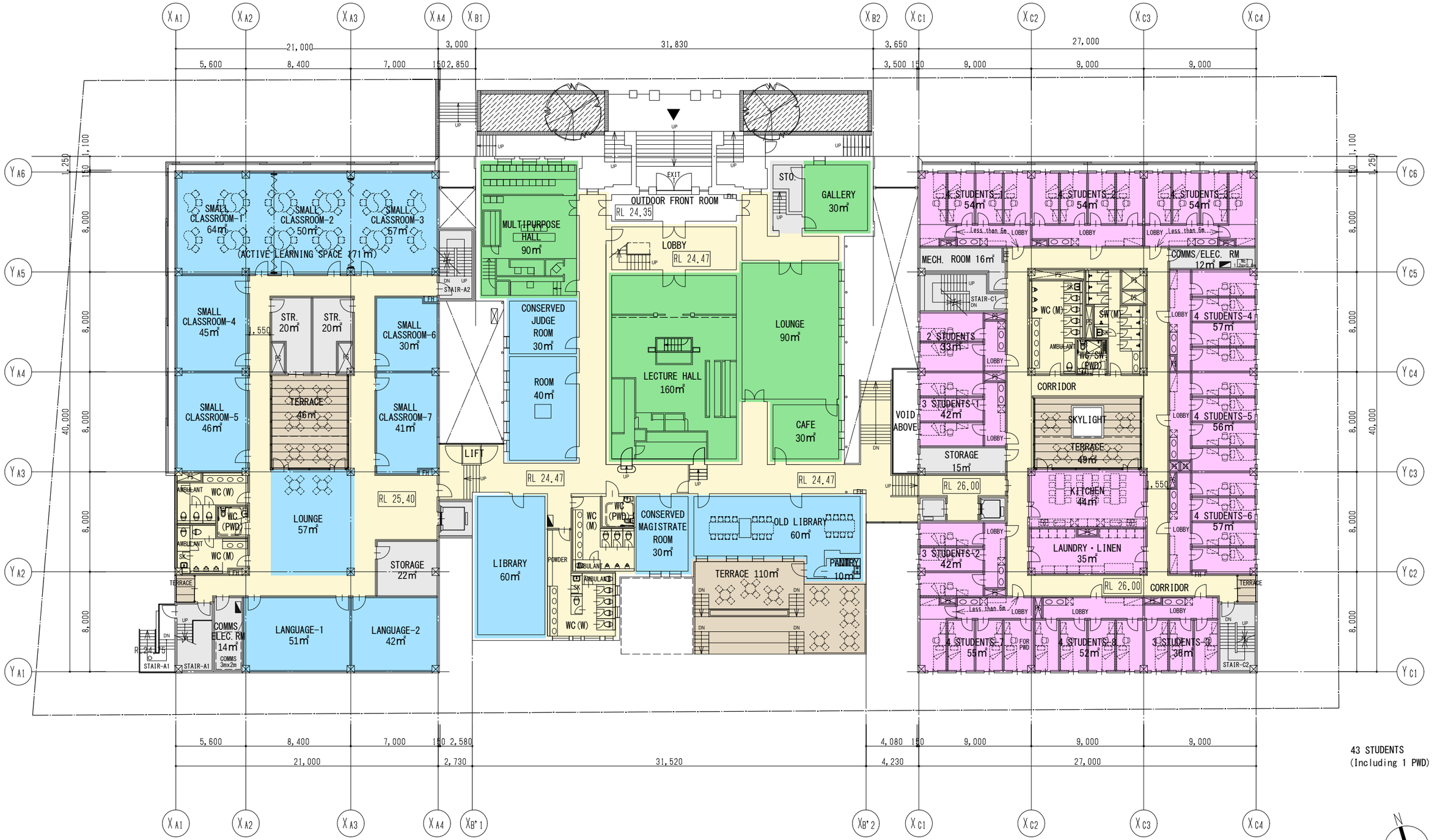
AZUSA SEKKEI Architects, Engineers & Consultants | dwp | moir | Cardno Shaping the Future | marline

Nihon University
Australia Newcastle Campus Project

1st Floor Plan

Scale: 1/150 (A1), 1/300 (A3)

Drawing No. A — 108



AZUSA SEKKEI Architects,Engineers & Consultants

dwp

moir landscape architecture

Cardno Shaping the Future

marline BUILDING SERVICES ENGINEERS MECHANICAL・ELECTRICAL・HYDRAULIC・FIRE・ENERGY

Planner

Nihon University
Australia Newcastle Campus Project

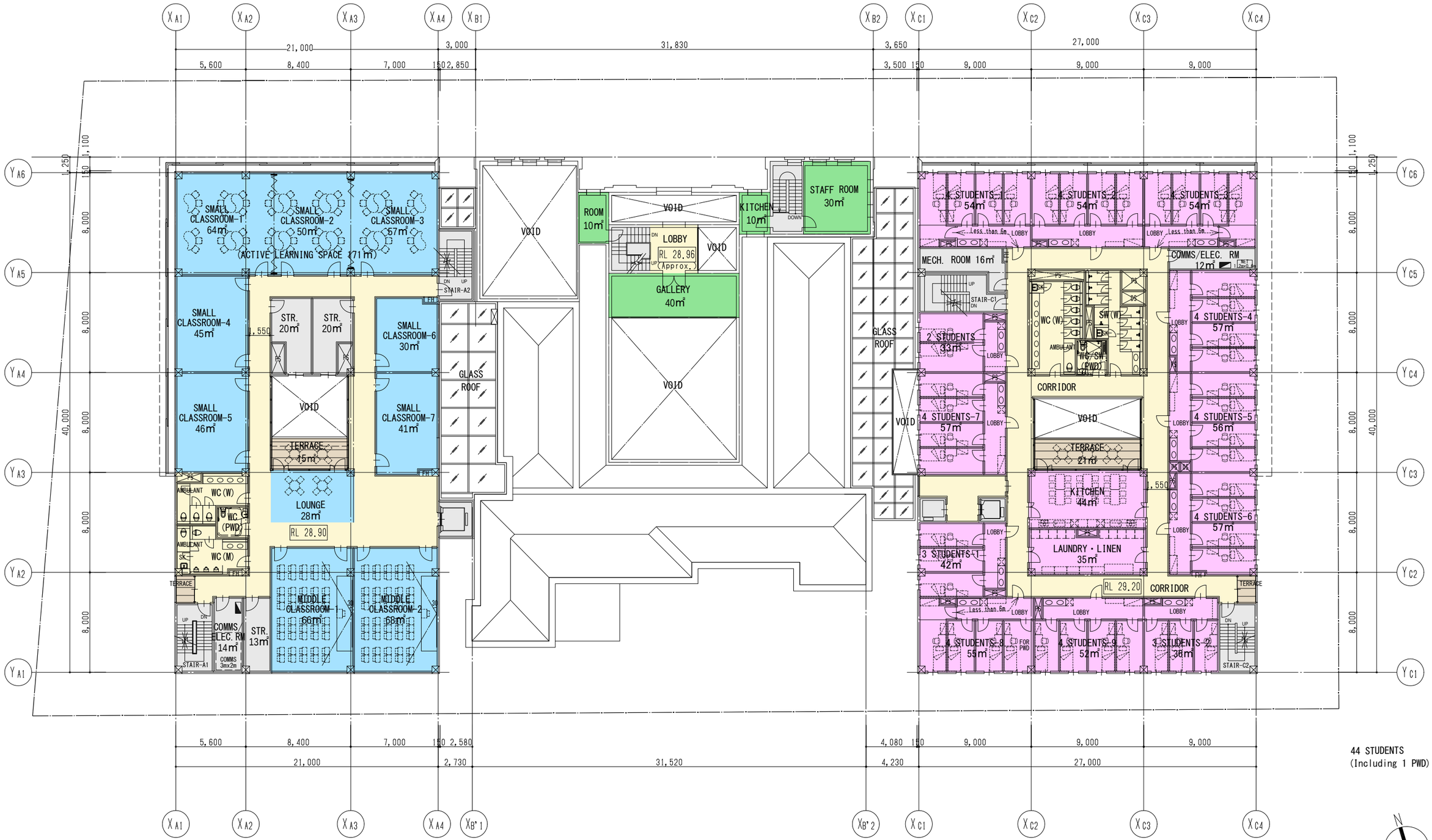
2nd Floor Plan

Scale 1/A1:150 A3:300

Date 2018・12・14

Drawing No. A — 109

No



AZUSA SEKKEI Architects,Engineers & Consultants

dwp

moir landscape architecture

Cardno Shaping the Future

marline CIVIL, STRUCTURAL, ENVIRONMENTAL & INFRASTRUCTURE MECHANICAL, ELECTRICAL, HYDRAULIC, FIRE, ENERGY

Planner

Nihon University
Australia Newcastle Campus Project

3rd Floor Plan

Scale 1/A1:150 A3:300

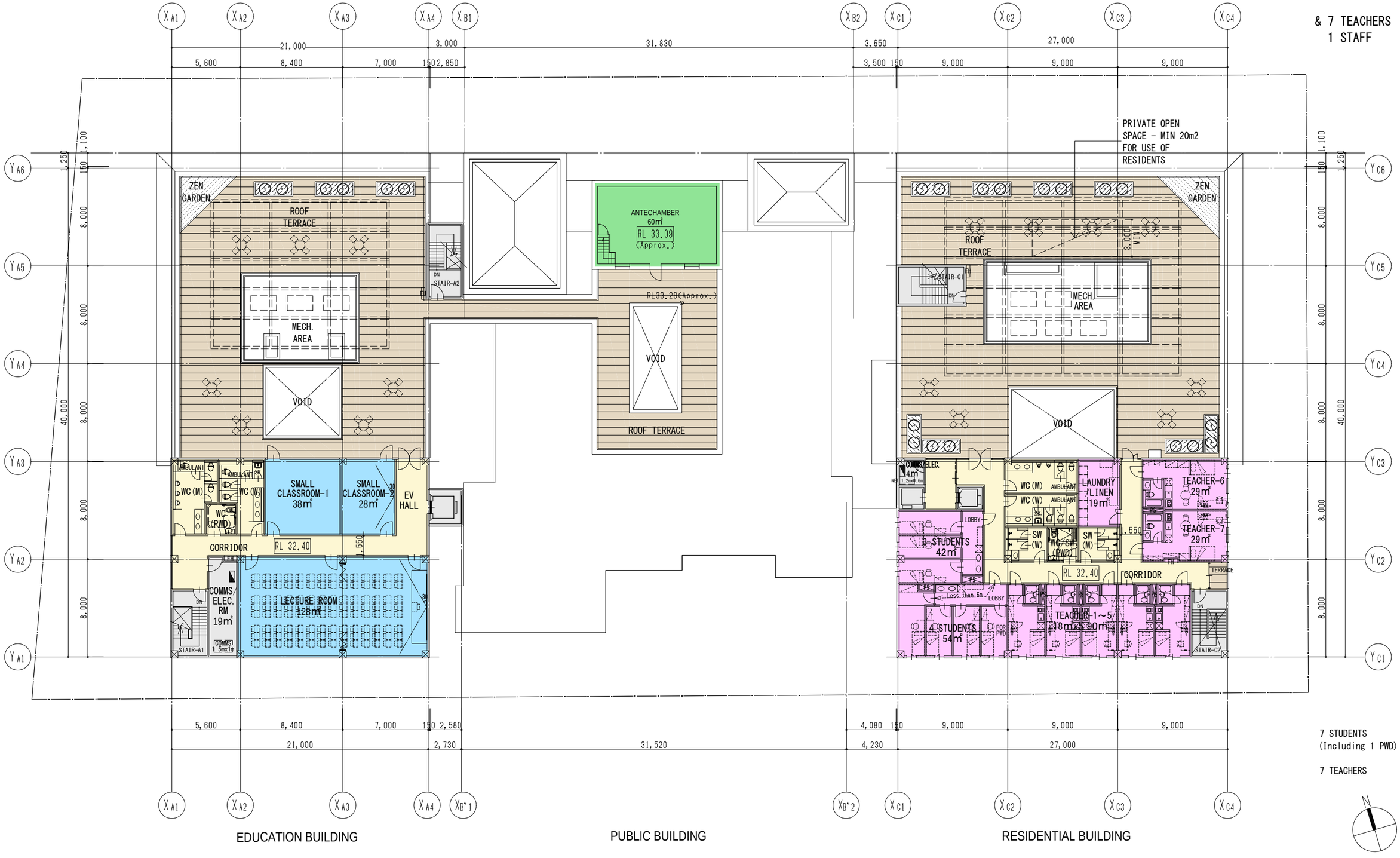
Date 2016・12・14

Drawing No. A — 110

No

1F	6 STUDENTS
2F	43 STUDENTS
3F	44 STUDENTS
4F	7 STUDENTS
TOTAL	100 STUDENTS

& 7 TEACHERS
1 STAFF



EDUCATION BUILDING

PUBLIC BUILDING

RESIDENTIAL BUILDING

7 STUDENTS
(Including 1 PWD)

7 TEACHERS

AZUSA SEKKEI Architects,Engineers & Consultants

dwp

moir landscape architecture

Cardno Shaping the Future

marline BUILDING SERVICES ENGINEERING MECHANICAL, ELECTRICAL, HYDRAULIC, FIRE ENERGY

Planner

Nihon University
Australia Newcastle Campus Project

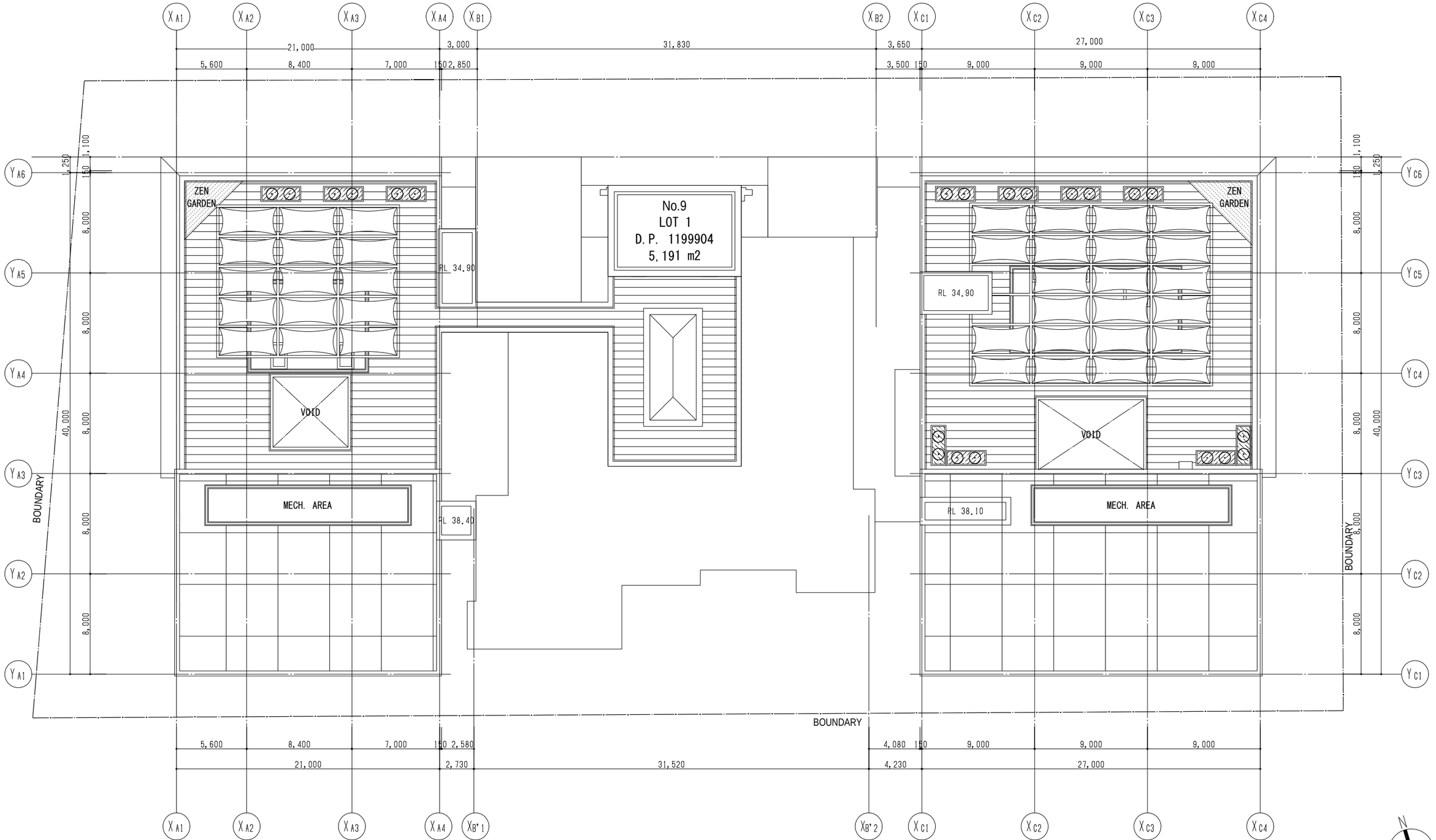
4th Floor Plan

Scale 1/ A1:100 A3:200

Date 2018 - 12 - 14

Drawing No. A — 111

No



AZUSA SEKKEI
Architects,Engineers & Consultants

dwp

moir

Cardno
Shaping the Future

marline
BUILDING SERVICES ENGINEERS
MECHANICAL . ELECTRICAL . HYDRAULIC . FIRE . ENERGY

Planner

Nihon University
Australia Newcastle Campus Project

Roof Floor Plan

Scale 1/A1:150 A3:300

Date 2014 - 12 - 14

Drawing No. A — 112

No

Appendix C

Calibration certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 24152

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: B & K
Type No: 4230 **Serial No:** 1276091
Owner: EMM Consulting
Level 1, 146 Hunter Street
Newcastle, NSW 2300

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	93.81	989.84	1.58
Level 2:	NA	N	NA	NA	NA
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1004 hPa ±1.5 hPa **Relative Humidity:** 47% ±5%
Temperature: 20 °C ±2° C
Date of Calibration: 14/02/2019 **Issue Date:** 15/02/2019
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017
CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....
Jack Kielt

.Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
Web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 22129 & FILT 4384**

Equipment Description:	Sound Level Meter		
Manufacturer:	B & K		
Model No:	2250	**Serial No:**	2759405
Microphone Type:	4189	**Serial No:**	2888134
Filter Type:	1/3 Octave	**Serial No:**	2759405
Comments:	All tests passed for class 1. (See over for details)		
Owner:	EMGA Mitchell Mclennan Ground Floor, Suite 01, 20 Chandos St St Leonards NSW 2065		
Ambient Pressure:	1008 hPa ±1.5 hPa		
Temperature:	25 °C ±2° C	**Relative Humidity:**	48% ±5%
Date of Calibration:	07/02/2018	**Issue Date:**	09/02/2018

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jack Kitt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au