

MARSHALL DAY Acoustics

UOA STUDENT CENTRE & LIBRARY ACOUSTIC ASSESSMENT

Rp 002 20260741 | 10 November 2026

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Project: **Student Centre & Library Building**

Prepared for: **University of Auckland**
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Attention: **John Carter**

Report No.: **Rp 002 20260741**

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1.0 SUMMARY

Marshall Day Acoustics (MDA) has been engaged to prepare an acoustic assessment for The University of Auckland (UoA) Student Centre and Library Project. This report provides an acoustic review of the proposed activities and assesses compliance against the applicable noise and vibration rules in the Auckland Unitary Plan (AUP). In summary:

- Consent is required as a restricted discretionary activity under E25.4.1(A2) of the AUP to exceed the applicable long-term construction noise limits at adjacent UoA buildings.
- Construction noise and vibration will be managed using a Construction Noise and Vibration Management Plan (CNVMP), including predicted infringements of the noise limits at immediately adjacent UoA buildings, consistent with established noise management practice for other major UoA projects within the University campus.
- The construction vibration standards are predicted to be met with the CNVMP in place.
- Operational noise will be controlled by mechanical services noise emissions, which will be designed to comply with the AUP permitted noise limits at other sites.

A glossary of terminology is included in Appendix A.

This report was authored by Craig Fitzgerald[1] and reviewed by Shaun King[2]. Both are suitably qualified experts who have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023 and agree to comply with it. This report is within their respective areas of expertise, except where they state that they rely on the evidence of another person. They have not omitted material facts that might alter or detract from the opinions expressed.

2.0 PROJECT DESCRIPTION

The Project involves the demolition of the existing the Student Union buildings and construction of a new building comprising eight levels, including six above-ground levels , with rooftop plant in addition, plus two underground levels. The new building will house a range of teaching, library, study, storage, and administrative activities. Rooftop mechanical services are the focus for operational noise emissions. Appendix B shows the site plan, its zoning, and nearby buildings. In summary:

- The only non-UoA building within 100m of the Project site is the Albert Park Caretaker's Cottage, a single-level building approximately 38m from the Student Union Building demolition footprint at its closest point. The Auckland City Mission occupies the building with an office and shop within normal office hours, and shop staff advised that the building is not occupied overnight.
- All other occupied buildings within 100m of the Project site are owned and operated by UoA. Three of the UoA buildings are directly adjacent to the Project (i.e. AUSA House, Kate Edgar Commons, and the Hiwa Recreation and Wellness Centre). AUSA House is also included on the New Zealand Heritage List and is scheduled as a Category B historic heritage place under the AUP.

[1] Craig Fitzgerald an Acoustic Consultant and Shareholder at Marshall Day Acoustics. He holds a Bachelor of Engineering (Mechanical) from the University of Auckland and is a Chartered Engineer registered with the Engineering Council (UK). Craig is a member of the Acoustical Society of New Zealand, the Institute of Acoustics (UK). Craig has over 19 years' experience in acoustic consulting, specialising in noise and vibration assessment for large infrastructure projects. Craig has provided expert evidence in numerous consent hearings, mediations, and Environment Court proceedings.

[2] Shaun an Acoustic Consultant and Shareholder at Marshall Day Acoustics. He holds a Bachelor of Engineering (Mechanical) with Honours from the University of Auckland. Shaun is a member of the Acoustical Society of New Zealand and a member of Engineering New Zealand. Shaun has 17 years' experience in acoustic consulting. His experience includes the resource consent for University of Auckland Recreation and Wellness Centre.

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3.0 CONSTRUCTION NOISE AND VIBRATION

3.1 Construction Methodology

The construction methodology and programme are detailed in the CMP[3]. We have discussed the representative construction methodology with Hawkins (the ECI contractor). For the purposes of this assessment, it is similar to other recent UoA campus projects where we have prepared CNVMPs projects and supported the contractors during construction. A draft CNVMP for this Project is attached as Appendix C. This report refers to components of the CNVMP to evidence best practice commitments. The CNVMP includes:

- The performance standards that must, where practicable, be complied with
- Predicted noise and vibration levels for relevant equipment and/or activities
- Mitigation considerations to identify the BPO with respect to construction noise and vibration
- Noise and vibration monitoring requirements, with triggers and feedback mechanisms
- Communication, consultation and complaints response protocols

The works are scheduled between 2027 and 2031. The key phases are summarised as follows:

- Hard demolition 2.5 months
- Piling and excavation 8 months
- Super structure and envelope 24 months

Table 1 identities representative worst-case, and typical, construction activities for each phase.

Table 1: Construction activities

Construction Phase	Representative worst-case activity	Typical activity
Demolition	Concrete breaking	Excavator with pulveriser
Piling and excavation	Bored piling rig	Excavator
Building Construction	Rattle gun	Tower crane

Key mitigation measures include:

- Construction hours: 06:30 am to 10:30 pm Monday to Friday, 7 am to 11 pm Saturdays, and 9 am to 7 pm Sundays (excluding public holidays). Early mornings may be required for steel deliveries and concrete pours, otherwise, only quiet works at other times. The hard demolition phase is deliberately planned between December 2027 to February 2028 so that the noisiest activities fall within the UoA summer break and outside teaching and examination periods.
- Noise barriers: Perimeter hoardings and local barriers near activities as detailed in Section 5.4 of the CNVMP. Effective noise barriers typically reduce the received noise level by 10 decibels.
- Demolition of the Student Union building: Cut and lower large sections of the structure adjacent to sensitive buildings (AUSA House), favour a pulveriser or shear attachment to crush concrete over a breaker method where practicable, fit breakers with breaker-blankets, and remove large concrete pieces for offsite breaking. Refer Section 5.6 and 5.7 of the CNVMP.
- Piling: The primary noise effects are from banging from shaking or bouncing of the auger to remove spoil. We recommend this is avoided where practicable. Refer section 5.8 of the CNVMP.

[3] UoA Student Centre Library Draft CMP, rev 4.0, prepared by RCP, dated 21 Sep 2026

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3.2 Construction Noise

3.2.1 Performance Standards

AUP Rule E25.6.28 sets construction noise limits for the City Centre zone. Construction noise must be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 "*Acoustics - Construction Noise*". The noise limits apply at 1m from external façades of occupied buildings. 75 dB L_{Aeq} is the most relevant limit during the normal weekday daytime construction hours, whilst 80 dB L_{Aeq} applies on Saturdays and 65 dB L_{Aeq} on Sundays.

3.2.2 Construction Noise Levels

Table 2 predicts levels for representative high-noise construction activities (included in CNVMP Section 3.2). The 5m and 10m setback columns represent infringements at the most exposed occupied rooms of neighbouring UoA buildings overlooking the works.

The noise levels are predicted to comply at the closest non-UoA building when occupied, during normal office hours (Albert Park Caretaker's Cottage is approximately 38m away from the buildings to be demolished and 30m from the new buildings). Periods of inactivity, hand tools and idling equipment are generally much quieter and are not addressed further.

Table 2: Indicative noise levels at 1m from a building façade[4]

Equipment	Sound Power Level (dB L_{Aeq})	Mitigation[5] (dB)	Noise Level (dB L_{Aeq})				Setback (m)
			5 m	10 m	38 m	100 m	75 dB L_{Aeq}
Demolition (Concrete Breaking[6]							
Large excavator (30t) mounted concrete breaker	121	10	92	86	74	63	33
Medium excavator (8-10t) mounted concrete breaker	116	10	87	81	69	58	20
Concrete Cutting	115	10	86	80	68	57	18
Excavator with pulveriser	104	0	75	69	67	56	16
Excavation and Foundations / Piling							
Bored piling rig (e.g. SR60)	106	0	87	81	69	58	20
Drum roller / compactor	103	0	84	78	66	55	14
Excavator (20t)	103	0	84	78	66	55	14
General Construction Activities							
Rattle gun	106	0	87	81	69	58	20
Concrete truck / pump	103	0	84	78	66	55	14
Mobile crane (100t)	99	0	80	74	62	51	9

[4] In accordance with the requirements of NZS 6803: 1999, inclusive of 3 decibels façade reflection

[5] Assuming 10 decibels shielding from effective noise barriers (CNVMP Section 5.4) to ground level receivers.

[6] Levels are for breaking solid concrete. Breaking fractured concrete may be up to 10-15 decibels quieter.

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Consent is required as a restricted discretionary activity under E25.4.1(A2) of the AUP to exceed the applicable long-term construction noise limits at adjacent UoA buildings. The relevant matters of discretion and assessment criteria are provided in standards E25.8.1 and E25.8.2. In short:

- **Activities**: The construction works are consistent with a multi-level urban commercial building.
- **Timing**: Construction hours are proposed during the day, plus some early mornings may be required to enable steel deliveries and concrete pours. The hard demolition phase is deliberately planned between December 2027 to February 2028 so that the noisiest activities fall within the UoA summer break and outside teaching and examination periods.
- **Duration**: The project uses the long-duration construction noise limits in this assessment and CNVMP, reflecting the scale of the Project.
- **Engagement**: AUSA house occupants have provided written approval, and the UoA will engage with all other relevant receivers within the campus through existing channels. The CNVMP includes engagement provisions directly relevant to construction noise and vibration.
- **Reasonable effects:** The exceedances are a consequence of the scale and location of the Project within a constrained urban environment and are comparable to those often encountered on urban redevelopment projects. The resulting effects are proposed to be managed through the CNVMP framework, which provides for project-specific mitigation, monitoring and management measures. With the implementation of the CNVMP, we consider that noise generated by the Project will be managed so that the Project activities do not generate unreasonable noise levels at adjacent UoA buildings.

3.3 Construction Vibration

3.3.1 Building Protection

AUP rule E25.6.30(1)(a) requires construction vibration to be measured and assessed against DIN 4150-3:1999 to protect building structures that are not on the same site as the works. The short-term (transient)[7] vibration limits in Figure 1 apply at building foundations in any axis. The long-term (continuous)[8] vibration limits in Table 3 apply at all floor levels, but levels are normally highest in horizontal axes on the top floor.

DIN 4150-3 limits are for avoiding cosmetic building damage, such as cracking in paint or plasterwork. Cosmetic building damage effects are deemed 'minor damage' in the Standard and can generally be easily repaired. The Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*." Much higher vibration levels (i.e. an order of magnitude higher) would be needed for potential structural damage.

[7] Short-term (transient) vibration is "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*"

[8] Long-term (continuous) vibration includes types not covered by the short-term vibration definition

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Figure 1: Short-term (transient)[1] vibration at building foundations (DIN 4150-3 2016: Figure 1)

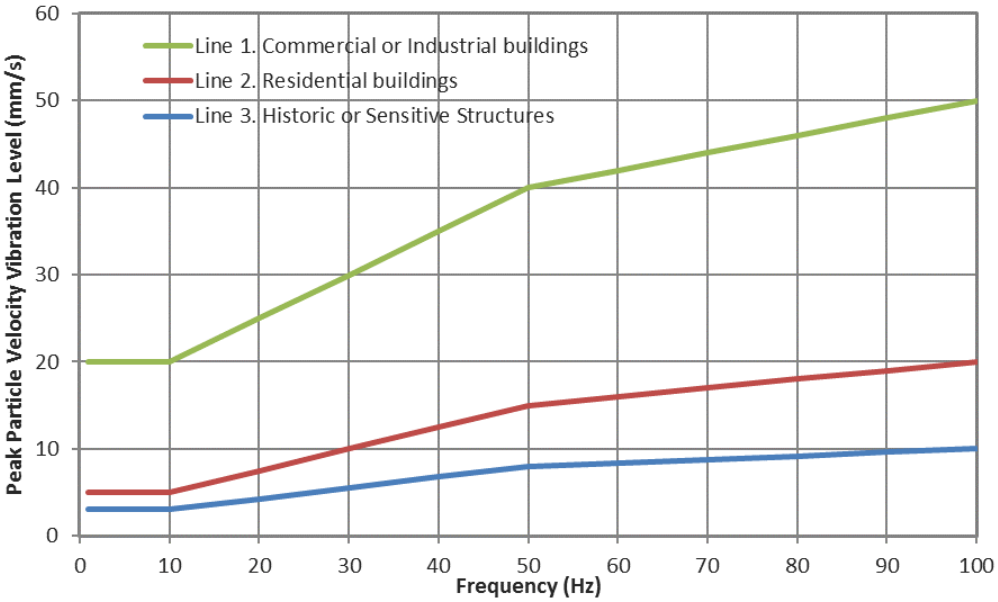

Table 3: Vibration at horizontal plane of highest floor (DIN 4150-3 2016: Tables 1 and 4)

Building Type	Peak Particle Velocity Vibration Level (mm/s)	
	Short-term (transient)[7]	Long-term (continuous)[8]
Line 1. Commercial or Industrial	40	10
Line 2. Residential	15	5
Line 3. Vibration sensitive	8	2.5

DIN 4150-3 states that Line 3 should be used for buildings "*that, because of their particular sensitivity to vibration, cannot be classified under Lines 1 and 2* ***and*** *are of great intrinsic value (e.g. listed building)*".

3.3.2 AUSA House

Appendix C identifies that AUSA House is a heritage building, positioned directly adjacent to the Project, within the UoA site. While not required to comply with AUP E25.6.30(1)(a), we have assessed the vibration effects on AUSA House due to its heritage listing.

We recommend applying DIN 4150-3 Line 2 limits at AUSA House to avoid building damage. Ultimately, compliance with DIN 4150-3 Line 2 is feasible via the adaptive management process detailed in CNVMP Section 4, including:

- Demolition methodology review
- Equipment type/size selection considerations
- Minimum 'safe' setbacks to structures
- Vibration monitoring to refine the 'safe' setback and/or confirm compliance
- Pre and post-construction building condition surveys

3.3.3 Vibration Amenity

AUP rule E25.6.30 (1)(b) requires construction vibration to comply with 2mm/s PPV in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.

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Where construction vibration from daytime works (7am to 6pm) is predicted to exceed 2mm/s PPV for up to 3 days, the occupants of all buildings within 50m must be advised of the works at least 3 days prior to the works commencing and the vibration level must not exceed 5mm/s.

We understand that written approval has been obtained from the occupants of AUSA house. Therefore, vibration amenity effects are focused on other UoA building occupants. Nonetheless, the vibration amenity levels and associated effects can be inferred using the subsequent sections.

3.3.4 Construction Vibration Levels

Table 4 predicts vibration levels for representative activities (included in CNVMP Section 4.2). It identifies potential for infringements at neighbouring UoA buildings, and a management process for enabling compliance. Similar to the assessment of construction noise above, the requirement for management to ensure compliance with vibration standards is standard for large urban construction projects, and the supporting CNVMP framework will be used to manage the associated effects. With the implementation of the CNVMP, we consider that the potential for vibration effects arising from the Project on neighbouring sites will be appropriately managed.

Table 4: Predicted vibration levels at building foundations (mm/s PPV)

	Vibration setback distance (m)		
	Amenity	Building Protection Criteria	
Equipment	**2mm/s**	**DIN 4150-3 Line 2 (AUSA House + Albert Park Caretaker's Cottage)**	**DIN 4150-3 Line 1 (Kate Edgar Commons + Hiwa Rec Centre)**
Excavator mounted breaker (30T)	12	10	7
Excavator mounted breaker (8-10T)	6	5	3
Excavator mounted breaker (1-5T)	3	2	1
Jackhammer	2	1	1
Drum roller (5t) with vibro function	8	6	3
Large plate compactor (450kg)	7	6	3
Small plate compactor (80kg)	2	2	1

The vibration levels are predicted to comply at the closest non-UoA building (Albert Park Caretaker's Cottage 38m away). AUSA House, Kate Edgar Commons and Hiwa buildings are setback approximately 3 – 5m from the Student Union building (to be demolished). To enable compliance:

- Building occupants within 8m of compaction and 12m of concrete breaking will receive timely communication in accordance with the vibration amenity rules (CNVMP Section 6.1).
- Compaction within 8m of a building will use a smaller unit unless attended vibration monitoring is undertaken (CNVMP Section 7.2)
- Concrete breaking within 10m of a building will use a smaller unit unless attended vibration monitoring is undertaken (CNVMP Section 7.2)
- Table 4 will be kept up to date by the Acoustic Specialist when new information becomes available and through vibration monitoring (CNVMP Section 7.2)

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4.0 OPERATIONS NOISE

4.1 Performance Standards

AUP rule E25.6.8 contains noise limits for activities within the Business – City Centre zone received at any other site in the same zone. The limits are reproduced in Table 5 below.

Table 5: City centre zone noise limits

Time	Noise level
7am to 11pm	65 dB L_{Aeq}
11pm to 7am	60 dB L_{Aeq} 65 dB L_{eq} at 63 Hz 60 dB L_{eq} at 125Hz 75 dB L_{AFmax}

The new building will house a range of teaching, library, study, storage, and administrative activities. If social and circulation spaces within the building are used for events, they will be operated within the permitted controls. Mechanical services are proposed in the basement level and on the rooftop (within a plantroom and outdoor plant deck). The rooftop mechanical plant noise emissions are the focus for this assessment.

4.2 Mechanical Plant Noise

In our experience, mechanical plant can achieve compliance with the permitted noise rules provided that suitable acoustic design is undertaken prior to construction, and the equipment is properly installed and maintained. This is standard design practice post consent.

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APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise"
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into vertical (up and down vibration), horizontal transverse (side to side) and horizontal longitudinal direction (front to back) components.
PPV	Peak Particle Velocity (PPV) is the measure of the vibration amplitude, zero to maximum, measured in mm/s.
DIN 4150-3:2016	German Standard DIN 4150-3:2016 "Vibrations in buildings – Part 3: Effects of vibration on structures"

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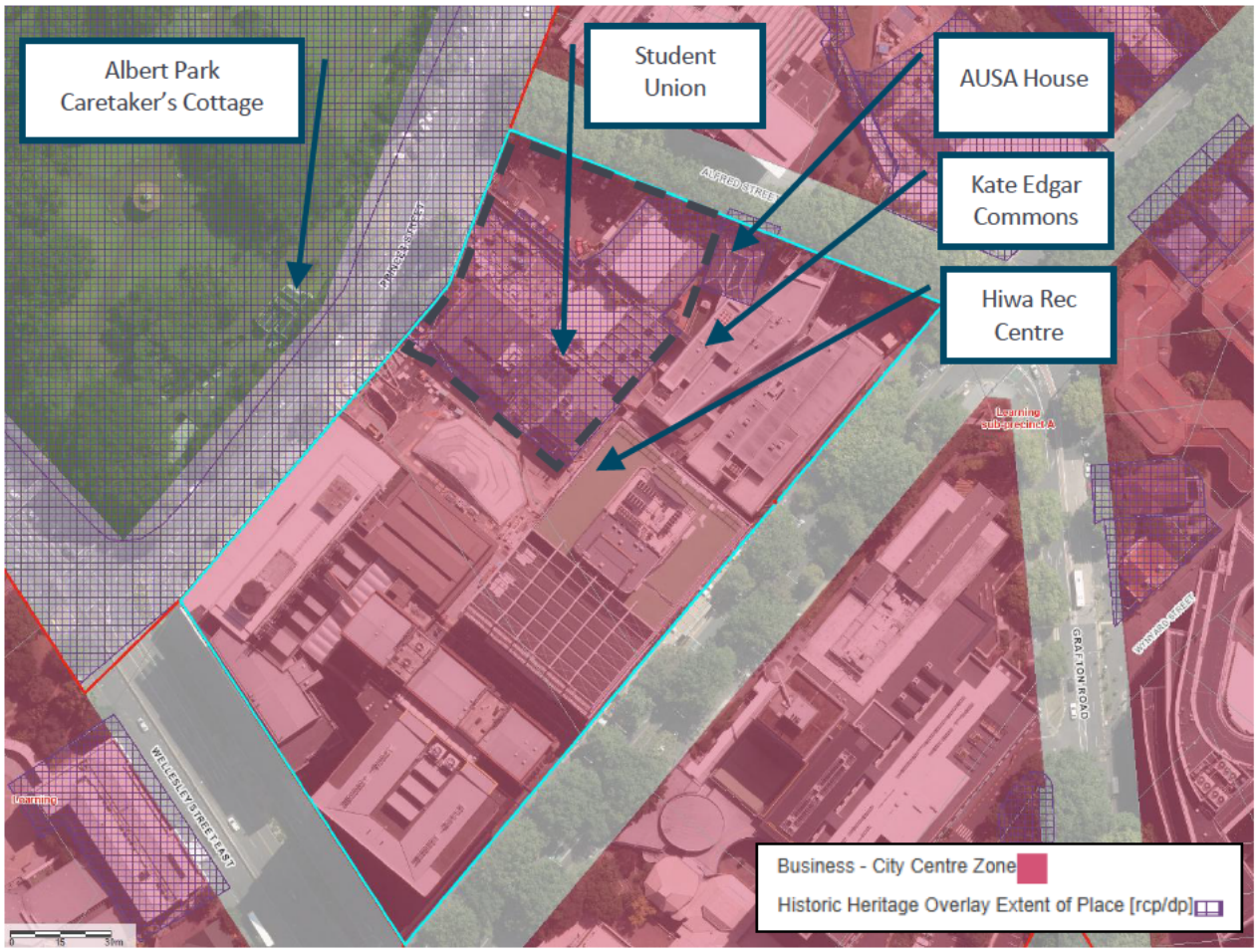
APPENDIX B SITE PLAN AND ZONING

Figure 2 shows the proposed site plan and Figure 3 shows the AUP Zoning with Project annotations.

Figure 2: Proposed Site Plan (100% FTAA Substantive Application, Appendix A, drawing A03.001 rev E)



Figure 3: AUP zoning with key receiver annotations



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APPENDIX C AUSA HOUSE

AUSA House is a heritage building directly adjacent to the Project, within the wider UoA site. Table 6 identifies the known relevant heritage values. DIN 4150-3 Line 2 criteria will be used for building protection limits, and pre and post-construction building condition surveys will be undertaken for certainty.

Table 6: AUSA House vibration sensitivity assessment

Field	Detail
AUP ID (Schedule 14.1)	01926
Place name	Residence (former), known as AUSA House
Address	4 Alfred Street, Auckland Central
Category (Sch 14.1)	B
Heritage Values (Sch 14.1)	A (Historical), F (Physical Attributes), G (Aesthetic)
Primary Feature (Sch 14.1)	None identified
Exclusions (Sch 14.1)	Interior of building
Heritage NZ List	Former Merchants' House, Category 2, List No. 7275
Current use	AUSA reception and administration offices (commercial/institutional)
Description	Two-storey rendered brick house, built 1895
DIN 4150-3 classification	Line 2 (Residential). Masonry dwelling by design, per DIN 4150-3's "dwellings and buildings of similar design and/or use", notwithstanding commercial occupancy. No known structural unsoundness or particularly vibration sensitive elements or features.

Note that DIN 4150-3 classifies building vibration sensitivity under three lines:

- Line 1 (commercial/industrial)
- Line 2 (residential)
- Line 3 (particularly vibration-sensitive structures of great intrinsic value)

Line 3 requires two criteria to be met cumulatively; the building must be of great intrinsic value, AND, must be particularly vibration sensitive (i.e., unable to be appropriately protected under Lines 1 or 2). Heritage listing alone satisfies the first criterion, but does not, by itself, establish the second.

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APPENDIX D DRAFT CNVMP

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MARSHALL DAY Acoustics

UOA STUDENT CENTRE & LIBRARY CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN (CNVMP)

Rp 001 20260741 | 10 November 2026

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1.0 INTRODUCTION

Marshall Day Acoustics (MDA) has been engaged to prepare a Construction Noise and Vibration Management Plan (CNVMP) for The University of Auckland (UoA) Student Centre and Library Project.

This CNVMP identifies the performance standards for the Project and sets out best practicable options (BPO) for noise and vibration management. This CNVMP will be implemented throughout the demolition and construction period. It will be considered a 'living document' that will be expanded and updated as the Project progresses. It is the primary tool for managing the Project's construction noise and vibration effects.

A glossary of terminology is included in Appendix A.

2.0 PROJECT DESCRIPTION

2.1 Overview

The Project will demolish the Student Union building and construct a new 9 level building, including two underground. Appendix B shows the site plan, its zoning, and key buildings nearby. In summary:

- The only non-UoA building within 100m of the Project site is the Albert Park Caretaker's Cottage, a single-level building approximately 38m from the Student Union Building demolition footprint at its closest point. The Auckland City Mission occupies the building with an office and shop within normal office hours, and shop staff advised that the building is not occupied overnight.
- All other occupied buildings within 100m of the project site are owned and operated by UoA. Three of the UoA buildings are directly adjacent to the Project (i.e. AUSA House, Kate Edgar Commons, and the Hiwa Recreation and Wellness Centre). AUSA House also has a heritage listing.

2.2 Construction Methodology

The construction methodology and programme are detailed in the CMP. The works are scheduled between 2027 and 2031. The key phases are summarised as follows:

- Hard demolition 2.5 months
- Piling and excavation 8 months
- Super structure and envelope 24 months

The hard demolition phase is deliberately planned between December 2027 to February 2028 to minimise the effects in neighbouring UoA buildings during semesters.

Normal construction hours will be 06:30 am to 10:30 pm Monday to Friday, 7 am to 11 pm Saturdays, and 9 am to 7 pm Sundays (excluding public holidays). Early morning or evening works may be required for steel deliveries and concrete pours, otherwise, only quiet works at other times.

2.3 Contact Details

Contact details for the relevant personnel are listed in Table 1. The Project Manager is responsible for implementing this CNVMP.

Table 1: Contacts

Role	Name	Organisation	Phone	Email
Project Manager	TBC	TBC	TBC	TBC
Engagement	TBC	TBC	TBC	TBC
Acoustic Specialist	Craig Fitzgerald	MDA	[redacted]	[redacted]

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3.0 NOISE

3.1 Performance Standards

AUP Rule E25.6.28 sets construction noise limits for the City Centre zone. Construction noise must be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 "*Acoustics - Construction Noise*". The noise limits apply at 1m from external façades of occupied buildings. 75 dB L_{Aeq} is the most relevant limit during the normal weekday daytime construction hours, whilst 80 dB L_{Aeq} applies on Saturdays and 65 dB L_{Aeq} on Sundays.

3.2 Predicted Noise Levels

Table 2 predicts levels for representative high-noise construction activities. The 5m and 10m setback columns represent infringements at the most exposed occupied rooms of neighbouring UoA buildings overlooking the works. The noise levels are predicted to comply at the closest non-UoA building when occupied, during normal office hours (Albert Park Caretaker's Cottage 38m away). It will be kept up to date by the Acoustic Specialist when new information becomes available, e.g. through noise monitoring (Section 7.1).

Table 2: Indicative noise levels at 1m from a building façade[1]

Equipment	Sound Power Level (dB L_{Aeq})	Mitigation[2] (dB)	Noise Level (dB L_{Aeq})				Setback (m)
			5 m	10 m	38 m	100 m	75 dB L_{Aeq}
Demolition (Concrete Breaking[3]							
Large excavator (30t) mounted concrete breaker	121	10	92	86	74	63	33
Medium excavator (8-10t) mounted concrete breaker	116	10	87	81	69	58	20
Concrete Cutting	115	10	86	80	68	57	18
Excavator with pulveriser	104	0	75	69	67	56	16
Excavation and Foundations / Piling							
Bored piling rig (e.g. SR60)	106	0	87	81	69	58	20
Drum roller / compactor	103	0	84	78	66	55	14
Excavator (20t)	103	0	84	78	66	55	14
General Construction Activities							
Rattle gun	106	0	87	81	69	58	20
Concrete truck / pump	103	0	84	78	66	55	14
Mobile crane (100t)	99	0	80	74	62	51	9

[1] In accordance with the requirements of NZS 6803: 1999 (Section 3.0), inclusive of 3 decibels façade reflection

[2] Assuming 10 decibels shielding from effective noise barriers (Section 5.4) to ground level receivers.

[3] Levels are for breaking solid concrete. Breaking fractured concrete may be up to 10-15 decibels quieter.

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4.0 VIBRATION

4.1 Performance Standards

4.1.1 Building Protection

AUP rule E25.6.30(1)(a) requires construction vibration to be measured and assessed against DIN 4150-3:1999 to protect building structures that are not on the same site as the works. The short-term (transient)[4] vibration limits in Figure 1 apply at building foundations in any axis. The long-term (continuous)[5] vibration limits in Table 3 apply at all floor levels, but levels are normally highest in horizontal axes on the top floor.

DIN 4150-3 limits are for avoiding cosmetic building damage, such as cracking in paint or plasterwork. Cosmetic building damage effects are deemed 'minor damage' in the Standard and can generally be easily repaired. The Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*." Much higher vibration levels (i.e. an order of magnitude higher) would be needed for potential structural damage.

Figure 1: Short-term (transient)[1] vibration at building foundations (DIN 4150-3 2016: Figure 1)

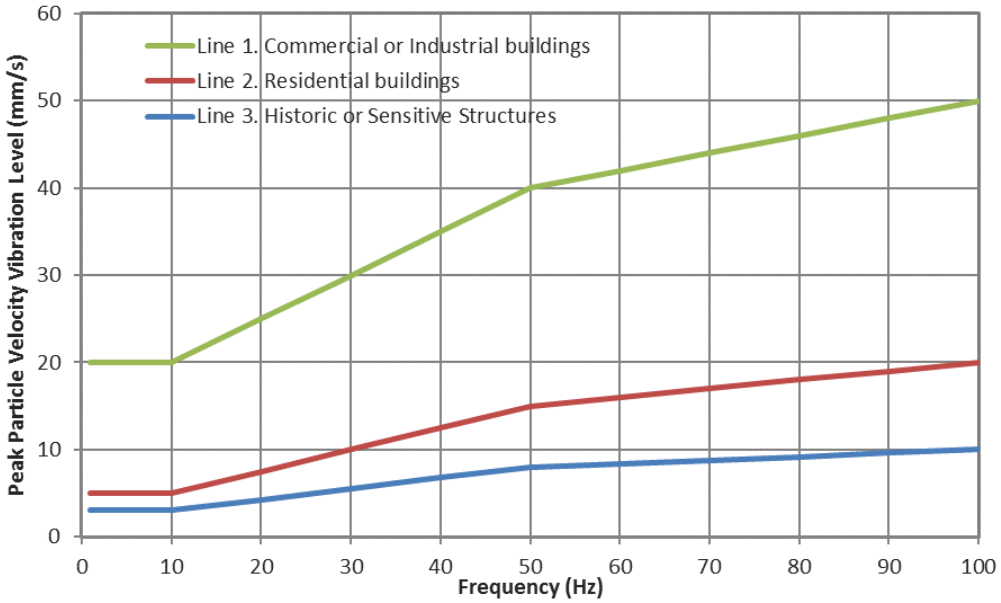

Table 3: Vibration at horizontal plane of highest floor (DIN 4150-3 2016: Tables 1 and 4)

Building Type	Peak Particle Velocity Vibration Level (mm/s)	
	Short-term (transient)[4]	Long-term (continuous)[5]
Line 1. Commercial or Industrial	40	10
Line 2. Residential	15	5
Line 3. Vibration sensitive	8	2.5

DIN 4150-3 states that Line 3 should be used for buildings "*that, because of their particular sensitivity to vibration, cannot be classified under Lines 1 and 2* ***and*** *are of great intrinsic value (e.g. listed building)*".

[4] Short-term (transient) vibration is "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*"

[5] Long-term (continuous) vibration includes types not covered by the short-term vibration definition

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4.1.2 Amenity

AUP rule E25.6.30 (1)(b) requires construction vibration to comply with 2mm/s PPV in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.

Where construction vibration from daytime works (7am to 6pm) is predicted to exceed 2mm/s PPV for no more than three days, the occupants of all buildings within 50m must be advised of the works at least 3 days prior to the works commencing (Section 6.1) and the vibration level must not exceed 5mm/s.

UoA has obtained written approval from the occupants of AUSA house. Therefore, vibration amenity effects are focused on other UoA building occupants. Nonetheless, the vibration amenity levels and associated effects can be inferred using the subsequent sections.

4.1.3 AUSA House

AUSA House is a heritage building, positioned within the site and directly adjacent to the Project. While not required to comply with AUP E25.6.30(1)(a), Appendix C identifies that the vibration levels will be managed to comply with the DIN 4150-3 Line 2 limits in Table 3.

4.2 Predicted Vibration Levels

Table 4 predicts vibration levels for representative activities. The predictions are based on regression analysis of available vibration measurements. The amenity setbacks are based on typical levels, whereas the setbacks for building protection are more conservative (i.e. addition of a 100% safety factor).

Table 4: Predicted vibration levels at building foundations (mm/s PPV)

	Vibration setback distance (m)		
	Amenity	Building Protection Criteria	
Equipment	**2mm/s**	**DIN 4150-3 Line 2 (AUSA House + Albert Park Caretaker's Cottage)**	**DIN 4150-3 Line 1 (Kate Edgar Commons + Hiwa Rec Centre)**
Excavator mounted breaker (30T)	12	10	7
Excavator mounted breaker (8-10T)	6	5	3
Excavator mounted breaker (1-5T)	3	2	1
Jackhammer	2	1	1
Drum roller (5t) with vibro function	8	6	3
Large plate compactor (450kg)	7	6	3
Small plate compactor (80kg)	2	2	1

The vibration levels are predicted to comply at the closest non-UoA building (Albert Park Caretaker's Cottage 38m away). AUSA House, Kate Edgar Commons and Hiwa buildings are setback approximately 3 – 5m from the Student Union building (to be demolished). To enable compliance:

- Building occupants within 8m of compaction and 12m of concrete breaking will receive timely communication in accordance with the vibration amenity rules (Section 6.1).
- Compaction within 8m of a building will use a smaller unit unless attended vibration monitoring is undertaken (Section 7.2)

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- Concrete breaking within 10m of a building will use a smaller unit unless attended vibration monitoring is undertaken (Section 7.2)

Table 4 will be kept up to date by the Acoustic Specialist when new information becomes available and through vibration monitoring (Section 7.2).

5.0 MITIGATION AND MANAGEMENT

5.1 Training

All staff will participate in an induction training session before starting work on the construction, with attention given to the following matters:

- Activities with the potential to generate high levels noise and/or vibration
- Mitigation and management measures (Section 5.0)
- Sensitive receivers and any agreements made through engagement (Section 6.0)
- Monitoring requirements (Section 7.0)

As the construction progresses, any updates of noise and vibration matters will be addressed during regular site meetings and/or 'toolbox' training sessions.

5.2 Equipment Selection

When selecting construction equipment:

- Use quieter construction methodologies where practicable (e.g. pulveriser instead of a breaker)
- Use electric motors rather than diesel engines where practicable
- Use rubber tracked equipment rather than steel tracked equipment where practicable
- Use equipment that is suitably sized for the task
- Maintain equipment well to minimise rattles, squeaks etc
- Fit engines with exhaust silencers and engine covers where practicable
- Avoid tonal reversing or warning alarms where practicable (beepers). Alternatives include broadband alarms (squawkers/quackers), flashing lights, proximity sensors, reversing cameras and spotters

5.3 General Measures

Complaints can arise even if the noise and vibration levels comply with the Project limits. To minimise complaints, the following mitigation measures are recommended:

- Avoid unnecessary noise. This means managing the site to ensure:
  - No shouting
  - No unnecessary use of horns
  - No loud outdoor site radios
  - No rough handling of material and equipment
  - No banging or shaking excavator buckets
  - No unnecessary steel on steel contact (e.g. during the loading of scaffolding on trucks)
  - No high engine revs. This includes choosing the right sized equipment and turning engines off when idle.
- Avoid unnecessary vibration. This means managing the site to ensure:

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  - No unnecessary dropping of heavy objects
  - No potholes, bumps or corrugations in site accessways
  - Excavator operators are skilled and use their machine considerately
- Mitigate track squeal from tracked equipment, such as excavators. This may include tensioning and watering or lubricating the tracks regularly
- Locate stationary equipment (e.g. generators) away from noise sensitive receivers and/or screen them behind site buildings and material stores
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. bored piling rig)
- Utilise noise barriers and enclosures where appropriate (Section 5.4)
- Utilise specific measures for the following activities:
  - Excavators (Section 5.5)
  - Concrete cutting (Section 5.6)
  - Concrete and rock breaking (Section 5.7)
  - Piling (Section 5.8)
  - Compaction (Section 5.9)
  - Rattle Guns (Section 5.10)
- Engagement is complete (Section 6.0) prior to commencing high-noise and vibration activities
- Undertake monitoring (Section 7.0)

5.4 Noise Barriers

5.4.1 Temporary Noise Barriers

Temporary noise barriers will be used where an activity is predicted to exceed the construction noise limits (Section 3.2), unless they are ineffective (e.g. where a receiver is elevated and would look over the barrier). They will be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 10 decibels.

The following guidelines will be used in designing and installing temporary noise barriers:

- The panels will have a minimum surface mass of 6.5 kg/m^2. Suitable panels include 12 mm plywood or the following proprietary ‘noise curtains’: proprietary
  - SealedAir ‘WhisperFence 24dB’ (www.sealedair.com)
  - Hushtec ‘Premium Series Noise Barrier’ (www.duraflex.co.nz)
  - Soundbuffer ‘Performance Acoustic Curtain’ (soundbuffer.co.nz)
  - Hoardfast ‘Fast Wall Premium PVC partition panels' (www.ultimate-solutions.co.nz)
  - Safesmart ‘Acoustic Curtain 6.5kg/m^2’ (www.safesmartaccess.co.nz)
  - Alternatives will be approved by a suitably qualified and experienced acoustic specialist
- The panels will be a minimum height of 2 m, and higher if practicable to block line-of-sight
- The panels will be abutted, battened or overlapped to provide a continuous screen without gaps at the bottom or between panels

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- Barriers will be positioned as close as practicable to the high-noise activity to block line-of-sight between the activity and noise sensitive receivers. A site hoarding at the boundary may not be effective for all receivers. Add extra barriers close to high-noise activities to ensure effective mitigation for sensitive receivers on upper floors.

5.4.2 Noise Enclosures

Noise enclosures surround the source on more than one side and have a roof (an example is included as Figure B.3 in NZS 6803: 1999). How effective an enclosure is depends on how well the noise source can be enclosed without constraining its operation (e.g. mobility, heat, dust, lighting).

The following guidelines will be used in designing and installing enclosures:

- Enclosures will be considered where a noise barrier can't achieve compliance noise limits, particularly for stationary plant such as compressors, pumps and generators
- Enclosures can be made from the noise curtains listed above, or the following proprietary options are available:
  - Echo Barrier 'Cutting Station' (www.supplyforce.co.nz)
  - Soundbuffer 'Cutting Enclosure' (soundbuffer.co.nz)
  - Hushtec 'Acoustic Tent' (www.duraflex.co.nz)
- If a custom enclosure is needed, a suitably qualified and experienced acoustic specialist, such as a Member of the Acoustical Society of New Zealand (MASNZ), will be involved in its design.

5.5 Excavators

All excavators can generate high noise and vibration levels. The actual level they generate depends very much on the experience and temperament of the operator.

- Use the right sized excavator for the job
- Operate the bucket and armature with smooth movements (avoid jerking)
- Tip material from the bucket rather than shaking it clean where practicable
- Avoid hitting the bucket on the ground or dropping heavy objects
- Control the weight shift of the excavator to avoid the tracks lifting and thudding on the ground

5.6 Concrete Cutting

- Select blades that:
  - Are sharp
  - Maximise the number of teeth
  - Minimise the blade width
  - Minimise gullet depth
  - Have built in vibration damping slots
- Use a unit fitted with a blade shroud and operate with a water supply
- Use noise barriers for concrete cutting and a noise enclosure for paver cutting stations (Section 5.4)
- Minimise the cutting period and/or the number of cutting periods (e.g. complete all cutting in one extended period rather than two shorter periods with the same overall duration)

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5.7 Concrete Breaking

- Manage vibration within the safe setback distances (Section 4.2)
- Minimise the amount of breaking needed
- Match the size of breaker to the scale of the works. It will be large enough to carry out the work efficiently, but not over-sized (avoiding unnecessary noise and vibration)
- For concrete breaking, make an initial perimeter saw cut at the perimeter to reduce vibration transfer to nearby buildings
- Ensure effective noise mitigation is in place using noise barriers and enclosers (Section 5.4) and/or a breaker blanket (e.g. Hushtec 'breaker attachment' – www.duraflex.co.nz)
- Minimise the breaking period (e.g. remove concrete sections for breaking offsite), and/or the number of breaking periods (e.g. complete all breaking in one extended period rather than two shorter periods with the same overall duration)
- Match the chisel/tip type to the material and use a dampened bit to avoid ringing
- Avoid 'blank' firing by placing the chisel on the rock or concrete before starting, and minimising firing after it breaks through

5.8 Bored Piling

- The piling rig will be orientated to maximise the distance between the engine exhaust and the nearest sensitive building façade.
- Avoid shaking the auger to remove spoil where practicable. Shaking the kelly bit connection creates very loud banging that often results in noise complaints. If spoil does not fall off the auger easily, use tools to scrape the auger clean if necessary. If shaking is required due to Health and Safety constraints, ensure bushes are well maintained to minimise steel on steel contact.

5.9 Compaction

- Match the size of plate compactor or roller to the scale of the works (i.e. large enough to undertake the works efficiently, but avoiding oversized units)
- Avoid the use of the vibratory function on rollers where practicable (e.g. roll thinner layers of fill without the vibration function to achieve the same compaction standard)
- Where the vibration function is adjustable, minimise amplitude and maximise the driving frequency to minimise vibration effects where practicable
- Minimise the duration of the vibratory function on rollers (e.g. use vibro mode to settle and align aggregate, then turn vibratory function off for subsequent static rolling compaction)
- Minimise the number of periods (e.g. complete all plate compaction or vibratory rolling in one extended period rather than two shorter periods with the same overall duration)
- Start/stop vibratory function away from buildings and pass by while the vibration level is stable
- Manage vibration within the safe setback distances (Section 4.2)

5.10 Rattle Guns

- Prioritise use of a tension control bolt, hydraulic wrench or manual torque wrench to minimise rattle gun slippage on a tightened nut
- Ensure effective noise mitigation is in place using noise barriers where practicable (Section 5.4)

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6.0 ENGAGEMENT

6.1 Communication

6.1.1 Before construction

Written communication (e.g. newsletter) will be provided to neighbouring building occupants at least 10 working days prior starting demolition and construction. It will include:

- Details of the overall works, its timing and duration
- Contact details and names of personnel whose job is to receive complaints and enquiries (will also match a person identified in Section 2.3)
- Acknowledge that some activities (addressed in this CNVMP) are predicted to generate high noise and/or vibration levels and may result in disturbance for short periods

6.1.2 During construction

Once construction has begun, ongoing communication is important. Regular communication during the works will include:

- Public site signage that includes contact details
- Details of upcoming activities that may result in disturbance
- Any changes to scheduled timing and duration of activities

Occupants of buildings predicted to receive vibration levels exceeding 2mm/s PPV for more than three days will be advised at least 3 days prior to the works commencing (Section 4.1.2).

6.2 Consultation

The purpose of consultation is to address concerns about noise and vibration on a case-by-case basis. The Project Manager will address any concerns and complaints in accordance with Section 6.3.

Receivers that do not want ongoing consultation, will be offered communication (Section 6.1).

The following will be implemented by the Project Manager (or nominated person):

- Vibration activity will cease as soon as safe and practicable to do so if any exceedance of the building protection standard is measured
- Review the construction methodology, mitigation measures and management strategies to ensure they represent the BPO. The BPO considers:
    - Practicability
    - Predicted noise/vibration benefits
    - The interests of affected parties
    - Implications for Project timing and duration
    - Cost
- Consultation with affected parties to understand their sensitivities, including times they normally occupy an affected room. The objective is to establish a collaborative approach to managing adverse noise and vibration effects
- A Project representative will be contactable during work hours (Section 2.3)
- A record of consultation will be kept at the site office and be available to affected parties and Council if requested
- Implement any measures agreed with the affected party in good faith

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- Monitor the activity to verify the extent of any adverse effects (Section 7.0)
- A building condition survey will be undertaken (Section 7.3) if the vibration building protection limits are exceeded (Section 4.1),.
- Consider installing mechanical ventilation systems in buildings where external windows must be closed to avoid significant adverse noise effects and no alternative ventilation system is present. Only consider this option after all other BPO management and mitigation has been applied.
- Consider temporary relocation of sensitive receivers where all BPO management and mitigation measures have been applied and significant adverse noise effects are still likely. This will be in exceptional cases only, and advice from the Acoustic Specialist will be sought prior.

6.3 Complaints Response

All construction noise and/or vibration complaints will be recorded. For each complaint, an investigation will be undertaken as soon as practicable using the following steps:

- Acknowledge receipt of the concern or complaint:
  - The name, address and contact details of the complainant (unless they elect not to provide)
  - Time and date the complaint was received and who received it
  - Time and date of the activity that caused the complaint (estimated where not known)
  - The complainant's description of the activity and its resulting effects
  - Any relief sought by the complainant (e.g. scheduling of the activity)
- Identify the relevant activity and review the activity log to verify the complaint (or otherwise)
- If a complaint relates to building damage, inform the on-duty site manager as soon as practicable and stop the relevant works pending an investigation. In most cases, stopping the activity will provide immediate relief. But in some cases, this may not be practicable for safety or other reasons, in which case the complainant will be kept updated regularly during the time it takes to stop the activity.
- Review data from monitoring (if available) to identify the time in question and, if possible, verify exceedance
- Review the predicted noise and/or vibration levels to determine if the activity was identified. Consider attended monitoring to verify the underlying reference level assumptions
- Review the mitigation and management measures in place to ensure the BPO has been applied (Section 5.0). Review the relief sought by the complainant. Adopt further mitigation and management measures as appropriate.
- Review the potential residual effects if predicted to continue to exceed the relevant performance standards
- Report the findings and recommendations to the Project Manager, implement changes and update this CNVMP as appropriate
- Report the outcomes of the investigation to the complainant, identifying where the relief sought by the complainant has been adopted or the reason(s) otherwise.

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7.0 MONITORING

7.1 Noise

Attended monitoring will be undertaken:

- In response to a reasonable noise complaint (Section 6.3)
- At 1m from the building façade facing the construction site, or a proxy position adjusted for distance
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance with the requirements of New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
- For an appropriate duration, reported with the measured level (e.g. 65 dB $L_{Aeq\ (30min)}$)
- The results will be used to update Section 3.2 if appropriate

7.2 Vibration

Attended monitoring will be undertaken:

- At the beginning of concrete breaking, compaction and any other activities with potential to infringe the vibration limits at AUSA House (Section 4.2)
- In response to a reasonable vibration complaint (Section 6.3)
- On the foundations and/or the top floor of the closest building as appropriate (Section 4.1), provided access to the building has been requested and granted
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance the requirements of German Standard DIN 4150-3:1999 "*Vibrations in buildings – Part 3: Effects of vibration on structures*"
- For a representative construction duration, measured in [2] second intervals
- The results will be used to update Section 4.2 if appropriate

7.3 Building Condition Surveys

Building condition surveys for AUSA House will identify any existing cracks or damage. Completing one prior, and after construction, will provide a benchmark to evaluate any damage claims.

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APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise"
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into vertical (up and down vibration), horizontal transverse (side to side) and horizontal longitudinal direction (front to back) components.
PPV	Peak Particle Velocity (PPV) is the measure of the vibration amplitude, zero to maximum, measured in mm/s.
DIN 4150-3:2016	German Standard DIN 4150-3:2016 "Vibrations in buildings – Part 3: Effects of vibration on structures"

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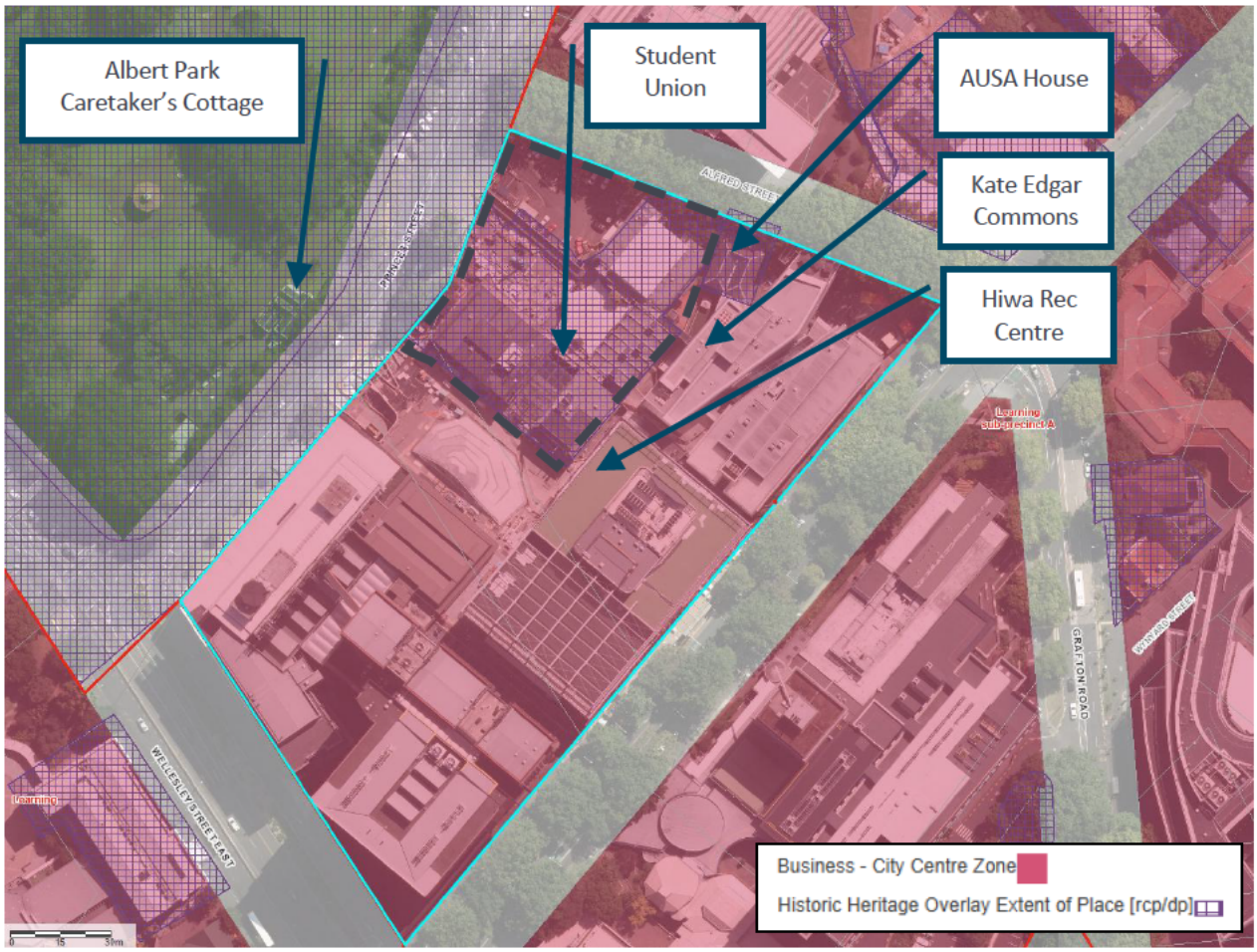
APPENDIX B SITE PLAN AND ZONING

Figure 2 shows the proposed site plan and Figure 3 shows the AUP Zoning with Project annotations.

Figure 2: Proposed Site Plan (100% FTAA Substantive Application, Appendix A, drawing A03.001 rev E)



Figure 3: AUP zoning with key receiver annotations



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APPENDIX C AUSA HOUSE

AUSA House is a heritage building directly adjacent to the Project, within the wider UoA site. Table 5 identifies the known relevant heritage values. DIN 4150-3 Line 2 criteria will be used for building protection limits, and pre and post-construction building condition surveys will be undertaken for certainty.

Table 5: AUSA House vibration sensitivity assessment

Field	Detail
AUP ID (Schedule 14.1)	01926
Place name	Residence (former), known as AUSA House
Address	4 Alfred Street, Auckland Central
Category (Sch 14.1)	B
Heritage Values (Sch 14.1)	A (Historical), F (Physical Attributes), G (Aesthetic)
Primary Feature (Sch 14.1)	None identified
Exclusions (Sch 14.1)	Interior of building
Heritage NZ List	Former Merchants' House, Category 2, List No. 7275
Current use	AUSA reception and administration offices (commercial/institutional)
Description	Two-storey rendered brick house, built 1895
DIN 4150-3 classification	Line 2 (Residential). Masonry dwelling by design, per DIN 4150-3's "dwellings and buildings of similar design and/or use", notwithstanding commercial occupancy. No known structural unsoundness or particularly vibration sensitive elements or features.

Note that DIN 4150-3 classifies building vibration sensitivity under three lines:

- Line 1 (commercial/industrial)
- Line 2 (residential)
- Line 3 (particularly vibration-sensitive structures of great intrinsic value)

Line 3 requires two criteria to be met cumulatively; the building must be of great intrinsic value, AND, must be particularly vibration sensitive (i.e., unable to be appropriately protected under Lines 1 or 2). Heritage listing alone satisfies the first criterion, but does not, by itself, establish the second.

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