MARSHALL DAY Acoustics

DOWNTOWN CARPARK SITE DEVELOPMENT CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

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Project: **DOWNTOWN CARPARK SITE DEVELOPMENT PROJECT**

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1.0 INTRODUCTION

Marshall Day Acoustics ("**MDA**") has been engaged by Precinct Properties New Zealand Limited to prepare a Construction Noise and Vibration Management Plan ("**CNVMP**") for the proposed development of the Downtown Carpark Site into an integrated mixed-use precinct ("**Project**"), located at 2 Lower Hobson Street in the Auckland City Centre ("**Site**"). The project involves the demolition of the Downtown carpark at 2 Lower Hobson Street and the construction of a mixed use development with three buildings.

This CNVMP is required to satisfy the resource consent conditions. It identifies the performance standards for the Project and sets out best practicable options ("**BPO**") for noise and vibration management.

The objective of the CNVMP is to provide a framework for the development and implementation of the BPO for the management of construction noise and vibration effects to achieve compliance with the construction noise and vibration standards set out in the consent conditions to the extent practicable.

This CNVMP will be implemented throughout the demolition and construction period. It should 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 works involve the:

- Demolition of the existing carparking building and associated pedestrian bridge and vehicle ramps
- Removal of the concrete slab including foundations and services
- Excavation of a 4-level basement
- Construction the following buildings:
  - Tower 1 – Commercial (55 Levels including the podium)
  - Tower 2 – Hotel and Residential (45 Levels including the podium)
  - Three podium buildings including office spaces, retail and food and beverage units and a new public realm space known as the Urban Room (Te Urunga Hau)

Site maps showing the site and sensitive receivers are attached in Appendix B.

The works are scheduled for approximately 56-64 months, between [month year] and [month year].

2.2 Working Hours

Demolition and construction hours will be Monday to Friday 7am – 6pm and Saturdays 8am – 5pm. Construction hours may be extended for the following activities:

- Customs Street vehicle bridge demolition – 24h works over 2 weekends
- Lower Hobson Street pedestrian bridge demolition – 24h works over 1 weekend
- Large concrete pours – anticipated 3am start
- Sheet piling within 40m of Aon – to 10:30pm Monday to Friday

2.3 Construction Methodology

A summary of the demolition and construction methodology is set out below:

Overall summary

High noise and vibration activities will occur mostly during demolition, foundations and excavation. The predicted duration for each phase is:

- Demolition 8.5 to 10 months
- Retention and excavation 10 to 12 months
- Basement structure 10.5 to 12 months
- Building construction 24 to 27 months

The following activities have the potential to create elevated noise and vibration effects. The focus is on them as the primary indicators of the noise and vibration effects.

Customs Street vehicle bridge

The Customs Street vehicle bridge will be demolished using a cut and crane method. This work will likely occur over two weekends and works would occur 24 hours per day.

Lower Hobson Street pedestrian bridge

The Lower Hobson Street pedestrian bridge is proposed to be demolished using a cut and crane method. This work will likely occur over one weekend and works would occur 24 hours per day.

Downtown carpark building demolition

The main carpark building is proposed to be demolished using a top down methodology.

- A scaffold will be erected on all four sides and have an incorporated noise barrier
- A mobile crane will lift excavators and skid steers onto the roof of the carpark
- The slab structure will be demolished with pulveriser and breaker attachments (and potentially concrete saws)
- The skid steers will progressively clear the demolished rubble from the floor and transfer the rubble to the designated drop-zones
- Once the demolition debris is cleared, excavators will demolish columns, then re-commence slab demolition on the next lower floor, and the process repeats
- The scaffold with noise barrier will reduce is height as the building is demolished, but remain 2m above the floor being demolished

Once piling is completed (see below), excavation will commence. During this phase, it may be necessary to remove inground foundations leftover from the demolition phase. This would be undertaken using a medium (8-10t) excavator with breaker attachment.

Diaphragm wall

A diaphragm wall (d-wall) will be constructed around the northern and western perimeter of the site.

Sheet piling

The southern and eastern perimeter of the site is proposed to have a sheet piled wall. The sheet piles will be pre-drilled to minimise noise and vibration and only the final ~2m of pile will be vibrated in. Sheet piling (including pre-drilling and vibro) will take approximately 3 weeks to complete.

Excavation

Excavation will typically occur with excavator mounted buckets. There is a small possibility that rippers, rock saws or breaker attachments will be required.

Building piles

Foundation piling will occur across the site using large piling rigs using augers or circular cutters with buckets. Pile casings will be required but these will be pushed and rotated into the ground.

Large concrete pours

It is expected that large concrete pours will need to start early in the morning with a typical 3am start time.

General building construction

The remainder of the construction period will involve typical commercial building construction methodologies, including as concrete works, cranage and hand tools.

2.4 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	TBC	TBC	TBC	TBC

2.5 Conditions of Consent

This CNVMP is required to satisfy the following conditions of consent:

[X]

3.0 NOISE

3.1 Noise Performance Standards

Construction noise must be measured and assessed according to New Zealand Standard NZS 6803:1999 "*Acoustics – Construction Noise*". The noise limits apply at 1m outside the façades of buildings, and only while they are occupied.

The construction noise limits are summarised in Table 2.

Table 2: Construction noise limits for construction duration of at least 15 days

Time	Noise Limit	
	Average ($L_{Aeq(30min)}$)	Maximum (L_{AFmax})
Monday to Friday 6.30am – 10:30pm	75 dB	90 dB
Saturday 7am-11pm	80 dB	90 dB
Sunday 9am – 7pm	65 dB	85 dB
All other times	60 dB	75 dB

3.2 Predicted Noise Levels

Table 3 predicts levels for high-noise construction activities. It identifies the equipment that requires mitigation and/or management and the source-receiver distances where the risk begins. It will be kept up to date by the Acoustic Specialist when new information becomes available, e.g. through noise monitoring (Section 7.3).

Table 3: Construction noise levels at 1m from a building façade (excluding screening)

Equipment	Sound Power Level (dB L_{Aeq})	Noise Level (dB L_{Aeq})				Setback (m)
		5 m	10 m	20 m	50 m	75 dB L_{Aeq}
Excavator (20t)	103	84	78	72	64	14
Mobile crane (35t)	98	79	73	67	58	8
Small excavator (2-5t) mounted concrete breaker*	106	87	81	75	66	20
Medium excavator (8-10t) mounted concrete breaker*	111	92	86	80	71	33
Concrete truck and pump	103	84	78	72	64	14
D Wall and Bored piling	106	87	81	75	66	20
Vibro sheet piling	116	97	91	85	76	52
Concrete saw	115	96	90	84	75	48
Wire saw	101	82	76	70	61	11

* includes 5 dB from breaker shroud

Table 4: Highest representative noise levels

Building Address	Predicted Noise Level, dB L_{Aeq}			Indicative duration of infringement
	D-wall / Bored Piling	Sheet Piling	Concrete saw (slab removal)	
M Social – 196 – 200 Quay Street	79	< 75	80[1] – 75	3.5 months
Aon Building – 29 Customs Street West – Tower	76	85	< 75[1]	6 weeks
Aon Building – 29 Customs Street West – Podium	79	90	< 75[1]	6 weeks
HSBC – 188 Quay Street – Tower	< 75	80	< 75[1]	3 weeks
The Sebel - 85 Customs Street West	< 75	80	< 75[1]	3 weeks

[1] includes 15 dB of shielding from a concrete cutting enclosure

A Schedule (see Section 5.10) will be required for the following activities:

- Concrete saws – 196 – 200 Quay Street
- D-wall piling – 20 Customs Street West & 196 – 200 Quay Street
- Bored piling – 20 Customs Street West & 196 – 200 Quay Street
- Sheet piling – 20 Customs Street West, 188 Quay Street & 196 – 200 Quay Street

4.0 VIBRATION

4.1 Vibration Performance Standards

4.1.1 Cosmetic Building Damage

Condition X requires construction vibration to be measured and assessed in accordance with German Standard DIN 4150-3:2016 "*Vibrations in buildings – Part 3: Effects of vibration on structures*".

The short-term (transient)[1] vibration limits in Figure 1 apply at building foundations in any axis.

The long-term (continuous)[2] vibration limits in Table 5 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.

204 Quay Street is listed as Historic and will be assessed against the sensitive structures category.

[1] 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*"

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

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

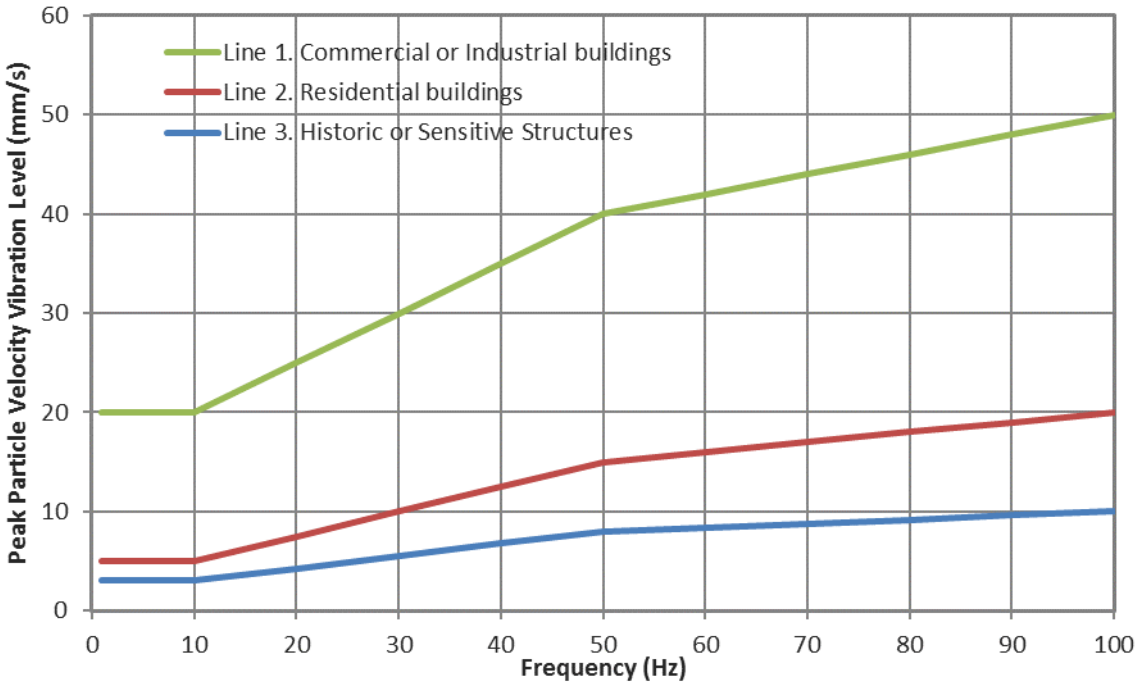

Table 5: Vibration at horizontal plane of highest floor (DIN 4150-3 2016: Tables 1 and 4)

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

4.1.2 Amenity

Condition X requires construction vibration to comply with the limits in Table 6 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.

Table 6: Vibration amenity at horizontal plane of floor level of interest (AUP E25.6.30.1)

Receiver	Peak Particle Velocity Vibration Level (mm/s)	
	0700 – 2200	2200 – 0700
Occupied activity sensitive to noise	2	0.3
Other occupied buildings	2	2

4.2 Predicted Vibration Levels

Table 7 predicts levels for high-vibration construction activities. It identifies the equipment that requires mitigation and/or management, and the source-receiver distances where the risk begins.

The predictions are based on regression analysis of available vibration measurements. The amenity setbacks are based on typical levels, whereas the setbacks for cosmetic building damage are more conservative and include a 100% safety factor

Table 7 will be kept up to date by the Acoustic Specialist when new information becomes available and through vibration monitoring (Section 7.4).

Table 7: Indicative vibration levels at building foundations

	Vibration setback distance (m)				
	Vibration Amenity		Cosmetic Building Damage[1]		
	BS 5228	AUP	Heritage	Residential	Commercial
Equipment	1 mm/s	2 mm/s	2.5 mm/s	5 mm/s	10 mm/s
Small excavator (2 - 5t) mounted concrete breaker	<1	1	2	1	1
Medium excavator (8 – 10t) mounted concrete breaker	2	3	4	3	2
Sheet piling (based on predrilled holes)	11	4	8	3	1

1 – Includes 100% safety factor

5.0 MITIGATION AND MANAGEMENT

5.1 Training

All staff will participate in an induction training session before starting work on the demolition and 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. pulverising instead of concrete breaking)
- 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 (beepers). Alternatives include broadband alarms (squawkers/quackers), flashing lights, proximity sensors, reversing cameras and spotters

5.3 Scheduling

Do not undertake night works (ie works outside Monday to Friday 6.30am – 10.30pm and Saturdays 7am – 11pm) unless it can be demonstrated to be the BPO.

Scheduling is an important management tool, particularly where a receiver expresses concern about construction works at a certain time of day. Where necessary, high noise and vibration noisy works will be programmed to minimise disturbance.

Scheduling activities to be undertaken when nearby sensitive receiver buildings are unoccupied is the most effective measure as it avoids the effect. For example, piling works could be undertaken during the daytime when occupants of a dwelling are more likely at work/school.

Scheduling should be considered as the first measure for all activities which are predicted to exceed the relevant noise and vibration limits. If scheduling is not practicable, then other measures such as noise barriers, revising methodology and temporary relocation should be considered.

Sheet piling within 40m of 29 Customs Street West will be undertaken between 5:00pm and 10:30pm or on Saturdays.

5.4 General Measures

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

- Avoid unnecessary noise. This means managing the site to ensure:
  - No shouting
  - No unnecessary use of horns
  - No loud 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:
  - 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. excavators)
- Utilise noise barriers and enclosures where appropriate (Section 5.5)
- Utilise specific measures for the following activities:
  - Excavators (Section 5.6)
  - Concrete cutting (Section 5.7)

- Concrete and rock breaking (Section 5.8)
- Piling (Section 5.9)

- Engagement is complete (Section 6.0) prior to commencing high-noise and vibration activities
- Undertake monitoring (Section 7.0)

5.5 Noise Barriers and Enclosures

5.5.1 Temporary Noise Barriers

Temporary noise barriers will be installed on the edge of the Aon Building podium at 29 Customs Street West on the ground floor and level 2.

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.

Where practicable, 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
- 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.

5.5.2 Noise Enclosures

When concrete cutting is required within 25m of the façade of M Social at 196 – 200 Quay Street an enclosure will be used.

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).

Where practicable, the following guidelines will be used in designing and installing enclosures:

- Enclosures will be considered where a noise barrier cannot achieve compliance noise limits, particularly for stationary plant such as compressors, pumps, generators, air tools and paver cutting stations

- 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.

5.6 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. The following management measures are recommended:

- 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

5.7 Concrete Cutting

- If practical use a wire saw instead of a concrete saw (see Section 5.2)
- Avoid evening and night-time periods and Sundays/public holidays (see Section 5.3)
- 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 a noise enclosure for a concrete saw (see Section 5.5)
- 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)

5.8 Concrete Breaking

- Use a maximum 10T breaker unless monitoring shows a large unit can comply with the noise limits in Section 3.1 and the vibration limits in Section 4.1. If compliance isn't practicable a Schedule will be prepared in accordance with Section 5.10
- Avoid evening and night-time periods and Sundays/public holidays
- Minimise the amount of breaking needed (e.g. use a crushing shear or pulveriser attachment in place of a breaker, or use a cut and lift approach to enable breaking offsite)
- Match the size of breaker to the scale of the works. It should 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 5.5) and/or a breaker blanket (e.g. Hushtec 'breaker attachment' – www.duraflex.co.nz)
- Minimise the breaking period (e.g. remove larger boulders 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 concrete before starting, and minimising firing after it breaks through

5.9 Piling

- Avoid evening and night-time periods and Sundays/public holidays
- Prioritise piling methods that minimise noise and vibration where practicable (e.g. augured, screw or press-in piles rather than drop-hammer, impact hammer or vibratory methods)
- For bored piling, 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
- For sheet piling, pre-drill the hole so that the duration of vibratory piling is minimised and vibration is reduced

5.10 Schedules to the CNVMP

Where an infringement of the noise and/or vibration criteria is predicted or measured, a Schedule to the CNVMP will be prepared. The Schedule will contain the following content in accordance with Condition X:

- the activity start and finish dates, equipment and methodology;
- a plan showing the location of the activity and the receivers to be affected by a measured or predicted exceedance;
- for each identified receiver, the predicted noise and/or vibration levels and durations of the exceedance;
- the proposed site-specific noise and/or vibration mitigation measures that are proposed to be adopted and any mitigation options that have been discounted as being impracticable, and the reasons why;
- a summary of the consultation undertaken with each identified receiver, and how consultation has been considered; and
- the locations, times and types of any monitoring.

6.0 ENGAGEMENT

6.1 Communication

6.1.1 Before construction

Written communication (e.g. newsletter) will be provided to building occupants within 50 m of the site at least 1 week prior starting demolition and construction. It will include:

High level details of the overall works, its timing and duration

- Contact details and names of personnel whose job is to receive complaints and enquiries (should also match a person identified in Section 2.4)
- Acknowledge that some activities (listed in this document) 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 significant changes to scheduled timing and duration of activities

6.2 Consultation

Consultation in person will be offered to the sensitive receivers listed in Table 8 when noise and/or vibration is predicted to exceed the performance standards. The purpose of the consultation is to inform the mitigation and management measures in the Schedule (see Section 5.10).

Table 8: Sensitive receivers

Address	Building Type[3]	Occupancy	Noise (Section 3.2)	Vibration (Section 4.2)	
				Amenity	Cosmetic Building Damage
85 Customs Street West	Residential/Commercial	Hotel and Apartments	X		
196 – 200 Quay Street	Commercial	Hotel	X	-	-
29 Customs Street West	Commercial	Office	X	-	-
188 Quay Street	Commercial	Office	X	-	-

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. A copy of all correspondence will be made available to Council upon request.

Where nearby sensitive receivers are identified with particularly noise and/or vibration sensitive equipment and/or activities (e.g. childcare centre), a suitably qualified and experienced specialist

[3] Classifications with respect to Tables 1 and 4 of DIN 4150-3:2016 "Vibrations in buildings – Part 3: Effects of vibration on structures" (i.e. historic/sensitive, residential or commercial/industrial)

(e.g. Member of the Acoustical Society of New Zealand) will review the performance standards to ensure they are appropriate and participate in consultation.

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):

- 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 time the relevant building is occupied. 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 2.4
- 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
- Monitor the activity to verify the extent of any adverse effects (Section 7.0)

6.3 Complaints Response

Complaints will be acknowledged immediately where practicable and responded to within 24 hours. If a more detailed response is needed, it will be provided within a timeframe agreed with the complainant.

All construction noise and/or vibration complaints will be recorded in a complaints file that is available to affected parties and Council on request. For each complaint, an investigation will be undertaken as soon as practicable using the following steps:

- Acknowledge receipt of the concern or complaint and record:
  - 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.

7.0 MONITORING

7.1 Attended monitoring

This is where a suitably qualified acoustic engineer visits the site and measures levels in real time. This enables:

- Review the implementation of this CNVMP, including the mitigation and management measures in Section 5.0 and engagement in Section 6.0
- Verify the predicted levels are representative and the response protocols are appropriate for the resulting effects
- Determine compliance

7.2 Long term monitoring

This option involves noise and vibration monitors being installed in suitable locations to measure continuously for a long period of time. They are setup to send a message to the Project Manager (or nominated person) when levels exceed a pre-set alert threshold. An alert triggers review of the BPO measures (Section 5.0) and attended monitoring (Section 7.1) to inform compliance. These options and locations will be assessed as required over the duration of construction.

7.3 Noise

Construction noise will be monitored:

- 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

7.4 Vibration

Construction vibration will be monitored:

- 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 4150-3:2016 "*Vibrations in buildings – Part 3: Effects of vibration on structures*"
- For a representative construction duration, measured in 2 second intervals
- If any exceedance of the cosmetic building damage standard is measured, that vibration generating activity will cease as soon as safe and practicable to do so
- The results will be used to update Section 4.2 if appropriate

8.0 CNVMP REVIEW

This CNVMP shall be reviewed and/or updated i as follows:

- In the event of a material change to the construction methodology, timing, or alignment.
- Annually, to check for any minor amendments and confirm the continued integrity of the overall plan.

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.
BS 5228:2009	British Standard BS 5228:2009 "Code of practice for noise and vibration control on construction and open sites, Part 1: Noise, Part 2: Vibration"
DIN 4150-3:2016	German Standard DIN 4150-3:2016 "Vibrations in buildings – Part 3: Effects of vibration on structures"

APPENDIX B SITE