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Construction Noise and Vibration Management Plan
10-12 Marshall Avenue
St Leonards

NOISE MANAGEMENT PLAN




Client:
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Disclaimer

TABLE OF CONTENTS

TABLE INDEX

FIGURE INDEX

1. Introduction

This report is in response to a request by New Golden St Leonards Pty Ltd for a construction noise management plan for the proposed residential development located at10-12 Marshall Avenue, St Leonards. This report provides a noise management plan and recommendations for noise control during construction of the proposed development as required by Lane Cove Council.

2. Site Description

2.1 Site location

The site is described by the following:

1-3 Holdsworth Avenue and 10-12 Marshall Avenue
Lot 8 on DP1275969

Refer to Figure 1 for site location.

Figure 1: Site location (not to scale)

A comprehensive site survey was conducted on the 26th October 2021 and identified the following:

a) The site is currently occupied by single and two storey residential dwellings which will be demolished to make way for the proposed development.
b) The site is located in a R4 High Density Residential zone as defined in the Lane Cove Local Environmental Plan 2009.
c) The surrounding area consists of residential and commercial land uses.
d) The Pacific Highway is located approximately 100m to the north of the site.

2.2 Proposal

The proposal is the demolition of the existing residential dwellings and the construction of a new apartment building. Although the construction schedule is not known at this stage of the development, demolition and construction activities are expected to consist of the following;

- Jackhammering
- Soft and hard stripping with excavator
- Removal of rubble by trucks
- Bored piling
- Truck deliveries
- Concrete pouring
- Concrete saws
- Waste collection
- Forklift operation (unloading)
- Compressor operation

The recommended hours of demolition and construction works are 7am to 6pm Mondays to Fridays and 8am to 1pm Saturdays with no work on Sundays or public holidays.

2.3 Acoustic environment

The surrounding area is primarily affected by road traffic noise from the surrounding road network.

3. Noise Standards and Codes

We provide the following summary of noise standards and codes that may be applicable to the construction works at the site. This may include;

- Protection of the Environment Operations Act 1997
- Protection of the Environment (Noise Control) Regulation 2017
- NSW Noise Policy for Industry 2017
- NSW Interim Construction Noise Guideline 2009
- Australian Standard AS2107 – *Acoustics-Recommended Design Sound Levels and Reverberation Times for building interiors*
- Australian Standard AS2436 – *Guide to noise control on construction, maintenance and construction sites*.

The application relevance of each of these is summarised as follows;

Table 1: Application of codes and regulations

Code/standard title (abbreviated)	Applicable to construction noise?	Sets specific goals?	Comments
Protection of the Environment Operations Act 1997	Not mentioned	No	Construction noise and vibration not specifically referenced but may be implied
Protection of the Environment (Noise Control) Regulation 2017	Not mentioned	No	Construction noise and vibration not specifically referenced but may be implied
NSW Noise Policy for Industry 2017	No	No	Construction noise is not dealt with by the INP as described in Section 1.3 of the policy
NSW Interim Construction Noise Guideline 2009	Yes	Yes	Primarily for noise from construction works that are regulated by the NSW EPA
Australian Standard AS2107	No	Yes	Not relevant to construction noise
Australian Standard AS2436	Yes	No	Applicable to noise associated with construction

Review of the relevant codes and standards listed above is provided in the following sections of this report.

3.1 NSW Interim Construction Noise Guideline 2009

3.1.1 Hours for construction work

The recommended standard hours for construction work are shown below in Table 2, however they are not mandatory. There are some situations where construction work may need to be undertaken outside of these hours. The likely noise impacts and the ability to undertake works during the recommended standard hours should be considered when scheduling work.

Table 2: Recommended standard hours for construction work

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

Work outside of hours may be done under one of the following five categories;

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

3.1.2 Assessment criteria

The quantitative assessment method involves predicting airborne noise levels and comparing them with the levels in the relevant section of the Guideline. The noise criteria for quantitative assessment are shown below.

3.1.2.1 Residential uses

Noise criteria assessed at residential properties are listed in Section 4.1.1 of the guideline. The relevant criteria and associated notes are as follows;

Table 3: Noise criteria for quantitative assessment - Residential

Time of day	Criterion LAeq(15min) *	How to apply
Recommended standard hours	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (15 min) is greater than

		the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended hours	Noise affected RBL + 5dB	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. For guidance on negotiating agreements see section 7.2.2.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

3.1.2.2 Other sensitive uses

The following table presents management levels for noise at other sensitive land uses. The proponent should also consult with noise sensitive land use occupants potentially affected by noise from the works, to schedule achieve a reasonable noise outcome.

Table 4: Noise criteria for quantitative assessment - Other uses

Land use	Management level LAeq(15min)	Assessment location
Classrooms at schools and other educational institutions	45dBA	Internal
Hospital wards and operating theatres	45dBA	Internal
Places of worship	45dBA	Internal
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	65dBA	External
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	60dBA	External
Community centres	Depends on the use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.	Internal

3.1.2.3 Commercial and industrial properties

Noise management levels for commercial and industrial premises are contained in Section 4.1.3 of the guideline.

Table 5: Noise criteria - Commercial and industrial premises

Land use	Management level LAeq(15min)	Assessment location
Industrial	75dBA	External, most-affected occupied point of the premises
Offices, retail shops	70dBA	External, most-affected occupied point of the premises
Other businesses e.g. theatre, childcare etc	Depends on the use. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.	Varies, refer to AS2107

Where noise from construction works is above the 'noise affected' levels presented, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform potentially affected parties of the activities to be carried out, the expected noise impacts and duration.

If any of the following activities are to be undertaken, they should be factored into the quantitative assessment by adding 5 dB to the predicted levels;

- use of 'beeper' style reversing or movement alarms
- use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or
- steel work
- grinding metal, concrete or masonry
- rock drilling
- line drilling
- vibratory rolling
- rail tamping and regulating
- bitumen milling or profiling
- jackhammering, rock hammering or rock breaking
- impact piling.

3.1.3 Ground-borne noise

Noise within dwellings resulting from ground vibration from construction processes would be required to comply with the following criteria;

Table 6: Recommended standard hours for construction work

Time	Criterion LAeq(15min) dB(A)
Evening (6pm to 10pm)	40
Night (10pm to 7am)	35

The criteria only apply to evening and night time construction works.

3.2 Australian Standard AS2107

Australian Standard 2107-2016 *Acoustics-Recommended design sound levels and reverberation times for building interiors* lists the desired noise levels for residential buildings. This standard includes the assessment of building services noise (i.e. mechanical services, hydraulics etc), and building components that exclude noise external to the building (e.g. traffic noise, industrial noise).

Section 2 *Application* - specifically states that the standard is not intended either for the assessment or prescription of acceptable noise levels from transient or variable noises such as construction.

3.3 Australian Standard AS2436

Australian Standard AS2436-2010 *Guide to noise control on construction, maintenance and construction sites* provides guidance in noise control in respect of engineering construction, maintenance and construction works. This includes guidance in investigation and identification of noise sources, measurement of sound and assessment, with a view to appropriate planning of measures for noise control.

AS2436 also contains a table of typical sound levels from construction plant and equipment, and a discussion of the effectiveness of acoustic treatments and acoustic screens and enclosures. Section 1.5 Regulatory Requirements states that the legislation for the control of noise on construction, maintenance and construction sites is generally the responsibility of the relevant State government or local Council body.

4. Noise Monitoring and Receivers

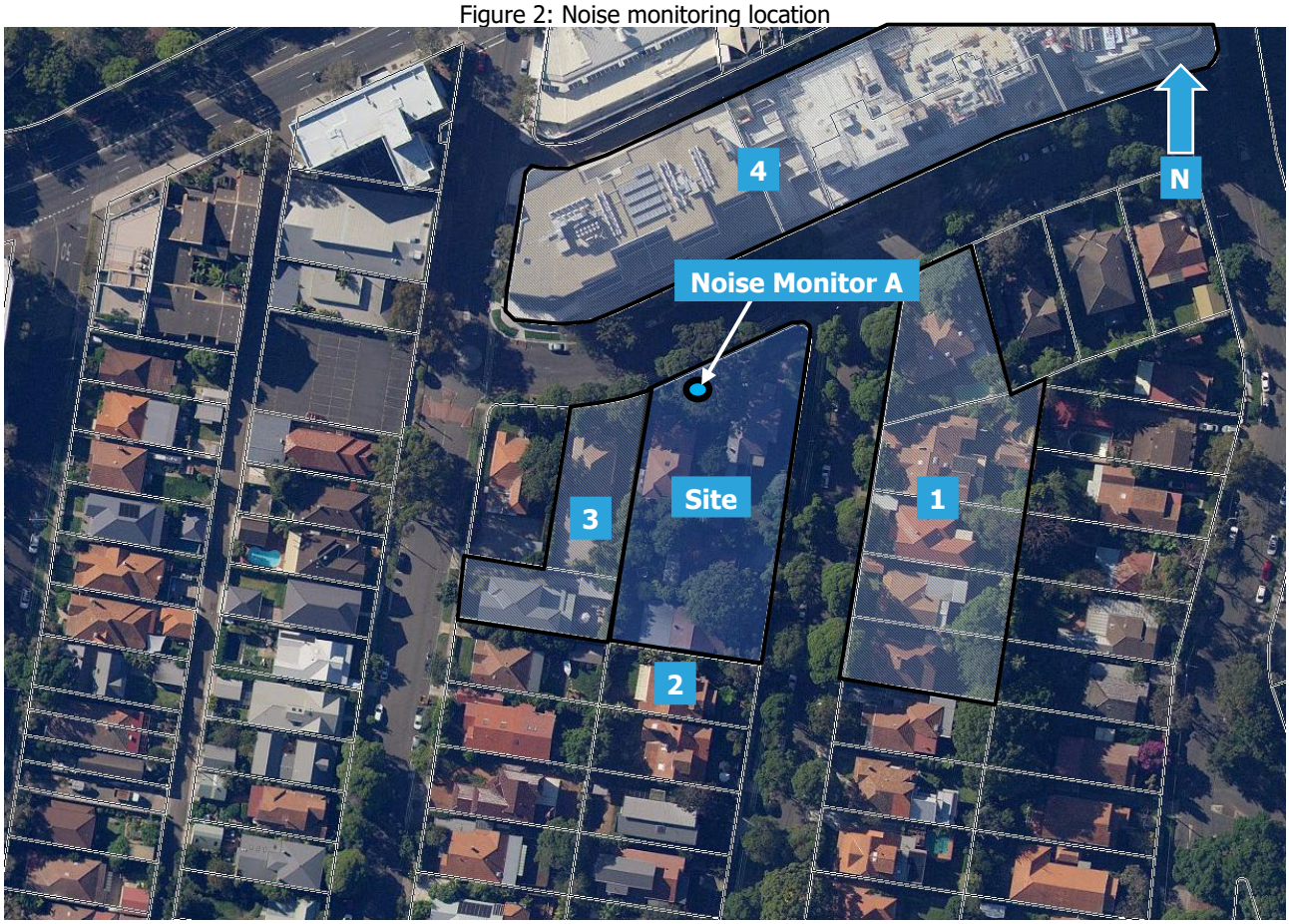
4.1 Monitoring locations and receivers

The nearest sensitive receiver locations were identified as follows;

1. Single storey residential dwellings are located to the east at 8 Marshall Avenue and 2-8 Holdsworth Avenue.
2. A single storey residential dwelling is located adjacent the southern site boundary at 5 Holdsworth Avenue.
3. Single and two storey residential dwellings are located adjacent the western site boundary at 14 Marshall Avenue and 2 Berry Road.
4. Multi-storey residential apartment buildings are located to the north at 1 to 25 Marshall Avenue.

Refer to Figure 2 for these locations.

Figure 2: Noise monitoring location



4.2 Equipment

The following equipment was used to record noise levels:

- Rion NL42 Environmental Noise Monitor (SN# 00345935)
- Pulsar Model 105 Ltd Sound Calibrator (SN # 57417)

The Environmental Noise Monitors hold current NATA Laboratory Certification and were field calibrated before and after the monitoring period, with no significant drift from the reference signal recorded.

4.3 Monitoring Procedure

A Rion NL42 environmental noise monitor was placed onsite at 12 Marshall Avenue to measure ambient noise levels. The monitor was located in a free field position with the microphone approximately 1.4 metres above ground surface level. The noise monitor was set to record noise levels between 26th October and 4th November 2021.

The environmental noise monitor was set to record noise levels in "A" Weighting, Fast response using 15-minute statistical intervals. Ambient noise monitoring was conducted generally in accordance with Australian Standard AS1055:2018 *Acoustics – Description and measurement of environmental noise*. Refer to Figure 2 for noise monitoring location.

Weather conditions were fine for most of the monitoring period, with some minor periods of rainfall and intermittent wind.

5. Existing Noise Levels

The following tables present the measured ambient noise levels from the unattended noise survey and meteorological conditions. Any periods of inclement weather or extraneous noise are omitted from the measured data prior to determining the overall results.

5.1 Meteorological conditions

Meteorological observations during the unattended noise monitoring survey were obtained from the Bureau of Meteorology website (http://www.bom.gov.au/climate/data), shown in Table 7 below.

Table 7: Meteorological conditions – Sydney NSW

Day	Date	Rainfall (mm)	Wind			
			9am		3pm	
			Speed (km/h)	Direction	Speed (km/h)	Direction
Tuesday	26/10/2021	0	9	WNW	22	ESE
Wednesday	27/10/2021	0	4	E	22	ENE
Thursday	28/10/2021	0	15	W	17	E
Friday	29/10/2021	0	9	NNW	50	W
Saturday	30/10/2021	0	17	SSE	24	SE
Sunday	31/10/2021	0	13	WNW	20	E
Monday	01/11/2021	0	4	W	17	NE
Tuesday	02/11/2021	0	11	E	30	ENE
Wednesday	03/11/2021	0	20	NNE	26	NE

5.2 Background noise level

The measured rating background noise levels (RBL), in accordance with the NSW Noise Policy for Industry, are as follows;

Table 8: Measured RBL noise levels

Day	Date	Background L90 dBA		
		Day	Evening	Night
Tuesday	26/10/2021	x	40.3	32.1
Wednesday	27/10/2021	48.5	42.6	34.6
Thursday	28/10/2021	48.4	42.7	36.4
Friday	29/10/2021	*50.4	42.1	34.9
Saturday	30/10/2021	45.5	41.3	33.9
Sunday	31/10/2021	42.5	39.8	32.9
Monday	01/11/2021	48.4	41.3	34.0
Tuesday	02/11/2021	48.4	41.9	34.3
Wednesday	03/11/2021	48.5	45.3	33.7
RBL		48	42	34

*Note high wind speeds recorded on Friday 29th October were found to have affected the measured noise levels, therefore the data for these time periods was omitted.

6. Project specific noise criteria

6.1 Construction noise criteria

Based on the relevant codes and standards and the measured background noise levels, the applicable construction/demolition noise limits would be as follows;

Table 9: Applicable noise limits for construction work

Receiver	Time	Criterion LAeq(15min)		Assessment location
Residential	During standard construction hours	Noise affected	Highly noise affected	External
		58dBA	75dBA	External
Residential	Outside standard construction hours (daytime only)	53dBA		External

7. Predicted Noise Levels

Predicted noise associated with the earthworks and construction of the proposed development has been assessed based on the source noise levels and procedures contained in AS2436-2010, as well as the results of previous noise measurements and assessments conducted by Acoustic Works. Calculations are done, based on the earthworks/demolition and construction activities being at the closest relevant distance to each existing receiver.

It is noted that the calculations assume that all noise sources are operating simultaneously, at the closest point to the receiver in each case. In practice, this will generally not occur as the process will be either spread over the site or occur on different days. The predicted noise levels represent the expected worst-case noise emissions due to site works.

7.1 Earthworks/demolition

The predicted noise impacts of construction and earthworks/demolition are summarised as follows;

Table 10: Predicted earthworks/demolition noise impacts

Receivers
1. 8 Marshall Avenue & 2-8 Holdsworth Avenue (E)
2. 5 Holdsworth Avenue (S)
3. 14 Marshall Avenue & 2 Berry Road (W)
4. 1 to 25 Marshall Avenue (N)

Receiver	Description	Source Leq@1m dB(A)	Correction dB(A)*	Corrected Leq@1m dB(A)	LAeq adj, T ext. dB(A) NA	LAeq adj, T ext. dB(A) HNA	LAeq 15 min Compliance: Noise affected	LAeq 15 min Compliance: Highly noise affected
1	Criteria						58	75
	Truck passby	82		82	40	40	Yes	Yes
	Piling (bored meas)	93		93	52	52	Yes	Yes
	Excavator small	92		92	59	59	No	Yes
	Loader (wheeled)	97		97	58	58	No	Yes
	Hand tools (electric)	94		94	51	51	Yes	Yes
	Total				63	63	**No**	**Yes**
2	Criteria						58	75
	Truck passby	82		82	41	41	Yes	Yes
	Piling (bored meas)	93		93	58	58	No	Yes
	Excavator small	92		92	62	62	No	Yes
	Loader (wheeled)	97		97	61	61	No	Yes
	Hand tools (electric)	94		94	53	53	Yes	Yes
	Total				66	66	**No**	**Yes**
3	Criteria						58	75
	Truck passby	82		82	35	35	Yes	Yes
	Piling (bored meas)	93		93	57	57	Yes	Yes
	Excavator small	92		92	64	64	No	Yes
	Loader (wheeled)	97		97	63	63	No	Yes
	Hand tools (electric)	94		94	56	56	Yes	Yes
	Total				68	68	**No**	**Yes**
4	Criteria						58	75
	Truck passby	82		82	33	33	Yes	Yes
	Piling (bored meas)	93		93	49	49	Yes	Yes
	Excavator small	92		92	54	54	Yes	Yes
	Loader (wheeled)	97		97	53	53	Yes	Yes
	Hand tools (electric)	94		94	48	48	Yes	Yes
	Total				58	58	**Yes**	**Yes**

Earthworks/demolition noise levels are predicted to be above the noise affected limit of 58dB(A) LAeq 15min but comply with the highly affected noise limit of 75dB(A) LAeq 15min. Refer to Section 8 for details.

7.2 Construction

The predicted noise impacts of construction are summarised as follows;

Table 11: Predicted construction noise impacts

Receivers
1. 8 Marshall Avenue & 2-8 Holdsworth Avenue (E)
2. 5 Holdsworth Avenue (S)
3. 14 Marshall Avenue & 2 Berry Road (W)
4. 1 to 25 Marshall Avenue (N)

Receiver	Description	Source Leq@1m dB(A)	Correction dB(A)*	Corrected Leq@1m dB(A)	LAeq adj, T ext. dB(A) NA	LAeq adj, T ext. dB(A) HNA	LAeq 15 min Compliance: Noise Affected	LAeq 15 min Compliance: Highly Noise Affected
1	Criteria						58	75
	Hand tools (electric)	94		94	37	37	Yes	Yes
	Concrete truck	95		95	68	68	No	Yes
	Concrete pump	94	2	96	55	55	Yes	Yes
	Truck passby	82		82	40	40	Yes	Yes
	Crane (tower)	97		97	44	44	Yes	Yes
	Compressor large (silenced)	85	2	87	40	40	Yes	Yes
	Forklift unloading	82	2	84	31	31	Yes	Yes
	Total				68	68	**No**	**Yes**
2	Criteria						58	75
	Hand tools (electric)	94		94	47	47	Yes	Yes
	Concrete truck	95		95	69	69	No	Yes
	Concrete pump	94	2	96	70	70	No	Yes
	Truck passby	82		82	41	41	Yes	Yes
	Crane (tower)	97		97	61	61	No	Yes
	Compressor large (silenced)	85	2	87	57	57	Yes	Yes
	Forklift unloading	82	2	84	48	48	Yes	Yes
	Total				73	73	**No**	**Yes**
3	Criteria						58	75
	Hand tools (electric)	94		94	56	56	Yes	Yes
	Concrete truck	95		95	63	63	No	Yes
	Concrete pump	94	2	96	64	64	No	Yes
	Truck passby	82		82	35	35	Yes	Yes
	Crane (tower)	97		97	63	63	No	Yes
	Compressor large (silenced)	85	2	87	59	59	No	Yes
	Forklift unloading	82	2	84	50	50	Yes	Yes
	Total				69	69	**No**	**Yes**
4	Criteria						58	75
	Hand tools (electric)	94		94	48	48	Yes	Yes
	Concrete truck	95		95	61	61	No	Yes
	Concrete pump	94	2	96	62	62	No	Yes
	Truck passby	82		82	33	33	Yes	Yes
	Crane (tower)	97		97	53	53	Yes	Yes
	Compressor large (silenced)	85	2	87	49	49	Yes	Yes
	Forklift unloading	82	2	84	40	40	Yes	Yes
	Total				65	65	**No**	**Yes**

Construction noise levels are predicted to be above the noise affected limit of 58dB(A) LAeq 15min but comply with the highly affected noise limit of 75dB(A) LAeq 15min. Refer to Section 8 for details.

8. Recommendations - Noise

The following general acoustic treatments and management principles are recommended for the project:

1. Recommended construction hours would be as follows:

   Monday to Friday 7 am to 6 pm
   Saturday 8 am to 1 pm
   No work on Sundays or public holidays

2. If further noise mitigation is required, acoustic barriers around the perimeter of the site can be installed during the works. If further noise reductions are required, install additional screening around noise sensitive areas.
3. Workers or delivery trucks do not congregate at or outside the site before 7am. This is an important factor in managing noise from the site.
4. Assign the task of managing noise emissions to a person (the 'responsible person') that is likely to be present on-site most of the time that activity is occurring (usually the Site Manager). This person would be responsible for handling noise complaints, and ensuring that work does not commence before the specified allowable times. The name and contact details of the 'responsible person' should be displayed outside the principal construction office.
5. If complaints arise regarding noise, the complaint will be directed to the 'responsible person', who will determine the source of the noise, and take immediate steps to investigate further or mitigate the noise as required. This may involve moving the noise source further away from affected premises, replacing the equipment, installing high performance silencers, or in some cases, engaging a qualified acoustic consultant to provide specialist control advice.
6. The Responsible Person should notify the adjacent residential premises of the intention to commence work that may cause adverse impacts on surrounding residents. If plant is to be operated in close proximity to residential premises, the Responsible Person should advise the occupants of the premises the length of time that the plant will be in operation proximate to the property boundary.
7. Any moveable plant (e.g. compressors) should be located as far as practical from the residential premises.
8. The Responsible Person maintain a record of complaints, which records the following details (refer to the example complaint record sheet in the appendix to this plan):
   - The time and date of lodgement of the complaint;
   - The name and telephone number of the complainant;
   - The nature of the complaint, including a description of the noise (e.g. likely noise source, duration of the noise event - is the noise continuous, or of a short duration);
   - The outcome of the investigation.

9. If a complaint is raised regarding a particular piece of plant, the plant shall be inspected for working condition, with particular attention given to the condition of engine covers or enclosures, and exhaust system. If machinery is in good condition, a high performance silencer should be installed.

The noise management plan is described in more detail in Section 8.1 with recommendations for noise monitoring provided in Section 8.2.

8.1 Construction Noise Management Plan

The overall aim of the noise management plan is to provide a program of actions and practices to minimise potential noise annoyance associated with onsite activities impacting adjacent properties.

Site management are to elect a "Responsible Person" who is responsible for implementation of the Noise Management Plan to ensure the aims and objectives are achieved. The "Responsible Person" should ensure actions are being carried out by management, staff and subcontractors and that it is reviewed at appropriate times.

Where possible, performance indicators should be used to ensure noise annoyance from onsite activities is minimised. The most apparent performance indicator is the number of complaints made with regards to noise annoyance.

The effectiveness and time spent to act and remediate noise issues, if complaints are made, is also considered a performance indicator for the site.

The "Responsible Person" should also document comments by others on the performance of the Noise Management Plan and provide his/her own performance overview during reviews of the plan. The various elements, aims and actions of the noise management plan are as follows;

8.1.1 All activities

Element	Operation of site works
Aim	To limit the times of potentially noisy onsite activities
Action	Recommended construction hours as follows: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays Workers or delivery trucks do not congregate outside the site before 6.45am.

8.1.2 Implementation of Management Plan

Element	Responsible Person
Aim	Provide a personnel contact for the Noise Management Plan
Action	The head contractor is to elect a "Responsible Person" who is onsite during construction hours and who has sufficient time and authority to implement the management plan. The Responsible Person will be required to receive, document and respond in an appropriate manner to complaints made against the centre with regards to noise. The Responsible Person is to keep record of performance indicators and feedback from management, staff, subcontractors and adjacent noise receivers as appropriate.

	The person would also be responsible for documenting changes/modifications to the Noise Management Plan.

8.1.3 Active Involvement

Element	Responsible Person
Aim	All management, staff and sub-contractors actively support and implement the noise management plan.
Action	The management, staff and Responsible Person should show active support and implementation for the management plan so that all are aware of the importance of the plan. Notify staff and subcontractors of the importance of the management plan. Actions and practices of the management plan, where relevant, should also be placed in appropriate locations. Responsible Person to implement notification new staff or subcontractors with respect to the Noise Management Plan.

8.1.4 Deliveries

Element	Deliveries
Aim	Minimise noise impacts from vehicle activities delivering to the site.
Action	Deliveries only between; Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No deliveries on Sundays or public holidays Delivery trucks do not congregate outside the site before 6.45am.

8.1.5 Onsite Mechanical Plant

Element	New equipment
Aim	Ensure new onsite equipment does not cause annoyance to noise sensitive receivers.
Action	All fixed onsite mechanical plant (e.g. air conditioning for site sheds) must be designed and installed to satisfy noise requirements.

8.1.6 Complaints

Element	Response to complaints
Aim	Provide a friendly and immediate response to complaints.

Action	Occupants of surrounding commercial premises should be provided with a telephone number for the "Responsible Person" in the event of a noise complaint. If a complaint is made, the "Responsible Person" responds to it in an appropriate and friendly manner and investigates the source of the complaint, and takes action to immediately reduce the noise level, if it is reasonable complaint. The "Responsible Person" maintains a record of complaints, which records the following details (refer to the example noise complaint record sheet): -The time and date of lodgement of the complaint; -The name and telephone number of the complainant; -The nature of the complaint, including a description of the noise (e.g. likely noise source, duration of the noise event - is the noise continuous, or of a short duration); If the complaint is on-going, an investigation by a qualified acoustical consultant may be necessary to determine if the complaint is bona-fide (i.e. noise is occurring beyond the limits set out in the approved acoustic assessment), and if so, recommend noise controls to achieve the approved noise limits. In cases where a compliant has been determined to be bona-fide, the "Responsible Person" should contact the complainant (if the complainant wishes) to advise on noise control measures, if any, adopted to reduce the noise impact. The noise control measures may include behavioural or physical, or a combination of the two.

8.1.7 Review

Element	Schedule for the Review Process
Aim	To review the incidents/ complaints register and to ensure the Noise Management Plan remains relevant to the operations/activities of the site.
Action	Management is to review the incident/complaints register on a regular basis (at least fortnightly) to determine any common or recurring issues to be addressed. The plan should be reviewed if processes or activities onsite are change/modified or new activities are introduced. The plan should also be reviewed if noise complaints are being made with regards to a single activity or type of noisy activity occurring onsite. Document all changes/modifications to the Noise Management Plan.

8.2 Construction noise monitoring

If required, short-term operator-attended noise measurements will be suitable for investigating 'spot-checks' of noise complaints in most situations. The methodology must establish the level of noise from the noise source being investigated and check for compliance.

8.2.1 Equipment

Sound level meters must have an accuracy at least equivalent to a Type 1 meter as described in Australian Standard AS1259. The sound level meter must be fitted with a windshield and must

have a current laboratory calibration certificate or label in accordance with calibration requirements outlined in AS1259 and AS2659. Equipment should also be calibrated in the field in accordance with these standards.

The sound level meter must be capable of L_{eq} measurement and statistical L_n measurement (e.g. L_{10}, L_{90} etc), using the broadband 'A' scale frequency weighting.

8.2.2 Parameters

For measurement of ambient noise (without site noise), the sound level meter must be set to the following parameters;

- 15 minute measurement duration.
- Broadband
- 'Fast' time response.
- 'A' frequency weighting.

The measured descriptors of ambient noise are background noise $L_{A90,15min}$ and $L_{Aeq,15min}$.

For measurement of noise from construction activities at the site, the sound level meter must be set to the following parameters;

- 15 minute measurement duration.
- 'Z' (Linear) frequency weighting for 1/3 octave frequency spectrum.
- 'A' frequency weighting for overall broadband result.
- 'Fast' time response.

The measured descriptors of site noise should include (when available on a sound meter); L_{eq}, Lp, and 1/3 octave spectrum (to establish any tonal characteristics).

Measurement duration may change depending on the duration of each relevant source.

8.2.3 Procedure for measuring noise

8.2.3.1 Where to measure noise

In accordance with the code, noise levels should be measured at the property boundary that is most exposed to construction noise, at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Typically this would be an outdoor location in the most exposed position in a receivers' yard. The address of locations for assessment should be those locations where complaints have been received.

The sound level meter should be held at arm's length or set up on a tripod so the microphone is 1.5 metres above the ground. Where possible the measurement position should be 3 to 5 metres from walls, buildings and other reflecting surfaces.

The location of vegetation also needs to be considered, because noise levels can be increased locally by even a light breeze rustling leaves. Noise due to wind in vegetation can make accurate measurement difficult. Where possible, move away from nearby plants if rustling noise is present.

8.2.3.2 When to measure ambient noise

Ambient noise should be measured when it is representative of minimum levels that would occur during the time the activity would typically be conducted. Suitable times may include;

- Prior to commencement of daily activities.
- During smoko or lunchbreak (if site activities are ceased).
- On RDO's (rostered days off).
- After completion of daily activities.

Ideally, a number of ambient noise measurements should be taken at various times of day. Ambient noise measurement should only be done at times or locations unaffected by noise from the site.

8.2.3.3 When to measure noise from construction

Measurements of construction noise should be taken at the time(s) when the noise is representative of the current maximum level of noise emanating from the site, or at times when a complaint has been received.

8.2.3.4 What to avoid

The following conditions shall be avoided during the noise assessment;

- Average wind speed (at the microphone height) greater than 5m/s (approximately 20km/h). Typically at a wind speed of 5 m/s, leaves and branches would be in constant motion and the wind would extend a small flag.
- Rain periods (if intermittent, any affected data can be excluded).
- Other extraneous noise, such as train passby etc.
- Noise such as talking or physically bumping the sound level meter in a manner that will affect the readings.

8.2.3.5 Steps for measurement

The steps for performing a noise measurement are as follows;

1. Calibrate the sound level meter before commencing noise measurements. The sound pressure level shown on the meter should match the stated sound pressure level for the calibrator being used. The equipment should not vary by more than 1 dB. If it has then the measurements may be invalid.
2. Ensure the meter is set to 'Fast' time weighting, 'A' frequency weighting for broadband measurement, 'Z' weighting for 1/3 octave measurement. Descriptors include L_{90}, L_{eq}, and LpA.
3. Measure the ambient noise level continuously for 15 minutes (where possible), excluding all distinct extraneous noises. If extraneous noise is present, pause the meter when this occurs or choose another measuring time or restart the measurement at another location. If more than one valid noise measurement of the ambient noise for a location is obtained, use the lowest level as the ambient noise level. Note the $L_{A90,15min}$ value and other relevant values as described above. Where it is not possible to continuously measure over a 15-minute period, then note the duration of the measurement.

4. Measure the noise emanating from the site, excluding all distinct extraneous noises. Note the duration of the measurement. Note the relevant measured values and description of the types of noise that were audible/measurable from the site.
5. Note whether the measured noise appears to contain tonal or impulsive characteristics and apply correction factors where appropriate.
6. Check the field calibration at the end of the monitoring period in accordance with Australian Standard IEC 61672.1-2004 and Australian Standard 2659. Re-monitoring may be required where there is a calibration drift greater than that allowed by the standards.

8.2.3.6 Information to be reported

Any reporting should be concise. The minimum requirements to be included in a report are;

- Date of measurements.
- Time of measurements.
- Person(s) performing measurements.
- Equipment used for measurements.
- Location of measurements.
- Measured values.
- Corrected values (where applicable).
- Notes regarding audibility of noise sources.
- Notes regarding any extraneous sources that may have influenced measurements.
- Detail of instrumentation and calibration.
- Meteorological conditions.

9. Vibration Standards and Codes

We provide the following summary of vibration standards and codes that may be applicable to the construction works at the site. This may include;

- Assessing Vibration: A Technical Guideline 2006
- Australian Standard AS 2670.2-1990 *Evaluation of Human Exposure to whole body Vibration Part 2 Continuous and shock induced vibration in buildings (1 to 80 Hz)*
- Australian Standard 2187-1993 *SAA Explosives Code, Part 2 - Use of Explosives*

The application relevance of each of these is summarised as follows;

Table 12: Application of codes and regulations

Code/standard title (abbreviated)	Applicable to construction vibration?	Sets specific goals?	Comments
Assessing Vibration: A Technical Guideline 2006	Yes	Yes	Continuous, impulsive and intermittent vibration. Based on BS6472-1992
Australian Standard AS2670.2	Yes	Specific vibration goals	Used for vibration only
Australian Standard AS2187-1993	Yes	Specific vibration goals	Relevant to demolition

Review of the relevant codes and standards listed above is provided in the following sections of this report.

9.1 Assessing Vibration: A Technical Guideline 2006

9.1.1 Types of vibration

There are three types of vibration as classified in the guide;

- Continuous - vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values
- Impulsive - rapid build up to a peak followed by a damped decay that may or may not involve several cycles. The duration is short, typically less than 2 seconds. Impulsive vibration (no more than three occurrences in an assessment period) is assessed on the basis of acceleration values.
- Intermittent - interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. Assessed on the basis of vibration dose values.

9.1.2 Acceptable values for continuous and impulsive vibration (1-80Hz)

The relevant criteria for continuous and impulsive vibration are as follows;

Table 13: Preferred weighted RMS vibration acceleration values

Type	Location	Assessment period	Preferred values m/s^2		Maximum values m/s^2	
			z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration	Critical areas	Day or night time	0.005	0.0036	0.01	0.0072
	Residences	Day time	0.01	0.0071	0.02	0.014
		Night time	0.007	0.005	0.014	0.01
	Offices, schools, educational institutions and places of worship	Day or night time	0.02	0.014	0.04	0.028
	Workshops	Day or night time	0.04	0.029	0.08	0.058
Impulsive vibration	Critical areas	Day or night time	0.005	0.0036	0.01	0.0072
	Residences	Day time	0.3	0.21	0.6	0.42
		Night time	0.1	0.071	0.2	0.14
	Offices, schools, educational institutions and places of worship	Day or night time	0.64	0.46	1.28	0.92
	Workshops	Day or night time	0.64	0.46	1.28	0.92

9.1.3 Acceptable values for intermittent vibration

Intermittent vibration is assessed using the vibration dose value (VDV) root-mean-quad method. VDV accumulates the vibration energy received over the daytime and night-time periods. The vibration dose methodology is as per standard BS 6472–1992.

The relevant criteria for vibration dose values are as follows;

Table 14: Vibration dose values for intermittent vibration

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	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

9.2 Australian Standard AS2670.2-1990

Definitions of acceptable perceived vibration criteria can be found in AS 2670.2-1990 Evaluation of Human Exposure to whole body Vibration Part 2 Continuous and shock induced vibration in buildings (1 to 80 Hz). This code provides frequency weighted curves for acceptable vibration levels. These relate to a resultant of vibration in all three axis'; more specifically the x, y and z directions. The curves are based on multiples of a single base curve depending on type of receiver.

Table 15: AS2670.2-1990 vibration multiplying factors

Place	Time	Continuous or intermittent vibration	Transient vibration excitation with several occurrences per day
Critical working areas (for example some hospital operating-theatres, some precision laboratories, etc.)	Day & Night	1	1
Residential	Day	2 to 4	30 to 90
	Night	1.4	1.4 to 20
Office	Day & Night	4	60 to 128
Workshop	Day & Night	8	90 to 128

9.3 Australian Standard AS2187-1993

Australian Standard 2187-1993 *SAA Explosives Code, Part 2 - Use of Explosives* specifies acceptable levels of ground vibration to limit the probability of structural damage and human discomfort. The criteria presented in this Standard are summarised below;

Table 16: AS2187-1993 recommended peak particle velocity

Type of building or structure	Particle velocity (Vp) mm/s
Historical buildings and monuments, and buildings of special value and significance	2
House and low rise residential buildings: Commercial buildings not included in item 3 below	10
Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

While the use of explosives is not expected for the site, the values presented in the table would still form an appropriate guide to reducing the risk of potential structural damage due to vibration from construction processes.

10. Project Specific Vibration Criteria

Based on the relevant codes and standards, the applicable vibration limits would be as follows;

Table 17: Applicable vibration limits

Type of building or structure	Particle velocity (Vp) mm/s
House and low rise residential buildings	6

11. Predicted Vibration Levels

Potential vibration impacts were assessed to determine typical levels within a set distance of the activity to the receiver with a predicted maximum combined Peak Particle Velocity of level of 3 to 6mm/s predicted depending on the equipment in operation and its proximity to the receiver. The level of impact may change depending on the ground composition, example stone/rock or concrete will allow higher levels of ground vibration than soft soil. It is recommended that a strict management plan is implemented to allow for a proactive approach to addressing complaints including vibration monitoring of activities if complaints are received and when bored piling and basement construction works are underway.

After review of the proposal in relation to vibration impacts, we provide the following recommendations:

- The residential dwelling located adjacent the western site boundary at 14 Marshall Avenue - given the proximity of the development to the building, it is recommended that proactive monitoring of any issues in relation to complaints is undertaken to ensure no adverse impacts are experienced by the tenants. Potentially, high vibration impacts may occur depending on the type of equipment in use onsite, this would most likely occur during basement construction, specifically basement excavation/construction and piling. Based on the existing building construction, they are not predicted to occur at levels that will cause cosmetic damage on the condition the vibration impacts occur at levels below 6mm/s, it is recommended that dilapidation assessment is undertaken prior to works being conducted.
- The residential dwelling located adjacent the southern site boundary at 5 Holdsworth Avenue - given the proximity of the development to the dwellings, it is recommended that proactive monitoring of any issues in relation to complaints is undertaken to ensure no adverse impacts are experienced by the tenants. Potentially, high vibration impacts may occur depending on the type of equipment in use onsite, this would most likely occur during basement construction, specifically basement excavation/construction and piling. Based on the existing building construction, they are not predicted to occur at levels that will cause cosmetic damage on the condition the vibration impacts occur at levels below 6mm/s, it is recommended that dilapidation assessment is undertaken prior to works being conducted.

Residents not identified are predicted to comply on the condition that vibration monitoring is conducted at the nearest sensitive receivers as identified above during the basement excavation/construction and piling. Contact details should still be provided to residents in the vicinity of the site in case of complaints.

11.1 Basement construction and piling

The piling method is not known at this stage of the development, therefore bored piling was assumed. This assessment should be updated prior to construction certification in the event another piling method is proposed. It's recommended that the process to be employed for the installation of the piles is as follows:

- Bored/Contiguous piles are installed as cast in situ bored or CFA piles. Past experience from other recent projects using this method with the vibration monitor at a distance of 17 metres produced vibration levels with a peak particle velocity up to 6mm/s.

In addition to the piling, excavation works will require the following consideration for works onsite:

- If concrete elements are common to the site under development and the adjoining receivers, prior to removal of the material we recommend saw cuts are made to the full depth and length of the material to remove any direct connections before removal.

Based on the separation distance to the nearest receiver locations to the west and south, the maximum vibration level due to piling is expected to be approximately 3-6mm/s. The maximum vibration level due to piling at all other receivers is expected to be less than 3mm/s.

Therefore, vibration monitoring is recommended at the western and southern receivers (14 Marshall Avenue and 5 Holdsworth Avenue) in order to monitor and manage any potential impacts to residents and should be located in line with the nearest point of the building to the development. This would also allow construction methods to be altered or time restrictions if needed, depending on the measured levels of vibration. Conversely, if vibration levels are measured to be lower than the predicted levels, the use of bored piling may be deemed acceptable to continue.

11.2 Building construction

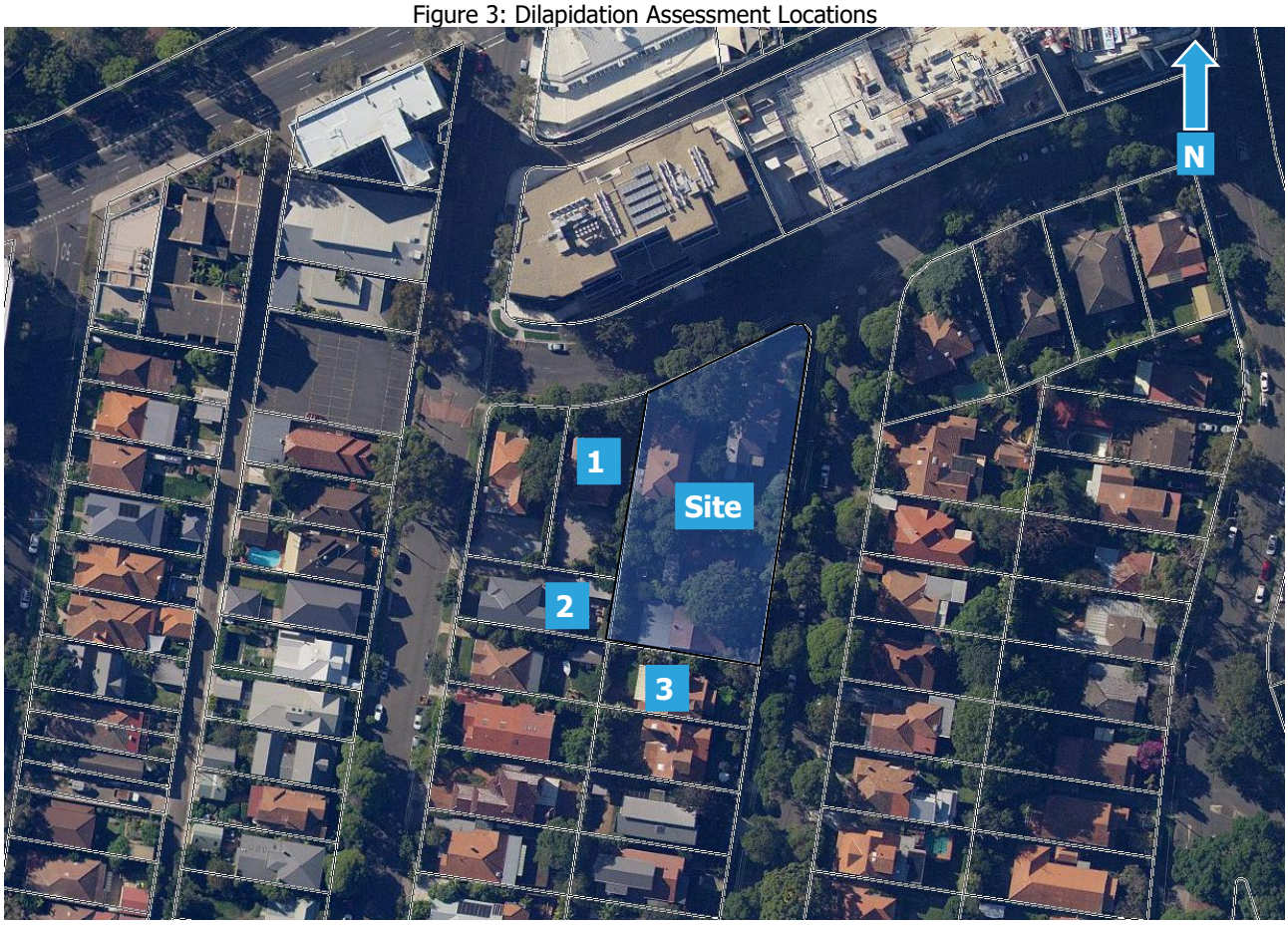
If complaints are received regarding vibration, we recommend that activities are minimised in proximity to the complainant, a vibration monitor should be installed to monitor the levels and to ensure no adverse impacts. The monitor should be located at the complainants until the works have been completed or for a period to show that the cause of the complaint was a one off occurrence.

12. Recommendations – Vibration

12.1 Location of Dilapidation Assessments – Vibration

Based on our review, it is recommended the following numbered locations in Figure 3 have a dilapidation assessment before works proceed.

Figure 3: Dilapidation Assessment Locations



12.2 Vibration Control

Due to the proximity of the proposed piling activities and basement construction in relation to nearby buildings (in particular to the west at 14 Marshall Avenue and south at 5 Holdsworth Avenue), it is recommended that vibration monitoring is undertaken at this location for the duration of the piling and basement excavation. To minimise exceedances, monitoring equipment shall include SMS alert to the site manager and project staff including the acoustic consultant. Where an alert indicates exceedance of the criteria, use of the onsite plant responsible for the vibration shall cease until the cause is identified and mitigated.

Alternative construction methods may be required if problems are identified onsite as follows:

- Basement Construction and Piling – bored piling is predicted to be suitable for use onsite. We recommend due to the proximity of the piling to the adjoining residences that the rig moves at a reduced speed when operating in proximity to the common boundary.
- Excavators – if vibration levels are triggered by the movement of excavators onsite, we recommend they reduce their movement speed onsite and maintain a minimum separation distance of 5 metres from the nearest sensitive receivers for vehicle movement.

- Dump trucks – during the basement excavation for the development, we recommend the trucks maintain a minimum 5 metre separation distance to the building's sensitive receivers when no located on the road.
- If equipment causes vibration levels to be triggered multiple times at the monitoring location that exceed the maximum allowable criteria, the works/equipment responsible will cease with an investigation to determine management controls to prevent exceedances in the future. These may include but not limited to minimum separation distances being set from the receiver, construction of a ditch along the boundary to reduce the vibration path and possibly reducing the speed of equipment movement onsite.
- During all works onsite, the nominated person will keep a log regarding any SMS events from the vibration monitors including exceedances of the criteria and the equipment causing the issue. Immediate action will be taken to minimise the potential for the exceedance occurring again.

12.1 Vibration Management

1. Recommended construction hours as follows:

   Monday to Friday, from 7am to 6pm.
   Saturday, from 8am to 1pm.
   No construction work to take place on Sundays or Public Holidays.
2. Assign the task of managing vibration complaints or recorded exceedance of the criteria to a person (the 'responsible person') that is likely to be present on-site most of the time that activity is occurring (usually the Site Manager). This person would be responsible for handling vibration complaints and ensuring that work does not commence before the specified allowable times. The name and contact details of the 'responsible person' should be displayed outside the principal construction office.
3. If complaints arise regarding vibration, the complaint will be directed to the 'responsible person', who will determine the source of the vibration or engage the acoustic consultant to investigate immediately. This may involve moving the vibration source further away from affected premises, replacing the equipment, operating at a reduced speed, or excavating a ditch 0.5 metre wide and 1 metre deep between the receiver and the site.
4. The Responsible Person should notify the adjacent residential premises of the intention to commence work that may cause adverse impacts on surrounding residents. If plant is to be operated in close proximity to residential premises, the Responsible Person should advise the occupants of the premises the length of time that the plant will be in operation proximate to the property boundary.
5. Any moveable vibrating plant (e.g. compressors) should be located as far as practical from the adjacent residential premises.
6. The Responsible Person maintain a record of complaints, which records the following details (refer to the example complaint record sheet in the appendix to this plan):
   - The time and date of lodgement of the complaint;
   - The name and telephone number of the complainant;
   - The nature of the complaint, including a description of the vibration (e.g. likely vibration source, duration of the event - is the vibration continuous, or of a short duration);
   - The outcome of the investigation.
7. If a complaint is raised regarding a particular piece of plant, the plant shall be inspected for working condition, with particular attention given to the condition of equipment operating components. If machinery is in good condition, attended vibration measurements shall be undertaken to determine the cause with recommendations provided by a qualified acoustic consultant to rectify the situation.

8. If complaints continue regarding excessive vibration and this is confirmed that vibration levels exceed the criteria continually, then respite periods can be adopted in consultation with council officers and the acoustic consultant to reduce non-compliant impacts to sensitive receivers.

A sample complaint form is provided in the appendices.

12.2 Maximum Vibration Levels

Based on inspection of the surrounding buildings, the maximum allowable levels would be a peak particle velocity of 6mm/s. all monitors installed onsite shall be set to a maximum limit of 3.96mm/s to provide adequate warning and to avoid exceedances of the maximum noise limits.

12.3 Vibration Monitoring Procedure

To ensure the vibration monitoring is effective, we recommend the following:

- All vibration monitors will be set to a maximum measurement interval of 5 minutes and record over the construction period commencing at 6am to 7pm every day.
- The client shall provide a list of relevant construction staff (including mobile phone numbers) working on the project to be notified of exceedance of the nominated vibration levels.
- All vibration monitors will be fitted with an internal SMS warning system (allow the unit to send SMS notification of vibration levels when the nominated level is exceeded). The SMS warning from the vibration monitors will go out to all staff who have provided their mobile numbers for use for notifications from the vibration monitor.
- The vibration monitor will be set to provide vibration impact warnings at a trigger value 2/3 of the criterion limit. Therefore, in this case the vibration impact warning level trigger is to be set at 3.96mm/s. This will allow staff to be notified of vibration levels and take a proactive approach before the 6mm/s criteria is exceeded. The Acoustic consultant will also have a minimum of 2 staff nominated on the warning system.
- Regardless of warning or notification, the vibration monitor will be downloaded on a monthly basis with a monthly report provided to the client, the report will be suitable for submission to council.

12.3.1 Procedure for measuring Vibration

12.3.1.1 Where to measure vibration

Vibration is required to be measured at 14 Marshall Avenue and 5 Holdsworth Avenuewith the geophone located at the nearest point of the building to the site. The geophone can be fixed to the ground using mounting spikes in line with the nearest point of the basement or fixed directly to building elements, note that relocation of the geophone may be required to be representative of the nearest location of works being conducted onsite.

12.3.1.2 When to measure vibration from construction

Measurements of construction vibration should be undertaken at the time(s) when the site is operating during the approved hours. If attended vibration measurements are required, they should be representative of the current maximum level of activity from the site, or at times when complaint has been received. Based on the review of construction works, we recommend vibration monitoring is undertaken during piling and basement construction, this can be extended if complaints are received.

12.3.1.3 Information to be reported

Any reporting should be concise. The minimum requirements to be included in a report are;

- Date and duration of measurements.
- Time of measurements or measurement period.
- Person(s) performing measurements or placing equipment used for long term monitoring.
- Equipment used for measurements.
- Location of measurements including photos.
- Measured values including graphed PPV for the period of monitoring.
- Corrected values (where applicable).
- Notes regarding vibrating sources.
- Notes regarding any extraneous sources that may have influenced measurements.
- Detail of instrumentation and calibration.
- Meteorological conditions.
- Explanation of any high levels below the criteria including exceedances

Action taken for any exceedance including changes to site operations

13. Conclusion

A noise assessment has been conducted for the proposed residential development at 10-12 Marshall Avenue, St Leonards. Specific criteria have been referenced for construction noise and vibration as required by the development approval. A management strategy has been recommended that ensures attention to noise complaints and includes a system for achieving reasonable outcomes.

With respect to vibration, the methods to be used during construction may exceed the relevant vibration limits at the nearest receivers. Management should monitor complaints from these residents and if complaints regarding vibration are received, a detailed investigation may be required. Vibration monitoring is recommended throughout the construction period of the basement retention including piling for the receiver to the west (14 Marshall Avenue) and south (5 Holdsworth Avenue).

If you should have any queries please do not hesitate to contact us.

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14. Appendices

14.1 Example noise complaint record sheet

COMPLAINT LODGEMENT INFORMATION	
Date of complaint	
Time of complaint	
Name of complainant (if given)	
Contact telephone number of complainant	
Description of noise (e.g. mechanical plant, vehicle noise)	
Duration of noise event (e.g. did it last a short time, or is it continuous)	

ACTION TAKEN	
Identification of noise source by Responsible Person	
Immediate action taken	
Previous similar complaints	
Contact with complainant after noise control implemented (e.g. is noise still an issue?)	
Is further action required (e.g. is an Acoustical Consultant required?)	