

1 Lawson Square Redfern
Mixed Use Development
Operational Noise and Vibration Assessment

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Lawson Square Pty Ltd
C/O Candalepas Associates
Level 9, 219 Castlereagh Street
Sydney
NSW 2000

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PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street
Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: +61 2 9427 8100 F: +61 2 9427 8200
sydney@slrconsulting.com www.slrconsulting.com

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610.11623-R1	Revision 1	2 December 2015	Antony Williams	Matthew Harrison	Mathew Harrison
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1 INTRODUCTION

SLR Consulting Pty Ltd (SLR) has been engaged to provide a noise and vibration assessment in relation to the proposed redevelopment of two existing multi-story buildings located on Lawson square, Redfern, NSW. The proposed development is located in an area of high existing road traffic noise and is also located adjacent to a major rail corridor.

This assessment forms part of the supporting documentation associated with the Development Application (DA) for the proposed redevelopment.

The assessment aims to address the potential impact of surrounding noise levels on the development and any associated constraints for the purpose of assessing the suitability of the site for residential development. The impact of the development itself on nearby sensitive receivers will also be assessed.

This report will:

- Describe those parts of the development and the site that are relevant for noise and vibration.
- Summarise the noise and vibration survey work undertaken.
- Recommend criteria for noise emissions from building services plant associated with the development into the environment.
- Recommend criteria for road traffic noise intrusion, and suggest typical building envelope constructions that would normally be capable of meeting these targets.
- Recommend criteria for internal noise levels from building services within the development.
- Establish appropriate rail induced vibration criteria for the development.
- Report the measured vibration levels measured in the existing building.
- Summarise the rail induced vibration and ground-borne noise assessment.

2 PROJECT DESCRIPTION

2.1 Site Description

The development site is located on Lawson Square in Redfern NSW, as shown in **Figure 1**.

The site is bounded by Lawson Square to the north, Wyndham Street to the north-east, Regent Street to the east, Gibbons Street to the west. To the south of the site is the pedestrianised Redfern Street.

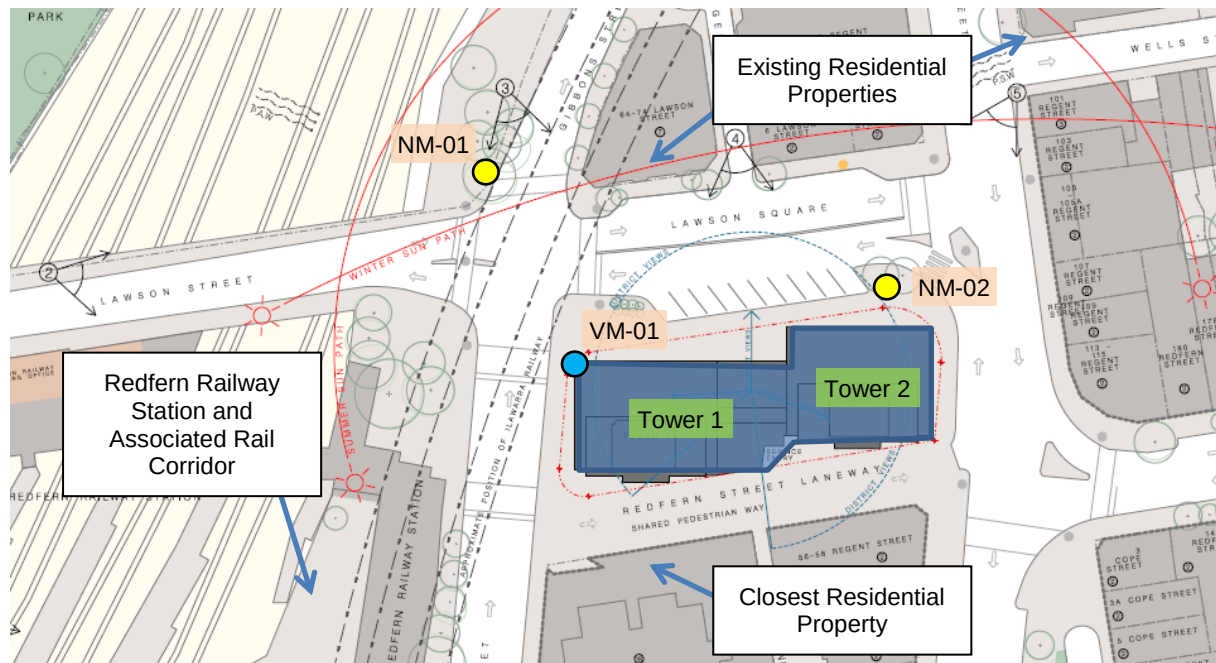
The nearest noise-sensitive receivers are:

- A seven storey mixed use commercial and residential apartment building (Lawson Point) located approximately 25 m to the north of the site, across Lawson Square at 64-74 Gibbons Street.
- A five storey mixed use commercial and residential building on the opposite side of Regent Street, around 25 m to the east of the development site.
- A multistorey residential building, approximately 20 m to the south of the development site on the opposite side of Redfern Street.

Other receivers within the area would be classified as a mixture of commercial and retail.

The Redfern railway station, a major connecting station on the CityRail network, and associated rail corridor, are located to the west of the development site, with closest tracks at a distance of approximately 30 m.

Figure 1 Site location (indicating approximate development boundary in blue)



2.2 Project Overview

The project comprises the redevelopment of the two existing towers into mixed use residential and commercial space. Generally the development will comprise the following:

- **Tower 1:** one basement level with car parking, concierge and retail tenancies at ground level, and residential units on levels 1 to 17.

Note that apartments on the western facade of levels 15 to 17 in Tower 1 have been removed to prevent loss of amenity to the neighbouring residential tower (157 Redfern Street). Communal open space is now proposed in these locations.

- **Tower 2:** one basement level with car parking, commercial tenancy (Police) at ground level and levels 1 to 4, and residential units on levels 5 to 17.

3 DESCRIPTION OF EXISTING NOISE AND VIBRATION ENVIRONMENT

3.1 Ambient Noise Surveys and Monitoring Locations

In order to characterise the existing ambient noise environment at the project site, environmental noise monitoring was performed during September 2012. The noise monitoring locations are shown in **Figure 1**.

Noise monitoring locations were selected based on a detailed inspection of all the potentially affected areas and considering the following:

- Other noise sources which may influence the measurements
- Security issues for the noise monitoring devices

The purpose of the unattended noise monitoring is to determine the existing LAeq, LA90 and other relevant statistical noise levels during the daytime, evening and night-time periods. Detailed descriptions of the acoustic terminology used within this report are presented in **Appendix A**.

Unattended noise loggers were deployed adjacent to sensitive receivers in order to measure the prevailing levels of ambient noise. The measurements were conducted at a height of 1.5 m above the local ground level.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of Australian Standard AS 1259.2-1990 *Acoustics - Sound Level Meters. Part 2: Integrating – Averaging* and carried appropriate and current NATA calibration certificates.

The equipment utilised for the continuous unattended noise surveys comprised of an Australian Research Laboratories Type 316 environmental noise logger, together with a Svantek Type 957 noise logger. All noise loggers were fitted with microphone wind shields.

The calibration of the loggers was checked before and after each measurement survey and the variation in calibration at all locations was found to be within acceptable limits at all times.

All noise loggers were set to record statistical noise descriptors in contiguous 15 minute sampling periods for the duration of their deployment.

The results of the noise monitoring have been processed in accordance with the procedures contained in the NSW *Industrial Noise Policy* (INP) so as to establish receiver background noise levels representative of that at the nearest noise-sensitive receivers.

3.1.1 Unattended Noise Monitoring Results

The results of the unattended ambient noise surveys are presented in **Table 1** and **Table 2**.

Table 1 Summary of Unattended Noise Logging

Location	Description/ Address	Measured Noise Level (dBA)					
		Daytime 7.00 am to 6.00 pm		Evening 6.00 pm to 10.00 pm		Night-time 10.00 pm to 7.00 am	
		RBL	LAeq	RBL	LAeq	RBL	LAeq
NM-01	Gibbons Street	61	73	57	71	47	68
NM-02	Lawson Square	59	69	55	66	44	64

Table 2 Unattended Noise Logger Results –SEPP Defined Time Periods

Location	Period	Measured Noise Level (dBA)
NM-01 Gibbons Street	Daytime (0700-2200)	73
	Night-time (2200-0700)	68
NM-02 Lawson Square	Daytime (0700-2200)	68
	Night-time (2200-0700)	64

3.2 Attended Vibration Measurements

Attended vibration measurements were undertaken at the site during September 2012. Measurements were completed at the foundations of the existing Tower 1, adjacent to Gibbons Street, at the location indicated in **Figure 1** (VM-01).

This location is the closest point of entry for vibration from both surface and underground train lines to enter the towers and represents a worst-case measurement location.

During the vibration survey, surface trains were noted as arriving and departing Redfern Station. The survey duration was sufficient to ensure that a number of underground trains were also captured (with reference to the train timetable for the line).

4 ASSESSMENT CRITERIA

This section presents noise criteria, relating to noise intrusion and noise emission, applicable to the proposed development.

4.1 Internal Sound Separation Requirements

4.1.1 City of Sydney Council – Central Sydney DCP Requirements

The requirements of Council are detailed in Clauses 6.1.14 and 6.1.15 of Central Sydney Development Control Plan (DCP) 1996" as reproduced below:

6.1.14 In order to assist acoustic control of airborne noise between units:

(1) A wall shall have a Field Sound Transmission Class (FSTC) of not less than 50 if it separates;

(a) Sole occupancy units,

(b) A sole occupancy unit from a plant room, stairway, public corridor, hallway or the like.

(2) A wall separating a bathroom, sanitary compartment, laundry or kitchen in one sole occupancy unit from a habitable room (other than a kitchen) in an adjoining unit, shall have an FSTC of not less than 55.

(3) A floor separating sole occupancy units must not have an FSTC less than 50.

6.1.15 In order to assist acoustic control of impact noise between units:

(i) A floor shall have an Impact Isolation Class (IIC) of not less than 50 if it separates:

(a) Habitable rooms of sole occupancy units.

(b) A sole occupancy unit from a plant room, stairway, public corridor, hallway or the like.

(ii) A floor separating a bathroom, sanitary compartment, laundry or kitchen in one sole occupancy unit from a habitable room (other than a kitchen) in an adjoining unit, shall have an IIC of not less than 55.

(iii) Walls between sole occupancy units shall comply with the impact sound resistance standards specified in the BCA

4.1.2 Building Code of Australia (BCA)

The development will be required to comply with the BCA requirements for airborne sound insulation and impact noise isolation.

Table 3 details the minimum acoustic performance required for all residential projects.

Table 3 Sound Insulation Requirements (BCA 2005-2010)

Construction	BCA Requirements	
	Laboratory Rating	Verification
Walls between sole occupancy units	$R_w + C_{tr}$ not < 50	$D_{nT,w} + C_{tr} \geq 45$
Walls between a bathroom, sanitary compartment, laundry or kitchen in one sole occupancy unit and a habitable room (other than a kitchen) in an adjoining unit	$R_w + C_{tr} \geq 50$ and Must have a minimum 20 mm cavity between two separate leaves	$D_{nT,w} + C_{tr} \geq 45$ “Expert Judgment” Comparison to the “Deemed to satisfy” Provisions
Walls between sole occupancy units and a plant room or lift shaft	$R_w \geq 50$ and Must have a minimum 20 mm cavity between two separate leaves¹	$D_{nT,w} \geq 45$
Walls between sole occupancy units and a stairway, public corridor, public lobby or the like, or parts of a different classification	$R_w \geq 50$	$D_{nT,w} \geq 45$
Door assemblies located in a wall between a sole-occupancy unit and a stairway, public corridor, public lobby or the like	$R_w \geq 30$ ²	$D_{nT,w} \geq 25$
Floors between sole-occupancy units or between a sole-occupancy unit and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification	$R_w + C_{tr} \geq 50$ $L_{n,w} + C_1 \leq 62$	$D_{nT,w} + C_{tr} \geq 45$ $L'_{nT,w} + C_1 \leq 62$
Soil, waste, water supply and stormwater pipes and ductwork to habitable rooms	$R_w + C_{tr} \geq 40$	n/a
Soil, waste, water supply and stormwater pipes and ductwork to kitchens and other rooms	$R_w + C_{tr} \geq 25$	n/a
Intra-tenancy Walls	There is no statutory requirement for airborne isolation via intra-tenancy walls.	

Note 1: A wall must be of “discontinuous construction” if it separates a sole occupancy unit from a plant room or lift shaft. Clause F5.3(c) defines “discontinuous construction” as a wall having a minimum 20 mm cavity between two separate leaves with no mechanical linkage except at the periphery.

Note 2: Clause FP5.3(b) in the 2010 BCA states that the required insulation of a floor or wall must not be compromised by a door assembly.

4.2 Noise Intrusion

4.2.1 City of Sydney Council – Central Sydney DCP Requirements

Requirements for noise intrusion are detailed in the City of Sydney's "Central Sydney DCP 1996" in Clauses 6.1.13 and 6.1.16, as reproduced below:

6.1.13 Soundproofing of all dwelling units by such means as acoustic glazing is required to reduce noise impacts on residents

6.1.16 All residential buildings and serviced apartments are to be constructed so that the repeatable maximum LAeq(1hour) level does not exceed the following levels:

(1) In a naturally ventilated - windows closed condition:

Sleeping areas (night-time only: 2200-0700) 35 dBA.

Living areas (24 hours) 45 dBA.

(2) In a naturally ventilated - windows open condition, (i.e. windows open up to 5% of the floor area, or attenuated natural ventilation open to 5% of the floor area):

Sleeping areas (night-time only: 2200-0700) 45 dBA.

Living areas (24 hours) 55 dBA.

(3) Where a naturally ventilated - windows open condition cannot be achieved, it is necessary to incorporate mechanical ventilation or air-conditioning.

(4) The following repeatable maximum LAeq(1hour) levels shall not be exceeded when doors and windows are shut and mechanical ventilation or air-conditioning is operating.

Sleeping areas (night-time only: 2200-0700) 38 dBA.

Living areas (24 hours) 46 dBA

(These levels correspond to the combined measured level of external sources and the ventilation system operating normally.)

4.2.2 Road Traffic Noise Intrusion – Internal Noise Levels

The State Environmental Planning Policy (Infrastructure) 2007 (the 'Infrastructure SEPP') contains specific clauses; Clause 102 relating to residential development of land that may be adversely affected by road noise; and Clause 87 relating to residential development of land that may be adversely affected by road noise. Clause 87 (Rail) and 102 (Road) result in the same noise criteria and is reproduced as follows:

"If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

in any bedroom in the building: 35 dB(A) at any time 10pm-7am

anywhere else in the building (other than a garage, kitchen, bathroom or hallway: 40 dB(A) at any time."

Since compliance with the Infrastructure SEPP is based on internal noise levels, it is not possible to assess a particular development in the absence of details of its design. However, it is possible to comment on likely compliance with the Infrastructure SEPP based on external noise levels and typical noise attenuation between external and internal areas. Recommendations can also be made on the design of the proposed development that would assist in meeting the goals of the Infrastructure SEPP.

The NSW Department of Planning document *Development near Rail Corridors and Busy Roads – Interim Guideline* is intended to provide guidance on the planning, design and assessment of development adjacent to busy roads in accordance with the Infrastructure SEPP and is used in this assessment.

The internal noise levels in **Table 4** are recommended for the assessment of road traffic noise for this development, which is in agreement with the planning documents described earlier.

A general recommendation is also provided in **Table 4** for intrusive noise to the commercial floor base-build areas, to provide a reasonable basis for general commercial fit-out, respecting the maximum recommendation for ‘general office areas’ in *AS2107 2000 Acoustics – recommended design sound levels and reverberation times* (AS2107).

Table 4 Internal Noise Level targets

Space	Time Period	Noise Level LAeq(period), (dBA)
Sleeping areas	10.00 pm - 7.00 am	≤ 35
Other habitable rooms	7.00 am - 10.00 pm	≤ 40
Commercial floor base build areas	7.00 am - 10.00 pm	≤ 45 (recommendation only)

Further to this, the NSW Department of Planning’s ‘*Development Near Railway Corridors and Busy Roads*’ provides the following guidance for internal noise levels due to road and rail noise contribution with windows or doors open:

“If internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia”

4.3 Noise Emission Criteria

The NSW *Industrial Noise Policy* (INP) provides criteria for the assessment of noise impacts associated with industrial activities (eg mechanical plant). It aims to balance the need for industrial activity with the desire for quiet within the community.

The INP sets two separate noise criteria: one to account for intrusive noise and the other to protect the amenity of particular land uses. These criteria are to be met at the most-affected boundary of the receiver property.

4.3.1 INP Criteria for Intrusive Noise

To provide for protection against intrusive noise, the INP states that the LAeq noise level of the source, measured over a period of 15 minutes, should not be more than 5 dB above the ambient (background) LA90 noise level (or RBL), measured during the daytime, evening and night-time periods at the nearest sensitive receivers.

In this case, the intrusiveness criteria are determined from the RBLs listed in **Table 1**, as measured at the residential receiver locations near the proposed facility.

4.3.2 INP Criteria for Amenity

To provide protection against impacts on amenity, the INP specifies suitable maximum noise levels for particular land uses and activities during the daytime, evening and night-time periods. For this assessment, the existing residences in the vicinity of the factory are considered to be 'Urban'.

According to the INP, an 'Urban' area has an acoustical environment that is dominated by 'urban hum' or industrial source noise, or that has through traffic with characteristically heavy and continuous flows during peak periods. The relevant INP amenity criteria are presented in **Table 5**.

Table 5 INP Amenity Noise Levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

4.3.3 Modifying Factor Adjustments

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise sources at the same level. Where a noise event is limited to one event in any 24 hour period, the corresponding annoyance may be considerably less than other noise sources which are continuous or occur more frequently.

To account for this variation in annoyance according to noise character and duration, the INP describes modifying factors to be applied.

4.3.4 Sleep Disturbance

The current approach to assessing the potential for sleep disturbance is to apply an initial screening criterion of background plus 15 dB (as described in the Application Notes to the INP), and to undertake further analysis if the screening criterion cannot be achieved. The sleep disturbance screening criterion applies outside bedroom windows during the night-time period. Where the screening criterion cannot be met, the additional analysis should consider the level of exceedance as well as factors such as:

- How often high noise events will occur
- The time of day (normally between 10 pm and 7 am)
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Other guidelines that contain additional advice relating to the potential for sleep disturbance impacts should also be considered, including the NSW *Road Noise Policy* (RNP). The RNP provides a review of research into sleep disturbance. From the research to date, the RNP concludes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

It is generally accepted that internal noise levels in a dwelling, with the windows open are 10 dB lower than external noise levels. Based on a worst case minimum attenuation, with windows open, of 10 dB, the first conclusion above suggests that short term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions. The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to affect health and wellbeing significantly.

4.3.5 Project Specific INP Assessment

Having defined the area type (Urban), the processed results of the unattended noise monitoring have been used to generate project specific noise criteria for adjacent sensitive receivers (refer to **Figure 1**).

The resultant project specific noise levels are shown in **Table 6**.

Table 6 Project Specific INP Assessment Criteria for Noise Emissions to Nearby Receivers

Receiver	Time of Day	Noise Level (dBA re 20 µPa)			INP Criteria	
		ANL ¹ (period)	Measured RBL ^{2,3} LA90(15minute)	Measured LAeq(period) ³	Intrusive	Amenity
					LAeq(15minute) Criterion for New Sources	LAeq(Period) Criterion for New Sources
Residential to north east of site	Day	60	61	73	66	63 ⁴
	Evening	50	57	71	62	61 ⁴
	Night	45	47	68	52	58 ⁴
Residential to south of site	Day	60	59	69	64	59 ⁴
	Evening	50	55	66	60	56 ⁴
	Night	45	44	64	49	54 ⁴
Commercial	When in use	65	-	-	n/a	65

Note 1: ANL – Acceptable Noise Level for an urban area

Note 2: RBL – Rating Background Level

Note 3: Existing ambient noise levels representing residential receiver to the north east and south are taken from NM-01 and NM-02 logger results respectively.

Note 4: The INP states that in the case where the existing traffic noise level is 10 dB or more above the acceptable noise level and is highly unlikely to decrease in the future, the amenity criterion for noise from the industrial noise becomes the LAeq(period)(traffic) minus 10 dB.

The more stringent of the intrusiveness or the amenity criteria sets the noise goals. As the night-time Intrusiveness criterion (based on a 15-minute period) is lower than the night-time Amenity criterion (based on the entire period) the Intrusiveness criteria is controlling for night-time mechanical plant operation.

4.4 Vibration Intrusion Criteria

In order to evaluate the potential impact from sources of intermittent vibration at the project site, the NSW Government's *Assessing Vibration – a Technical Guideline* provides a methodology to assess vibration in terms of the Vibration Dose Value (VDV). This assessment parameter takes into account factors such as the overall vibration level, the duration of vibration events and number of vibration events in each assessment period (day and night).

The acceptable VDV criteria which are applicable to the project, as taken from the above guideline, are detailed in **Table 7**.

Table 7 Acceptable Vibration Dose Values for Intermittent Vibration ($\text{m/s}^{1.75}$)

Location	Daytime (7 am – 10 pm)		Night-time (10 pm – 7 am)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residence	0.2	0.4	0.13	0.26
Offices	0.4	0.8	0.4	0.8

Although rail vibration is classified as being intermittent, as an initial screening test the maximum vibration level (LV_{max}) at a receiver can be compared with the levels for exposure to continuous vibration stated in *Assessing Vibration: a technical guideline*. If the LV_{max} vibration level is less than the continuous vibration criteria then compliance with the VDV criteria follows automatically (where rail vibration is intermittent rather than continuous, as in this case).

The proposed vibration screening levels for assessing impacts on the proposed development are shown in **Table 8**.

Table 8 Vibration Screening Levels¹

Location	Time ²	Preferred RMS Vibration Velocity		Maximum RMS Vibration Velocity	
		mm/s	dB re 10^{-9} m/s	mm/s	dB re 10^{-9} m/s
Residential Properties	Day	0.2	106	0.4	112
	Night-time	0.14	103	0.28	109
Offices	Day or night-time	0.4	112	0.8	118

Note 1 Trigger levels are based on the continuous vibration values in the guideline *Assessing vibration: a technical guideline (2006)*.

Note 2 Daytime is 7.00 am to 10.00 pm and Night-time is 10.00 pm to 7.00 am.

5 OPERATIONAL NOISE AND VIBRATION IMPACT ASSESSMENT

5.1 Internal Sound Separation Requirements

The development will be required to comply with the BCA requirements for airborne sound insulation and impact noise isolation as outlined in **Section 4.1**. At the detailed design stage, a comprehensive construction specification will be prepared for the internal party walls, floors and other relevant dividing elements.

5.2 Noise Intrusion

The road traffic and rail noise impacts on the site have been determined by a combination of attended measurements and unattended noise monitoring as outlined in **Section 3**.

5.2.1 Predicted External Noise Levels

The predicted external daytime and night-time L_{Aeq} noise levels are shown in **Table 9** for the affected building facades, ie the facades with direct line of sight to the road/rail corridor.

Also shown in **Table 9** is the attenuation required across the facade to meet the internal noise criteria outlined in **Table 4**. The presented values are based directly on the results of the noise logging (refer to locations illustrated in **Figure 1**) as these are deemed to be representative of the noise level at the location of the nearest facade (excluding a facade correction).

Table 9 Predicted External Noise Levels – Road Traffic

Location	Noise Level (dBA)		Required Attenuation (dB)	
	Daytime $L_{Aeq}(15\text{hour})$	Night-time $L_{Aeq}(9\text{hour})$	Bedrooms	Other Habitable Rooms ¹
West facade	76 ²	71 ²	-36	-31
All other facades	71 ²	67 ²	-32	-26

Note 1: Habitable rooms exclude kitchens, bathrooms and hallways.

Note 2: Includes +2.5 dB facade correction.

5.2.2 Noise Intrusion to Residences

The west facing facade of the proposed development may experience $L_{Aeq}(15\text{hour})$ daytime facade noise levels of up to 76 dBA and $L_{Aeq}(9\text{hour})$ night-time noise levels of up to 71 dBA.

The north and east facing facades of the proposed development may experience $L_{Aeq}(15\text{hour})$ daytime facade noise levels of up to 71 dBA and $L_{Aeq}(9\text{hour})$ night-time noise levels of up to 67 dBA.

Standard window glazing of a building will typically attenuate these noise levels by up to 20 dBA with windows closed and 10 dBA with windows open (allowing for natural ventilation). The predicted internal noise levels for standard facade glazing are presented in **Table 10** for the windows open and windows closed scenarios for the affected facades.

Table 10 Predicted Internal Road Traffic Noise Levels – Standard Glazing

Location	Type of Occupancy	Descriptor	Internal Noise Level (dBA)		Internal Noise Criteria (dBA)
			Windows Closed	Windows Open	
West facade	Habitable rooms	Day LAeq(15hr)	56	66	40
		Night LAeq(9hr)	51	61	40
	Bedrooms	Night LAeq(9hr)	51	61	35
All other facades	Habitable rooms	Day LAeq(15hr)	51	61	40
		Night LAeq(9hr)	47	57	40
	Bedrooms	Night LAeq(9hr)	47	57	35

Note: For the purposes of this assessment, it is assumed that the parts of the southern facade with a direct line of sight to the adjacent roads will have similar noise levels to those reported for 'All other facades' in **Table 10**. It is, however, noted that rooms on central parts of the southern facades of the towers are likely to be subjected to reduced noise levels as they overlook the pedestrianised Redfern Street.

The predicted internal noise levels indicate that the criteria for noise intrusion to habitable and sleeping spaces are likely to be exceeded with windows open on all affected facades. With windows open on the west facing facade, the internal noise criteria are expected to be exceeded by up to 26 dB in habitable rooms during the daytime and up to 26 dB in sleeping areas during the night-time.

For all other facades, with windows open, the internal noise criteria are expected to be exceeded by up to 21 dB in habitable rooms during the daytime and up to 22 dB in sleeping areas during the night-time.

With windows closed and standard typical glazing, the exceedance of the internal noise levels would typically reduce by 10 dB from the 'windows open' scenario, however, for all facades the predicted exceedance would remain above 10 dB during both the daytime and night-time.

5.2.3 Recommended Noise Mitigation Measures

The provision of a noise wall would not be feasible or reasonable on the grounds of available space and the fact that no noise benefit would be apparent for floors above ground and first levels due to the remaining direct line of sight from upper floors to the road/rail corridor.

Building elements with improved sound insulation properties will therefore be required to meet the internal noise criteria for the development. The acoustically upgraded elements could typically consist of some or all of the following measures:

- Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors closed
- Windows, glazing and external doors with enhanced sound insulation properties
- Provision of acoustic window and door seals
- Acoustically attenuated wall vents

Incorporating acoustic design principles at an early stage would also be beneficial. Acoustic design principles include orientating the building or rooms to place bedrooms away from the sensitive facade, minimising windows facing the road/rail corridor or locating a bathroom or other non-habitable room against the sensitive facade.

Glazed balconies, or 'Winter Gardens', are an efficient double glazing alternative provided the windows can be closed and sealed properly. Winter gardens can therefore be used in lieu of acoustical double glazing, keeping in mind that the ventilation requirements still should be achieved.

For those parts of buildings exposed to high noise levels (ie where acoustical double glazing is required), all facade elements will need to be acoustically upgraded, including the facade walls and any make up air vents that may be required. Advice on appropriate upgrades can be provided during the detailed design phase of the project, as the architectural information becomes available.

5.2.3.1 Glazing

The reduction in noise across the facade may be estimated using typical attenuation values across various building elements. Examples are given in *Development near Rail Corridors and Busy Roads – Interim Guideline*. In this case, a worst case reduction of 36 dB across the facades of bedrooms and 31 dB for other habitable rooms would be required for external west-facing facade noise levels of 71 dBA and 76 dBA during the night-time and daytime respectively.

For residential development, the weakest acoustic element of the building facade is generally the glazing to windows. In this particular case, due to relatively high external noise levels from road traffic, it is likely that high sound insulation laminated double glazing would be required in order to provide the necessary sound reduction.

During the later design stages, a more detailed investigation should be undertaken to determine the extent to which internal noise level targets can be met with lower acoustic facade performances at higher floor levels, based on increasing distance from the road noise sources.

Specific glazing requirements depend on a large number of factors, for example window and room sizes and extent of balconies, and must therefore be determined during the detailed design stage of the project. Glazing design can be “optimised” taking into account the varying noise exposures of each facade as opposed to the conservative approach used in this assessment.

Examples of building treatments are given in Appendix C of the NSW Department of Planning document *Development near Rail Corridors and Busy Roads – Interim Guideline*.

5.2.3.2 Ventilation

It is noted that compliance with the Infrastructure SEPP would not be achieved in bedrooms and other habitable rooms facing the road with windows open. To give residents the option to keep windows closed, alternative mechanical ventilation must be provided, in accordance with the Building Code of Australia (BCA).

5.3 Mechanical Plant Noise Emissions

At this stage of the design, specific mechanical plant has not been selected. It is understood that the majority of the plant items will be located on the roof of the development.

Noise emissions from mechanical plant for the proposed development together with all other industrial noise sources on the premises are required to be assessed against the INP noise goals. The nearest noise sensitive receiver to the proposed development is located approximately 20 m to the south, on the opposite side of Redfern Street (see **Figure 1**).

Due to the variety of plant items anticipated to be required, it is not practical to specify acoustic requirements for individual units at this stage. The exact requirements for the plant systems will depend on the final design, operation during the daytime, evening and night-time periods and location.

The overall LAeq noise emissions from the development noise sources should not exceed the INP noise criteria outlined in **Section 4.3.5**. As an indication, for night-time operation mode, the combined mechanical plant noise contribution at the residential receiver to the south of the site on Redfern Street (see **Figure 1**), should not exceed 49 dBA.

The noise emission of mechanical plant associated with the development will be controlled so that the operation of such plant does not adversely impact nearby residential properties and other dwellings within the same development.

It is envisaged that the mechanical plant noise sources will be controllable by common engineering methods that may consist of:

- Judicious location
- Barriers and parapets
- Acoustic attenuators
- Acoustically lined ductwork

The selected mechanical equipment will be reviewed and assessed for conformance with established criteria at the detailed design stage of the project when specific plant selection is finalised and appropriate noise control measures can be determined, noting that the cumulative noise emissions from all noise sources should be considered when determining appropriate mitigation options.

5.4 Vibration Intrusion

5.4.1 Perceptible Vibration

The maximum measured vibration level (refer to **Section 3.2**) from all operational sources at the foundations of Tower 1, the most potentially affected location, was found to be 85 dB. This is significantly below the minimum vibration screening level of 103 dB identified in **Table 8** and is also well below the accepted vibration perception threshold of around 100 dB.

As such, the preferred and maximum Vibration Dose Value criteria (as detailed in **Table 7**) are not anticipated to be exceeded at any locations on the site.

5.4.2 Ground-borne Noise

Predictions for ground-borne noise (ie vibration radiated as noise) from train passbys have been undertaken for Tower 1 using the measured vibration data detailed in **Section 3.2**, and the criteria set out in **Table 4**. This assessment is summarised in **Table 11**.

Table 11 Operational Ground-borne Noise Predictions – Train Passbys

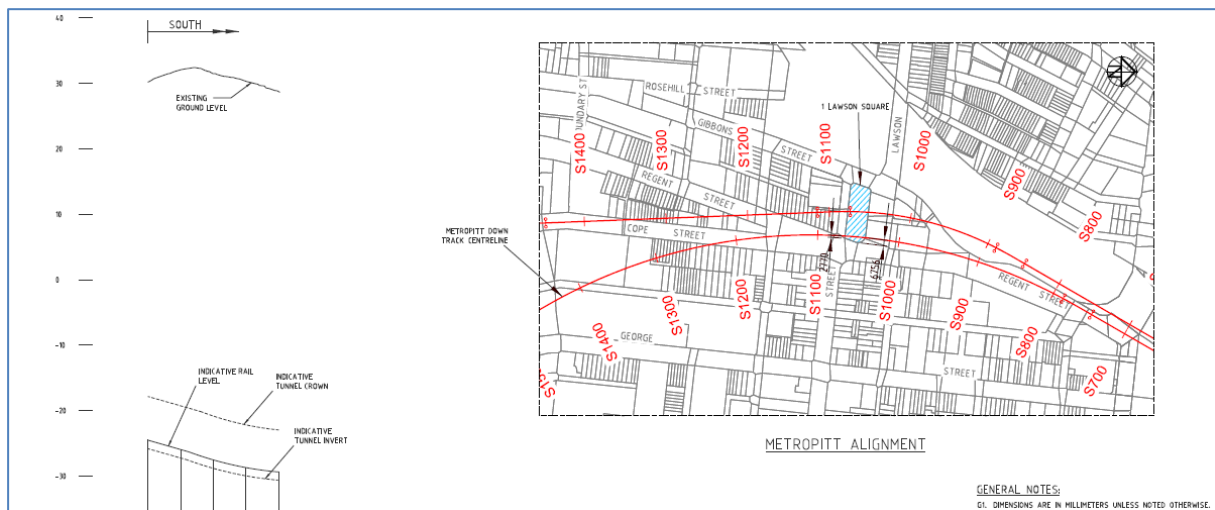
Location	Receiver Type	Noise L _{Amax(slow)} 95% (dBA)		
		Criteria (see Table 4)		Predicted level
		Daytime (7.00 am - 10.00 pm)	Night-time (10.00 pm - 7.00 am)	
Tower 1	Ground floor – lowest commercial floor	45	-	<30
	Level 1 – lowest residential floor	40	35	<30
Tower 2	Ground floor – lowest commercial floor	45	-	<20
	Level 5 – lowest residential floor	40	35	<20

Based on the information presented in **Table 11**, no adverse impacts from ground-borne noise are anticipated in either tower.

5.5 Future Rail Tunnel Corridor

SLR is aware that two potential RailCorp rail tunnels, known as the CBD Rail Link (CBDRL), would pass directly beneath 1 Lawson Street should they be built. The alignment of these potential tunnels is indicated in **Figure 2**.

Figure 2 Future CBD Rail Link Tunnel Alignments



Reference to **Figure 2** indicates that whilst the tunnels do pass underneath the towers at the project site, the depth of the tunnel is in excess of 50 m (from existing ground to rail height). As such, no adverse impacts from operational ground-borne noise or vibration are anticipated should they be built.

6 CONSTRUCTION NOISE AND VIBRATION GUIDELINES

6.1 Construction Noise Metrics

The three primary noise metrics used to describe construction noise emissions include:

- **LA1(1minute)** the “typical maximum noise level” for an event, used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level
- **LAeq(15minute)** the “energy average noise level” evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.
- **LA90** the “background noise level” in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The LAeq(15 minute) construction Noise Management Levels are based on the LA90 background noise levels.

The subscript “A” indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

6.2 NSW Interim Construction Noise Guideline

The *Interim Construction Noise Guideline* (ICNG) sets out ways to deal with the impacts of construction noise on residences and other sensitive land uses. It does this by presenting assessment approaches that are tailored to the scale of construction projects.

A portion of the main objectives from Section 1.3 of the ICNG are presented below:

- Promote a clear understanding of ways to identify and minimise noise from construction works
- Focus on applying all “feasible” and “reasonable” work practices to minimise construction noise impacts
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts

The ICNG contains a quantitative assessment method which is applicable to infrastructure projects. Guidance levels are given for airborne noise at residences and other sensitive land uses, including commercial and industrial premises.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the guidance, or Noise Management Levels (NMLs). The various NML categories have been reproduced from the guideline and are presented in **Table 12** and **Table 13**.

Table 12 Noise Management Levels for Airborne Construction Noise at Residences

Time of Day	Noise Management Level LAeq(15minute) ^{1,2}	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	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: - 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. - If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.
Note 1	Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.	
Note 2	The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).	

The ICNG also presents NMLs for areas of other sensitive land uses. These are detailed in **Table 13**.

Table 13 Interim Construction Noise Guideline – Other Sensitive Land Uses

Land Use	Noise Management Level LAeq(15minute) (applies when properties are being used)
Classrooms at schools and other educational facilities	45 dBA (internal)
Hospital wards and operating theatres	45 dBA (internal)
Places of worship	45 dBA (internal)
Active recreation areas ¹	65 dBA (external)
Passive recreation areas ²	60 dBA (external)
Community Centres	Depends on the intended use of the centre. Refer to the recommended “maximum” internal levels in AS2107 for specific uses.

Note 1: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.

Note 2: Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation.

Where internal NMLs are presented, the corresponding external noise level (which the assessments are based upon) has been determined on the conservative assumption that a 10 dBA noise reduction from outside to inside is applicable for an openable window.

Sleep Disturbance

The most recent guidance in relation to sleep disturbance is contained in the EPA’s *Application Notes - NSW Industrial Noise Policy*. The pertinent section of the Application Notes states the following:

“DECC[W] reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, DECC[W] recognised that current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dBA is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DECC[W] will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur.*
- Time of day (normally between 10pm and 7am).*
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*
- The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under “fast” time response. DECC[W] will accept analysis based on either LA1, (1 minute) or LAmx”*

For the purposes of this assessment, the following night-time sleep disturbance noise goal has been used:

- Night-time (10.00 pm to 7.00 am) RBL +15 dBA “screening criterion”

6.3 Construction-Related Vibration Assessment Criteria

The effects of vibration in buildings can be divided into three main categories – those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

6.3.1 Human Comfort Vibration

The EPA’s *Assessing Vibration: a technical guideline* provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV) rather than a continuous vibration level. The VDV is dependent upon the level and duration of the short-term vibration event, as well as the number of events occurring during the daytime or night-time period.

The VDV’s recommended in the document for vibration of an intermittent nature (ie construction works where more than three distinct vibration events occur) are presented in **Table 14**.

Table 14 Acceptable Vibration Dose Values for Intermittent Vibration ($\text{m/s}^{1.75}$) (*Assessing Vibration: a technical guideline*)

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

¹ Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

² Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Source: BS 6472-1992

6.3.2 Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. For most receivers, the controlling vibration criterion will be the human comfort criterion, and it is therefore not normally required to set separate criteria in relation to the effect of construction vibration on most building contents.

Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer’s data and/or other published objectives.

6.3.3 Structural Damage Vibration

Structural damage vibration limits are based on Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* and British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*. These standards provide frequency-dependent vibration limits related to cosmetic damage, noting that cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

The recommended vibration limits from BS7385 for transient vibration for minimal risk of cosmetic damage to residential and industrial buildings is shown in **Table 15**.

Table 15 Transient Vibration Guide Values for Minimal Risk of Cosmetic Damage (BS7385)

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

6.4 Construction Management Plan

A *Construction Noise and Vibration Management Plan* (CNVMP) should be developed during the detailed design phase of the project when the specific construction scenarios and methodologies have been defined.

The CNVMP should contain an assessment of the likely construction noise and vibration impacts at the surrounding receivers at the site. In preparing the document, consideration should be given to several guideline documents including the ICNG, Australian Standard AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* and the *Road Noise Policy*.

Furthermore, the CNVMP should be required to be adopted by all contractors to ensure the potential construction noise and vibration emissions are adequately managed.

7 CONCLUSIONS

SLR has undertaken a noise and vibration assessment in relation to the proposed redevelopment of two existing multi-story buildings located on Lawson square, Redfern, NSW. The assessment has considered the potential impact of surrounding noise levels on the development and any associated constraints for the purpose of assessing the suitability of the site for residential development, and the impact of the development itself on nearby sensitive receivers.

The noise and vibration criteria are based on publications produced by the Department of Planning, Environment Protection Authority and Sydney City Council. The guidelines applicable to this assessment include:

- Internal Sound Separation Requirements – Central Sydney Development Control Plan (DCP) 1996 (Clauses 6.1.14 and 6.1.15) and sound insulation requirements from the Building Code of Australia.
- Road/Rail Noise Intrusion - City of Sydney's "Central Sydney DCP 1996" (Clauses 6.1.13 and 6.1.16), and the State Environmental Planning Policy (Infrastructure) 2007.
- Operational Noise Emissions – *Industrial Noise Policy* (INP – OEH 2010).
- Vibration Intrusion (human comfort) – *Assessing Vibration – a technical guideline* (DEC 2006).

Internal constructions within the development will be designed such as to meet the acoustic requirements of the Building Code of Australia through the development of detailed design.

To achieve compliance with the Infrastructure SEPP, building elements with improved sound insulation properties will be required. In particular, upgraded glazing is likely to be required for bedrooms and other habitable rooms overlooking the adjacent roads. Mechanical ventilation in accordance with the BCA would also be required to all bedrooms or habitable rooms on the affected facades to allow residents to keep the windows closed if required.

Based on guidance given in *Development near Rail Corridors and Busy Roads – Interim Guideline*, it is expected that compliance with the Infrastructure SEPP could be achieved at this location through the selection of appropriate building elements and glazing. The precise specifications for building treatments depend on the final detailed design and layout of the building, and therefore cannot be determined at this stage.

The selected mechanical equipment should be reviewed and assessed for conformance with the established criteria at the detailed design stage of the project when specific plant selection is finalised and appropriate noise control measures can be determined. It is envisaged that the mechanical plant noise sources will be controllable by common engineering methods that may consist of judicious location, barriers, silencers and/or acoustically lined ductwork noting that the cumulative noise emissions from all operational noise sources should be considered when determining appropriate mitigation options.

This report also presents the results of a study on rail induced noise and vibration into the proposed development. It was found that tactile rail vibration levels within the development site comply with the established criteria. Predicted ground-borne noise levels inside the building also comply with the nominated noise level criteria.

A *Construction Noise and Vibration Management Plan* should be developed during the detailed design phase of the project when the specific construction scenarios and methodologies have been defined. The plan would contain an assessment of the likely construction noise and vibration impacts as per the requirements of the *Interim Construction Noise Guideline*.