REPORT

BEVERLY HILLS COMMUTER CAR PARK

BEVERLY HILLS. NSW

NOISE AND VIBRATION IMPACT ASSESSMENT

RWDI # 2201207

10 January 2022

SUBMITTED TO

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

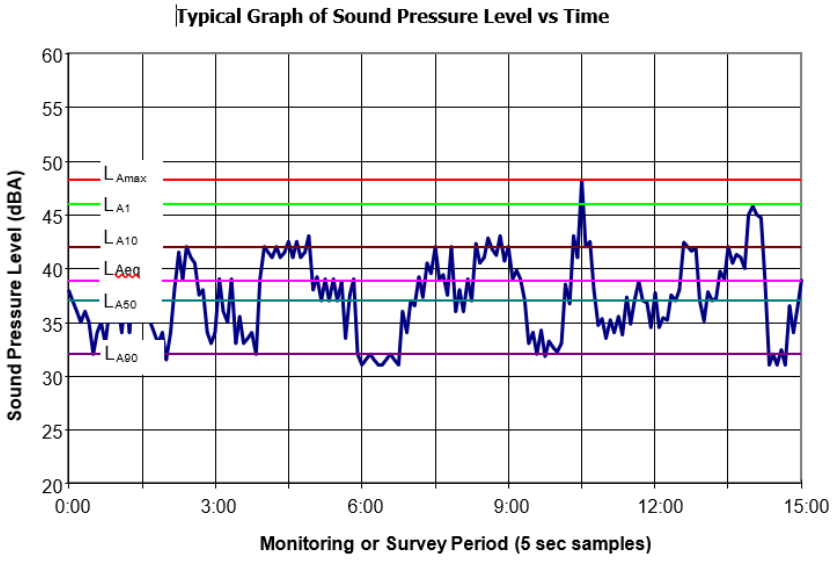
L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.



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1 INTRODUCTION

RWDI was commissioned by Pitt & Sherry Pty Ltd (the client) to conduct a noise and vibration impact assessment for the operation and construction of a proposed multistorey commuter car park at Beverly Hills, NSW (the Project).

Potential noise and vibration impacts have been assessed against relevant guidelines and policies, namely:

- EPA *Noise Policy for Industry* 2017 (*NPfI*)
- NSW *Road Noise Policy* 2011 (*RNP*)
- EPA *Interim Construction Noise Guideline* 2009, (*ICNG*)
- Transport for NSW *Construction Noise and Vibration Strategy* 2020, (*CNVS*)

The project consists of:

- Construction and operation of the Beverly Hills Commuter Car Park as part of the Commuter Car Park Program
- Conversion of six car parking spaces on Tooronga Terrace to four Disability Discrimination Act compliant spaces
- Widening of the footpath along Tooronga Terrace – from the proposed four Disability Discrimination Act compliant car parking spaces – to King Georges Road to the lift of the Beverly Hills Railway Station to satisfy the requirements of the Disability Discrimination Act.

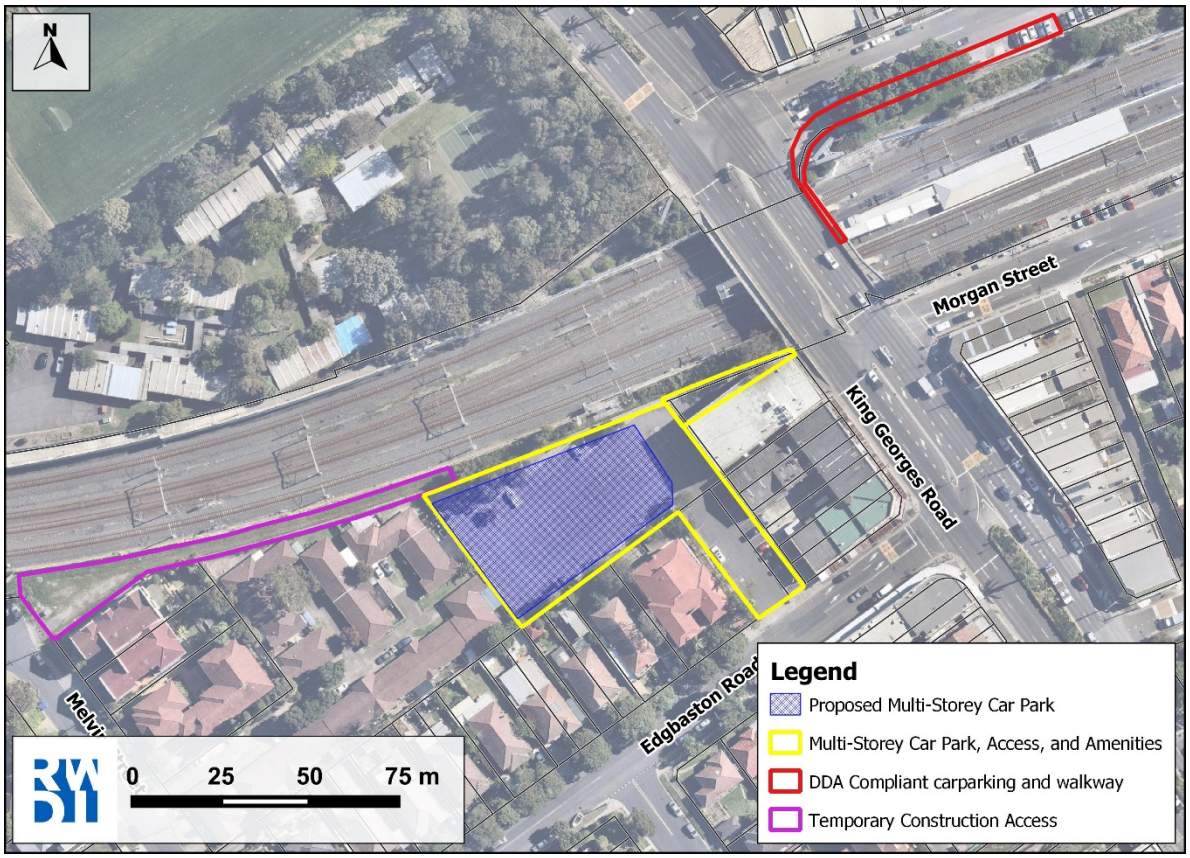

Figure 1-1 Aerial photograph showing site location

2 PROJECT DESCRIPTION

2.1 Commuter Car Park Project Extent

The Project extent is described as follows:

- Building footprint defined by property boundaries and offsets required to protect existing utilities and amenity
- Up to five levels above-ground and three levels below ground (eight level project extent)

Based on the above, the project envelope has a maximum height of 16 metres above existing ground level, and maximum depth of nine metres below existing ground. The maximum elevation of the building would be approximately 45 metres Australian Height Datum (AHD).

The car park would likely comprise of five levels of commuter car parking, including:

- Up to 200 commuter car parking spaces
- Access to each level of the car park via one lift and one stairwell
- Internal vehicle circulation ramps connected each level of the car park
- Transport Park&Ride infrastructure (Opal card operated boom gates).

The entry and exit point to the proposed car park would remain the same as the existing car park, directly from Edgbaston Road, with no restrictions on direction of movements. It is expected that the proposed car park would appeal mostly to those traveling to/from the west of King Georges Road, with the existing car parks on Morgan Street and Tooronga Terrace accommodating commuters coming from the east.

The movements to and from the commuter car park would largely be concentrated between a peak morning period when commuters arrive and a peak evening/afternoon period when commuters return to collect their vehicles, with minimal usage outside these periods (as advised by SECA Solution Pty Ltd).

This noise and vibration impact assessment will consider operational noise impacts from:

- a 3 level below-ground, 2 levels above-ground configuration (“3-Below”)
- a 5 level above ground (“5-Above”)

The noise and vibration impact assessment will also consider noise and vibration impacts associated with the construction of the Project.

2.2 Ancillary Works

To support the development and operation of the multistorey car park, the following accessible parking and footpath work is proposed:

- Provision of four new DDA compliant accessible commuter parking spaces on Tooronga Terrace adjacent to the Beverly Hills Station. This would be created by conversion of six existing commuter parking spaces. Works would include minor regrading, line marking, and signage
- Associated pavement work to ensure accessibility requirements are achieved, where required.
- footpath upgrades between the new accessible parking spaces and the lift to Beverly Hills Station as required to achieve DDA and DSAPT compliance. No trees would be removed. Removal of a small amount of landscaping and groundcover may be required.
- Stair upgrade on the west side of King Georges Road

2.3 Site Location and Surrounding Land Use

The site is located off Edgbaston Road, approximately 60 m west of Beverly Hills Train Station and south of the T8 Airport and South Rail Line. The site consists of Lot 2 DP 533022, Lot 1 DP 208878, and Lot 2 DP 208878 and is located within the Georges River Local Government Area. The main component of the site is zoned SP2 Infrastructure with ancillary components zoned as B2 Local Centre.

Figure 2-1 presents the location of the site and surrounding land uses.

Figure 2-1 Site Area and Surrounding Land Zoning

2.4 Nearest Sensitive Receivers

The nearest residential receivers are located on the western and southern boundary of the site with setbacks ranging from one to five metres. These receivers are all single-storey dwellings except for 4-6 Edgbaston Road which is a three-storey building. Commercial receivers are on the eastern boundary along King Georges Road. All commercial receivers face King Georges Road with little to no windows at the rear except for the Right2Drive facility which has windows overlooking the site. There are also residential receivers located along Hampden Street and Dumbleton Lane, which may be affected by additional traffic noise on the local road network. Across the rail corridor to the north is Beverly Hills High School with classrooms nearest to the boundary.

Additionally, temporary construction activity may impact the northern residences of 46-48 Melvin St and 56 Melvin St, as well commercial receivers along Tooronga Terrace and King Georges Road.

The residential receivers have been categorised into Noise Catchment Areas (NCAs) based on similar noise environments. Receivers in NCA01 would mostly be impacted by noise from the existing car park and train pass-bys in the rail corridor, with some contribution from the road traffic noise on King Georges Road. Receivers in NCA02 would be predominantly impacted by noise from Edgbaston Road and the commercial premises along King Georges Road. Representative receivers have been selected for assessment.

Table 2-1 provides a summary of the representative receivers and **Figure 2-2** presents a site overview with the location of these receivers.

Table 2-1 Representative Receivers

NCA	Receiver	Address	Receiver Type	Distance to Site Boundary
NCA01	R01	14/46-48 Melvin St	Residential	2 m
	R02	13/46-48 Melvin St	Residential	2 m
	R03	7/46-48 Melvin St	Residential	2 m
	R04	12 Edgbaston Rd	Residential	2 m
	R05	10 Edgbaston Rd	Residential	3 m
	R06	8 Edgbaston Rd	Residential	4 m
	R07 N	6 Edgbaston Rd, Northern Facade	Residential	4 m
	R08	10/46-48 Melvin St	Residential	2 m
	R09	56 Melvin St	Residential	2 m
NCA02	R07 E	6 Edgbaston Rd, Eastern Facade	Residential	2 m
-	C01	King Georges Road	Commercial	3 m
-	E01	Beverly Hills High School	Education	44 m

Figure 2-2 Site Overview and Nearest Receivers

3 EXISTING NOISE LEVELS

3.1 Noise Monitoring Methodology

Noise monitoring was initially conducted in 2018 for TfNSW concept considerations. Unattended noise monitoring was conducted for a period of 8 days between 16 October to 24 October 2018 and attended monitoring was completed on 27 September 2018 between 4.00pm to 6.30pm.

As the local noise environment is controlled by road traffic noise along King Georges Road, train pass-bys along the rail corridor, and the existing car park, which would not have changed significantly since 2018, the measurements would remain valid for this assessment. Unattended noise monitors were installed at the properties of nearest receivers, which would provide the best representation of existing background noise levels, see **Figure 3-1**.

The noise monitoring equipment used was set to A-weighted, fast response, continuously monitoring in 15-minute intervals. This equipment is capable of remotely monitoring and storing noise level descriptors for detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted. **Table 3-1** presents a summary of the monitor locations and monitor types.

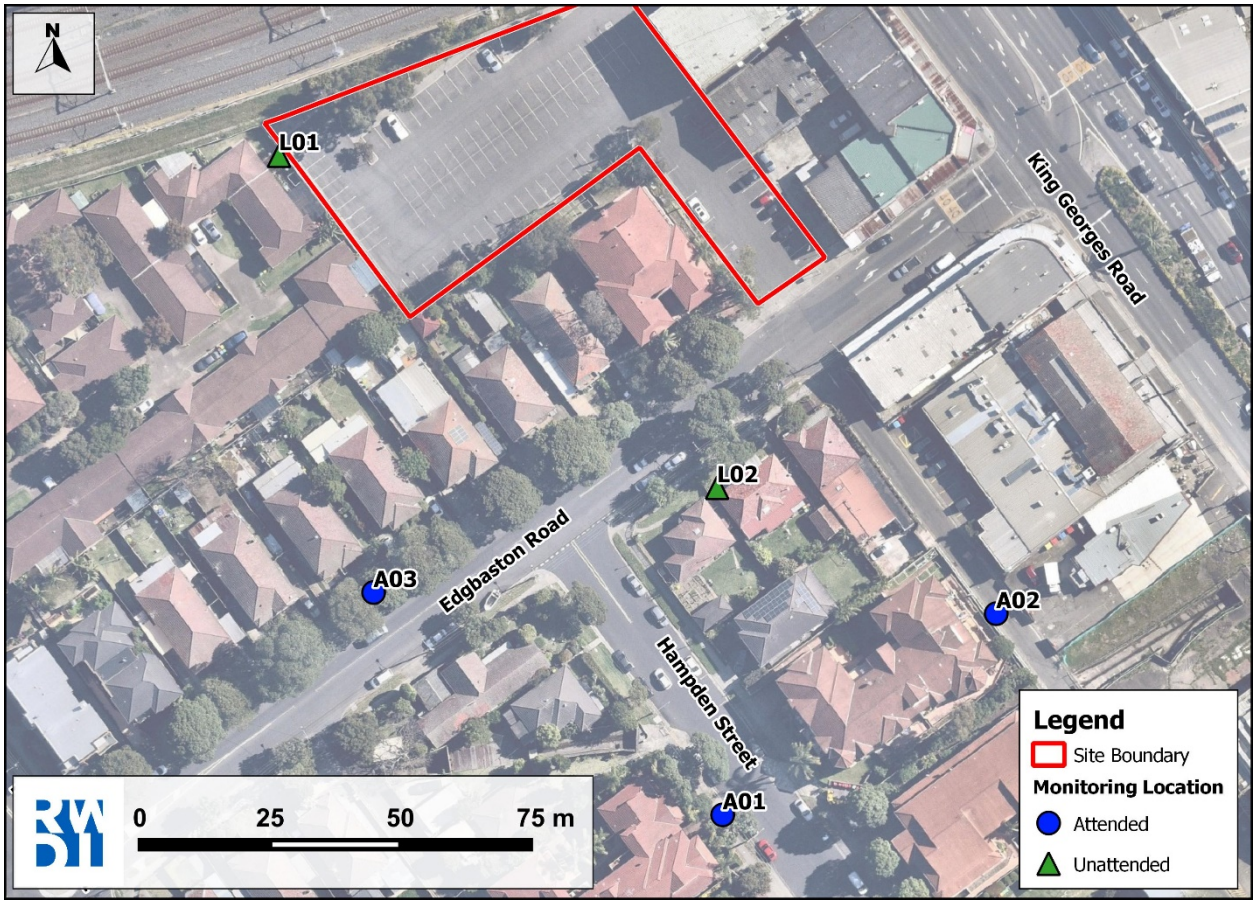

Figure 3-1 Noise Monitoring Locations

Table 3-1 Unattended Noise Monitor Summary

No.	Location	Monitor Type
L01	Rear of 14/46 Melvin Street	SVAN977
L02	Front of 3 Edgbaston Road	SVAN977

3.2 Background Noise

The existing noise environment consists primarily of road noise, predominantly from King Georges Road, and rail noise from the rail corridor to the north. Noise from the operation of the existing car park also forms part of the existing noise environment.

In order to correctly predict the potential noise impact from the proposed car park, noise levels have been assessed against different periods throughout the day, corresponding to the predicted fluctuation of car parking demand and variation in background noise levels.

Background monitoring data has been evaluated within these periods and is presented in **Table 3-2**. Full noise monitoring plots are provided in **Appendix A**. The RBL is the Rating Background Noise Level (RBL) as calculated in accordance with the *NPfI*.

Table 3-2 Unattended Noise Monitoring Results

Location	Period	Time	$L_{Aeq,period}$	RBL
L01	Early Morning	6.00am-7.00am	53	44
	Morning Peak	7.00am-9.00am	52	44
	Day	9.00am-5.00pm	55	44
	Evening Peak	5.00pm-7.00pm	56	47
	Evening	7.00pm-10.00pm	53	43
	Shoulder	10.00pm-12.00am	49	40
	Night	12.00am-6.00am	44	35
L02	Early Morning	6.00am-7.00am	58	44
	Morning Peak	7.00am-9.00am	54	46
	Day	9.00am-5.00pm	63	48
	Evening Peak	5.00pm-7.00pm	59	50
	Evening	7.00pm-10.00pm	58	46
	Shoulder	10.00pm-12.00am	54	43
	Night	12.00am-6.00am	52	34

3.3 Road Traffic Noise

The noise data at Location L02 was reviewed to determine the existing road traffic noise levels on Edgbaston Road. **Table 3-3** below presents the measured road traffic noise levels at this location.

Table 3-3 Measured Road Traffic Noise Levels

Measurement Location	Day $L_{Aeq,15hour}$	Night $L_{Aeq,9hour}$
L02	61	57

Additionally, attended noise monitoring was conducted in order to relate the movement of vehicles to the current noise environment. Attended measurements were completed on 27 September 2018 between 4.00pm to 6.30pm. **Table 3-4** summarises the attended monitoring results.

Table 3-4 Attended Noise Monitoring Results

Location	$L_{Aeq,15min}$	$L_{A90,15min}$	Comments
A01	58	48	9 cars, 1 small truck; some distant construction noise; aircraft noise in distance (not dominant)
A02	65	54	Exposed to King Georges Road; Cars 14-50% of vehicles going to drive in at Eat GRK. Background typically controlled by King Georges Road
A03	65	52	35 cars, 1 small truck, 1 heavy truck; Road noise dominant; 70% vehicles headed east towards King Georges Road; aircraft noise in distance

4 CONSTRUCTION NOISE CRITERIA

4.1 Interim Construction Noise Guideline

The *ICNG* provides the noise goals for construction noise to be achieved for this project.

All construction works will be carried out during the daytime period only and it is expected that the works will typically be undertaken in standard construction hours. Assessment of sleep disturbance from construction activity is therefore not required. Standard construction hours are Monday to Friday 7am – 6pm, and Saturday 8am – 1pm.

On this basis and specifically for residences, the construction Noise Management Level (NML) is that the noise should not exceed the RBL by more than 10 dBA.

It should be noted, the NMLs are considered as guidelines only and are not intended to apply as regulatory limits. The *ICNG* also prescribes a noise limit of 75 dBA above which there is likelihood of a strong adverse reaction from surrounding receivers. **Table 4-1** presents the application of the NML.

Table 4-1 Construction Noise Goals at Residences for a Quantitative Assessment

Time	NML	How to Apply
Recommended Standard Hours: Mon to Fri: 7am – 6pm Sat: 8am – 1pm Sun/Public Holidays: No Work	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 measure L_{AEQ} 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 affected 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 the very noisy activities can occur, taking into account: 1. Times identified by community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning, 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.

Table 4-2 presents the construction NMLs $L_{Aeq,15min}$ for other non-residential receivers relevant in this assessment.

Table 4-2 Construction Noise Management Levels for Non-Residential Receivers

Land use	Noise Management Levels Apply when in Use
Commercial	70 dBA External
Education	55 dBA External[1]

Note 1: The ICNG has an internal NML of 45 dBA for school classrooms. A conservative 10 dB external to internal correction has been applied for this assessment.

Table 4-3 presents the applicable NMLs for construction activities.

Table 4-3 Summary of Construction Noise Management Levels, $L_{Aeq,15min}$ dBA

Receiver Group	Address	NML
R01	14/46-48 Melvin St	54
R02	13/46-48 Melvin St	
R03	7/46-48 Melvin St	
R04	12 Edgbaston Rd	
R05	10 Edgbaston Rd	
R06	8 Edgbaston Rd	
R07 NW	6 Edgbaston Rd	
R07 NE	6 Edgbaston Rd	58
R08	10/46-48 Melvin St	54
R09	56 Melvin St	54
C01	King Georges Road	70
E01	Beverly Hills High School	55

4.2 Transport for NSW Construction Noise & Vibration Strategy

The Transport for NSW (TfNSW) Construction Noise and Vibration Strategy (*CNVS*) recognises the potential for a project's construction noise and vibration levels to exceed the objectives. The *CNVS* outlines a number of standard mitigation measures that should be implemented at all construction sites. If these do not reduce noise to the objective levels (in this case the NMLs specified in **Table 4-4**), a range of additional mitigation measures may be implemented. The additional mitigation measures are listed **Table 4-4**.

The application of any mitigation measure depends on the level of noise above the RBL or the airborne noise management level (NML) and the period of the day when construction is to take place, as listed in **Table 4-5**.

Table 4-4 CNVS Additional Management Measures (AMM)

Measure	Description	Code
Periodic Notification	For each IP project, a notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au). Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the IP Community Engagement Team in cases where AMMM are not triggered as shown in Tables 9 to 11, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking etc). In these circumstances the IP Community Engagement Team will determine the community engagement strategy on a case-by-case basis.	PN
Verification Monitoring	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise). The purpose of monitoring is to confirm that: - construction noise and vibration from the project are consistent with the predictions in the noise assessment - mitigation and management of construction noise and vibration is appropriate for receivers affected by the works Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Refer to Section 8.4 for more details.	V
Specific Notification	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit	SN

Measure	Description	Code
	identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. - Letters may be letterbox dropped or hand distributed - Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs - Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.	
Respite Offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise prepurchased movie tickets, bowling activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all IP projects.	RO
Alternative Accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	AA
Alternative Construction Methodology	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.	AC
Respite Period	OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week, except where there is a Duration Respite. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol (Section 6 of the CNVS). Note; this management measure does not apply to OOHW Period 1 – Days (See **Table 4-5**).	RP
Duration	Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights	DR

Measure	Description	Code
	through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all IP projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with IP Community Engagement Representatives	

Table 4-5 How to Implement Additional Noise Mitigation Measures

Construction Hours	Receiver Perception	dBA Above RBL	dBA Above ANML	Additional Management Measures
Standard Hours Mon-Fri (7am-6pm) Saturday (8am-1pm)	Noticeable	5 to 10	0	-
	Clearly Audible	>10 to 20	<10	-
	Moderately Intrusive	>20 to 30	> 10 to 20	PN, V
	Highly Intrusive	>30	>20	PN, V
	75dBA or greater	N/A	N/A	PN, V, SN
OOHW Period 1 Mon-Fri (6pm-10pm) Sat (7am-8am,1pm-10pm) Sunday/PH (8am-6pm)	Noticeable	5 to 10	<5	-
	Clearly Audible	>10 to 20	5 to 15	PN, RP#, DR#
	Moderately Intrusive	>20 to 30	> 15 to 25	PN, V, SN, RO, RP#, DR#
	Highly Intrusive	>30	> 25	PN, V, SN, RO, RP#, DR#
OOHW Period 2 Mon-Sat (12am-7am) Mon-Sat (10pm-12am) Sunday/PH (12am-8am, 6pm-12am)	Noticeable	5 to 10	< 5	PN
	Clearly Audible	>10 to 20	5 to 15	PN, V, SN, RO^, RP#, DR#
	Moderately Intrusive	>20 to 30	> 15 to 25	PN, V, SN, RO^, RP#, DR#
	Highly Intrusive	>30	> 25	PN, V, SN, RO^, RP#, DR#, AA

Notes: PN = Project notification
V = Verification monitoring
RP = Respite Period
AA = Alternative accommodation
SN = Specific notification, individual briefings, or phone call
DR = Duration Reduction
RO = Project specific respite offer

Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6am-7am & 1pm-6pm, Sundays/Public Holidays 8am-6pm)

^ Respite offers during OOHW Period 2 are only applicable for evening periods (i.e. Sundays/Public Holidays 6pm-10pm), and may not be required if a respite offer has already been made for the immediately preceding OOHW Period 1

5 CONSTRUCTION VIBRATION CRITERIA

The relevant standards and guidelines for the assessment of construction vibration are summarised in **Table 5-1**.

Table 5-1 Construction and Vibration Standards and Guidelines

Item	Standard/Guideline
Cosmetic Damage	British Standard BS 7385 – Part 2-1993 – Evaluation and measurement for vibration in buildings Part 2
Human Comfort (Tactile Vibration)[1]	Assessing Vibration – A technical Guideline (AVATG)

Note 1: This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard *was* superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings - Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive, or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities.
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities.
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

5.1 Cosmetic Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 "*Explosives – Storage and Use – Part 2: Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2*", as they "*are applicable to Australian conditions*".

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

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 5-2**.

Table 5-2 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

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

The Standard states that the guide values in **Table 5-2** relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

The British Standard goes on to state that "Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%. It should be noted that vibratory rollers are considered to have the potential to cause dynamic loading in some structures (e.g., residences) and it may therefore be appropriate to reduce the transient values by 50%.

5.2 Human Comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline *Assessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in **Table 5-3**. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 5-3 Preferred and Maximum Vibration Dose Values for Intermittent Vibration ($m/s^{1.76}$)

Location	Time of Day	Preferred	Maximum
Critical Areas	Day or Night	0.10	0.20
Residences	Day	0.20	0.40
	Night	0.13	0.26

Location	Time of Day	Preferred	Maximum
Offices, Schools, Educational Institutions and Places of Worship	Day or Night	0.40	0.80
Workshops	Day or Night	0.80	1.60

Table C1.1 of the AVTG (reproduced below in **Table 5-4**) also provides the criteria in alternative units.

Table 5-4 Preferred and Maximum Peak Velocity Values for Intermittent Vibration (mm/s)

Location	Time of Day	Preferred	Maximum
Critical Areas	Day or Night	0.14	0.28
Residences	Day	8.6	17.0
	Night	2.8	5.6
Offices, Schools, Educational Institutions and Places of Worship	Day or Night	18.0	36.0
Workshops	Day or Night	18.0	36.0

5.3 Additional Vibration Criteria

The proposed car park is located in close proximity to a high-pressure gas main situated in the rail corridor. APA Gas, the utility owner, outlines vibration limits for works near the pipeline.

No vibration generating activities within 3 m of the pipeline. Vibration from any works at a greater distance must not exceed:

a. **For coal tar enamel pipeline coatings or poorly coated pipelines:** 10 mm/s maximum Peak Particle Velocity (PPV) measured at the pipeline.
b. **For non-coal tar enamel pipeline coatings:** 20 mm/s maximum PPV measured at the pipeline.

Vibration monitoring must adopt an alert at 80% of the acceptable PPV value and when the alarm is activated, the work must stop and be re-assessed.

6 ROAD TRAFFIC NOISE CRITERIA

The *Road Noise Policy (RNP)* promulgated by the EPA sets out criteria for assessment of noise from vehicles on public roads.

The roads surrounding the proposed development would be classified as arterial and local roads. Edgbaston Road would fall into the sub arterial road category, whereas the Melvin St. Hampden Road, and Dumbleton Lane would be local roads. The relevant criteria for existing residences affected by additional traffic on these roads are shown in **Table 6-1**.

Table 6-1 RNP Road Traffic Noise Criteria

Road category	Type of project / land use	Assessment criteria – dBA	
		Day (7am–10pm)	Night (10pm–7am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing sub-arterial roads generated by land use developments	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)

Where these levels are already exceeded, the RNP suggests that increases in noise of less than 2 dB will have a minor impact that is considered barely perceptible to the average person.

Road traffic generated by the commuter car park would predominantly be within the day period (7am to 10pm) with few movements outside these hours. Any movements during the night period would be limited to the early morning 6am-7am, or late evening 10pm-11pm. Therefore, road traffic noise generated by the commuter car park during the night period would be negligible and not warrant further assessment.

Additionally, the RNP states that a relative increase of 12 dB in road traffic noise represents slightly more than an approximate doubling of perceived loudness and is likely to trigger community reaction, particularly in environments where there is low existing level of traffic noise.

7 OPERATIONAL NOISE CRITERIA

7.1 Noise Policy for Industry (*NPfI*)

The emission of noise and potential noise impact from the operation of the proposed development is to be assessed with respect to the site-specific noise trigger levels based on the *NPfI*. The assessment procedure has two components:

- Controlling intrusiveness noise impacts in the short-term for residents; and
- Maintaining noise level amenity for residences and other land uses.

If the trigger levels are predicted to be exceeded, the *NPfI* indicates that reasonable and feasible noise mitigation should be implemented.

The *NPfI* stipulates that intrusiveness and amenity noise levels are determined for the daytime (7.00am 6.00pm), evening (6.00pm-10.00pm), and night (10.00pm-7.00am) periods, as relevant. The determined trigger levels apply at the most affected point on or within the receiver property boundary.

The intrusiveness noise level requires that the $L_{Aeq,15min}$ noise level from the source being assessed should not exceed the Rating Background Noise Level (RBL) by more than 5 dBA.

The amenity noise level sets limits on the total noise level from all industrial noise sources affecting a receiver. Different amenity noise levels apply for different types of receivers (e.g. residential, commercial, industrial – or for areas specifically reserved for passive recreation) and different areas (e.g. urban, suburban, rural). The amenity noise level applies to the $L_{Aeq,Period}$ during the full day (or evening or night). To ensure that industrial noise levels remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise. Where there is likelihood of several industrial or commercial noise this is calculated as the recommended amenity noise level for the receiver type minus 5 dBA. Where noise sources are not continuous for the whole period, 3 dB is added to convert $L_{Aeq,Period}$ to $L_{Aeq,15minute}$.

Receiver R01-R06 and the northern façade of R07 would be considered as suburban and would only be exposed to the proposed car park. Therefore, the full amenity noise level can be applied.

The eastern façade of R07, which overlooks Edgbaston Road and the rear of the nearby commercial premises, would be considered as an urban area. As these receivers are exposed to other industrial noise, the 5 dB adjustment should be applied to the overall amenity trigger levels. The background levels at this façade are assumed to be equivalent to logger location L02.

Receivers R08 and R09 are in the same direction as receiver R01 and R02 and setback further from the proposed car park. Therefore, these receivers have been omitted from the operational noise assessment.

The relevant trigger levels are summarised in **Table 7-1**.

Table 7-1 NPfI Project Noise Trigger Levels

Receiver	Period	Intrusiveness $L_{Aeq,15min}$	Amenity $L_{Aeq,15min}$	Project $L_{Aeq,15min}$
R01-R06 R07 N	Morning Peak	49	58 (55+3)	49
	Day	49		49
	Evening Peak	52	48 (45+3)	48
	Evening	48		48
	Shoulder	45	43 (40+3)	43
	Night	40		40
	Early Morning	49		43
R07 E	Morning Peak	51	58 (60-5+3)	51
	Day	53		53
	Evening Peak	55	48 (50-5+3)	48
	Evening	51		48
	Shoulder	48	43 (45-5+3)	43
	Night	39		39
	Early Morning	49		43
C01	When in use	-	63 (65-5+3)	63
E01	When in use	-	45 (40+10-5)[1]	45

Note 1 The NPfI states that where existing schools are affected by noise from existing industrial sources (the existing car park and commercial premises along King Georges Road), the acceptable internal L_{Aeq} noise level may be increased to 40 dB $L_{Aeq,1hr}$. Additionally, a conservative 10 dB external to internal correction has been applied for this assessment.

7.2 Sleep Disturbance

The potential for a change in sleep disturbance from maximum noise level events needs to be considered. Although there is an existing car park on site, and there is not predicted to be a significant change in the number of vehicle movements to and from the site during the night period, occasional maximum noise levels will be generated from the upper floors, which may not be as well shielded to some receivers as the existing surface level car park.

The *NPfI* states that where night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40dBA or the RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52dBA or the prevailing RBL plus 15dB, whichever is greater,

A detailed maximum noise level event assessment should be undertaken.

Table 7-2 below summarises the screening levels that will be applied for this assessment.

Table 7-2 Sleep Disturbance Screening Levels

Receiver	Period	$L_{Aeq,15min}$	L_{AFmax}
R01-R06 **R07 N**	Night	40	52
R07 E	Night	41	52

8 CONSTRUCTION NOISE ASSESSMENT

8.1 Construction Noise Sources

At this stage, only an indicative list of equipment likely to be used during the construction of the project is available. Therefore, based on experience from similar projects and high-level guidance from the constructability reports prepared for the two reference designs, indicative construction stages have been developed for noise assessment purposes. The constructability reports indicate that the construction of the proposed car park could take up to 78 weeks.

The plant and equipment selection are indicative, based on the current preliminary design, and may change once the detailed design methodology is finalised. It is also dependent on the Contractor's preferred methodology, program, and sequencing of the work in consultation with TfNSW.

Table 8-1 below presents the expected construction stages required to complete the project. Stages 1-8 would be required if the proposed car park is to include any basement levels. Only stages 1, 6, 7, and 8 are required for construction of an above ground car park.

The sound power levels (Lw) presented in **Table 8-1** are taken from RWDI's internal database and external assessments of similar projects.

Table 8-1 Construction Staging and Sound Power Levels

Stage	Activities	Plant	Lw/unit	Lw Total
1	Enabling Works	Hand Tools	105	108
		Excavator 20t	104	
2	Piling	Concrete Truck	106	118
		Concrete Pump	106	
		Bored Piling Rig	117	
3	Excavation	Excavator w/ hammer	122	122
		Loader	108	
		Hand Tools	105	
		Tower Crane	100	
		Water cart	105	
		Haul Truck	106	
4	Anchor Bolt Installation	Drilling Machine	119	120
		Hammer Drill	110	
		Telehandler 7t	99	
		Excavator 5t	94	

Stage	Activities	Plant	Lw/unit	Lw Total
5	Shotcreting	EWP	95	113
		Shotcrete rig	104	
		Concrete Truck	106	
		Concrete Pump	106	
		Hammer Drill	110	
		EWP	95	
6	Construction of superstructure	Concrete Truck	106	111
		Concrete Pump	106	
		Tower Crane	100	
		Hand Tools	105	
7	Entrance upgrade	Concrete Truck	106	111
		Roller	107	
		Excavator 5t	94	
		Hand Tools	105	
8	Finishing works	Truck	104	108
		EWP	95	
		Hand Tools	105	
		Tower Crane	100	

8.2 Predicted Construction Noise at Receivers

The ICNG requires predicted noise levels at receivers to be based on 15-minute periods. The noise impact predictions assume a "typical worst-case" scenario whereby all the plant is running continuously.

As such, the impact predictions represent the likely noise levels that would occur during intensive periods of construction. Therefore, the presented noise levels can be considered in the upper range of noise levels that can be expected at surrounding receivers when the various construction stages occur.

Table 8-2 presents the predicted construction noise levels at surrounding receivers. Where the noise level exceeds the relevant NMLs, the value is presented in **BOLD**. Where the predicted noise level exceeds the "Highly-Affected" threshold of 75 dBA, the value is presented in **RED**.

Table 8-2 Predicted Construction Noise Levels, $L_{Aeq,15min}$ dBA

Receiver	Construction Stage								NML
	1	2	3	4	5	6	7	8	
R01	**61**	**69**	**73**	**71**	**64**	**63**	50	**60**	54
R02	**62**	**72**	**76**	**74**	**67**	**65**	50	**62**	54
R03	**62**	**71**	**75**	**73**	**66**	**64**	51	**61**	54
R04	**69**	**70**	**74**	**72**	**65**	**63**	54	**60**	54
R05	**69**	**71**	**75**	**73**	**66**	**64**	**54**	**61**	54
R06	**69**	**71**	**75**	**73**	**66**	**64**	**57**	**61**	54
R07 N 2F	**70**	**78**	**82**	**80**	**73**	**71**	**69**	**68**	54
R07 E 2F	**70**	**72**	**76**	**74**	**67**	**65**	**77**	**62**	58
R08	45	**55**	**59**	**57**	51	49	45	47	54
R09	33	**56**	**56**	**56**	**55**	**55**	**55**	**55**	54
C01	**70**	**79**	**83**	**81**	**74**	**72**	**74**	69	70
E01	52	**63**	**67**	**65**	**58**	**56**	51	53	55

The levels in **Table 8-2** indicates that stages 1-7 and stage 8 are likely to exceed relevant NMLs for all the receivers surrounding the site. Stage 7 is more isolated towards the entry/exit to Edgbaston Road and so exceedances are not expected at receivers R01 to R05, R08, and R09.

A number of receivers could be expected to receive noise levels above the "Highly-Affected" threshold of 75 dBA. The exceedances associated with Stage 3 are due to the use of a hydraulic hammer for rock breaking. When the hammer is not in use, levels are expected to be up to 10 dB less than presented.

The construction noise assessment has been completed assuming that all noisy works are occurring simultaneously. This was completed in order to understand a worst-case scenario. A more detailed analysis should be completed during the detailed design stage.

8.3 Construction Noise Mitigation and Management at Receivers

A number of standard mitigation measures are listed in the TfNSW *CNVS*. These include measures such as ensuring all plant is modern and well maintained to achieve the nominated equipment limits, is switched off when not in use and separated and shielded from receivers as much as possible. For small sites, separation and shielding is often hard to achieve.

Table 8-3 identifies the additional mitigation measures (AMM) as recommended by the CNVS for the representative receivers. For standard hours work the CNVS would recommend project notification and specific notification to all affected residential receivers and monitoring for all locations.

It is predicted that commercial receivers would be heavily affected by construction noise. It is recommended that the neighbouring areas be regularly updated with the construction schedule.

It should also be noted that if the proposed car park is to be completely above-ground then construction stages 2 to 5 would not be required or required at a lesser extent.

Table 8-3 Recommended Additional Mitigation Measures

Construction Stage	Exceedance of NMLs	Exceeds 75 dBA?	Receiver Perception	Additional Mitigation Measures[1]
1 – Enabling Works	9-16 dBA	No	Moderately Intrusive	PN, V
2 – Piling	1-24 dBA	Yes	75dBA or greater	PN, V, SN
3 – Excavation	2-28 dBA	Yes	75dBA or greater	PN, V, SN
4 – Anchor Bolt Installation	2-26 dBA	Yes	75dBA or greater	PN, V, SN
5 - Shotcreting	1-19 dBA	No	Moderately Intrusive	PN, V
6 – Construction of Superstructure	1-17 dBA	No	Moderately Intrusive	PN, V
7 – Entrance Upgrade	1-19 dBA	No[2]	Moderately Intrusive	PN, V
8 – Finishing Works	2-14 dBA	No	Moderately Intrusive	PN, V

Note 1: PN: Project Notification
V: Verification Monitoring
SN: Specific Notification

Note 2: The only "75dBA or greater" receiver is R07 NE 2F which overlooks the activity area, all other receivers are considered "Moderately Intrusive". Appropriate AMM (PN, V, SN) should be implemented for Receiver R07.

9 CONSTRUCTION VIBRATION ASSESSMENT

9.1 Vibration Intensive Activity

Vibration intensive works that may occur during the proposed works would be limited to the use of hydraulic hammers, piling, and rollers.

The Transport for NSW *Construction Noise and Vibration Strategy* suggests safe working distances between items of plant used for construction and vibration sensitive receivers. If these safe working distances are maintained, no adverse impacts from vibration intensive works are likely to occur at receivers in terms of human response or cosmetic damage.

The safe working distances shown in **Table 9-1** are recommended to be adopted as criteria for the proposed works. These distances are designed to meet PPVs levels of 7.5 mm/s (50% of the transient cosmetic damage limit for unreinforced structures) and 2.8 mm/s (preferred night limit for human response at residences). Based on vibration prediction formula and the reference values of the CNVS setback distances, setback distances for the APA Gas limits have has been provided.

Table 9-1 CNVS Recommended Setback Distances for Vibration Intensive Activity

Plant	Rating/Description	Cosmetic Damage (2.8 mm/s)	Human Response (7.5 mm/s)	APA Gas Limits[1]	
				Coated (10 mm/s)	Non-Coated (20 mm/s)
Medium Hydraulic Hammer	900 kg (12 to 18t Excavator)	7 m	23 m	5 m	2
Large Hydraulic Hammer	1600 kg (18 to 34t Excavator)	22 m	73 m	16 m	7 m
Vibratory Roller	< 100 kN (typically 2-4 tonnes)	6 m	20 m	4 m	2 m
Vibratory Roller	< 200kN (typically 4-6 tonnes)	12 m	40 m	9 m	4 m
Vibratory Pile Driver	Sheet piles	20 m	100 m	11 m	5 m
Bored Piling	<800 mm	2 m	7 m	< 1 m	< 1 m

Note 1: No vibration intensive activity is to occur within 3 m of APA Gas pipelines.

9.2 Construction Vibration Mitigation and Management

It is recommended that within the Construction Noise and Vibration Management Plan (CNVMP), a review of proposed vibration intensive activities be completed. Vibration propagation is dependent on the local geological makeup. Attended vibration testing should be conducted at the commencement of any vibration intensive activity to confirm the dominant frequency of the vibration and the corresponding upper limit "component" peak particle velocity for nearby structures to revise the safe working distance accordingly.

The CNVMP should also employ the follow standard mitigation measures where practicable:

- Maximising the offset distance between high vibration plant items and nearby buildings.
- Substitution by alternative equipment, plant, and processes.
- Reduction vibration settings levels when operating the vibratory roller nearby buildings.
- Consultation with affected residences and business owners.

10 ROAD TRAFFIC NOISE ASSESSMENT

10.1 Existing Traffic Noise Levels

Existing traffic noise levels are summarised below. Where measurements were not made at the façade, the measurements have been adjusted to account for the change in distance and façade correction (+2.5dB). The road traffic noise level on Melvin Street (north of Edgbaston Road) has been predicted using the *Calculation of Road Traffic Noise* (*CORTN*) model developed by the Welsh Office of the UK Department of Transport, 1998. It has been conservatively assumed that within an hour there could be up to 5 movements along the road.

Table 10-1 Existing Road Traffic Noise Levels

Road	Day
Edgbaston Road (façade)	$L_{Aeq,15hr}$ = 61
Hampden Street	$L_{Aeq,1hr}$ = 58
Melvin Street	$L_{Aeq,1hr}$ = 46
Dumbleton Laneway	$L_{Aeq,1hr}$ = 65

The existing levels marginally exceed the RNP criteria on Edgbaston Road by 1 dB at daytime and 2 dB at night. For Hampden Street and the Dumbleton Laneway short term measurements also indicate the RNP criteria are likely to be exceeded for a local road.

10.2 Existing Traffic Volumes

Estimated daily traffic volumes for 2017 have been provided to TfNSW by Seca Solutions and are summarised for the surrounding road network for light vehicles (LV) and heavy vehicles (HV) as follows:

Table 10-2 Existing Daily Road Traffic Volumes

Receiver	Day		
	Total	LV	HV
Edgbaston Road	4371	4152	219
Hampden Street	2647	2515	132
Dumbleton Laneway	535	508	27

For Hampden Street and Dumbleton Laneway, the hourly volumes range as follows:

Table 10-3 Hourly Traffic Volumes

Road	Daytime
Hampden Street	111-220

Road	Daytime
Dumbleton Laneway	22-45
Melvin Street	5

10.3 Operational Traffic Noise

Based on traffic generation input provided by Seca Solution Pty Ltd (see Section 11.1 of this report), **Table 10-4** presents the expected movements generated by the car park in the day and night periods.

Table 10-4 Car Park Traffic Movements

Assessment Period	Hours	Movements
Day	7am-10pm	380

Allowing for the split of traffic arriving and departing the car park; the range of additional hourly traffic volumes and the total of the whole day or night period on the surrounding road network are summarised in **Table 10-5**. It is expected that there would be no movements from the site onto Melvin Street.

Table 10-5 Additional Traffic Movements on Surrounding Road Network

Road	Period	Additional Movements
Edgbaston Road	Day (7am-10pm)	380
Hampden Street	Highest 1hr (6pm-7pm)	4
Dumbleton Laneway	Highest 1hr (6pm-7pm)	3

Table 10-6 summarises the predicted increases in noise levels associated with additional movements on the surrounding road network. The highest increase over the day, for the relevant assessment period is shown.

Table 10-6 Predicted Increases in Road Traffic Noise

Road	Noise Descriptor	Additional Road Traffic Noise
Edgbaston Road	$L_{Aeq,15hr}$	0.2 dB
Hampden Street	$L_{Aeq,1hr}$	0.2 dB
Dumbleton Laneway	$L_{Aeq,1hr}$	0.2 dB

The predicted changes in noise levels are negligible and below the 2dB, which the RNP in Section 3.4 states *"in assessing feasible and reasonable mitigation measures, an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person."*

10.4 Construction Traffic Noise

The most significant construction traffic would be associated with the excavation for the basement levels of the car park. The constructability report for the concept design which contained basement parking indicated that there could be between 20 to 45 trucks a day (with the maximum occurring during excavation and piling works). Assuming truck movements are spread evenly across the workday (7am-6pm), this could equate to between 2 to 5 trucks per hour.

A prediction was completed using *CORTN*. **Figure 10-1** below outlines the proposed construction traffic routes.

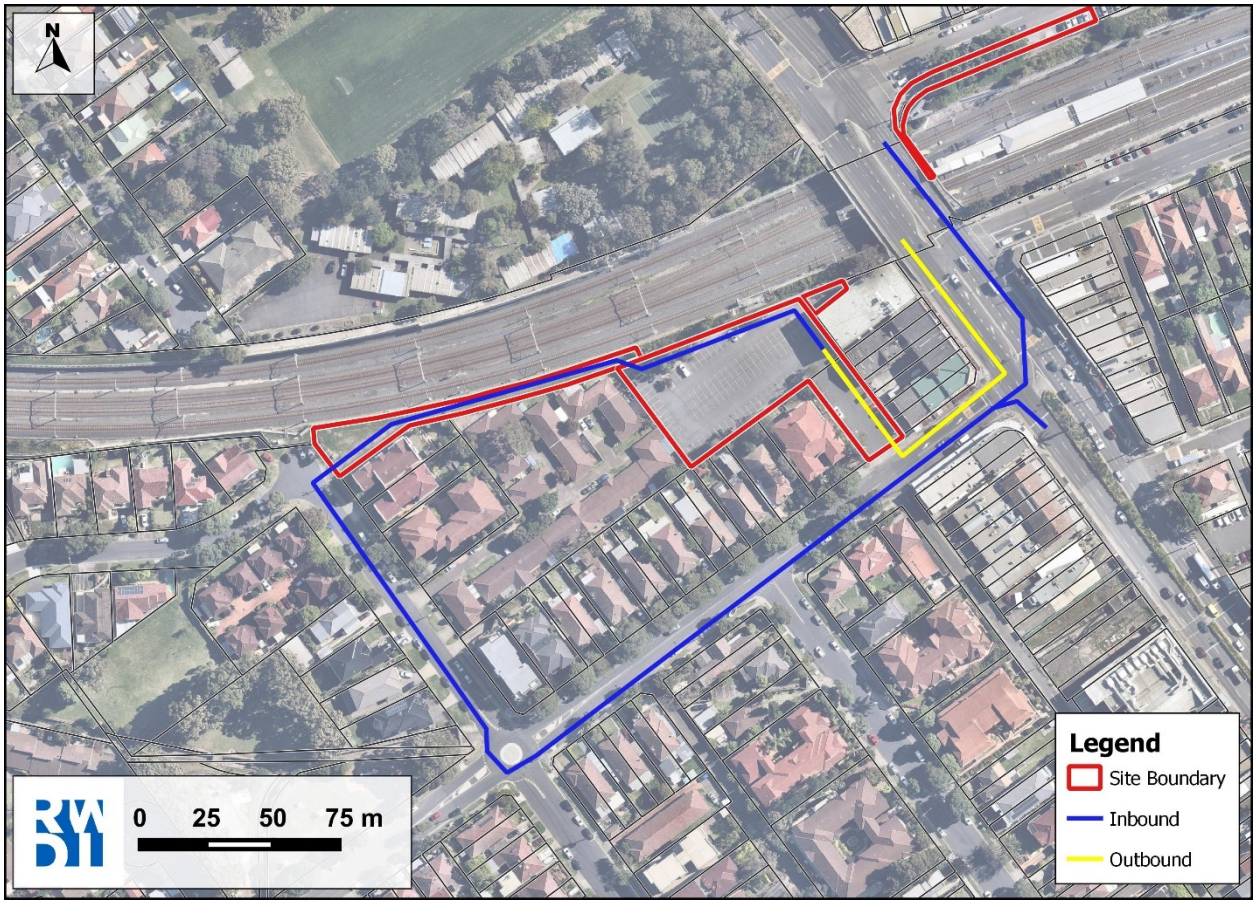

Figure 10-1 Proposed Construction Traffic Route

Construction traffic is expected to travel on Melvin St and Edgbaston Road before returning to King Georges Road. As Melvin St is a local road with limited existing traffic relative impacts would be greatest for these receivers. The facades of these receivers are approximately 11 m from the nearest travel lane. Predictions have assumed that within the worst-case hour, there would be 5 heavy vehicle movements and 5 light vehicle movements entering the site. Predictions have determined that the road traffic noise at the facades of these receivers would be $L_{Aeq,1hr}$ 55 dBA which is compliant with the daytime *RNP* criteria for local roads. Road traffic noise impacting Edgbaston Road receivers are also expected to comply given the higher noise limit.

The predicted noise level of 55 dBA is 9 dB higher than the existing noise level on Melvin Street, which was estimated to be 46 dBA. This relative increase is less than the 12 dB threshold identified in the RNP. It is important, however, that construction workers and drivers are to be trained to be considerate of surrounding receivers and drive appropriately.

11 OPERATIONAL NOISE ASSESSMENT

11.1 Noise Prediction Methodology

Noise emission prediction was completed using the CadnaA noise modelling software, which takes into account attenuation factors such as: geometric spreading, shielding by barriers and topography, and atmospheric absorption.

Predictions involved assuming a number of vehicle movements per floor in a 15-minute period and the resulting reverberant level within that floor. A noise breakout calculation was then completed to determine the area noise source level which would propagate to nearby receivers. Traffic input was provided by Seca Solution Pty Ltd and is follows:

- The car park would generate 200 movements inbound in the morning and 200 movements outbound in the evening.
- Morning movements expected to be predominantly between 6.30am to 8.30am.
- Approximately 45% of movements (90) would occur during the morning peak (7am-8am).
- Little to no movements between 9.30am and 4pm.
- Evening movements expected to be predominantly between 4pm to 7pm.
- Approximately 35% of movements (70) would occur during the evening peak (5.45pm-6.45pm), for the purpose of this assessment the evening peak will be between 6pm-7pm.

Based on the information provided, **Table 11-1** presents the hours and movements used in the assessment.

Table 11-1 Hourly Traffic Movements Generated by the Car Park

Period	Maximum Movements per Hour
Early Morning (6am-7am)	20
Morning Peak (7am-8am)	90
Evening Peak (6pm-7pm)	70
Evening (7pm-10pm)	20

- One movement consists of one vehicle either entering or exiting the car park to a parking spot.
- Sound Power Level for one vehicle movement of L_{Aeq} 64 dBA per floor.
- Vehicle movements are evenly spaced throughout the hour.

Noise measurements from recently completed car parks indicated that even with a textured car park finish, individual driver behaviour can result in wheel squeal which would increase noise levels depending on the number and duration of wheel squeal events. To account for this behaviour, the predicted noise levels are shown with and without wheel squeal.

It is expected that the increase in noise levels as a result of wheel squeal would range from 1-4 dBA. A 1 dBA increase would occur if either the textured surface is not maintained OR the proportion of vehicles exhibiting this behaviour is approximately 25%. A 4 dBA increase is expected where the textured surface is not well maintained AND approximately 25% of the vehicles exhibit the behaviour.

11.2 Predicted Noise Levels at Residential Receivers

Table 11-2 and **Table 11-3** presents the predicted best case ("3-Below") and worst case ("5-Above") noise levels from the operation of the proposed car park during the busiest hour in each period of the day. The relevant intrusiveness noise trigger levels (as identified in **Table 7-1**) are also presented for reference. The table identifies the residential receivers (as mapped in **Figure 2-2**) and the predicted noise levels likely to occur at each receiver.

The predicted levels with 4 dB of squeal are shown in brackets. The predictions also consider the different receiver floor levels at receiver R07 which is a residential flat building at 6 Edgbaston Road (ground Floor GF and second floor 2F). Exceedances are presented in **BOLD**.

Table 11-2 Predicted Operational Intrusiveness Noise Levels for "3-Below", $L_{Aeq,15min}$ dBA

Receiver	Early Morning	Morning Peak	Evening Peak	Evening
Intrusiveness Trigger Level	49	49	52	48
R01	34 (38)	41 (45)	40 (44)	34 (38)
R02	37 (41)	43 (47)	42 (46)	37 (41)
R03	40 (44)	47 **(51)**	46 (50)	40 (44)
R04	38 (42)	45 (49)	44 (48)	38 (42)
R05	38 (42)	45 (49)	44 (48)	38 (42)
R06	38 (42)	45 (49)	44 (48)	38 (42)
R07 N GF	39 (43)	45 (49)	44 (48)	39 (43)
R07 N 3F	42 (46)	49 **(53)**	48 (52)	42 (46)
Intrusiveness Trigger Level	49	51	55	51
R07 E GF	37 (41)	43 (47)	42 (46)	37 (41)
R07 E 3F	41 (45)	48 **(52)**	46 (50)	41 (45)

Table 11-3 Predicted Operational Intrusiveness Noise Levels for "5-Above", $L_{Aeq,15min}$ dBA

Receiver	Early Morning	Morning Peak	Evening Peak	Evening
Intrusiveness Trigger Level	49	49	52	48
R01	46 **(50)**	**53 (57)**	52 **(56)**	46 **(50)**
R02	49 **(53)**	**55 (59)**	**54 (58)**	**49 (53)**
R03	48 (52)	**54 (58)**	**53 (57)**	48 **(52)**
R04	40 (44)	47 **(51)**	46 (50)	40 (44)

Receiver	Early Morning	Morning Peak	Evening Peak	Evening
R05	41 (45)	47 **(51)**	46 (50)	41 (45)
R06	41 (45)	48 **(52)**	46 (50)	41 (45)
R07 N GF	41 (45)	48 **(52)**	47 (51)	41 (45)
R07 N 3F	44 (48)	50 **(54)**	49 **(53)**	44 (48)
Intrusiveness Trigger Level	49	51	55	51
R07 E GF	39 (43)	45 (49)	44 (48)	39 (43)
R07 E 3F	42 (46)	49 **(53)**	47 (51)	42 (46)

Table 11-2 indicates that the operational noise level from the "3-Below" car park is expected to comply with the intrusiveness trigger level at all receivers. Where wheel squeal is not managed, exceedances of up to 4 dB could be expected at the closest or elevated receivers during the peak morning period. Outside of the peak periods, the operational noise level with and without wheel squeal is generally expected to comply with the intrusiveness noise level.

Table 11-3 indicates that the operational noise level from the "5-Above" car park is expected to exceed the residential receivers to the west during the peak periods. Exceedances of up to 6 dB could be expected, and up to 10 dB where wheel squeal is not managed. Noise levels at the receivers to the south are expected to comply with the intrusiveness noise trigger level, with exceedances of up to 5 dB if wheel squeal is not managed. Outside of peak periods, the noise levels are generally expected to comply, with marginal exceedances of 1 dB where the car park overlooks the receiver.

This change in operational noise would be expected given that Melvin St and Edgbaston Road receivers are located within 2 m and 12 m of the boundary of the proposed car park, respectively.

As usage of the commuter car park would be concentrated within the peak periods, an amenity assessment was completed to understand the received noise levels for each of the daytime, evening, and night assessment periods. **Table 11-4** and **Table 11-5** summarises these results with the applicable amenity criteria with exceedances shown in bold. Over extended periods the influence of wheel squeal (shown in brackets) is considered to be 2 dBA.

Table 11-4 Predicted Operational Amenity Noise Levels for "3 Below", $L_{Aeq,Period}$ dBA

Receiver	Day	Evening	Night
Amenity Trigger Level	55	45	40
R01	36 (38)	35 (37)	25 (27)
R02	38 (40)	37 (39)	27 (29)
R03	42 (44)	41 (43)	31 (33)
R04	40 (42)	39 (41)	29 (31)

Receiver	Day	Evening	Night
R05	40 (42)	39 (41)	29 (31)
R06	40 (42)	39 (41)	29 (31)
R07 E GF	38 (40)	37 (39)	27 (29)
R07 E 2F	42 (44)	41 (43)	32 (34)
R07 N GF	40 (42)	39 (41)	29 (31)
R07 N 2F	44 (46)	43 (45)	33 (35)

Table 11-5 Predicted Operational Amenity Noise Levels for "5-Above", $L_{Aeq,Period}$ dBA

Receiver	Day	Evening	Night
Amenity Trigger Level	55	45	40
R01	47 (49)	**47 (49)**	37 (39)
R02	50 (52)	**49 (51)**	39 **(41)**
R03	49 (51)	**48 (50)**	38 (40)
R04	42 (44)	41 (43)	31 (33)
R05	42 (44)	41 (43)	31 (33)
R06	42 (44)	41 (43)	31 (33)
R07 E GF	40 (42)	39 (41)	29 (31)
R07 E 2F	43 (45)	42 (44)	33 (35)
R07 N GF	42 (44)	42 (44)	32 (34)
R07 N 2F	45 (47)	44 **(46)**	34 (36)

Table 11-4 indicates that the operation of the "3-Below" car park will comply during all periods with and without the influence of wheel squeal.

Table 11-5 indicates that the operation of the "5-Above" car park will comply in the day and night periods. During the evening period, exceedances of up to 4 dB could be expected at the residential receivers to the west. Exceedances at these receivers could be up to 6 dB if wheel squeal is not managed.

The predicted evening $L_{Aeq,Period}$ levels are generally less than the measured $L_{Aeq,Period}$ at monitoring Location L01 (56 dBA during the peak hours of 5.00pm-7.00pm, and 53 dBA between 7.00pm and 10.00pm). The existing L_{Aeq} level at this location would be dominated by the nearby road traffic noise along King Georges Road, as usage of the existing car park, and passing trains in the rail corridor. It is expected that the "5-Above" car park would shield the residential receivers to the west from some of the road traffic noise along King Georges Road. Ultimately, the noise levels from the operation of the "5-Above" car park during the evening period may be

comparable to existing noise levels experienced by the surrounding receivers and so marginal impacts could be expected.

11.3 Predicted Noise Level at Non-Residential Receivers

Table 11-6 below presents the predicted noise level at the nearest non-residential receivers. The levels indicate that the levels are expected to comply with the Project Noise Trigger Level for all periods.

Table 11-6 Predicted Noise Level at Non-Residential Receivers, $L_{Aeq,15min}$ dBA

Receiver	Scenario	Day	Evening	Night	Project Noise Trigger Level
C01	3 Below	52 (56)	51 (55)	45 (49)	63
	5 Above	60 (64)	59 (63)	54 (58)	
E01	3 Below	29 (33)	-	-	45
	5 Above	34 (38)	-	-	

11.4 Sleep Disturbance Assessment

Typical maximum noise level associated with car park usage includes closing of doors, engine starts and car acceleration. An L_{max} sound power level of 95 dBA has been assumed for these events. Predictions have been completed for typical levels, where cars are parked in nearby spaces, and highest levels, where cars are parked in the closest space to the residential receiver.

Whilst a sound power level range of 95-105 dBA is typical, a sound power level of 103 dBA has been assumed for wheel squeal events occurring at the top and bottom of ramps. A summary of predicted levels is presented in **Table 11-7**.

Table 11-7 Predicted L_{Amax} Noise Levels for Sleep Disturbance

Receiver	Predicted Noise Level		Screening Criteria Night
	Car Park Operations	Wheel Squeal	
R01	**57 – 64**	**58 – 65**	52
R02	**57 – 66**	**58 – 69**	52
R03	**56 – 62**	**56 – 68**	52
R04	**56 – 60**	**58 – 61**	52
R05	**56 – 61**	**59 – 61**	52
R06	**57 – 61**	**60 – 62**	52
R07 E GF	**53 – 55**	**60 – 62**	52
R07 E 2F	**57 – 60**	**62 – 70**	52

The predicted levels indicate that short term noise events have the potential to exceed the L_{Amax} criteria for sleep disturbance for all receivers. Noise levels are predicted to be higher than the existing car park as some of the receivers would no longer receive shielding from the boundary fence due to the elevation of the new structure. In addition, wheel squeal events are predicted to also exceed criteria.

The additional guidance relating to potential sleep disturbance impacts contained in the NSW *Road Noise Policy* (*RNP*) was reviewed to quantify the significance of the potential residual exceedance of the sleep disturbance screening levels at the residential receivers.

According to the *RNP*, research on sleep disturbance indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on currently available research results, the RNP concludes that:

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

Based on the predicted external levels, internal noise levels of around 43 dBA to 60 dBA can be expected within the most exposed dwellings with windows open. Additionally, no significant change in the number of night events is expected given night-time use is predicted to be similar to the existing car park, as commuter movements primarily occur during the daytime. On this basis, sleep disturbance appears unlikely.

11.5 Mechanical Plant

Mechanical plant services and design has not been completed at this stage. The plant should be designed such that it doesn't measurably increase other operational noise from the car park. Considerations must be made such that the cumulative noise emissions from mechanical plant and other operational noise sources do not exceed the project noise trigger level.

If the proposed car park is to include basement levels, mechanical ventilation would be required to supply fresh air to the basement levels. It recommended that all supply and exhaust points be located on the northern façade, facing the rail corridor. These louvres should be located towards the north-east as to be as far away from the residential receivers as possible. The placement of these louvres and standard attenuation measures such as silencers would be sufficient to meet noise trigger levels at all sensitive receivers, including E01 opposite the rail corridor.

The car park would include a lift to service commuters between floors. Operation of a typical lift motor would expect a sound power level of approximately 75 dBA. There would be sufficient opportunity to locate the lift such that noise from the operation of the lift at the receivers would be shielded by the car park structure and most likely be inaudible and satisfy the recommended criterion.

11.6 Mitigation

The following noise mitigation measures could be implemented and considered during detailed design where they are considered feasible and reasonable:

- Ensuring a textured car park finish is provided, particularly where turning movements occur at the ramps and entry/exit locations.
- Including traffic calming device to control speed within the car park.
- Speedbumps should be maintained for fully concrete rather than metal which may loosen over time and generate noise when driven over.
- Similarly, any drain grates should be maintained to minimise noise from vehicles driving over.
- Stairwell doors should implement soft closing to prevent door slamming.
- Include prominent signage on the ramps to manage speed and limit wheel squeal as the car park adjoins residences.
- Acoustically absorbent material be installed on the soffit of each level of the car park for at least 5 m around the perimeter to the south and west. This would achieve approximately a 2-3 dBA reduction in noise at receivers in these directions.
- Reducing the size of opening at the edge of the car park, using acoustic louvres or sealing some or all of the facades facing residential receivers, particularly at the closest locations to bedrooms. Fully enclosing the southern and western walls on levels 2 and above could result in reductions of up to 8 dB at the nearest receivers. The attenuated noise levels at the receiver would comply with the intrusiveness noise trigger level. However, these measures are likely to require mechanical ventilation if the free area isn't sufficient for natural ventilation.

12 CONCLUSION

RWDI Australia has completed a noise and vibration assessment for the proposed multi-storey car park and associated works at an existing surface level Council car park in Beverly Hills. The assessment covers operational and construction aspects of the proposal.

Construction noise and vibration has been assessed and noise levels are predicted to exceed the Noise Management Levels for much of the construction period. Exceedances are mostly due to the close proximity of the construction activity to adjoining residential receivers. In addition, for a small proportion of the work, when plant is adjacent to the boundary, noise levels are predicted to exceed the "Highly Affected" 75dBA limit.

As construction would be carried out during standard hours, there are no specific mitigation measures applicable to this site beyond the standard measures discussed in the Construction Noise and Vibration Strategy. Additional mitigation measures are outlined in Section 8.3.

If out-of-hours work is required, a separate approval must be sought, and further mitigation measures considered in accordance with the *CNVS*.

Only minimal vibration is expected to be generated from detailed excavation and bored piling. The location of these vibration intensive activities should be reviewed against the recommended setback distances outlined in **Table 9-1** of this report. Where vibration activities are expected to occur within these setback distances, additional vibration mitigation and measures should be implemented as recommended in 9.2 of this report. Additionally, no vibration intensive activity is to occur within 3 m of the APA gas main.

The operational noise assessment determined that noise emissions from a "3-Below" car park is expected to meet the noise trigger levels stipulated in the NSW *NPfI*. For the "5-Above" car park, noise levels may exceed the relevant trigger levels during the peak periods at the closest receivers. Outside of peak hours, the noise emissions are expected to comply or marginally exceed at the elevated receivers.

It is predicted the proposal would also generate additional traffic on the surrounding road network. The increases have been assessed in accordance with the EPA *Road Noise Policy* and are less than 0.2dB. Negligible impact is therefore expected.