RAPT CONSULTING

NGH

Noise and Vibration Assessment, Revesby Commuter Car Park Expansion - November 2020

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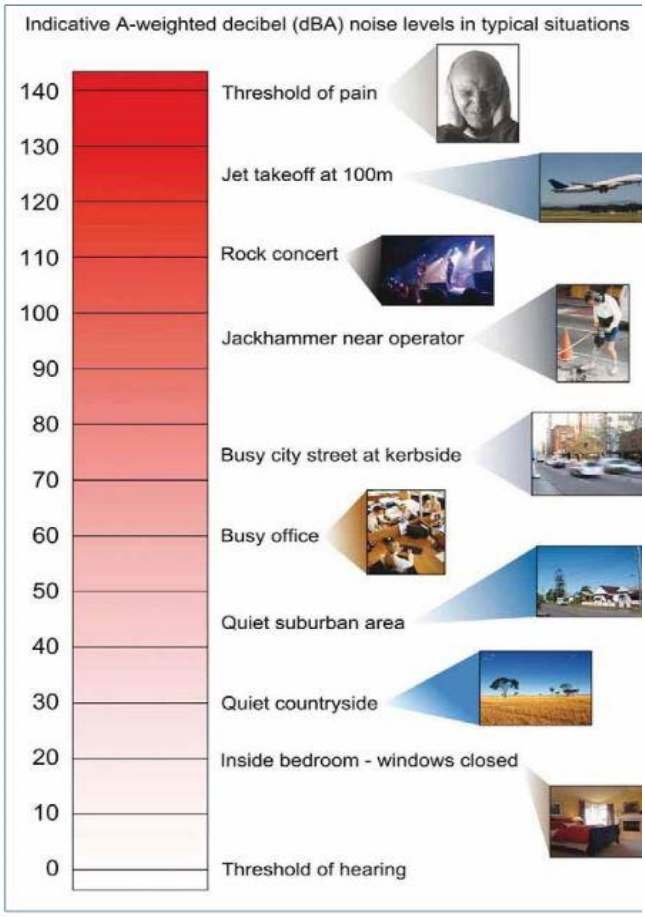
Glossary of Acoustic Terms

Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics. The picture below indicates typical noise levels from common noise sources. 
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A10(period)}$	The sound pressure level that is exceeded for 10% of the measurement period.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90% of the measurement period.
L_{Amax}	The maximum sound level recorded during the measurement period.
Noise sensitive receiver	An area or place potentially affected by noise which includes:

	A residential dwelling. An educational institution, library, childcare centre or kindergarten. A hospital, surgery or other medical institution. An active (e.g. sports field, golf course) or passive (e.g. national park) recreational area. Commercial or industrial premises. A place of worship.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
Feasible and Reasonable (Noise Policy for Industry Definition)	**Feasible** mitigation measure is a noise mitigation measure that can be engineered and is practical to build and/or implement, given project constraints such as safety, maintenance and reliability requirements. Selecting **Reasonable** measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure. To make a judgement, consider the following: Noise impacts Noise mitigation benefits Cost effectiveness of noise mitigation Community views.
Sound power level (SWL)	The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in dB(A).

1. Executive Summary

The NSW Government recognises the important role Commuter Car Parks (CCPs) continue to play in improving the quality of access to public transport in the customer's first and last mile. The provision of CCP's increase public transport patronage and make public transport more accessible to all customers. This is particularly important in lower-density areas, where it is both expensive and challenging to provide frequent bus services and ensure access to transport for the elderly or people with a disability.

The NSW Government has committed to the provision of up to an additional 385 commuter car spaces at Revesby.

The Proposal is to construct an additional two floors on the western side and three floors on the eastern side over the existing Multi-Storey Car Park (MSCP) building within the Revesby Station precinct. This will provide up to an additional 385 commuter car parking spaces with a total of 964 commuter car park spaces

This noise and vibration impact assessment forms part of the Review of Environmental Factors (REF) which assesses the potential impacts of the Proposal on the environment. Relevant guidelines and assessment procedures have been followed to ensure all applicable State requirements have been considered.

A survey has been undertaken of the existing conditions in the Proposal area. Background noise levels have been monitored at a representative location to identify the existing noise environment in the Proposal area. The existing noise environment allows this assessment to establish appropriate noise criteria.

A construction noise impact assessment has been conducted with consideration to the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) and *Construction Noise and Vibration Strategy* (CNVS) (TfNSW, 2019). Reasonable worst-case construction scenarios have been assessed. Construction of the Proposal is expected to occur during standard construction hours. However out of hours scenarios have also been assessed.

The assessment of noise associated with the construction of the Proposal indicates some exceedances of the ICNG noise management levels at the most affected sensitive receivers. Exceedances of the noise management levels occur during the day and night at the most affected sensitive receivers during certain activities. The magnitude of these impacts is consistent with similar construction projects and highlights the need for effective noise mitigation and management planning.

Measures have been recommended to mitigate the construction noise impacts at adjacent sensitive receivers. Specific noise management and mitigation measures would be detailed in the contractor's Construction Noise and Vibration Management Plan.

Minimum working distances for vibration intensive construction works have been presented. Equipment size would be selected by the contractor taking into account the minimum working distances and the distance between the construction works and the most affected sensitive receiver. If works need to be undertaken within minimum working distances, vibration monitoring would be undertaken.

An assessment of the likely construction and operational traffic indicated that the noise increases along construction and operational traffic routes are predicted to be well below the

2 dB(A) increase screening criteria. Therefore, no further assessment is required with consideration to the Environment Protection Authority's *NSW Road Noise Policy* (RNP) (DECCW 2011).

An operational noise assessment for the MSCP facility has been completed with consideration to the Environment Protection Authority's *NSW Noise Policy for Industry* (NPfI), 2017. The results of the assessment indicated maximum noise level events have the potential to exceed project noise trigger levels. A set of management and mitigation measures has been provided to address these maximum noise level events.

2. Introduction

2.1 Background

RAPT Consulting has been engaged to undertake a construction and operational Noise and Vibration Impact Assessment (NVIA) for NGH as part of a Review of Environmental Factors for the proposed Multi-Storey Car Park (MSCP) expansion at Revesby.

2.2 Purpose

The purpose of this NVIA is to assess potential noise and vibration from the proposal and to recommend mitigation measures where required.

The outcomes of this assessment include recommendations for potential noise and vibration mitigation and management measures designed to achieve an acceptable noise amenity for residential (dwelling) occupants and other sensitive receivers surrounding the proposal site.

2.3 Scope

The NVIA scope of work included:

- Initial desk top review to identify key environmental noise catchment areas and noise sensitive receptors from aerial photography
- Undertake noise measurements for to determine ambient and background noise levels
- Establish project specific noise goals for the construction and operation of the proposed project
- Identify the likely principal noise sources during construction and operation, and their potential impacts on noise receptors
- undertake noise modelling to predict noise levels that may occur as a result of the construction of the proposal at the closest and/or potentially most affected receivers
- providing a comparison of predicted noise levels (and likely vibration events) to the construction NMLs and construction vibration objectives
- assessment of potential impacts associated with construction noise and vibration; operational noise and sleep disturbance aspects of the proposal, and
- provide recommendations (to be implemented by TfNSW to manage impacts) for feasible and reasonable noise and vibration mitigation and management measures, where NMLs or vibration objectives may be exceeded.

2.4 Proposal Description

The proposal is to add additional levels onto the existing Revesby Station MSCP. This MSCP is a split-level structure (five levels on one side and four levels on the other) with a total of 714 spaces of which 579 are designated as all day (unrestricted) parking spaces. The proposal is to construct two additional levels on the eastern side of the MSCP and three additional levels

on the western side. This will provide an additional 385 parking bays, all of which are understood to be designated as all day (unrestricted) parking bays. The total parking provision after constructing the additional levels would therefore be 1,099 bays of which 964 would be all-day parking spaces.

The existing MSCP is located approximately 150 m north of Revesby Station in an area bounded by River Road to the east, Haydock Lane to the south and Simmons Street to the west. The main shopping centre in the area is Revesby Village Centre, which is situated immediately south of the station entry. There are also local retail strips to the north of the station along Marco Avenue and Selems Parade. The MSCP at Revesby is zoned as a SP2 Road Infrastructure Facility, B2 Local Centre and R2 Low Density Residential. The majority of the sites around the station have local centre and low-density residential use.

The project site and surrounding area is shown in Figure 1.

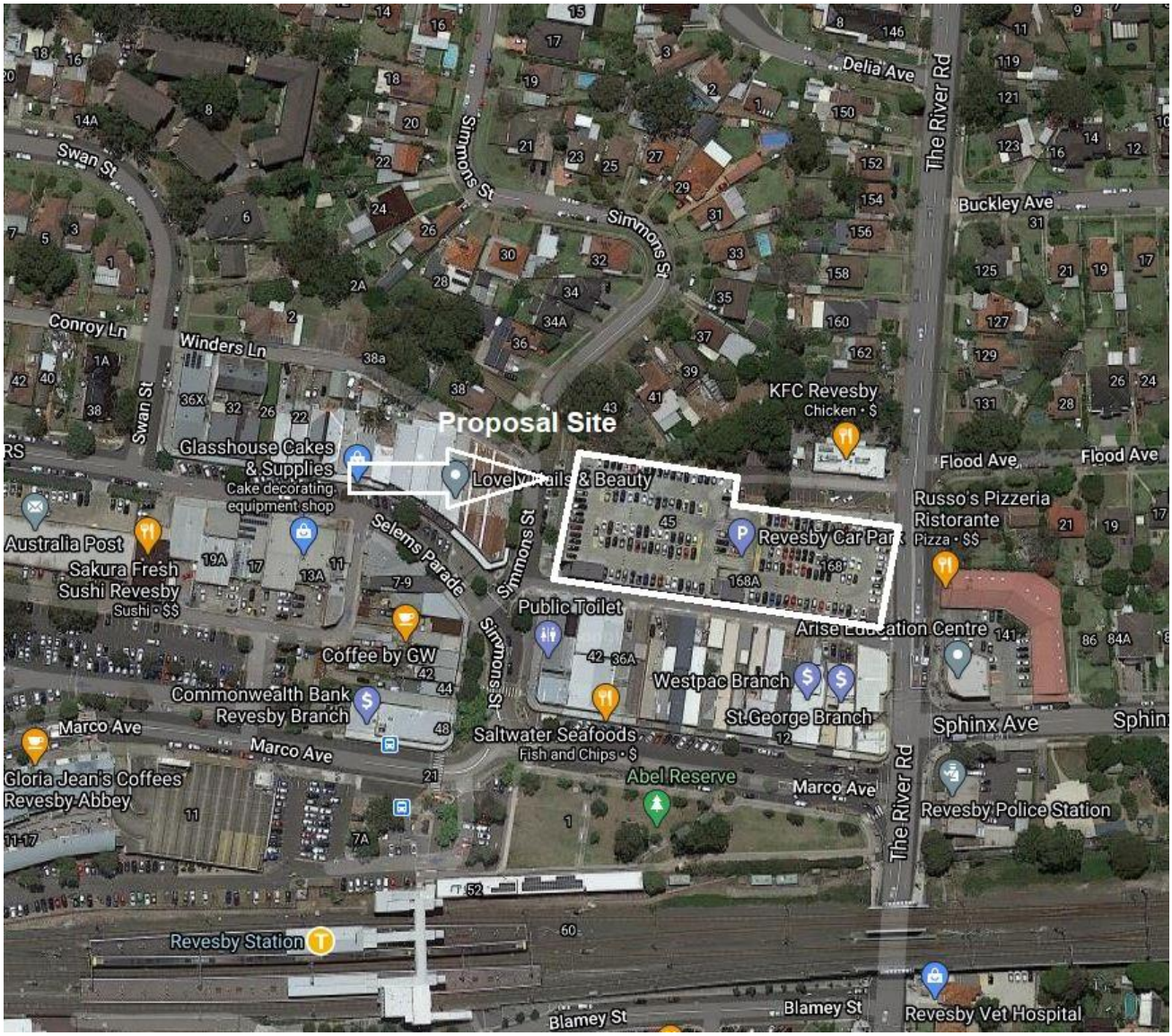


Figure 1 Site and Surrounding Area

This assessment has been undertaken with consideration to:

- TfNSW *Construction Noise and Vibration Strategy*, v4 (TfNSW, 2019)

- TfNSW *Construction Noise and Vibration Strategy*, v4 Addendum Nov 2019 (TfNSW, 2019)
- *Road Noise Policy* (RNP, DECCW, 2011)
- *Noise Policy for Industry* (NPfI) (NSW EPA, 2017)
- *Interim Construction Noise Guideline* (ICNG) (NSW DECC, 2009)
- *Noise Criteria Guideline / Noise Mitigation Guideline* (NMG, RMS, 2015)
- *Environmental Noise Management Manual* (ENMM, RTA, 2001)
- German Standard DIN 4150, Part 3: *Structural Vibration in Buildings: Effects on Structures*
- British Standard BS *7385 Part 2-1993 Evaluation and measurement for vibration in buildings*
- *Assessing Vibration: A Technical Guideline* (DECC, 2006).

2.5 Limitations

The purpose of the report is to provide an independent noise assessment for the proposal.

It is not the intention of the assessment to cover every element of the acoustic environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the noise assessment represent the findings apparent at the date and time of the assessment undertaken. It is the nature of environmental assessments that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

In conducting this assessment and preparing the report, current guidelines for noise and vibration were referred to. This work has been conducted in good faith with RAPT Consulting's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other uses.

3. Existing Environment

3.1 Ambient Noise Environment

To establish background and ambient noise levels, noise monitoring was undertaken from 27 October to 02 November 2020. The monitoring was undertaken at 41 Simmons Street, Revesby. This location was selected as it was considered indicative and representative of the background and ambient noise environment at the nearest potentially affected receptors for the project. This site also presented as a secure location whereby minimising the risk of theft or vandalism to the monitoring equipment.

During site visits it was noted that existing road traffic, light aircraft, wildlife (birds) and an underlying urban "hum" primarily described the ambient noise environment and is indicative of an urban area. The monitoring location is shown in Figures 2 and 3.

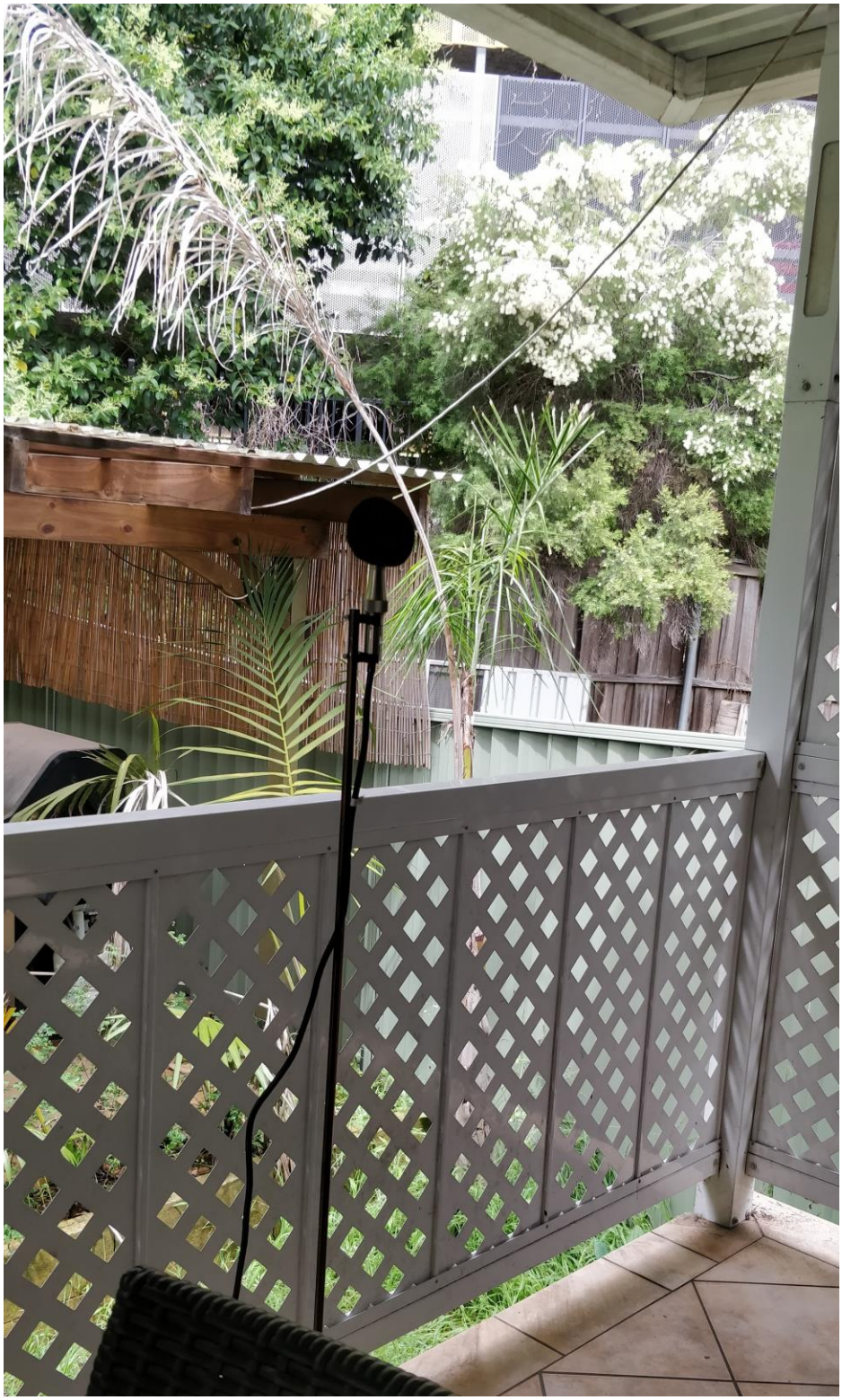


Figure 2 Noise Monitoring Location, Existing MSCP in the Background

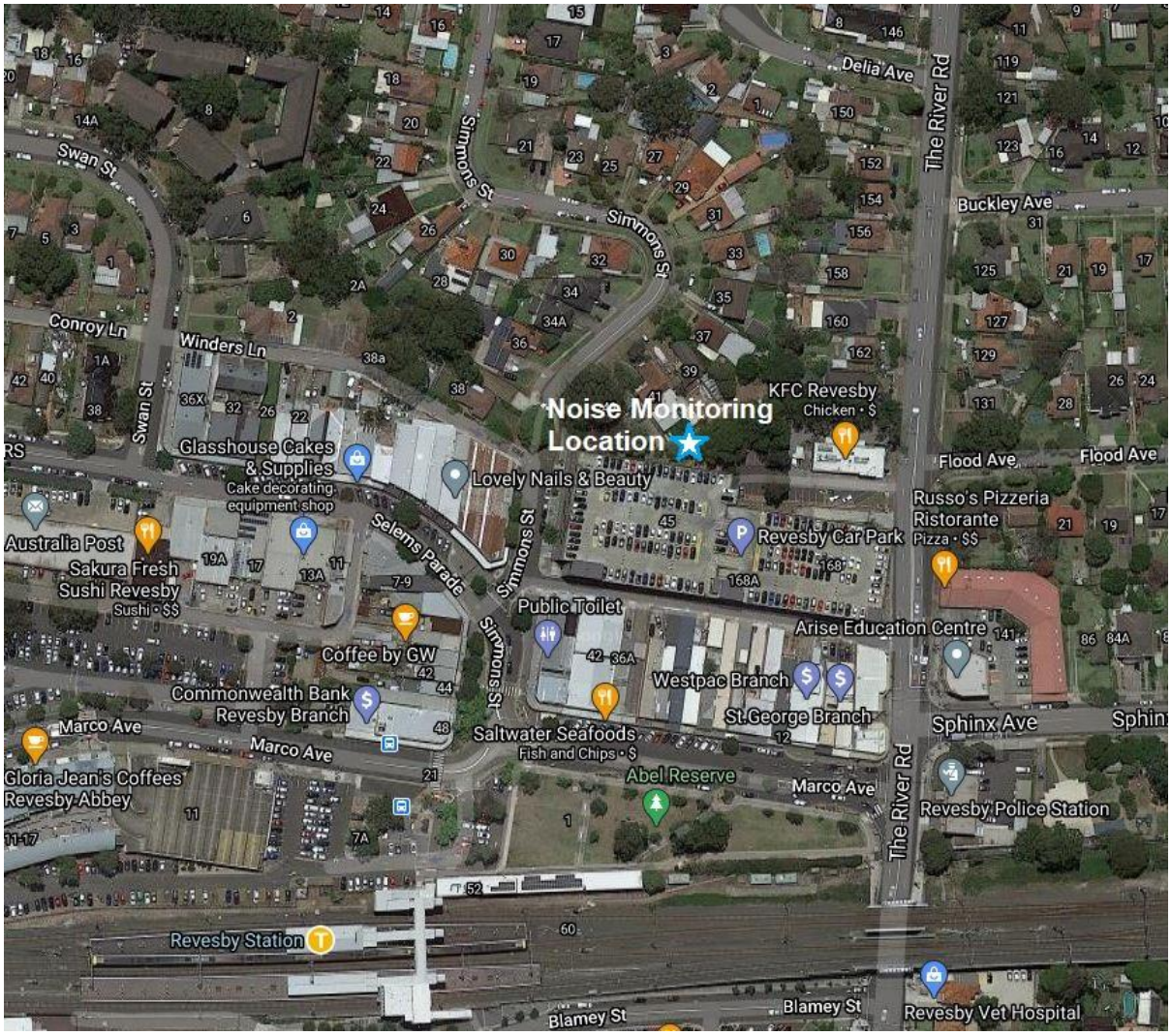


Figure 3 Noise Monitoring Location

Monitoring was undertaken using an RION NL-42 noise logger with Type 2 Precision. Calibration was checked prior to and at the conclusion of the measurements with no significant drift. These loggers are capable of measuring continuous sound pressure levels and are able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

The L_{A90} descriptor is used to measure the background noise level. This descriptor represents the noise level that is exceeded for 90 per cent of the time over a relevant period of measurement. In line with the procedures described in the EPA's NPfI, the assessment background level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration. The RBL is representative of the average minimum background sound level, or simply the background level.

The L_{Aeq} is the equivalent continuous noise level which would have the same total acoustic energy over the measurement period as the varying noise actually measured, so it is in effect an energy average.

Logged data was reviewed and filtered to exclude any extraneous data during the monitoring period. Weather information for the unattended noise logging was obtained from the Bureau of Meteorology, Bankstown weather station for the monitoring period. Any data adversely affected by rain or wind (more than 5 m/s as per NPfI) was discarded. Noise monitoring graphs are provided in Appendix A.

The RBL and ambient L_{Aeq} levels are provided in **Error! Reference source not found.** below.

Table 1 Background and Ambient Noise Monitoring Results

Address	Rating background level, L_{A90}, dB(A)			Ambient noise levels, L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
41 Simmons Street	43	40	33	52	57	49

Note 1 Day: 7:00 to 18:00 Monday to Saturday and 8:00 to 18:00 Sundays & Public Holidays , Evening: 18:00 to 22:00 Monday to Sunday & Public Holidays , Night: 22:00 to 7:00 Monday to Saturday and 22:00 to 8:00 Sundays & Public Holidays

Operator attended measurements were also conducted on 2 November 2020 to supplement the noise data. Measurements were conducted using a RION NL-42 Sound Level Meter with Type 2 Precision. The measurements were undertaken with consideration to AS 1055-1997, "*Acoustics – Description and measurement of Environmental Noise*." The acoustic instrumentation employed during the monitoring complies with the requirements of AS 1259.2 – 1990, "*Sound Level Metres*" and is within current calibration. Calibration was checked before and after the measurements with no significant drift.

The attended noise measurement results are provided in Table 2 below.

Table 2 Summary of Measured Noise Levels 2 November 2020

Location	Noise Period	Noise Level dB(A)		Noise Sources SPL dB(A)
		$L_{Aeq(15min)}$	$L_{A90(15min)}$	
41 Simmons Street	11:30-11:45am	52	47	Car Pass-by 50 -54 Light Aircraft 56 Birds 45 - 55

4. Noise and Vibration Objectives

4.1 Construction Noise

Construction noise is assessed with consideration to DECCW *Interim Construction Noise Guidelines* (ICNG) (July 2009). The ICNG is a non-mandatory guideline that is usually referred to by local councils and other NSW government entities when construction / demolition works require development approval. The ICNG recommend standard hours for construction activity as detailed in Table 3.

Table 3 ICNG Recommended Construction Hours

Work type	Recommended standard hours of work
Normal construction	Monday to Friday: 7 am to 6 pm. Saturday: 8 am to 1 pm. No work on Sundays or Public Holidays.

The ICNG provides noise management levels for construction noise at residential and other potentially sensitive receivers. These management levels are to be calculated based on the adopted rating background level (RBL) at nearby locations, as shown in Table 4.

Table 4 Recommended Construction Noise Management Levels

Period	Management Level $L_{Aeq(15\ min)}$
Residential Recommended standard hours	Noise affected level: RBL + 10 Highly noise affected level: 75 dB(A)
Residential Outside recommended standard hours	Noise affected level: RBL + 5
Classrooms at schools and other educational institutions	Internal Noise Level 45 dB(A) (applies when properties are being used)
Hospital wards and operating theatres	Internal Noise Level 45 dB(A) (applies when properties are being used)
Places of worship	Internal Noise Level 45 dB(A) (applies when properties are being used)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)

Period	Management Level $L_{Aeq(15\ min)}$
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Offices, retail outlets	70 dB(A)

The above levels apply at the boundary of the most affected residences / offices or within 30 m from the residence where the property boundary is more than 30 m from the residence.

The *noise affected level* represents the point above which there may be some community reaction to noise. Where the *noise affected level* is exceeded all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. The *noise affected level* is the background noise level plus 10 dB(A) during recommended standard hours and the background noise level plus 5 dB(A) outside of recommended standard hours.

The *highly noise affected level* represents the point above which there may be strong community reaction to noise and is set at 75 dB(A). Where noise is above this level, the relevant authority may require respite periods by restricting the hours when the subject noisy activities can occur, considering:

- Times identified by the community when they are less sensitive to noise (such as 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.

It is understood most works required for the proposal would be undertaken during standard construction hours. Based on the above and the RBL's established from site monitoring construction noise management levels for residential receivers have been derived, as shown in Table 5. Approval from Transport for NSW would be required for any out of hours work and the affected community would be notified as outlined in Transport for NSW's *Construction Noise and Vibration Strategy*.

Table 5 Construction Noise Management Levels dB(A) Leq(15min)

Period	RBL L_{A90}, dB(A)	Standard hours noise management levels,$L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels,$L_{Aeq,15min}$, dB(A)
Day	43	53	48
Evening	40	-	45
Night	33	-	38

4.2 Construction Sleep Disturbance

The ICNG requires a sleep disturbance assessment to be undertaken where construction works are planned to extend over more than two consecutive nights. The ICNG makes reference to the EPA's NSW *Environment Criteria for Road Traffic Noise* (ECRTN), now superseded by the NSW RNP, for the assessment of sleep disturbance. The RNP references the recommendations in the ECRTN as providing the most appropriate assessment guidance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10pm to 7am), the $L_{A1(1\ min)}$ noise level outside a bedroom window should not exceed the $L_{A90(15\ min)}$ background noise level by more than 15 dB(A). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken that should include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, 'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'. Therefore, given that an open window provides around 10 dB(A) in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions. While construction is expected to take place during standard hours, sleep disturbance is not expected to be an issue. However, there may be some out of hours works to ensure the car park is empty and minimize disruption to commuter Therefore, for the construction of the proposal, an assessment of sleep disturbance has been undertaken and construction sleep disturbance assessment levels are presented in Table 6.

Table 6 Construction Noise Sleep Disturbance Assessment Levels

Night-time rating background level, dB(A)	Sleep disturbance screening $L_{A1(1min)}$ criteria, dB(A)	Sleep disturbance awakening reaction $L_{A1(1min)}$ criteria, dB(A)
33	48	60

4.3 Construction Road Traffic

Noise from construction traffic on public roads is not covered by the ICNG. However, the ICNG does refer to the ECRTN, which is now superseded by the RNP, for the assessment of noise relating to construction traffic on public roads.

To assess noise impacts from construction traffic, an initial screening test is undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

Trucks accessing the MSCP would be required to approach from the north via The River Road, Bransgrove Road, Polo Street, Swan Street and Winders Lane. No construction access is proposed via the eastern entry to the MSCP from The River Road.

Trucks leaving the site would do so via Simmons Street followed by Haydock Lane and then The River Road from where they would travel northbound. Right turns from Haydock Lane onto The River Road to travel southbound would not be permitted (there is appropriate signage and a median in place at this location on The River Road to prevent this right turn).

Winders Lane and Haydock Lane provide access to the back entrances to a number of shops. It is recommended that a Traffic Management Plan be prepared by the selected construction contractor prior to construction to address this matter by notifying any affected businesses along Winders Lane and Haydock Lane and coordinating activities with those businesses. Access restrictions to businesses on Winders Lane and Haydock Lane would only be intermittent and consultation would be required with businesses to assess the impacts.

Deliveries to and from the site will peak at 50 trucks per day during the concrete pours and will be spread evenly throughout the day (six-seven trucks per hour). This is considered negligible and is not expected to increase existing road traffic noise levels at receivers along the route. Furthermore, the proposal is not expected to generate a significant increase in vehicles on the surrounding road network.

4.4 Vibration Guidelines

Vibration during construction and operational activity is expected to primarily originate from trucks and machinery during stages of construction and activities. RAPT Consulting also understand that blasting and heavy ground impact activities is not expected to occur during the construction works.

4.4.1 Human Exposure

Vibration goals during the were sourced from the DECCW's *Assessing Vibration: a technical guideline*, which is based on guidelines contained in British Standard (BS) 6472–1992, *Evaluation of human exposure to vibration in buildings (1–80 Hz).*

Intermittent vibration is assessed using the vibration dose value (VDV), fully described in BS 6472 – 1992. Acceptable values of vibration dose are presented in Table 7.

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

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

4.5 Building Damage

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to the following International Standards and Guidelines:

- British Standard BS7385.2 - 1993 *Evaluation and Measurement for Vibration in Buildings*, Part 2 - Guide to damage levels from ground borne vibration; and
- German Standard DIN 4150-3: 1999-02 *Structural Vibration – Part 3*: *Effects of vibration on structures*.

DIN 4150-3: 1999-02 is utilised in this case in the assessment of potential building damage resulting from ground borne vibration produced by the proposed activity.

The recommended Peak Particle Velocity (PPV) guidelines for the possibility of vibration induced building damage are derived from the minimum vibration levels above which any damage has previously been encountered and are presented in Table 8.

Table 8 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20-40	40-50	40
Dwellings and buildings of similar design and/or occupancy	5	5-15	15-20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 of table 5-7 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Ground Vibration – Minimum Working Distances from Sensitive Receivers

The Transport for NSW *Construction Noise and Vibration Strategy* (CNVS) provides guidance for minimum working distances. As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 9. The minimum distances are quoted for both "cosmetic" damage (refer BS 7385) and human comfort (refer OH&E's *Assessing Vibration - a technical guideline*). DIN 4150 has criteria of particular reference for heritage structures.

Table 9 Recommended Minimum Safe Working Distances for Vibration Intensive Plant from Sensitive Receiver

Plant Item	Rating / Description	Minimum Distance Cosmetic Damage		Minimum Distance Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1-2 tonne)	5m	11m	15m to 20m
	<100 kN (2-4 tonne)	6m	13m	20m
	<200 kN (4-6 tonne)	12m	15m	40m
	<300kN (7-13 tonne)	15m	31m	100m
	>300kN (13-18 tonne)	20m	40m	100m
	>300kN (>18 tonne)	25m	50m	100m
Small Hydraulic Hammer	300kg (5 to 12 t excavator)	2m	5m	7m
Medium Hydraulic Hammer	900kg (12 to 18 t excavator)	7m	15m	23m
Large Hydraulic Hammer	1600kg (18 to 34 t excavator)	22m	44m	73m
Vibratory Pile Driver	Sheet Piles	2m to 20m	5m to 40m	20m
Pile Boring	≤ 800mm	2m (nominal)	5m	4m
Jack Hammer	Hand Held	1m (nominal)	3m	2m

Unlike noise which travels through air, the transmission of vibration is highly dependent on substratum conditions between the source/s and receiver. Also dissimilar to noise travelling through air, vibration levels diminish quickly over distance, thus an adverse impact from vibration on the broader community is not typically expected. Vibration during works is considered an intermittent source associated with two main types of impact; disturbance at

receivers and potential architectural/structural damage to buildings. Generally, if disturbance issues are controlled, there is limited potential for structural damage to buildings.

4.6 Operational Noise

The New South Wales *Noise Policy for Industry* (NPfI) provides guidance on the assessment of operational noise impacts. The guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

Intrusive noise levels set by the NPfI control the relative audibility of operational noise compared to the background level. Amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the lower of the two in each time period normally apply. Intrusive criteria are simply 5 decibels above the measured (or adopted) background level with a minimum of 40 dB(A) for daytime and 35 dB(A) for evening and night time.

Amenity noise levels are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise excluding other noises such as traffic and insects. Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic. Project amenity noise levels are the recommended amenity noise level (Table 2.1 of the NPfI) minus 5 dB(A) and plus 3 dB(A) to convert from a period level to a 15-minute level. The project noise trigger level is the lower value between the intrusive and the amenity noise levels.

The NPfI noise criteria are planning levels and are not mandatory limits required by legislation however the noise criteria assist the regulatory authorities to establish licensing conditions. Where noise criteria are predicted to be exceeded, feasible and reasonable noise mitigation strategies should be considered. In circumstances where noise criteria cannot be achieved negotiation is required to evaluate the economic, social and environmental costs and benefits of the development against the noise impacts.

The NPfI is generally intended for large and complex industrial sources and recommends considerable monitoring and assessment measures that may not always be applicable to certain situations. However, the NPfI will be referred to for determining operational noise goals for this project.

Nearest residential receptors are considered urban. Target noise levels are provided for residences and commercial premises in Table 10.

Table 10 Project Noise Trigger Levels

	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
Rating Background Level $L_{A90(Period)}$	43	40	33
Project Intrusive Noise Level, $L_{Aeq(15min)}$	48	45	38
Project Amenity Noise Level (Urban), $L_{Aeq(Period)}$	55	45	40

	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
Project Amenity Noise Level $L_{Aeq(15min)}$	58	48	43
Project Trigger Level Residential $L_{Aeq(15min)}$	**48**	**45**	**38**
Commercial Premises (When in use) $L_{Aeq(15min)}$	**63**	**63**	**63**
School Classroom – Internal (Noisiest 1 hr period when in use)	**35**	**35**	**35**
Active Recreation (When in use) $L_{Aeq(15min)}$	**53**	**53**	**53**

4.7 Maximum noise level assessment

The NPfI requires the potential for sleep disturbance to be assessed by considering maximum noise levels events during the night-time period.

Where the subject development/premises night-time noise levels at a residential location exceed the following screening levels a detailed maximum noise level event assessment should be undertaken:

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

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 11.

Table 11 Night-Time Sleep Disturbance Screening Levels

Type of receiver	night-time RBL, $L_{A90,15min}$, dB(A)	Sleep disturbance screening levels	
		$L_{Aeq,15min}$	L_{AFmax}
Residential	33	40	52

4.8 Road Noise Criteria

The NSW *Road Noise Policy* (RNP) recommends various criteria for different road and residential developments and uses. Although it is not mandatory to achieve the noise assessment criteria in the RNP, proponents will need to provide justification if it is not considered feasible or reasonable to achieve them. Based on the definitions in the RNP, The River Road is a sub-arterial road and Simmons Street isa local road. The following noise goals provided in Table 12 Below.

Table 12 Road Noise Policy Goals

Road Category	Day	Night
Freeway/ arterial/ sub-arterial roads: Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	60 $L_{Aeq(15hr)}$ (External)	55 $L_{Aeq(9hr)}$ (External)
Local roads: Existing residences affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq(1\ hour)}$ (External)	50 $L_{Aeq(1\ hour)}$ (External)
School Classrooms	40 $L_{Aeq,\ (1\ hour)}$ (internal) when in use	-
Hospital Wards	35 $L_{Aeq,\ (1\ hour)}$ (internal)	35 $L_{Aeq,\ (1\ hour)}$ (internal)
Places of Worship	40 $L_{Aeq,\ (1\ hour)}$ (internal)	40 $L_{Aeq,\ (1\ hour)}$ (internal)
Open space (active use)	60 $L_{Aeq,\ (15\ hour)}$ (external) when in use	--
Open space (passive use)	55 $L_{Aeq,\ (15\ hour)}$ (external) when in use	--

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

5. Assessment of Potential Impacts

5.1 Construction Noise

Construction can occur in the vicinity of residences or other sensitive land uses and be variable in times of occurrence. These aspects of construction can exacerbate noise levels and their effects. Construction noise by its nature is temporary, may not be amenable to purpose-built noise control measures applied to industrial processes, and may move as construction progresses. With these constraints in mind, the ICNG was developed to focus on applying a range of work practices most suited to minimise construction noise impacts, rather than focusing only on achieving numeric noise levels. While some noise from construction sites is inevitable, the aim of the Guideline is to protect much of residences and other sensitive land uses from noise pollution most of the time.

This section provides a summary of the likely methodology, staging, work hours, plant and equipment that would be used to complete the proposed work. For the purposes of the REF, indicative construction staging, and options are provided. Detailed methods and staging would be established by the construction contractor. Construction sequencing and methods are understood to generally be as follows in Table 13.

Table 13 Indicative Construction Staging

Stage	Activities	Duration (Weeks)	Maximum daily Deliveries (Trucks)	Maximum Daily Workforce
Site Establishment and enabling works	• Secure site boundary with temporary fencing, scaffolding and hoarding • Provide traffic and pedestrian controls in the vicinity of the Site in accordance with City of Canterbury Bankstown requirements • Undertake survey to identify site boundary and mark out existing	6	32	18

Stage	Activities	Duration (Weeks)	Maximum daily Deliveries (Trucks)	Maximum Daily Workforce
	services, protect/relocate services (as required) • Clear site of any existing vegetation not being retained, and demolish obsolete kerbs and pavements • Establish site office, amenities and plant/material storage areas including temporary services • Establish other environmental controls, such as erosion and sediment controls.			
Structural and Building Services	• Strengthening of existing structure • Demolition of existing structure to allow for extension • Construct suspended levels, including stairs, walls and columns one level at a time	36	60	80

Stage	Activities	Duration (Weeks)	Maximum daily Deliveries (Trucks)	Maximum Daily Workforce
	• Construct block work on each level • make good of at grade car park where existing surface has been disturbed for installation of services • Extend existing lift shafts • Install new services and upgrade existing services (including services rooms) including electrical, hydraulic, CCTV and mechanical • Install solar panels on rooftop level • Upgrade of power supply (if required)			
Architectural Features / Finishes	• Install facade • Install vehicular crash barriers • Install balustrades • Install new cladding • Landscape area at ground level	8		

Stage	Activities	Duration (Weeks)	Maximum daily Deliveries (Trucks)	Maximum Daily Workforce
	• Painting of car park concrete elements • Marking of car park lines, directional arrows etc and installation of way finding signage • Construct new footpaths, kerbs, and accesses within the proposal site to link adjacent infrastructure.			
	•			

The construction methodology would be further developed during the detailed design of the proposal by the selected construction contractor in consultation with Transport for NSW.

This staging is indicative, based on the current concept design and may change once the detailed design methodology is finalised. The staging is also dependent on the selected construction contractor's preferred methodology, program and sequencing of work.

5.1.1 Construction Hours and Duration

The proposed work would generally be undertaken during standard work hours

- Monday to Friday, 7am to 6pm
- Saturday, 8am to 1pm
- No works on Sundays or public holidays.

Certain works may need to occur outside standard hours to minimise disruption to customers, pedestrians, road users and nearby sensitive receivers. Approval from Transport for NSW would be required for any out of hours work and the affected community would be notified as outlined in Transport for NSW's *Construction Noise and Vibration Strategy*.

5.1.2 Construction Equipment Source Noise Levels

An indicative list of plant and equipment that may be used for the construction of this proposal includes:

- Tower and Mobile Cranes
- Water trucks
- Road Saws
- Rollers
- Trench Compactors
- Concrete trucks
- Semi-trailers
- Spoil trucks (truck and dog)
- Welding equipment
- Air compressors
- Concrete saws,
- Generators
- Concrete vibrators
- Concrete pumps
- Jack hammers
- Excavator (8-30 tonne)
- Elevated work platforms

The individual sound power levels (SWL) for the anticipated type of construction plant have been referenced from RAPT Consulting's database of noise sources and the RMS Construction Noise Estimator. Other items of plant may be used, however it is expected they would generate similar sound power levels as what is reported.

Table 14 Construction Plant and Equipment Sound Power Levels

Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)	Estimated Usage % during 15-minute period
Site Establishment and enabling works	Road Truck / Light Vehicle	108	50

Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)	Estimated Usage % during 15-minute period
	Trucks medium rigid	103	50
	Dump Truck	110	50
	Power Generator	96	100
	Mobile Crane	98	50
	Excavator	110	50
Structural and Building Services	Tower / Mobile Crane	98	50
	Water Truck	107	25
	Road (concrete) Saw	118	50
	Roller	109	50
	Trench Compactor	106	50
	Concrete Truck	109	50
	Road Truck	108	50
	Truck and Dog	110	50
	Welding equipment	105	50
	Air compressor	109	50

Activities	Anticipated type of plant and equipment	SWL L_{Aeq} dB(A)	Estimated Usage % during 15-minute period
	Power generator	96	100
	Concrete vibrator	113	50
	Concrete pump	109	50
	Jack Hammer	113	50
	Elevated work platform	98	50
Architectural Features / Finishes	Trucks / Light Vehicle	108	50
	Trucks Medium Rigid	103	50
	Power Generator	96	100
	Mobile /Tower Crane	98	50

Note 2 The sound power levels for the individual plant items are worst-case levels representative of the equipment operating at maximum capacity. In practice, not all plant items would operate at maximum capacity at the same time and therefore the estimated usage has been adjusted to reflect this. This adjustment is consistent with RAPT Consulting experience on similar projects.

5.1.3 Construction Noise Assessment

Acoustic modelling was undertaken using Bruel and Kjaer's "Predictor" to predict the effects of site noise. Predictor is a computer program for the calculation, assessment and prognosis of noise propagation. Predictor calculates environmental noise propagation according to ISO 9613-2, "Acoustics – Attenuation of sound during propagation outdoors". Terrain topography, ground absorption, atmospheric absorption and relevant shielding objects are taken into account in the calculations.

The calculated noise levels would inevitably depend on the number and type of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. In practice, the noise levels would vary due to the fact that plant and equipment would move about the worksites and would not all be operating concurrently. In some cases, reductions in noise levels would occur when plant are located behind obstacles or even other

items of equipment. Predicted noise levels have been assessed from each of the work scenarios outlined above.

Results of the predicted construction noise levels are provided in Tables 15 – 18 and are compared against operating hours. The noise levels are representative of the worst-case impact, for a given receiver type and are intended to give an indication of the possible noise levels from construction work when work is at their closest. For most construction activities, it is expected that construction noise levels would frequently be lower than predicted at the most exposed receiver. A general description of NML exceedance groups are provided below. The impact of these potential exceedances depends on the period in which they were to occur (generally night-time is more sensitive than daytime or evening for most people).

- Noise levels 1 – 10 dB(A) above NML – Impact generally marginal to minor
- Noise Levels 11 – 20 dB(A) above NML – Impact generally moderate
- Noise Levels > 20 dB(A) above NML – Impact generally high

Locations predicted to exceed construction NML's are shown in red. Predicted exceedances are also provided in brackets.

Receivers assessed are shown in Figure 4.

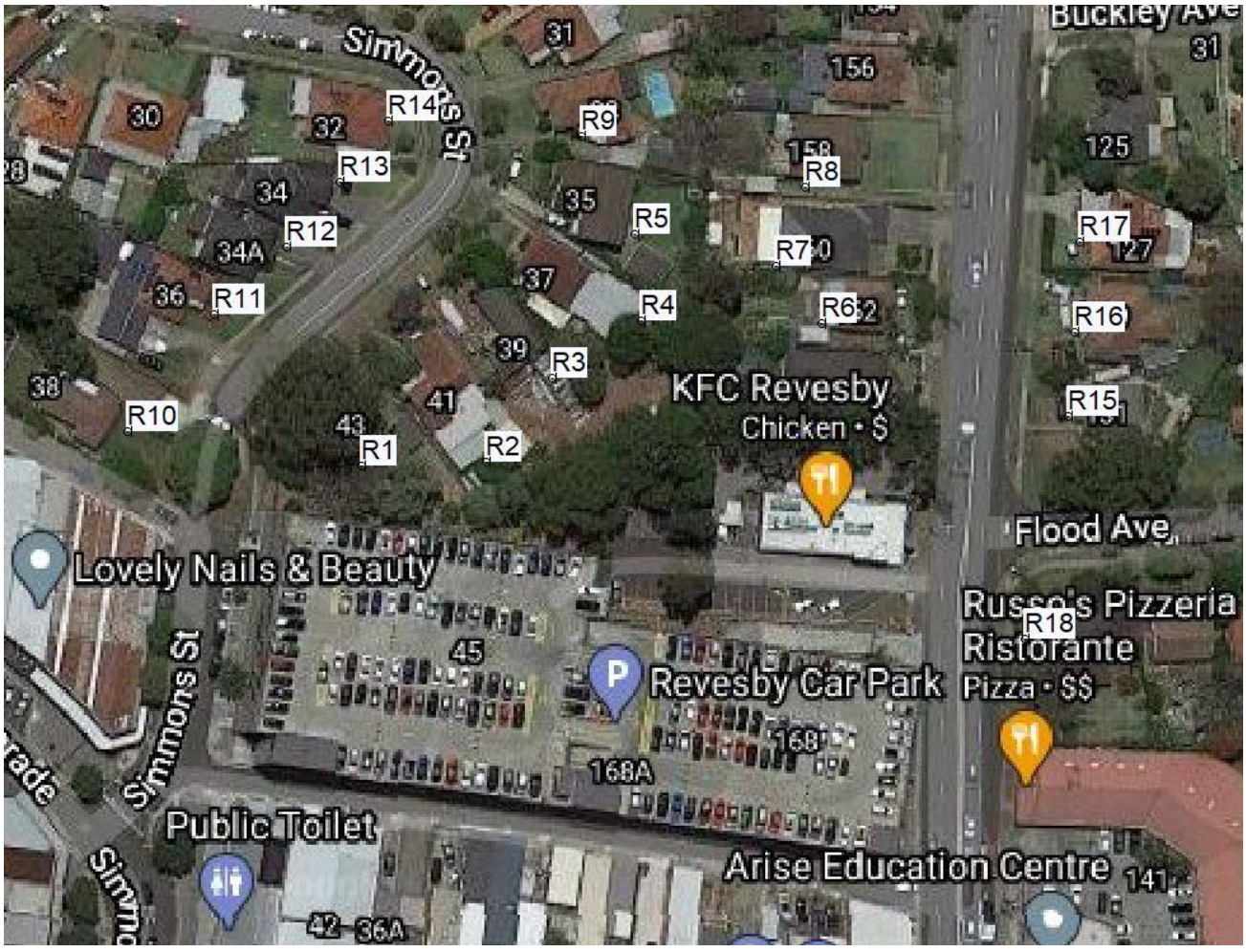


Figure 4 Assessed Locations

Table 15 Predicted Construction Noise Levels SPL dB(A) Leq(15min) - Daytime

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Standard Daytime NML 53dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R1 43 Simmons Street	67 (14)	68 (15)	71 (18)	64 (11)	53	75	No
R2 41 Simmons Street	63 (10)	64 (11)	67 (14)	63 (10)	53	75	No
R3 39 Simmons Street	57 (4)	57 (4)	58 (5)	57 (4)	53	75	No
R4 37 Simmons Street	52	54 (1)	58 (5)	52	53	75	No
R5 35 Simmons Street	42	48	50	41	53	75	No
R6 162 The River Road	34	45	46	31	53	75	No
R7 160 The River Road	49	53	55 (2)	48	53	75	No
R8 158 The	46	53	54 (1)	45	53	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Standard Daytime NML 53dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
River Road							
R9 33 Simmons Street	34	44	44	31	53	75	No
R10 38 Simmons Street	65 (12)	65 (12)	65 (12)	62 (9)	53	75	No
R11 36 Simmons Street	63 (10)	63 (10)	67 (14)	60 (7)	53	75	No
R12 34A Simmons Street	61 (8)	61 (4)	63 (10)	57 (4)	53	75	No
R13 34 Simmons Street	50	55 (2)	56 (3)	47	53	75	No
R14 32 Simmons Street	38	51	52	37	53	75	No
R15 131 The River Road	41	51	53	40	53	75	No
R16 129 The	35	52	53	34	53	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Standard Daytime NML 53dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
River Road							
R17 127 The River Road	38	56 (3)	56 (3)	37	53	75	No
R18 25 Flood Avenue	43	49	50	36	53	75	No

Table 16 Predicted Construction Noise Levels SPL dB(A) Leq(15min) – Out of Hours Daytime

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Daytime NML 48 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R1 43 Simmons Street	67 (19)	68 (20)	71 (23)	64 (16)	48	75	No
R2 41 Simmons Street	63 (15)	64 (16)	67 (19)	63 (15)	48	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Daytime NML 48 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R3 39 Simmons Street	57 (9)	57 (9)	58 (10)	57 (9)	48	75	No
R4 37 Simmons Street	52 (4)	54 (6)	58 (10)	52 (4)	48	75	No
R5 35 Simmons Street	42	48	50 (2)	41	48	75	No
R6 162 The River Road	34	45	46	31	48	75	No
R7 160 The River Road	49 (1)	53 (5)	55 (7)	48	48	75	No
R8 158 The River Road	46	53 (5)	54 (6)	45	48	75	No
R9 33 Simmons Street	34	44	44	31	48	75	No
R10 38 Simmons Street	65 (17)	65 (17)	65 (17)	62 (14)	48	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Daytime NML 48 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R11 36 Simmons Street	63 (15)	63 (15)	67 (19)	60 (12)	48	75	No
R12 34A Simmons Street	61 (13)	61 (13)	63 (15)	57 (9)	48	75	No
R13 34 Simmons Street	50 (2)	55 (7)	56 (8)	47	48	75	No
R14 32 Simmons Street	38	51 (3)	52 (4)	37	48	75	No
R15 131 The River Road	41	51 (3)	53 (5)	40	48	75	No
R16 129 The River Road	35	52 (4)	53 (5)	34	48	75	No
R17 127 The River Road	38	56 (8)	56 (8)	37	48	75	No
R18 25 Flood Avenue	43	49 (8)	50 (2)	36	48	75	No

Table 17 Predicted Construction Noise Levels SPL dB(A) Leq(15min) - Evening

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Evening NML 45 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R1 43 Simmons Street	67 (22)	68 (23)	71 (26)	64 (20)	45	75	No
R2 41 Simmons Street	63 (18)	64 (19)	67 (22)	63 (18)	45	75	No
R3 39 Simmons Street	57 (12)	57 (12)	58 (13)	57 (12)	45	75	No
R4 37 Simmons Street	52 (7)	54 (9)	58 (13)	52 (7)	45	75	No
R5 35 Simmons Street	42	48 (3)	50 (5)	41	45	75	No
R6 162 The River Road	34	45	46 (1)	31	45	75	No
R7 160 The River Road	49 (4)	53 (8)	55 (10)	48 (3)	45	75	No
R8 158 The	46 (1)	53 (8)	54 (9)	45	45	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Evening NML 45 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
River Road							
R9 33 Simmons Street	34	44	44	31	45	75	No
R10 38 Simmons Street	65 (20)	65 (20)	65 (20)	62 (17)	45	75	No
R11 36 Simmons Street	63 (18)	63 (18)	67 (22)	60 (15)	45	75	No
R12 34A Simmons Street	61 (16)	61 (16)	63 (18)	57 (12)	45	75	No
R13 34 Simmons Street	50 (5)	55 (10)	56 (11)	47 (2)	45	75	No
R14 32 Simmons Street	38	51 (6)	52 (7)	37	45	75	No
R15 131 The River Road	41	51 (6)	53 (8)	40	45	75	No
R16 129 The	35	52 (7)	53 (8)	34	45	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Evening NML 45 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
River Road							
R17 127 The River Road	38	56 (11)	56 (11)	37	45	75	No
R18 25 Flood Avenue	43	49 (4)	50 (5)	36	45	75	No

Table 18 Predicted Construction Noise Levels SPL dB(A) Leq(15min) - Night

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Night-Time NML 38 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R1 43 Simmons Street	67 (29)	68 (30)	71 (33)	64 (26)	38	75	No
R2 41 Simmons Street	63 (25)	64 (26)	67 (29)	63 (25)	38	75	No
R3 39 Simmons Street	57 (19)	57 (19)	58 (28)	57 (19)	38	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Night-Time NML 38 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R4 37 Simmons Street	52 (14)	54 (16)	58 (20)	52 (14)	38	75	No
R5 35 Simmons Street	42 (4)	48 (10)	50 (12)	41 (3)	38	75	No
R6 162 The River Road	34	45 (7)	46 (8)	31	38	75	No
R7 160 The River Road	49 (11)	53 (15)	55 (17)	48 (10)	38	75	No
R8 158 The River Road	46 (8)	53 (15)	54 (16)	45 (7)	38	75	No
R9 33 Simmons Street	34	44 (6)	44 (6)	31	38	75	No
R10 38 Simmons Street	65 (27)	65 (27)	65 (27)	62 (24)	38	75	No
R11 36 Simmons Street	63 (25)	63 (25)	67 (29)	60 (22)	38	75	No

Receiver	Site Preparation	Utilities Infrastructure	Superstructure	Architectural Features/Finishes	Out of Hours Night-Time NML 38 dB(A)	Highly Affected Noise Level 75 dB(A)	Exceed Highly Affected Noise Level (Yes / No)
R12 34A Simmons Street	61 (23)	61 (23)	63 (25)	57 (19)	38	75	No
R13 34 Simmons Street	50 (12)	55 (17)	56 (18)	47 (9)	38	75	No
R14 32 Simmons Street	38	51 (13)	52 (14)	37	38	75	No
R15 131 The River Road	41 (3)	51 (13)	53 (15)	40 (2)	38	75	No
R16 129 The River Road	35	52 (14)	53 (15)	34	38	75	No
R17 127 The River Road	38	56 (18)	56 (18)	37	38	75	No
R18 25 Flood Avenue	43 (5)	49 (11)	50 (12)	36	38	75	No

Noise results present the worst-case scenario if all items of plant outlined in Table 14 were operating at their maximum sound power levels simultaneously. In reality, this is unlikely to occur and actual received sound levels due to construction are expected to be lower than is reported in Table 14. It is understood construction works are planned for standard daytime hours and results presented for out of hours work are for informational purposes.

However, certain less intensive works may need to occur outside standard hours to minimise disruption to customers, pedestrians, road users and nearby sensitive receivers. Approval from Transport for NSW would be required for any out of hours work and the affected community would be notified as outlined in Transport for NSW's Construction Noise and Vibration Strategy.

Highly affected noise levels are also predicted to be complied with at all assessed locations. While actual noise levels are not expected to be of this magnitude, it is recommended a construction noise and vibration management plan (CNVMP) be implemented as part of this proposal to manage and minimise construction noise and vibration.

5.2 Construction Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (e.g. dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of vibration, are all important aspects in both the annoyances caused and the strains induced in structures.

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment)
- The Frequency content;
- The impact medium stiffness;
- The type of wave (surface or body)
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data.

Generally, piling is not expected to be used in this proposal but is included for informational purposes. Based on distances from the proposal to nearest receivers which are approximately 30 metres away and items of plant to be used, vibration goals are expected to be met. However, if hammering is to occur, it is recommended this activity does not exceed the medium hydraulic hammer specification. Additionally vibratory rolling is recommended to not exceed the <100 kN (2-4 tonne) specification.

Ground Vibration – Minimum Working Distances from Sensitive Receivers

The Transport for NSW CNVS provides guidance for minimum working distances. As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 19. The minimum distances are quoted for both "cosmetic" damage (refer BS 7385) and human comfort (refer OH&E's Assessing Vibration - a technical guideline). DIN 4150 has criteria of particular reference for heritage structures. The minimum working distances are indicative and will vary depending on the particular item of plant and

local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Table 19 Recommended Minimum Safe Working Distances for Vibration Intensive Plant from Sensitive Receiver

Plant Item	Rating / Description	Minimum Distance Cosmetic Damage		Minimum Distance Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1-2 tonne)	5m	11m	15m to 20m
	<100 kN (2-4 tonne)	6m	13m	20m
	<200 kN (4-6 tonne)	12m	15m	40m
	<300kN (7-13 tonne)	15m	31m	100m
	>300kN (13-18 tonne)	20m	40m	100m
	>300kN (>18 tonne)	25m	50m	100m
Small Hydraulic Hammer	300kg (5 to 12 t excavator)	2m	5m	7m
Medium Hydraulic Hammer	900kg (12 to 18 t excavator)	7m	15m	23m
Large Hydraulic Hammer	1600kg (18 to 34 t excavator)	22m	44m	73m
Vibratory Pile Driver	Sheet Piles	2m to 20m	5m to 40m	20m
Pile Boring	≤ 800mm	2m (nominal)	5m	4m
Jack Hammer	Hand Held	1m (nominal)	3m	2m

Given the nearest residential receptors are approximately 20 metres from the project, where vibratory rollers are proposed it is recommended <50 kN (1-2 tonne) be utilised. Additionally, if hydraulic hammering were to occur, it is recommended no larger than small 300kg (5 to 12t excavator) be utilised.

5.3 Operational Noise

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'. Tables 20 and 21 provide data obtained from the Futurerail publication, *Commuter Car Park Program – Traffic, Transport and Access Impact Assessment Revesby Commuter Car Park (Futurerail 2020).*

Table 20 AM Peak Intersection Performance With and Without CCP

		AM				
Intersection	**Scenario**	**Intersection volume**	**Delay (sec)**	**LOS**	**DoS**	**95% Back of Q length (m)**
The River Rd/Sphinx Ave/Marco Ave	Without CCP	1922	45	D	0.68	152 (south)
	With CCP	2072	45	D	0.75	177 (south)
The River Rd/Blamey St	Without CCP	1774	22	B	0.64	194 (South)
	With CCP	1921	22	B	0.73	247 (South)
The River Rd/Uranus Rd/Weston St	Without	2718	42	C	0.81	211 (South)
	With CCP	2876	46	D	0.87	258 (South)

Table 21 PM Peak Hour Performance With and Without CCP

		PM				
Intersection	**Scenario**	**Intersection volume**	**Delay (sec)**	**LOS**	**DoS**	**95% Back of Q length (m)**
The River Rd/Sphinx Ave/Marco Ave	Without CCP	2105	51	D	0.78	156 (North)
	With CCP	2256	52	D	0.82	195 (North)
The River Rd/Blamey St	Without	1984	22	B	0.61	158 (North)
	With CCP	2132	27	B	0.66	184 (North)
The River Rd/Uranus Rd/Weston St	Without CCP	2505	33	C	0.67	177 (North)
	With CCP	2653	32	C	0.69	196 (North)

An L_{Aeq} noise level increase of more than 2 dB(A) is equivalent to approximately a 60 percent increase in total road traffic. The comparison of network performance with and without the expansion of the MSCP show that the road network around the MSCP will increase by a maximum of 8%. as such, it is unlikely the proposal would increase road noise levels by 2dB(A).

5.4 Car Park Operational Noise

To assess the potential noise impacts associated with the operation of the proposal, two key scenarios were assessed:

- general operational noise from normal car park usage within the MSCP; and
- transient noise events such as car door slams, boot slams or horn and alarm emissions and wheel squeals.

For the assessment of operational noise, a sound power for general car usage (i.e. car movement and engine noise) of 75dB(A) $L_{eq(15min)}$ was adopted. To assess the impact transient noise events such as door or boot slams a sound power level of 85dB(A) L_{max} was adopted, 120dB(A)L_{max} for car horns and alarms and 110dB(A)Lmax for wheel squeals were utilised .

Predicted noise levels from the general operation of the car park are less than 38dB(A) $L_{eq(15min)}$ at all existing identified residential receivers satisfying the minimum applicable night time project noise trigger level and NPfI sleep disturbance trigger level of 40dB(A) $L_{eq(15min)}$. However, predicted maximum noise level events from items such as car alarms, horns, and wheel squeals are greater than 52dB(A) L_{max} at all existing identified residential receivers, which exceeds the operational maximum noise trigger levels for sleep disturbance. Based on this, it is recommended during detailed design an investigation into methods to reduce potential noise emissions emanating from the operation of the carpark be undertaken. Appropriate mitigation measures would then be implemented where possible.

6. Noise and Vibration Mitigation Measures

6.1 Construction Noise and Vibration Mitigation Measures

6.1.1 Noise Mitigation Measures

Construction noise levels are predicted to exceed noise management levels at the residences outlined in Tables 15 - 18. Where exceedances are anticipated after implementing standard mitigation measures, additional mitigation measures can be applied where feasible and reasonable. The TfNSW CNVS provides guidance for additional mitigation measures and may be used to minimise the impacts on the community from noise and vibration. The provision of additional mitigation is based on predicted exceedances above RBLs and when the exceedances occur. Table 22 provides how to implement additional airborne noise management levels.

Table 22 How to implement additional airborne noise management levels

Construction hours	Receiver perception	dB(A) above RBL	dB(A) above NML	Additional management measures
Standard hours Monday-Friday (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
	75 dB(A) or greater	N/A	N/A	PN, V, SN
OOHW Period 1 Monday-Friday (6pm-10pm) Saturday (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 Monday-Saturday (12am-7am, 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,

Note 3 PN = Project notification SN = Specific notification, individual briefings, or phone call V = Verification monitoring DR = Duration reduction RP = Respite period RO = Project specific respite order AA = Alternative accommodation

** SWLs used for the purpose of estimating noise impact shall be increased by 5 dB(A) where works will include: power saws for the cutting of timber, masonry & steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling & profiling; jack hammering, rock hammering & rock breaking; or impact piling as a correction factor for noise with special audible characteristics. # 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-6am). ^ 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.*

Table 23 outlines the additional mitigation measures, as outlined in the CNVS.

Table 23 Description of Additional Mitigation Measures

Measure	Description	Abbreviation
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

Measure	Description	Abbreviation
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 Construction Noise and Vibration Impact Statement (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 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	SN

Measure	Description	Abbreviation
	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 Vibration Management Levels (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). Note; this management measure does not apply to OOHW Period 1 – Days (See Table 1).	RP

Measure	Description	Abbreviation
Duration Reduction	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 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.	DR

6.1.2 Vibration Mitigation Measures

While vibration generated by the proposal is expected to comply with established vibration goals, Table 24 provides further guidance for triggers for additional vibration mitigation measures taken from Table 11 of the CNVS.

Table 24 Vibration Mitigation Measures

Construction Hours	Receiver Perception	Above VML	Additional Management Measures
Standard Hours Monday – Friday (7am-6pm) Saturday (8am-1pm)	Human Disturbance	>HVML	P, V, RO
	Building Damage	>DVML	V, AC
OOHW Period 1 Monday – Friday (6pm-10pm) Saturday (7am-8am, 1pm-10pm) Sunday/Public Holiday (8am-6pm)	Human Disturbance	>HVML	PN, V, SN, RO, RP, DR
	Building Damage	>DVML	V, AC
OOHW Period 2 Monday-Saturday (12am-7am, 10pm-12am) Sunday/Public Holiday (12am-8am, 6pm-12am)	Human Disturbance	>HVML	PN, V, SN, RO, AA, RP, DR
	Building Damage	>DVML	V, AC

Note 4 PN=Project Notification; SN=Specific Notification, Individual Briefings, or Phone Call; V=Verification of Monitoring; AA=Alternative Accommodation; DR=Duration Reduction; RO=Project Specific Respite Offer; RP=Respite Period; AC=Alternative Construction Methodology

6.2 Operation Mitigation Measures

Site observations noted the MSCP has numerous extended skid marks an all levels indicating persons doing 'burnouts' in the MSCP which creates wheel squeal. The following figures show the skid marks.

Figure 5 Skid Marks

Figure 6 Skid Marks

Figure 7 Skid Marks

Additionally, it is noted the MSCP is open aired as shown in figures 8 and 9.

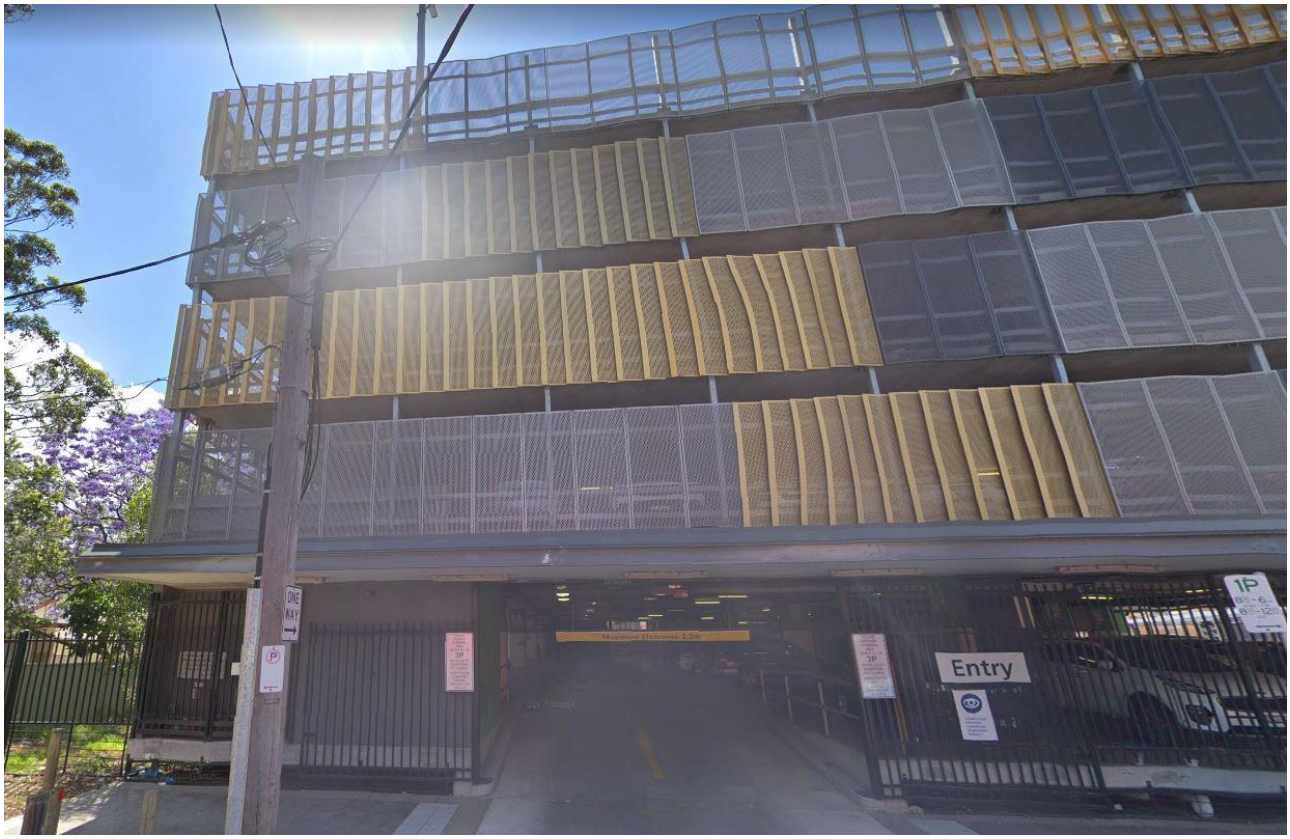


Figure 8 MSCP Simmons Street Entrance

Figure 9 MSCP from River Road

The following operational management / mitigation measures are recommended to be investigated for implementation.

- Install boom gates at all entry and exit points for timed usage for non-commuter parking
- Opal Card controlled boom-gate entry/exit facilities for commuters

- Install sound absorptive linings in all ceiling spaces
- Install speed bumps from end to end on all levels of MSCP
- Install antiskid materials on concrete to minimise wheel squealing
- Install floor to ceiling partitions on the exterior of the building
- Install video surveillance cameras on all levels

7. Conclusion

RAPT Consulting has undertaken a construction and operational noise and vibration assessment (NVIA) for NGH as part of a Review of Environmental Factors for the proposed Multi Storey Car Park (MSCP) expansion at Revesby.

Construction

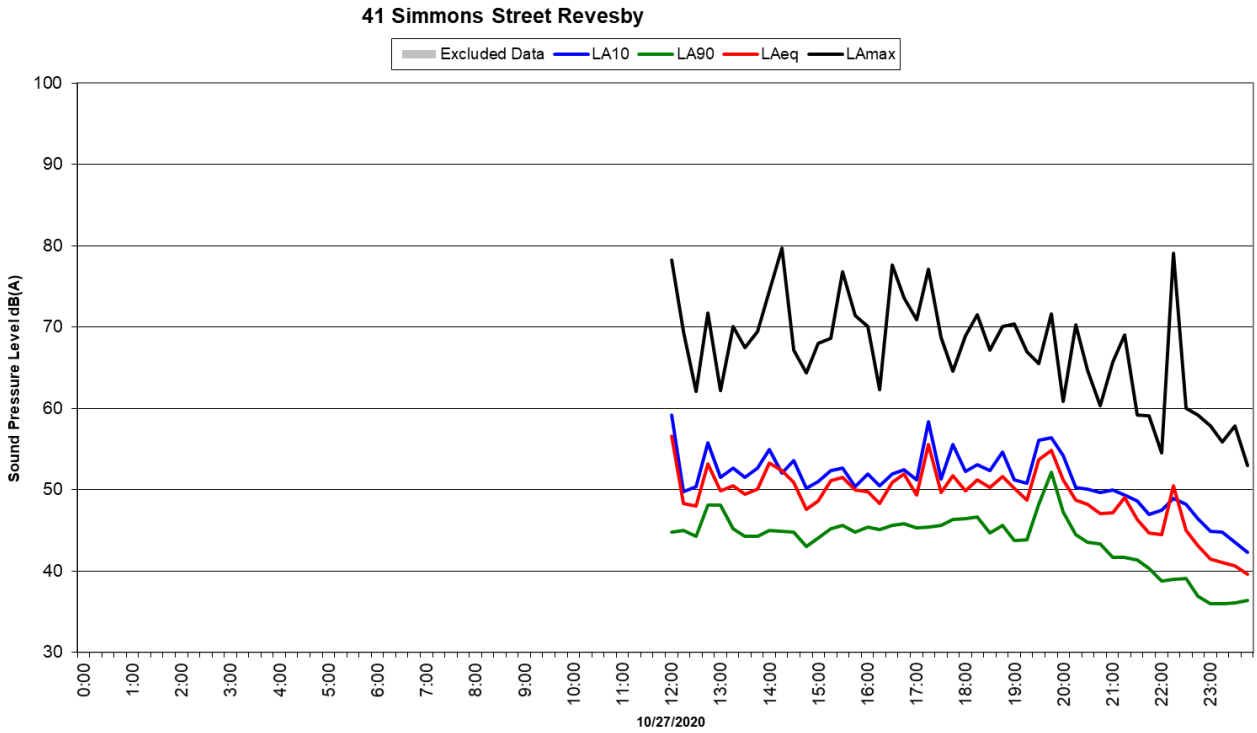
The assessment outlined in this report indicates that construction noise management levels may be exceeded for some receivers assessed. However, the highly noise affected level of 75dB(A) $L_{Aeq(15min)}$ is expected to be complied with. A set of standard mitigation measures for construction noise and vibration have been provided based on anticipated requirements of the proposal. It is believed construction noise can be minimised and managed acceptable to the local community through the implementation of a CNVMP similar to what has been recommended in this report.

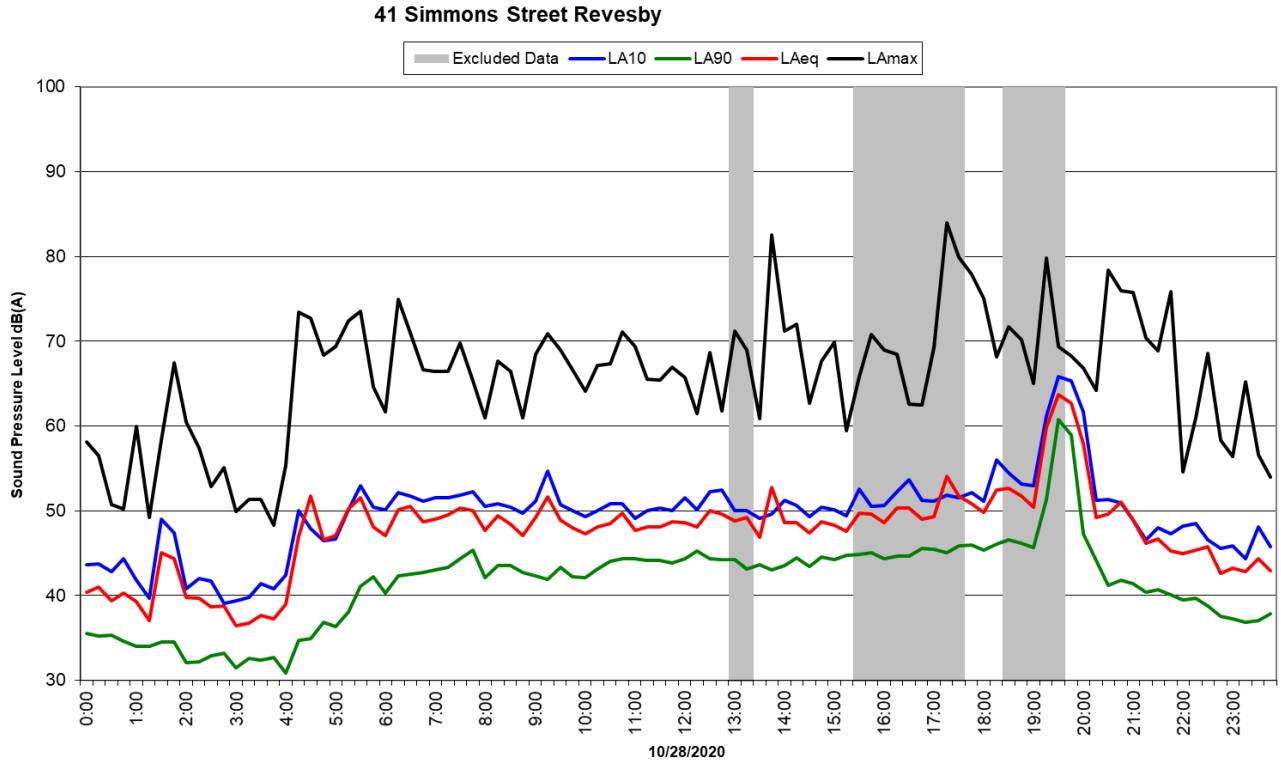
Operation

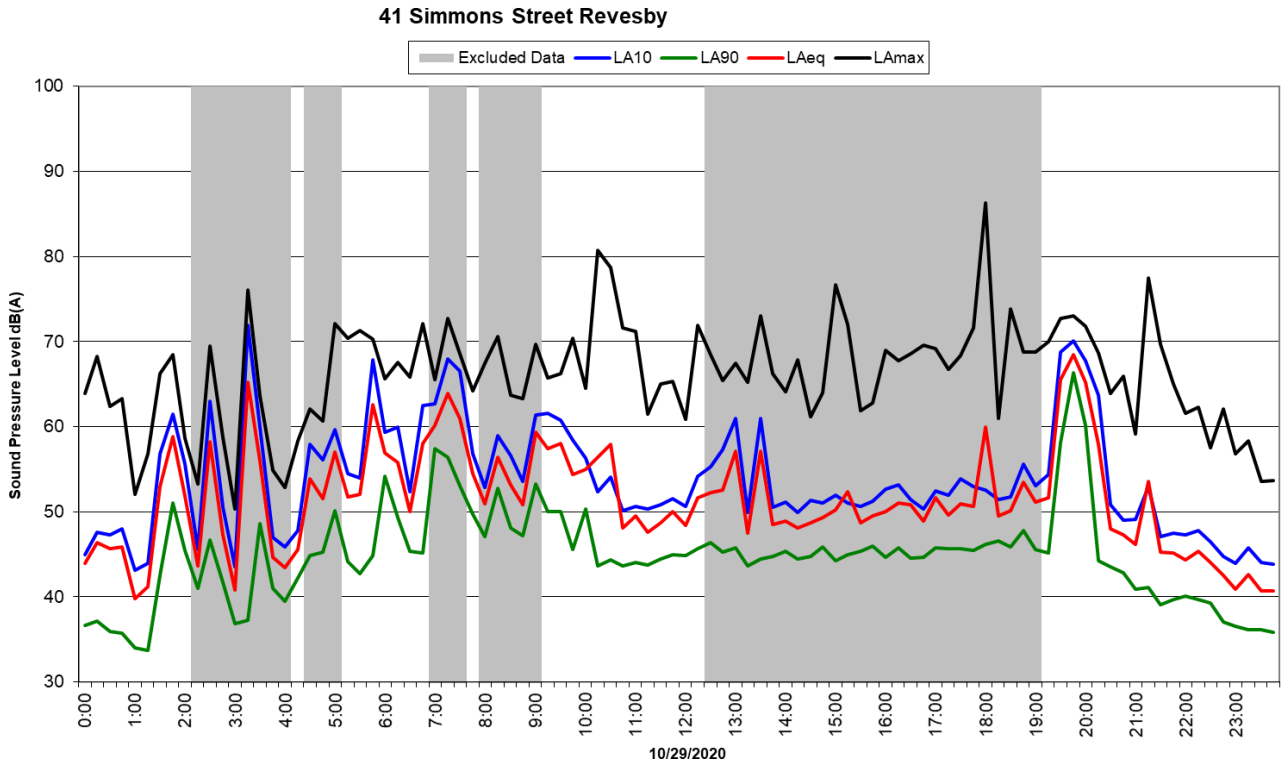
The results of the assessment indicate the proposal is predicted to increase traffic noise levels by less than 2dB(A). Additionally Predicted noise levels from the general operation of the car park are less than 38dB(A) Leq(15min) at all existing identified residential receivers receivers, satisfying the minimum applicable night time NPfI trigger level of 38dB(A) $L_{eq(15min)}$ and 40dB(A) $L_{eq(15min)}$ for sleep disturbance.

However, predicted maximum noise level events are greater than 52dB(A) L_{max} at all existing identified residential receivers. A standard set of mitigation and management measures has been provided in this report to manage maximum noise level events. It is recommended these mitigation measures or similar be investigated and implemented wherever reasonable and feasible to minimise this risk of operational maximum noise trigger levels.

8. Appendix A Noise Monitoring Graphs



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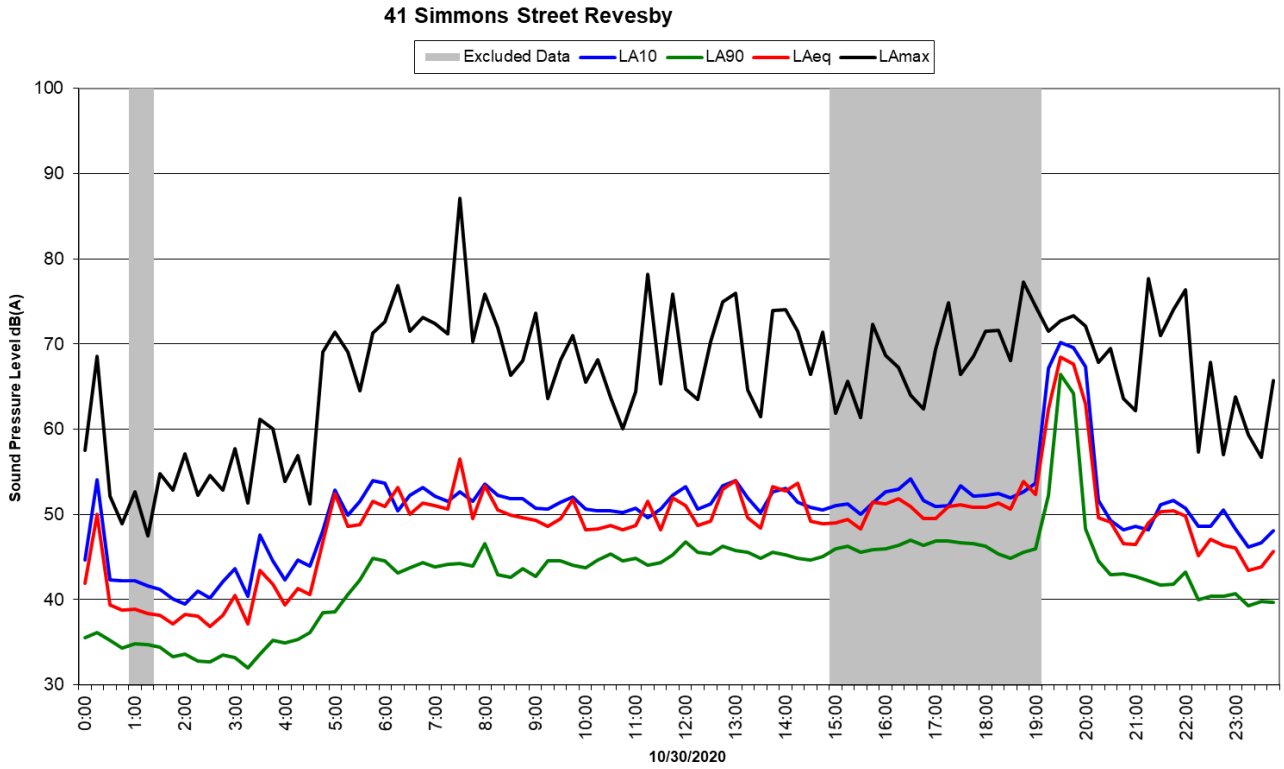
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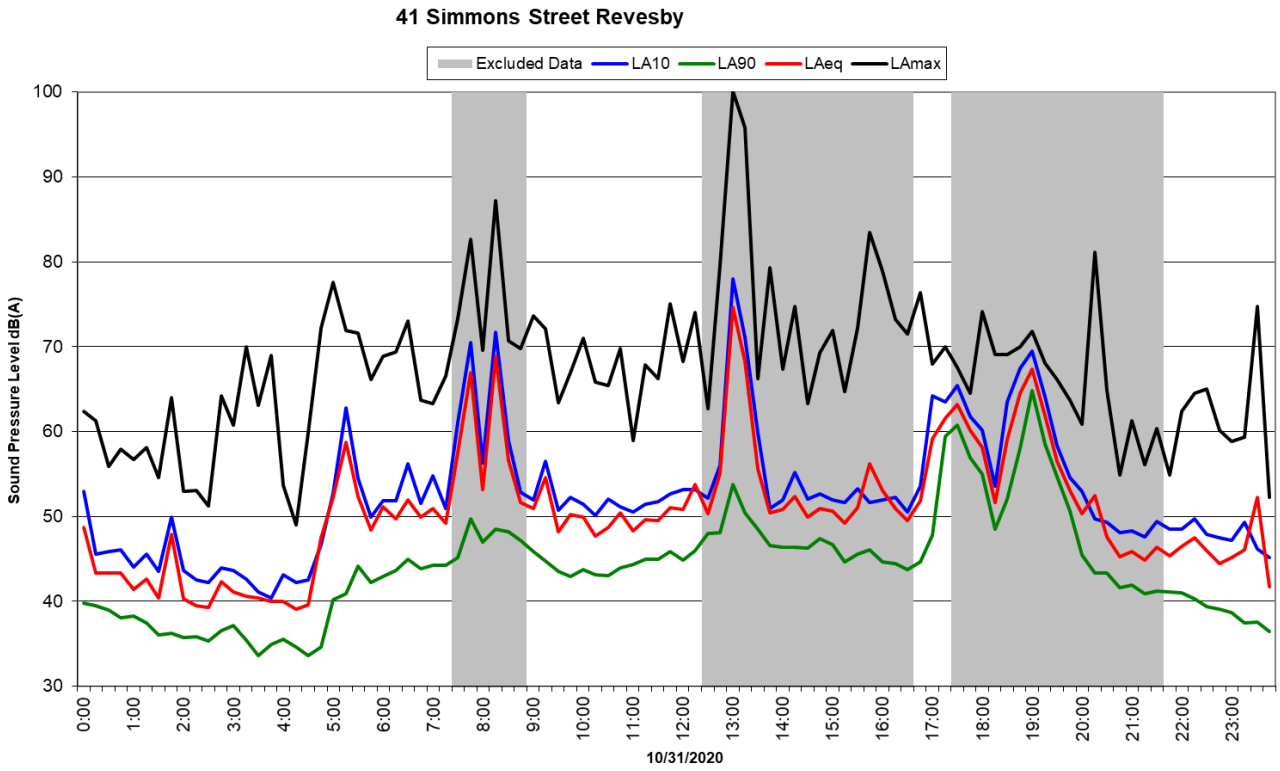
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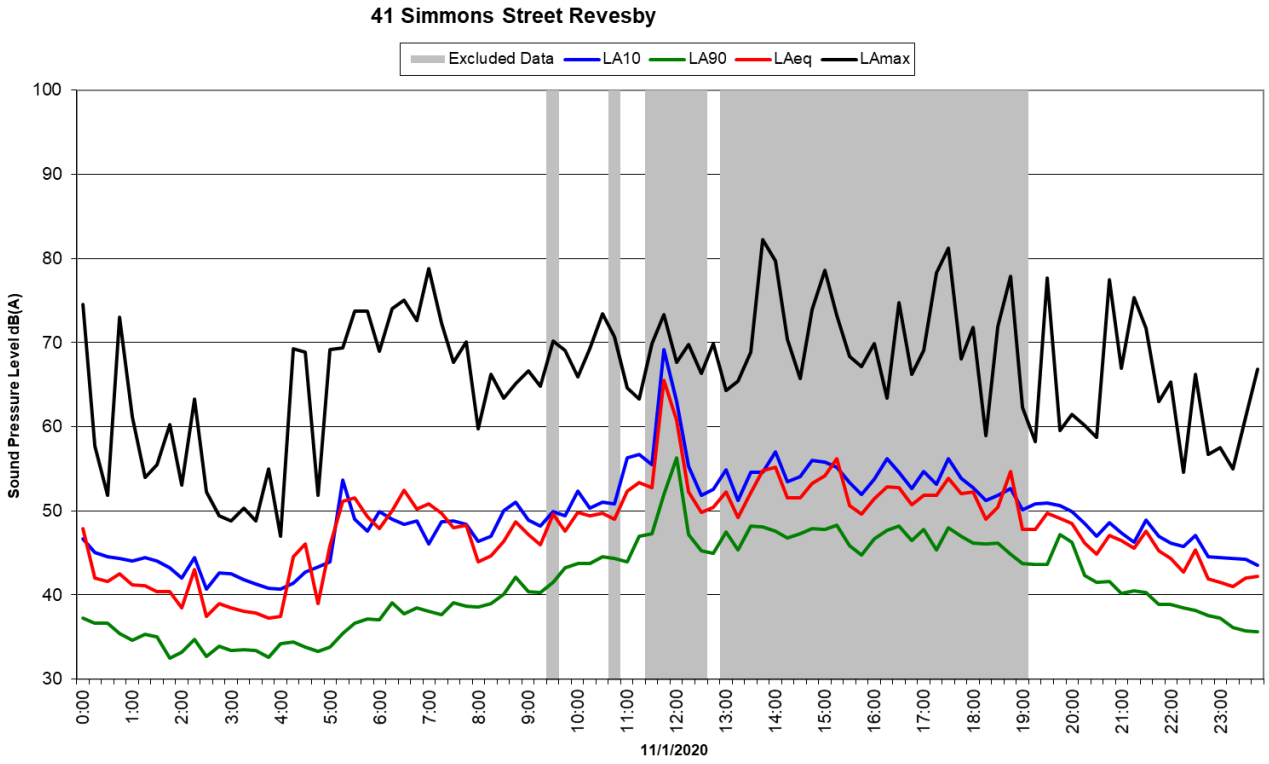
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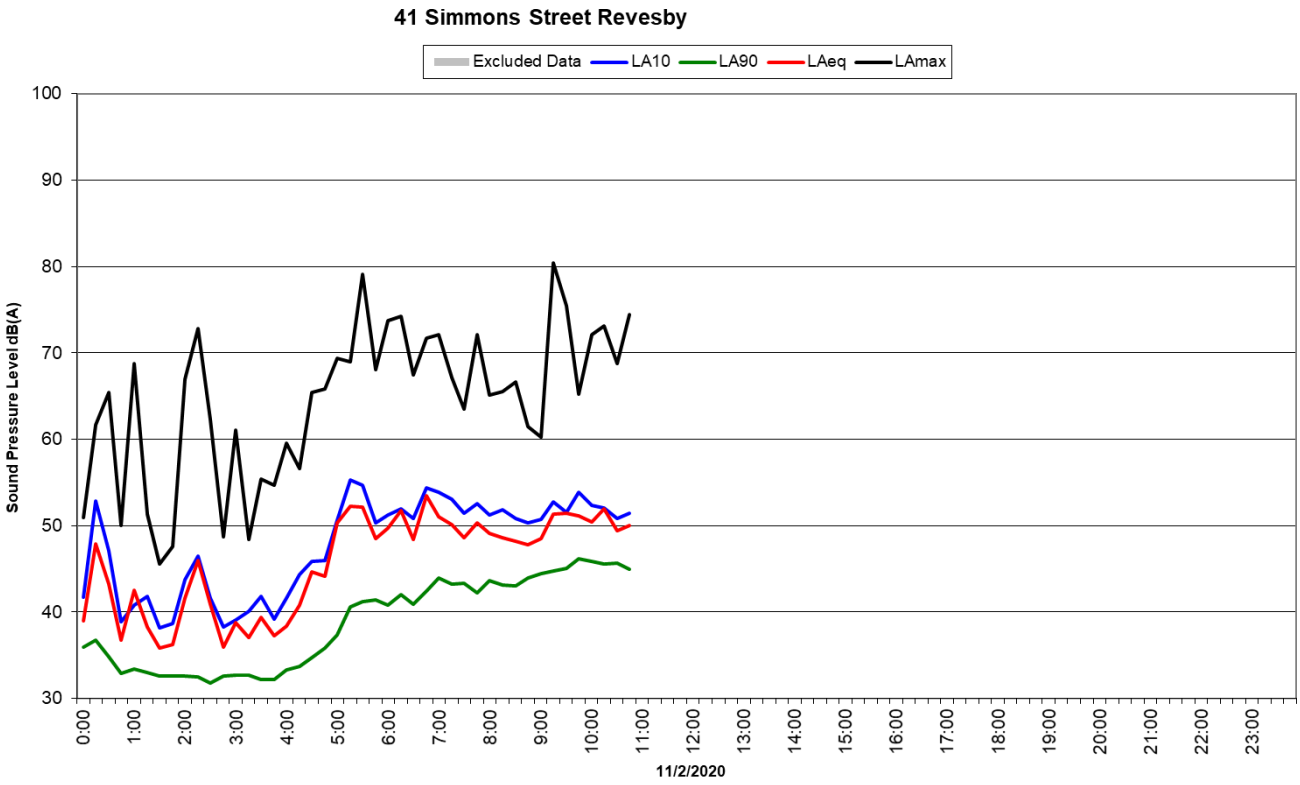
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