Appendix D

Noise and Vibration Assessment

SYDNEY PARK JUNCTION

Noise and Vibration Assessment

Prepared for:

Sydney Program Alliance
52 Alfred Street
Milsons Point NSW

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EXECUTIVE SUMMARY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Sydney Program Alliance (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

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1 Introduction

1.1 Proposal Identification

Transport for NSW (TfNSW) proposes to improve the southern 'gateway' to King Street, Newtown by reducing the capacity of King Street, Princes Highway and Sydney Park Road and enhancing pedestrian and cyclist access between King Street, St Peters Station and Sydney Park (the proposal).

The proposal objectives align with the strategic objectives articulated in the Greater Sydney Region Plan (Greater Sydney Commission, 2018), the Road Safety Plan 2021 (Transport for NSW, 2018) and the Future Transport Strategy 2056 (Transport for NSW, 2018). The location of the proposal and the identification of nearby sensitive receivers is shown in **Figure 1**.

Key features of the proposal would include:

- Reducing the Princes Highway/King Street carriageway from six lanes (generally) to four lanes(two lanes off-peak) from Campbell Street to Sydney Park Road, to accommodate a two way on-road segregated cycleway (on the western side of King Street between May Street and St Peters square), additional landscaping and community spaces to increase urban amenities
- Reducing the Sydney Park Road carriageway from four lanes to two lanes to accommodate a permanent solution for the existing temporary two-way on-road segregated cycleway (northern side), parking and additional landscaping to increase urban amenities,
- New mid-block pedestrian shared crossings to improve access across the Princes Highway/King Street and into Sydney Park, including:
  - A new mid-block pedestrian crossing on Princes Highway north of Short Street.
  - A new mid-block pedestrian and cyclist crossing on Princes Highway between May Street and Goodsell Street.
- Traffic signal and intersection reconfiguration works to improve safety, including:
  - Princes Highway/King Street and Sydney Park Road intersection:
    - King Street southbound approach: Reduce existing three though lanes and one left turn slip lane to a one through lane and one through/left turn lane
    - King Street northbound approach: Maintain existing two through lanes and reduce existing two dedicated right turn lanes to one lane
    - Sydney Park Road approach: Reduce existing two left turn lanes and two right turn lanes to one left turn lane and one right turn lane
    - Replacing existing signalised pedestrian crossing facilities with signalised shared crossing facilities on all approaches
- Princes Highway/King Street and Goodsell Street intersection:
  - New raised zebra crossing to prioritise pedestrians at the entrance of Goodsell Street
- Princes Highway/King Street and May Street intersection:
  - Removing traffic signals and re-configuring May Street to left in and left out only movements with a new raised zebra crossing to prioritise pedestrians at the entrance of May Street

- Princes Highway/King Street and Barwon Park Road intersection:
  - Installing new traffic signals with new pedestrian crossings
- Sydney Park Road and Mitchell Road intersection:
  - Eastbound approach: Reduce existing two though lanes and one left turn lane to one through lane and a through/left turn lane
  - Westbound approach: Reduce existing one right turn lane, one through lane and one through/left turn lane to one through/right turn lane and one through/left turn lane
  - Mitchell Road approach: Change existing one right turn lane and one right/through/left turn lane to one bus dedicated right turn lane and one through/left turn lane
- Reducing the posted speed limit on Princes Highway from 50 kilometres per hour to 40 kilometres from Campbell Street to Goodsell Street
- Sydney Park carpark access on Kings St will be modified so that Barwon Park Road access will be entry only into the carpark, and King Street will be exit only from the carpark
- Adjustments and relocation of parking spaces along the road corridor
- Road re-surfacing at signalised intersections and along road corridor where required
- Providing dynamic community spaces on both sides of Princes Highway
- Providing landscaped buildouts on Sydney Park Road and Princes Highway
- Relocating the bus stops on Princes Highway near the Short Street intersection, and on Sydney Park Road near the Mitchell Road intersection
- Relocating utilities and adjustments to streetlights where required
- Removing the Princes Highway and Sydney Park Road corridors from the approved B-double freight access network
- Adjusting stormwater to accommodate designed works
- Relocating existing VMS and CCTV camera
- Relocating road signs and line marking works
- Temporary construction facilities, including site compounds and an ancillary facility at Burrows Road and Venice Street, Mascot.

1.2 Purpose of this report

This Noise and Vibration Technical Working Paper has been prepared by SLR Consulting Australia Pty Ltd on behalf of Sydney Program Alliance. For the purposes of these works, TfNSW is the proponent and the determining authority under Division 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The purpose of the assessment is to describe the proposal, to document the potential noise and vibration impacts from construction and operation of the proposal on the environment, and to detail mitigation and management measures to be implemented. This assessment forms part of the overarching Review of Environmental Factors (REF) in accordance with TfNSW requirements under the EP&A Act, section 5.5.

The scope and objectives of the proposal are as follows:

- Detail the existing environment
- Identify noise and vibration sensitive receivers in the area around the proposal
- Detail the relevant guidelines and determine suitable criteria for construction and operational noise and vibration
- Detail the assessment methodology and representative construction activities
- Detail the assessment methodology and operational features of the proposal
- Undertake a high-level construction noise and vibration assessment
- Assess the potential for operational road traffic noise impacts

TfNSW have advised that these works are to be considered as 'minor works' for the purposes of the noise assessment. Minor works are defined in the TfNSW Noise Criteria Guideline as works which are primarily to improve safety. This includes minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments. In relation to the assessment of operation noise, these works are not considered as redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic. The project is intended to be a place making exercise which will result in a reduction in traffic.

1.3 Terminology

The assessment uses specific acoustic terminology and an explanation of common terms is included in **Appendix A**. A glossary is also at the end of this document which lists the various terms used.

2 Existing Environment

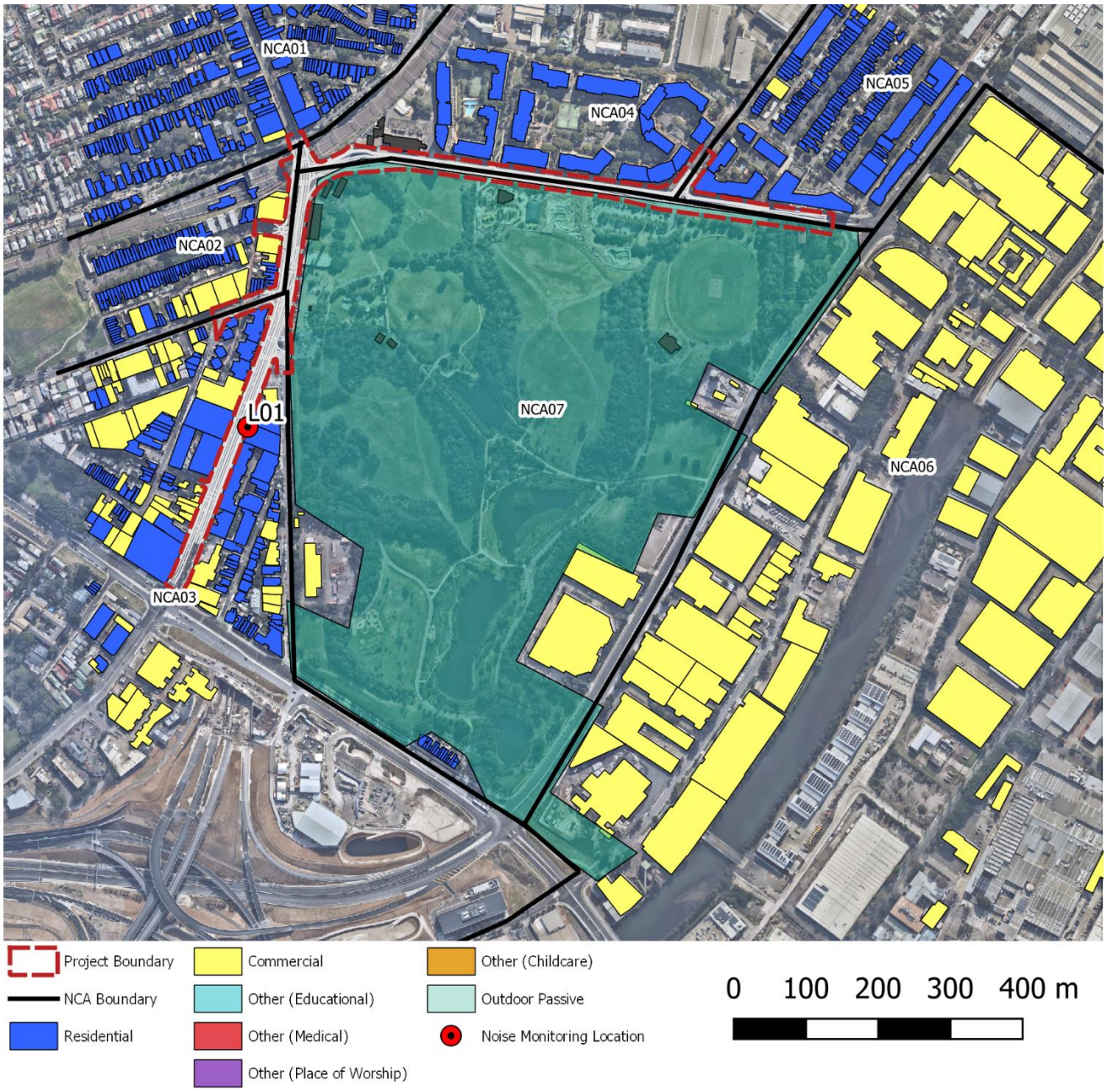
The proposal is located about four kilometres south west of the Sydney Central Business District (CBD), in the suburbs of St Peters, Newtown, Erskineville and Alexandria along the boundary between the Inner West and Sydney Local Government Areas (LGAs).

Major roads within or near to the proposal include Campbell Road, Princess Highway, King Street and Euston Road. The St Peters Interchange component of theM8 Motorway (M8)) project is located to the south of the proposal. As a result of the construction of the New M5 project, Campbell Road and Euston Road have been recently upgraded to support vehicle access to the new tunnels.

The proposal is surrounded by a mix of commercial and residential receivers. Directly to the north of the proposal are several residential apartment buildings between King street and Euston Road. To the east of the proposal along Euston Road, receivers are predominantly of commercial use. Adjoining King Street between Campbell Road and Sydney Park Road receivers are a mix of commercial and residential use. The proposal adjoins the western and northern boundary of Sydney Park.

The locality of the proposal along with nearby sensitive receivers is shown in **Figure 1**. Receivers potentially sensitive to noise and vibration have been categorised as residential dwellings, commercial/industrial buildings, or 'other sensitive' land uses which includes educational institutions, child care centres, medical facilities, places of worship, outdoor recreation areas. The project area has been divided into seven noise catchments (NCAs) which are based on the building use (i.e residential / commercial) and logical boundaries to help describe construction noise impacts.

Figure 1 Site Overview Map and Noise Monitoring Location



2.1 Existing Noise Surveys and Monitoring Location

Unattended noise monitoring was completed in the study area during June 2021. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal.

The measured existing noise levels are representative of the background noise levels at receiver that would likely be most affected by the construction of the proposal across the project.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current National Association of Testing Authorities (NATA) calibration certificates and calibration was checked before and after each measurement.

The results of the noise monitoring have been analysed to exclude noise from extraneous events and data affected by adverse weather conditions, such as strong wind or rain (taken from the Bureau of Meteorology weather station located at Sydney Airport), to establish representative existing noise levels for the project area.

The noise monitoring location is shown in **Figure 1** and the results are summarised in **Table 1**. Details of the monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 1 Summary of Unattended Noise Logging Results

ID	Address	Measured Noise Level (dBA)					
		Background Noise (RBL)			Average Noise (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L01	206/44-43 Princes Hwy, St Peters	54	52	42	70	69	67

2.2 Attended Noise Measurements

Short-term attended noise monitoring was also completed at each monitoring location. The attended measurements allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Appendix B**.

The attended measurements were generally found to be consistent with the results of the unattended noise monitoring and show that existing noise levels are dominated by road traffic noise from the surrounding road network.

3 Legislative and Policy Context

3.1 Construction Noise and Vibration Guidelines

The guidelines and standards used to assess and manage noise and vibration from the construction of the proposal are listed in **Table 2**. The guidelines aim to protect the community and environment from excessive adverse noise and vibration impacts through the consideration and implementation of feasible and reasonable measures to mitigate impacts

Table 2 Construction Noise and Vibration Guidelines

Guideline/Policy Name	Where Guideline Used
Interim Construction Noise Guideline (ICNG) (DECC, 2009)	Assessment of airborne noise and ground-borne noise impacts on sensitive receivers
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces
Road Noise Policy (RNP) (DECCW, 2011)	Assessment of construction traffic impacts
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts (structural damage) to non-heritage sensitive structures
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999	Screening assessment of vibration impacts (structural damage) to heritage sensitive structures, where the structure is found to be unsound
Assessing Vibration: a technical guideline (DEC, 2006)	Assessment of vibration impacts on sensitive receivers
Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime Services, 2016)	Assessment and management protocols for airborne noise, ground-borne noise and vibration impacts for road infrastructure projects

3.1.1 NSW Interim Construction Noise Guideline

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The typical 'worst-case' noise levels from the construction of a project are determined and then compared to the NMLs in a 15 minute assessment period to determine the likely impact of the project at identified sensitive receivers.

The NMLs are applied as noise trigger levels not mandatory noise limits. Where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated and implemented.

3.1.2 Residential Receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at adjacent residential receivers based on measured $L_{A90(15minute)}$ rating background noise levels (RBL), as described in **Table 3**.

Table 3 Determination of NMLs for Residential Receivers

Time of Day	NML LAeq(15minute)	How to Apply
Standard hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practises to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	The Highly Noise Affected (HNA) 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 restructuring the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences. • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	RBL + 5 dBA	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practises have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Note 1 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy.

3.1.3 Sleep Disturbance

Where night works are located close to residential receivers there is potential for sleep disturbance impacts. The ICNG lists five categories of works that might be undertaken outside of Standard Construction Hours:

- The **delivery of oversized equipment or structures** that require special arrangements to transport on public roads
- **Emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
- **Maintenance and repair of public infrastructure** where disruption to essential services or considerations of worker safety do not allow work within standard hours
- **Public infrastructure works** that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies **a need to operate outside the recommended standard hours**.

Where construction works are planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be completed. The ICNG refers to the NSW *Environmental Criteria for Road Traffic Noise* for assessing the potential impacts, which notes that to limit the level of sleep disturbance the L_{A1} level should not exceed the existing L_{90} noise level by more than 15 dB. If this does occur, additional mitigation measures would be considered and implemented, where appropriate.

Other Sensitive' Land Uses and Commercial Receivers

A number of non-residential land uses have been identified in the study area. These include 'other sensitive' land uses such as educational institutes, medical facilities, outdoor recreational areas and commercial properties. The ICNG NMLs for 'other sensitive' receivers are shown in **Table 4**.

Table 4 ICNG NMLs for 'Other Sensitive' Receivers

Land Use	Noise Management Level $L_{Aeq(15minute)}$ (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion)	External noise level 60 dBA
Community centres	Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses
Commercial	External noise level 70 dBA

For certain receiver types, criteria presented in **Table 4** above is specified as an internal noise level. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation. Hospital wards are assumed to have fixed windows with 20 dB higher external levels.

3.2 NML Summary

Using the measured background noise levels in **Section 2.1** Error! Reference source not found., the NMLs derived for the project are detailed in **Table 5**.

Table 5 Residential Receiver NMLs for Construction

Standard Construction (RBL+10dB)	Out of Hours (RBL+5dB)			Sleep Disturbance (RBL+15dB)
Daytime	**Daytime**	**Evening**	**Night-time**	
64	59	57	47	57

3.3 Construction Vibration Criteria

The effects of vibration from construction works can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where building contents such as sensitive equipment may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

3.3.1 Human Comfort Vibration

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings.

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 6**.

Table 6 Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	**Maximum**
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

While the construction activities for this proposal are generally not expected to result in continuous or impulsive vibration impacts, it is noted that the construction activities are subject to refinement during detailed design. Continuous and impulsive criteria are shown in **Table 7**.

Table 7 Preferred and Maximum Weighted Root Mean Square Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1–80 Hz

Location	Assessment period	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Critical working areas[1] (eg operating theatres or precision laboratories where sensitive operations are occurring)	Day or night-time	0.0050	0.0036	0.010	0.0072
Residential	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical working areas[1] (eg operating theatres or precision laboratories where sensitive operations are occurring)	Day or night-time	0.0050	0.0036	0.010	0.0072
Residential	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Note 1: No critical working areas have been identified in the study area. This should be confirmed during the detailed design stage.

3.3.2 Effects on Building Contents

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes, are located in buildings near to construction works. Criteria for vibration sensitive equipment are discussed in **Section 3.3.7**.

3.3.3 Structural and Cosmetic Damage Vibration

If vibration from construction works is sufficiently high it can cause damage to structural elements of affected buildings. The levels of vibration required to cause cosmetic damage tend to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration.

Examples of damage that can occur includes cracks or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. Structural damage vibration limits are contained in British Standard BS 7385 and German Standard DIN 4150.

3.3.4 BS 7385

British Standard BS 7385 recommends vibration limits for transient vibration judged to give a minimal risk of vibration induced damage to affected buildings. The limits for residential and industrial buildings are shown in **Table 8**.

Table 8 BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	**15 Hz and Above**
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note 1: 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%.

For heritage buildings, the standard states that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive"*.

3.3.5 DIN 4150

German Standard DIN 4150 also provides guideline vibration limits for different buildings and buried pipework. Damage is not expected to occur where the values are complied with and the values are generally recognised to be conservative. The DIN 4150 values for buildings and structures are shown in **Table 9**.

Table 9 DIN 4150 Guideline Values for Short-term Vibration on Structures

Group	Type of Structure	Guideline Values Vibration Velocity (mm/s)				
		Foundation, All Directions at a Frequency of			**Topmost Floor, Horizontal**	**Floor Slabs, Vertical**
		1 to 10 Hz	**10 to 50 Hz**	**50 to 100 Hz**	**All frequencies**	**All frequencies**
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified as Group 1 or 2 **and** are of great intrinsic value (eg heritage listed buildings)	3	3 to 8	8 to 10	8	20[1]

Note 1: It may be necessary to lower the relevant guideline value markedly to prevent minor damage.

3.3.6 Heritage Items

Heritage buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound. Where a heritage building is deemed to be sensitive, the more stringent DIN 4150 Group 3 guideline values in **Table 9** can be applied.

3.3.7 Sensitive Scientific and Medical Equipment

Some scientific equipment, such as electron microscopes and microelectronics manufacturing equipment, can require stringent vibration goals.

Where vibration sensitive equipment is potentially affected by construction works, vibration limits for the operation of the equipment should be taken from manufacturer's data. Where this is not available the generic Vibration Criterion (VC) curves in **Table 10** can be used.

Table 10 VC Curves for Vibration Sensitive Equipment

Criterion Curve	Max Level (µm/sec, rms)[1]	Detail Size (microns)[2]	Description of Use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note: Vibration Criterion curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon – 28 September 1999).

3.3.8 Minimum Working Distances for Vibration Intensive Works

Minimum working distances for typical vibration intensive construction equipment are provided in the CNVG and are shown in **Table 11**. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Vibration Guideline). They are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

Table 11 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Rating/Description	Minimum Distance		
		Cosmetic Damage		Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1–2 tonne)	5 m	11 m	15 m to 20 m
	<100 kN (2–4 tonne)	6 m	13 m	20 m
	<200 kN (4–6 tonne)	12 m	15 m	40 m
	<300 kN (7–13 tonne)	15 m	31 m	100 m
	>300 kN (13–18 tonne)	20 m	40 m	100 m
	>300 kN (>18 tonne)	25 m	50 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	2 m	5 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	7 m	15 m	23 m
Large Hydraulic Hammer	1,600 kg (18 to 34 t excavator)	22 m	44 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	5 m to 40 m	20 m
Piling Rig – Bored	≤ 800 mm	2 m (nominal)	5 m	4 m
Jackhammer	Hand held	1 m (nominal)	3 m	2 m

The minimum working distances are indicative and would vary depending on the particular item of equipment and local geotechnical conditions. The distances apply to cosmetic damage of typical buildings under typical geotechnical conditions.

3.4 Construction Traffic

When construction related traffic moves onto the public road network, vehicle movements are regarded as 'additional road traffic' and the CNVG refers to criteria in the NSW EPA *Road Noise Policy* (RNP, 2011).

For Transport for NSW projects, an initial screening test is first applied by evaluating whether noise levels would increase by more than 2 dB (an increase in the number vehicles of approximately 60%) due to construction traffic. The screening assessment has been included in **Section 4.7**.

Where noise levels increase by more than 2 dB (ie 2.1 dB or greater) further assessment is required using the criteria presented in the Transport for NSW's *Noise Criteria Guideline*.

3.5 Operational Noise and Vibration Guidelines

The guidelines used to assess the potential operational road traffic impacts from the proposal are listed in **Table 12**. The guidelines aim to protect the community and environment from excessive noise and vibration impacts from the long-term operation of the proposal.

Table 12 Operational Road Traffic Noise and Vibration Guidelines

Guideline/Policy Name	When Guideline is Used
Road Noise Policy (RNP) (DECCW, 2011)	Operational road traffic noise assessment
Noise Criteria Guideline (NCG) (Roads and Maritime, 2015)	Defines Roads and Maritime's interpretation of the RNP and details how criteria is applied to sensitive receivers

3.5.1 Noise Criteria Guideline and NSW Road Noise Policy

Where a development has the potential to result in an increase in operational road traffic noise levels, the impacts on sensitive receivers are assessed under the NSW *Road Noise Policy* (RNP, 2011).

The *Noise Criteria Guideline* (NCG) provides Transport for NSW' interpretation of the RNP. The NCG provides a consistent approach to identifying road noise criteria for Transport for NSW projects.

Although it is not mandatory to achieve the noise assessment criteria in the NCG, project proponents need to provide justification if it is not considered feasible or reasonable to achieve them.

The Project is regarded as 'minor works'. The NCG notes the following with regard to minor works:

> *"Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments.*
>
> *These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic."*

3.5.2 Minor Works

The NCG applies existing road criteria where minor works increase noise levels by more than 2 dB at receivers from the 'No Build' to 'Build' scenarios.

For traffic operating on public roads the noise criteria for existing residences affected by additional traffic on existing sub-arterial roads are set out in **Table 13**.

Table 13 Target Noise Abatement Levels for Existing Road not Subject to Redevelopment

Existing Road Category	Target Noise Level (dBA)[1]	
	Daytime (7 am - 10 pm)	**Night-time (10 pm - 7 am)**
Freeway/arterial/sub-arterial road	$L_{Aeq(15hour)}$ 60	$L_{Aeq(9hour)}$ 55

Note 1: All criteria are external, applicable at the facade of the affected residence.

An assessment against the target noise levels as shown in **Table 13** would be undertaken where the proposal increased road traffic noise levels by more than 2 dB.

4 Construction Noise Assessment

4.1 Construction Airborne Noise Assessment Methodology

A noise model of the study area has been used to predict noise levels from the proposed construction works to all surrounding receivers. The model uses ISO 9613 algorithms in SoundPLAN software 8.0.

The noise prediction model included a detailed terrain model to develop a 3-dimensional (3D) representation of the study area. The terrain datasets comprised elevation contours of the existing ground along with the surrounding environment.

Building heights were determined from the referenced geospatial database. Receiver locations were located on all facades of every floor. The construction assessment presents the highest noise level per building.

The construction noise model considers:

- 3D ground terrain and the shielding attenuation provided topography and structures
- The location of construction works.
- All facades and floors of sensitive buildings have been considered as receiver points.
- The sound power levels of all plant and equipment which have the potential to operate simultaneously within any 15 minute period.
- Noise propagation calculated on the implementation of the noise propagation algorithm ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions, implemented in accordance with ISO/TR 17534-3 (2015), based on a typical ground absorption of 0.5, and zero for hard/acoustically reflective areas such as water

4.1.1.1 Working Hours

Where possible, construction of the proposal would be carried out during 'Standard Construction Hours'. Construction Hours are defined in the ICNG and shown in **Table 14**.

Table 14 Standard and Out of Hours Construction Hours[1]

Hour commencing	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Monday																								
Tuesday																								
Wednesday																								
Thursday																								
Friday																								
Saturday																								
Sunday																								
Public Holiday																								

Monday																								
Tuesday																								
Wednesday									**Standard**											**OOH[3]**				
Thursday				**OOH**					**Construction Hours[2]**											**Period 1**				
Friday				**Period 2**																**Evening**				
Saturday																								
Sunday									**OOH[3] Period 1**											**OOH[3]**				
Public Holiday									**Day**											**Period 2**				

Note 1: Taken from the TfNSW *Construction Noise and Vibration Strategy*.

Note 2: Standard Construction Hours are Monday to Friday 7 am to 6 pm and Saturdays from 8 am to 1 pm, as defined in the ICNG.

Note 3: OOH = Out of Hours (ie not during Standard Construction Hours).

However, the proposals specific constraints mean that evening and night-time works would be required to minimise impacts on road traffic, and for safety reasons.

Works would be required outside of Standard Construction Hours to:

- Minimise unacceptable traffic impacts on and disruptions to the road network and local utilities such as water, power and gas.
- Ensure the safety of the construction workers, motorists and the general public

The periods in which the construction works are expected to be required along with the compounding construction activity are shown in **Table 15**.

4.1.2 Construction Activities

The activities likely to be required to construct the project involve conventional road infrastructure construction equipment such as jackhammers, earth moving equipment, concreting equipment, paving plant, and small cranes.

A number of indicative scenarios have been developed to assess potential impacts associated with construction of the project and are shown in **Table 15**.

The individual items of equipment which form each construction scenario presented in **Table 15** along with the corresponding sound power levels are presented in **Appendix C**.

Table 15 Construction Activities and Period of Construction

Works ID	Scenario	Activity (dBA SWL)	Hours of Works[1]			
			Standard Day	Day OOH	Evening	Night
1	Mobilisation and Site Establishment	107	✓	-	-	-
2	Traffic Switches	116	✓	✓	✓	✓
3	Tree Felling	117	✓	-	✓	✓
4	Utility Locating	116	✓	-	✓	✓
5	Utility Relocation (noisy works)	117	✓	✓	✓	✓
6	Utility Relocation	108	✓	✓	✓	✓
7	Drainage infrastructure	115	✓	✓	✓	✓
8	Road Works – General Civil	119	✓	✓	✓	✓
9	Road Works – Milling Works	119	✓	✓	✓	✓
10	Paving Works – Pavement Works	118	✓	✓	✓	✓
11	Finishing Works	113	✓	✓	✓	✓

Note 1: OOH = Out of hours. During the daytime this refers to the period on Saturday between 7 am - 8 am and 1 pm - 6 pm, on Sunday and public holidays between 8 am - 6 pm.

4.1.3 Project Staging, Duration and Locality

The proposal would be constructed in two main construction zones over approximately 24 months from mid-2021 to Mid-2023. The two zones are noted as the following:

- Zone A: King Street and Princes Highway – Campbell Street to Sydney Park Road
- Zone B: Sydney Park Road – Princes Highway to Euston Road.

Airborne construction impacts have been modelled separately for Zone A and Zone B. All works activities shown in **Table 15** would be required in both Zone A and Zone B. The general works locations are shown in **Figure 2**.

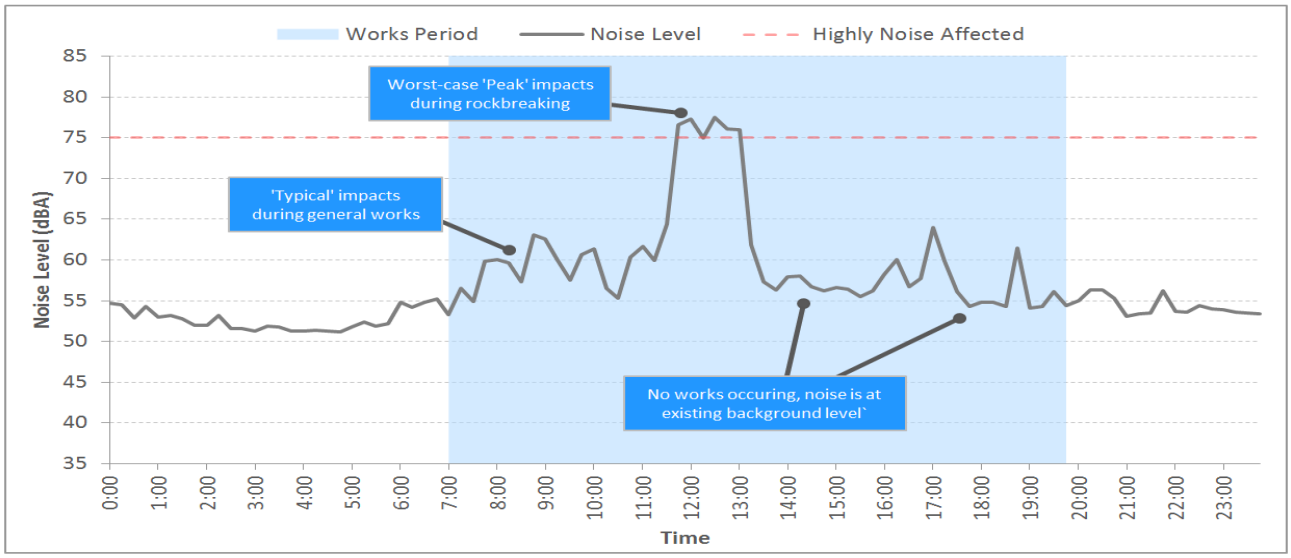
Figure 2 Construction Works Locations

4.2 Overview of Construction Impacts at Residential Receivers

The following overview is based on the predicted noise impacts at the most affected receivers in each NCA and is representative of the worst-case situation where construction equipment is at the closest point to each receiver.

For most works, the construction noise impacts would frequently be lower than predicted as the worst-case situation is typically only apparent for a relatively short period when noisy equipment is in use nearby. This concept is illustrated indicatively in **Figure 3** which shows noise levels measured next to major construction works during a period of 'Peak' impact and shows how construction noise levels can vary over the works period. The example below uses the noise impacts associated with a rock breaker to demonstrate the variability of construction noise levels.

Figure 3 Example of Indicative Construction Noise Levels



Note: The measurement location was around 40 m away from the works.

In the above example, while the worst-case noise levels result in Highly Noise Affected impacts, these only last for part of the works period and the noise levels during 'Typical' activities are much lower. There are also periods when no works are occurring and noise levels are at existing background level (eg road traffic and general urban hum).

The following assessment shows the predicted noise impacts based on the exceedance of the NML, as per the perception categories in **Table 16** which are taken from the CNVG. Residential receivers that are subject to noise levels of 75 dBA or greater are considered Highly Noise Affected by the ICNG and have been identified in **Section 4.2.3** .

Table 16 NML Exceedance Bands and Corresponding Subjective Response to Impacts

CNVG Perception Categories	Daytime –Standard Construction Hours		Out of Hours Periods	
	Symbol	**NML Exceedance**	**Symbol**	**NML Exceedance**
Noticeable	•	-[1]	♦	1 to 5 dB
Clearly Audible	●	1 to 10 dB	●	6 to 15 dB
Moderately Intrusive	◆	11 dB to 20 dB	◆	16 dB to 25 dB
Highly Intrusive	■	>20 dB	■	>25 dB

Note 1: Applicable for noise levels of 5-10 dB above RBL.

The predicted construction noise impacts are presented for the most affected receivers. Receivers which are further away from the works and/or shielded from view would have substantially lower impacts. The assessment is generally considered conservative as the calculations assume several items of construction equipment are in use at the same time within individual scenarios.

A summary of the predicted construction noise impacts in each NCA for residential receivers located in Zone A (King Street and Princes Highway – Campbell Street to Sydney Park Road) and Zone B (Sydney Park Road – Princes Highway to Euston Road) is shown in **Table 17** and **Table 18**, respectively.

Where impacts are predicted, the methods for controlling the impacts through the use of mitigation measures and management techniques are discussed in more detail in **Section 6**.

4.2.1 Zone A – King Street and Princes Highway – Campbell Street to Sydney Park Road

Table 17 Predicted Worst-case Construction Noise Exceedances – Residential Receivers

Period	ID	Scenario	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Daytime	1	Mobilisation and Site Establishment	●	●	◆	·	·	·	·
	2	Traffic Switches	◆	■	■	·	·	·	·
	3	Tree Felling	◆	■	■	●	·	·	·
	4	Utility Locating	◆	■	■	·	·	·	·
	5	Utility Relocation (noisy works)	◆	■	■	●	·	·	·
	6	Utility Relocation	●	◆	◆	·	·	·	·
	7	Drainage Infrastructure	◆	■	■	·	·	·	·
	8	Road Works – General Civil	◆	■	■	●	·	·	·
	9	Road Works – Milling Works	◆	■	■	●	·	·	·
	10	Paving Works – Pavement Works	◆	■	■	●	·	·	·
	11	Finishing Works	●	◆	■	·	·	·	·
Evening	1	Mobilisation and Site Establishment	·	·	·	·	·	·	·
	2	Traffic Switches	◆	■	■	●	·	·	·
	3	Tree Felling	◆	■	■	●	·	·	·
	4	Utility Locating	◆	■	■	●	·	·	·
	5	Utility Relocation (noisy works)	◆	■	■	●	·	·	·
	6	Utility Relocation	●	◆	◆	·	·	·	·
	7	Drainage Infrastructure	◆	■	■	●	·	·	·
	8	Road Works – General Civil	◆	■	■	●	·	·	·
	9	Road Works – Milling Works	◆	■	■	●	·	·	·
	10	Paving Works – Pavement Works	◆	■	■	●	·	·	·
	11	Finishing Works	◆	■	■	♦	·	·	·
Night time	1	Mobilisation and Site Establishment	·	·	·	·	·	·	·
	2	Traffic Switches	■	■	■	◆	♦	·	♦
	3	Tree Felling	■	■	■	◆	♦	·	♦
	4	Utility Locating	■	■	■	◆	♦	·	♦
	5	Utility Relocation (noisy works)	■	■	■	◆	♦	·	♦
	6	Utility Relocation	◆	■	■	●	·	·	·
	7	Drainage Infrastructure	■	■	■	◆	♦	·	♦
	8	Road Works – General Civil	■	■	■	◆	●	·	●
	9	Road Works – Milling Works	■	■	■	◆	●	·	●
	10	Paving Works – Pavement Works	■	■	■	◆	●	·	♦
	11	Finishing Works	■	■	■	●	♦	·	·

Key to impacts

Daytime (Standard Hours)
● Clearly Audible
1 dB to 10 dB NML Exceedance
◆ Moderately Intrusive
11 dB to 20 dB NML Exceedance
■ Highly Intrusive
> 20 dB NML Exceedance

Outside standard hours (Evening and night-time)
♦ Noticeable (Evening and Night
1 dB to 5 dB NML Exceedance
● Clearly Audible
6 dB to 15 dB NML Exceedance
◆ Moderately Intrusive
16 dB to 25 dB NML Exceedance
■ Highly Intrusive
> 25 dB NML Exceedance
Grey shading indicates no work during that time period

4.2.2 Zone B – Sydney Park Road – Princes Highway to Euston Road.

Table 18 Predicted Worst-case Construction Noise Exceedances – Residential Receivers

Period	ID	Scenario	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Daytime	1	Mobilisation and Site Establishment	·	·	·	◆	◆	·	·
	2	Traffic Switches	●	●	·	■	◆	·	·
	3	Tree Felling	●	●	·	■	■	·	·
	4	Utility Locating	●	●	·	■	◆	·	·
	5	Utility Relocation (noisy works)	●	●	·	■	■	·	·
	6	Utility Relocation	●	·	·	◆	◆	·	·
	7	Drainage Infrastructure	●	·	·	■	◆	·	·
	8	Road Works – General Civil	◆	●	·	■	■	·	·
	9	Road Works – Milling Works	◆	●	·	■	■	·	·
	10	Paving Works – Pavement Works	◆	●	·	■	■	·	·
	11	Finishing Works	●	·	·	◆	◆	·	·
Evening	1	Mobilisation and Site Establishment	·	·	·	·	·	·	·
	2	Traffic Switches	◆	●	♦	■	■	·	·
	3	Tree Felling	◆	●	♦	■	■	·	·
	4	Utility Locating	◆	●	♦	■	■	·	·
	5	Utility Relocation (noisy works)	◆	●	♦	■	■	·	·
	6	Utility Relocation	●	♦	·	◆	◆	·	·
	7	Drainage Infrastructure	●	●	♦	■	■	·	·
	8	Road Works – General Civil	◆	●	●	■	■	·	·
	9	Road Works – Milling Works	◆	●	●	■	■	·	·
	10	Paving Works – Pavement Works	◆	●	♦	■	■	·	·
	11	Finishing Works	●	●	·	■	◆	·	·
Night time	1	Mobilisation and Site Establishment	·	·	·	·	·	·	·
	2	Traffic Switches	■	◆	●	■	■	·	♦
	3	Tree Felling	■	◆	●	■	■	·	♦
	4	Utility Locating	■	◆	●	■	■	·	♦
	5	Utility Relocation (noisy works)	■	◆	●	■	■	·	♦
	6	Utility Relocation	◆	●	♦	■	■	·	·
	7	Drainage Infrastructure	◆	◆	●	■	■	·	·
	8	Road Works – General Civil	■	◆	◆	■	■	·	♦
	9	Road Works – Milling Works	■	◆	◆	■	■	·	♦
	10	Paving Works – Pavement Works	■	◆	●	■	■	·	♦
	11	Finishing Works	◆	◆	●	■	■	·	·

Key to impacts

Daytime (Standard Hours)

● Clearly Audible
1 dB to 10 dB NML Exceedance

◆ Moderately Intrusive
11 dB to 20 dB NML Exceedance

■ Highly Intrusive
> 20 dB NML Exceedance

Outside standard hours (Evening and night-time)

♦ Noticeable (Evening and Night
1 dB to 5 dB NML Exceedance

● Clearly Audible
6 dB to 15 dB NML Exceedance

◆ Moderately Intrusive
16 dB to 25 dB NML Exceedance

■ Highly Intrusive
> 25 dB NML Exceedance

Grey shading indicates no work during that time period

Table 17 and **Table 18** summaries the highest impact at the worst case receiver for each NCA. Receivers which are further away from the works and/or shielded from view would have substantially lower impacts than what are summarised in the tables above. Further breakdown of the level of NML exceedances per NCA is provided in **Appendix C** for each works scenario.

Receivers within NCA01, NCA02 and NCA03 experience higher noise levels when construction works are located within Zone A. NCA04 and NCA05 are predicted to experience the highest noise levels when works are located within Zone B.

Highly intrusive noise impacts are generally limited to the first row of receivers within both Zone A and B. Whilst the works are intrusive, works would progress along the road and as such the duration of the noise impacts would be expected to be relatively short at a specific receiver location.

As a result of works being located near to receivers in both Zone A and Zone B, highly intrusive (>25 dB NML exceedances) are predicted at the front row receivers when noise intensive equipment such as concrete saws and jackhammers are used. The use of noise intensive equipment would generally be limited to sporadic short periods. Noise levels and NML exceedances would drop by approximately 15 dB when the concrete saw is not in use.

Specific mitigations measures such as mobile plant screening (temporary noise barriers) and limiting the use of noise intensive equipment to before midnight would help mitigate noise levels and associated impacts. These specific mitigation measures should be specifically employed when works are conducted outside of standard hours.

4.2.3 Highly Noise Affected Residential Receivers

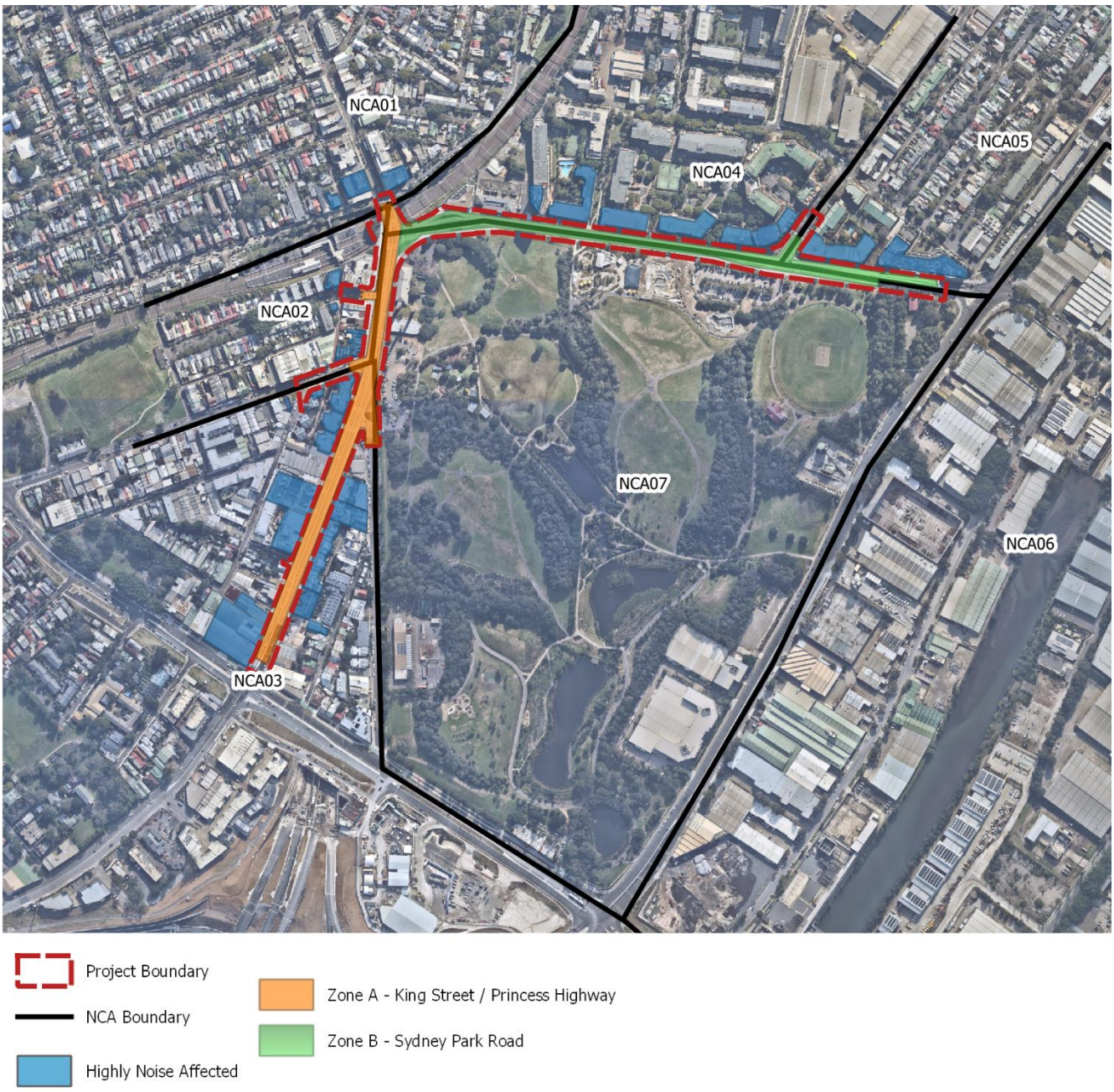
Residential receivers that are subject to noise levels of 75 dBA or greater are considered Highly Noise Affected by the ICNG. Receivers can be Highly Noise Affected when noisy works are occurring close to residents. The receivers which could potentially be Highly Noise Affected during the worst-case impacts from the project are summarised in **Table 19** and shown in **Figure 4**.

The predictions assume the worst-case scenarios are occurring at all locations and therefore present all Highly Noise Affected receivers in one assessment.

Table 19 Predicted Number of Highly Noise Affected Residential Receivers (Zone A and Zone B)

ID	Scenario	Count of Night-time Highly Noise Affected Receivers						
		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Zone A – Princes Highway – Campbell Street to Sydney Park Road								
1	Mobilisation and Site Establishment	-	7	11	-	-	-	-
2	Traffic Switches	1	13	13	-	-	-	-
3	Tree Felling	1	13	13	-	-	-	-
4	Utility Locating	1	13	13	-	-	-	-
5	Utility Relocation (noisy works)	1	13	13	-	-	-	-
6	Utility Relocation	-	8	12	-	-	-	-
7	Drainage Infrastructure	1	13	13	-	-	-	-
8	Road Works – General Civil	3	13	14	-	-	-	-
9	Road Works – Milling Works	3	13	14	-	-	-	-
10	Paving Works – Pavement Works	1	13	13	-	-	-	-
11	Finishing Works	-	12	12	-	-	-	-
Zone B – Sydney Park Road – Princes Highway to Euston Road								
1	Mobilisation and Site Establishment	-	-	-	3	-	-	-
2	Traffic Switches	-	-	-	7	2	-	-
3	Tree Felling	-	-	-	7	2	-	-
4	Utility Locating	-	-	-	7	2	-	-
5	Utility Relocation (noisy works)	-	-	-	7	2	-	-
6	Utility Relocation	-	-	-	5	1	-	-
7	Drainage Infrastructure	-	-	-	7	2	-	-
8	Road Works – General Civil	1	-	-	7	2	-	-
9	Road Works – Milling Works	1	-	-	7	2	-	-
10	Paving Works – Pavement Works	1	-	-	7	2	-	-
11	Finishing Works	-	-	-	7	2	-	-

Figure 4 Highly Noise Affected Receivers for both Zone A and Zone B



4.3 Other Sensitive Receivers

Other sensitive receivers identified near to the project are limited to public buildings within Sydney Park and the Park itself which is classified as a passive recreational area. NML exceedances greater than 25 dBA are predicted when works are within close proximity to Sydney Park Buildings, although noise levels across the general park area would only be approximately 5 dB above the NML daytime criteria of 60 dBA. The impacts presented above are based on all equipment working simultaneously in each assessed scenario. There would frequently be periods when construction noise levels are much lower than the worst-case predictions and there would be times when no equipment is in use and no exceedances occur.

4.4 Sleep Disturbance

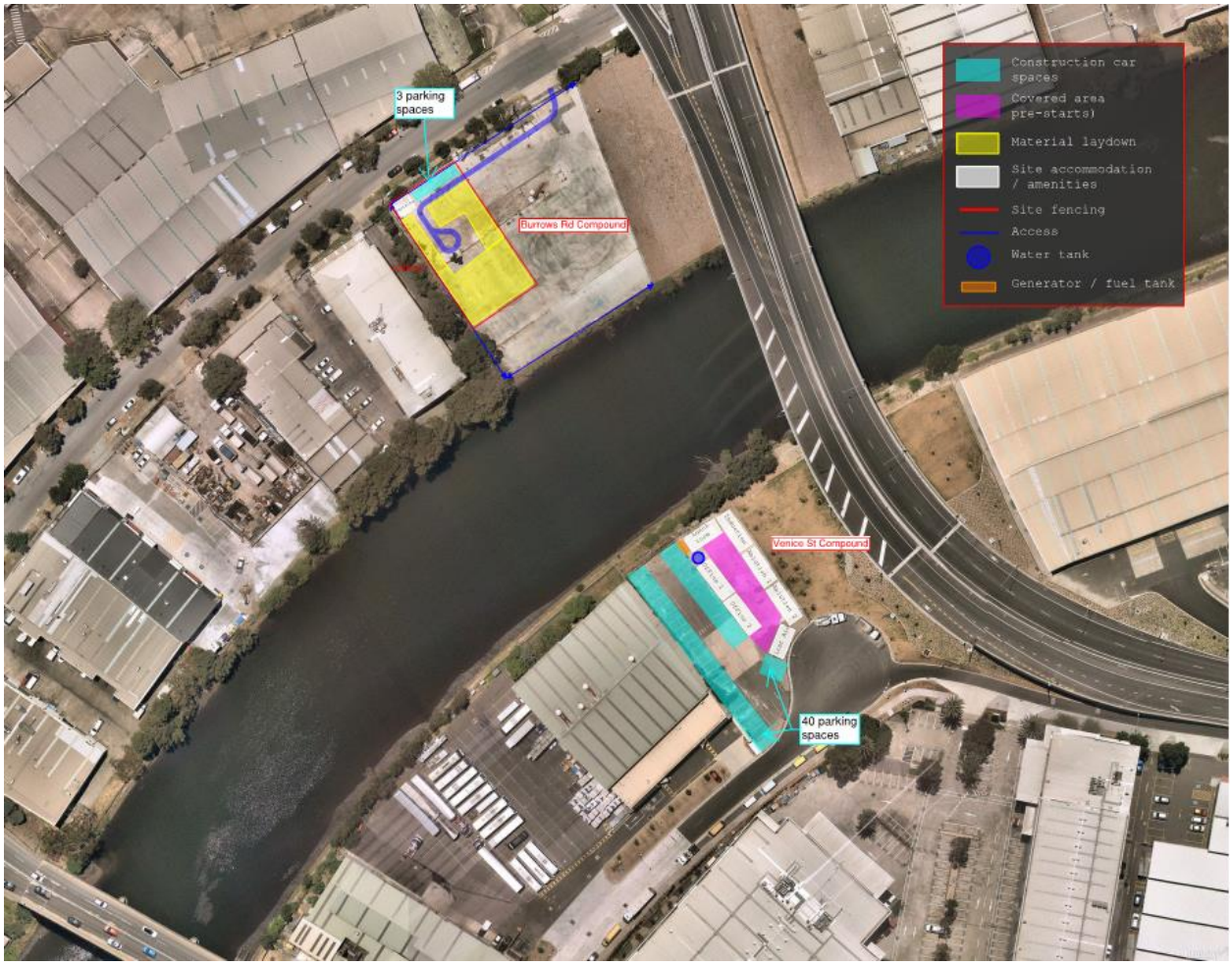
A Review of the predictions shows that the sleep disturbance screening criterion is likely to be exceeded when night works occur near residential receivers. The receivers which would potentially be affected by sleep disturbance impacts are generally the same receivers where 'highly intrusive' night-time impacts have been predicted. The number of receivers predicted to exceed the sleep disturbance screening criteria has been included in **Appendix C** for each works scenario and NCA.

The requirements for night-time works would be confirmed as the project progresses. Construction mitigation and management measures are discussed further in **Section 6**.

4.5 Construction Compounds

Two pre-existing compounds located off Burrows Road (previously utilised by WestConnex) would be used by the proposal, as shown in **Figure 5**. Compounds would be used for stockpiling and storage of equipment/materials and may be used during out-of-hours periods to support evening and night-time work. The nearest residential receiver to the compounds is around 350 m away to the west on the corner of Gardners Road and Kent Road and the potential noise impacts are expected to be negligible.

Figure 5 Construction Compound Locations



4.6 Construction Vibration Assessment

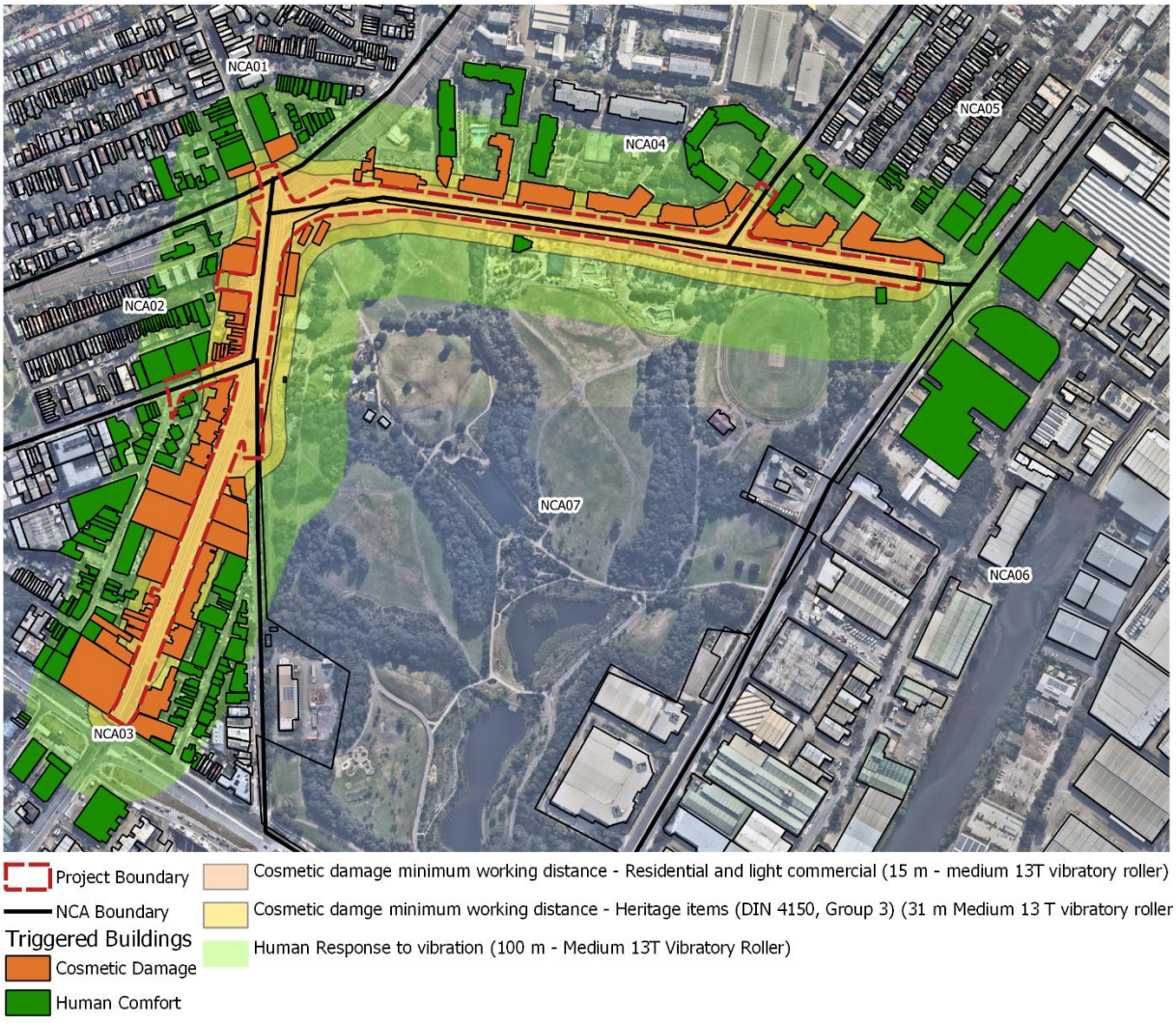
The main potential sources of vibration during construction would be from vibratory rollers and rock breakers. The construction scenarios which require vibration intensive equipment are shown in **Table 20**.

Table 20 Requirement for Vibration Intensive Equipment

ID	Scenario	Vibration Intensive Equipment
W.05	Utility Works – Relocation	Jackhammer
W.08	Road Works – Roadworks and Tie ins	Jackhammer, Vibratory Roller

Vibration offset distances have been determined from the CNVG minimum working distances for cosmetic damage, heritage and human response in **Table 11** for a medium vibratory roller (<300 kN (7–13 tonne)) and the assessment is summarised in **Figure 6** which indicates the minimum working distances for the selected items of plant. Where larger items of plant are required, such as a larger vibratory roller, the minimum distances would be as per the distances outlined in **Table 11**.

Figure 6 Construction Vibration Assessment – Medium Vibratory Roller



4.6.1 Cosmetic Damage Assessment

The above figure shows that the distance between the construction works and the nearest receivers are within the recommended minimum working distances. Buildings which are within the minimum working distances are shown in the figure.

Where works are within the minimum working distances and considered likely to exceed the cosmetic damage objectives, construction works would not proceed unless:

- A different construction method with lower source vibration levels is used, where feasible. This would include the use of smaller items of plant which would result in a lower level of vibration.
- Attended vibration measurements are carried out at the start of the works to determine the risk of exceeding of the vibration objectives and confirm the minimum working distances.

Where buildings are potentially affected by vibration, building condition surveys would be completed before and after works. Following confirmation of the specific location of vibration intensive works, building condition surveys should be considered for all buildings that are within the minimum working distances.

4.6.2 Human Comfort Vibration Assessment

As shown in the above figure, numerous receivers in the study area are also within the human comfort minimum working distance and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when equipment such as rock breakers or vibratory rollers are nearby.

4.6.3 Heritage Structures

The Sydney Park Junction Statement of Heritage Impact report (Heritage Report) prepared by Jacobs has identified ten heritage items that are located within the study area. Items that have been deemed to be of heritage significance in the heritage report and are likely to be impacted by vibration are listed below:

- St Peters Railway Station Group
- Electricity Substation No. 549
- Goodsell Estate Heritage Conservation Area
- St Peters Hotel, including interiors
- Former Brickworks Group
- King Street and Enmore Road Heritage Conservation area
- Former St Peters Theatre Façade
- King Street Heritage Conservation Area
- Tramways Road Corridor

The location of these heritage items in relation to the project is shown in Section 3 of the Heritage Report. All heritage items are within the minimum working distances for DIN 4150 group 3 for a medium size vibratory roller.

BS 7385 states that "a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive" and therefore buildings or structures should not be assumed to be sensitive to vibration on the basis of being classed a heritage item.

Heritage buildings are to be considered on a case by case basis and further investigation would be carried out during detailed design for all potentially affected structures. Where buildings or structures are considered sensitive to vibration, appropriate vibration criteria would be determined after detailed inspections have been completed. A dilapidation survey should be carried out to confirm the sensitivity of the item to vibration induced damage and the appropriate criteria applied.

4.7 Construction Traffic Noise Assessment

The existing traffic volumes along Princes Highway and Sydney Park Road is expected to be significantly greater than the proposed construction traffic volumes generated by the project and therefore an increase in traffic noise due to the construction traffic associated with the project of greater than 2dB is not considered likely. No mitigation is likely to be required as a result.

5 Operational Noise and Vibration Assessment

Transport for NSW proposes to improve the southern 'gateway' to King Street, Newtown by reducing the capacity of King Street, Princes Highway and Sydney Park Road and enhancing pedestrian and cyclist access between King Street, St Peters Station and Sydney Park (the proposal).

As a result of the improvements, an assessment of the residual traffic noise impacts from the redistributed traffic is required to be assessed for the surrounding roads outlined below:

- Princes Highway/King Street,
- Sydney Park Road,
- Campbell Road/Campbell Street,
- Euston Road,
- Mitchell Road, and
- Huntley Street

The improvements are considered to fall under a minor works assessment and therefore the change in noise levels associated with the redistributed traffic volumes have been assessed using spreadsheet calculations using the CoRTN algorithm.

The predicted change in noise level for each section of road is outlined in **Table 21** with the traffic volumes used for the assessment detailed in **Appendix D**.

Table 21 Change in Operational Noise Levels

Road Section	Predicted Increase in Operational Noise - L_{Aeq} (dBA)			
	2023		2033	
	Day 15hr	Night 9 hr	Day 15hr	Night 9 hr
King Street, north of Sydney Park Road Northbound	-1.4	-1.4	-0.2	-0.2
King Street, north of Sydney Park Road Southbound	-0.4	-0.4	-1.6	-1.6
Princes Highway, between Sydney Park Road and May Street Northbound	-2.1	-2.1	-5.1	-5.1
Princes Highway, between Sydney Park Road and May Street Southbound	-2.0	-2.0	-3.8	-3.8
Princes Highway, between May Street and Campbell Street Northbound	-2.9	-2.9	-2.2	-2.2
Princes Highway, between May Street and Campbell Street Southbound	-2.6	-2.6	-4.5	-4.5
Sydney Park Road, between Euston Road and Mitchell Road Eastbound	-0.3	-0.3	-0.3	-0.3
Sydney Park Road, between Euston Road and Mitchell Road Westbound	-0.6	-0.6	-0.7	-0.7
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Eastbound	-2.0	-2.0	-1.8	-1.8
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Westbound	-2.5	-2.5	-3.2	-3.2
Mitchell Road, north of Sydney Park Road Northbound	-0.9	-0.9	-1.0	-1.0
Mitchell Road, north of Sydney Park Road Southbound	-2.0	-2.0	-3.2	-3.2
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Northbound	0.0	0.0	0.3	0.3
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Southbound	-0.3	-0.3	0.3	0.3
Campbell Street / Campbell Road, between Euston Road and Princes Highway Eastbound	-0.5	-0.5	0.3	0.3
Campbell Street / Campbell Road, between Euston Road and Princes Highway Westbound	-0.3	-0.3	0.6	0.6
Huntley Street, east of Euston Road Eastbound	0.3	0.3	0.2	0.2
Huntley Street, east of Euston Road Westbound	-0.7	-0.7	0.0	0.0

The results indicate that there is a decrease in noise level on Princes Highway and Sydney Park Road as expected and a minor increase in redistributed traffic along Euston Road and Campbell Street/Campbell Road. The RNP notes that an increase of up to 2.0 dB represents a minor impact that is considered to be barely perceptible to the average person.

Given the marginal increase in operational traffic noise, no further assessment is required of the impacts of redistributed traffic.

6 Mitigation

6.1 Construction Noise Impacts

The ICNG acknowledges that due to the nature of construction works it is inevitable that there would be impacts where construction is near to sensitive receivers. Examples of potential mitigation and management measures which could be applied to the proposal to minimise the impacts are provided below.

6.1.1 Standard Mitigation Measures

The Transport for NSW *Construction Noise and Vibration Guideline* (CNVG) contains a number of 'standard mitigation measures' for mitigating and managing construction impacts. The measures are shown in **Appendix C** and should be applied to the works where feasible and reasonable.

6.1.2 Additional Mitigation Measures

Where noise impacts remain after the use of 'standard mitigation measures', the CNVG requires the use of 'additional mitigation measures' where feasible and reasonable. The 'additional mitigation measures' are determined on the basis of the exceedance of the appropriate management levels. Descriptions of the various measures are in **Appendix C**. The CNVG defines how 'additional mitigation measures' are applied to airborne noise impacts and the approach is shown in **Table 22**.

Table 22 CNVG Triggers for Additional Mitigation Measures – Airborne Noise

Predicted $L_{Aeq(15minute)}$ Airborne Noise Level at Receiver			Additional Mitigation Measures	
Perception	**dBA above RBL**	**dBA above NML**	**Type[1]**	**Mitigation Levels[2]**
All hours				
75 dBA or greater			N, V, PC, RO	HNA
Standard Hours: Mon – Fri (7am – 6pm), Sat (8am – 1pm), Sun/Public Holiday (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	<10	-	NML
Moderately Intrusive	20 to 30	10 to 20	N, V	NML+10
Highly Intrusive	>30	>20	N, V	NML+20
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Public Holiday (8am – 6pm)				
Noticeable	5 to 10	<5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately Intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly Intrusive	>30	>25	V, IB, N, R1, DR, PC, SN	NML+25

Predicted $L_{Aeq(15minute)}$ Airborne Noise Level at Receiver			Additional Mitigation Measures	
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Public Holiday (6pm – 7am)				
Noticeable	5 to 10	<5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately Intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly Intrusive	>30	>25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Note 1: N = Notification, SN = Specific Notification, PC = Phone Calls, IB = Individual Briefings, R1 = Respite Period 1, R2 = Respite Period 2, RO = Project Specific Respite Offer, DR = Duration Respite, AA = Alternative Accommodation, V = Verification.

Note 2: NML = Noise Management Level, HNA = Highly Noise Affected (ie 75 dBA or greater for residential receivers).

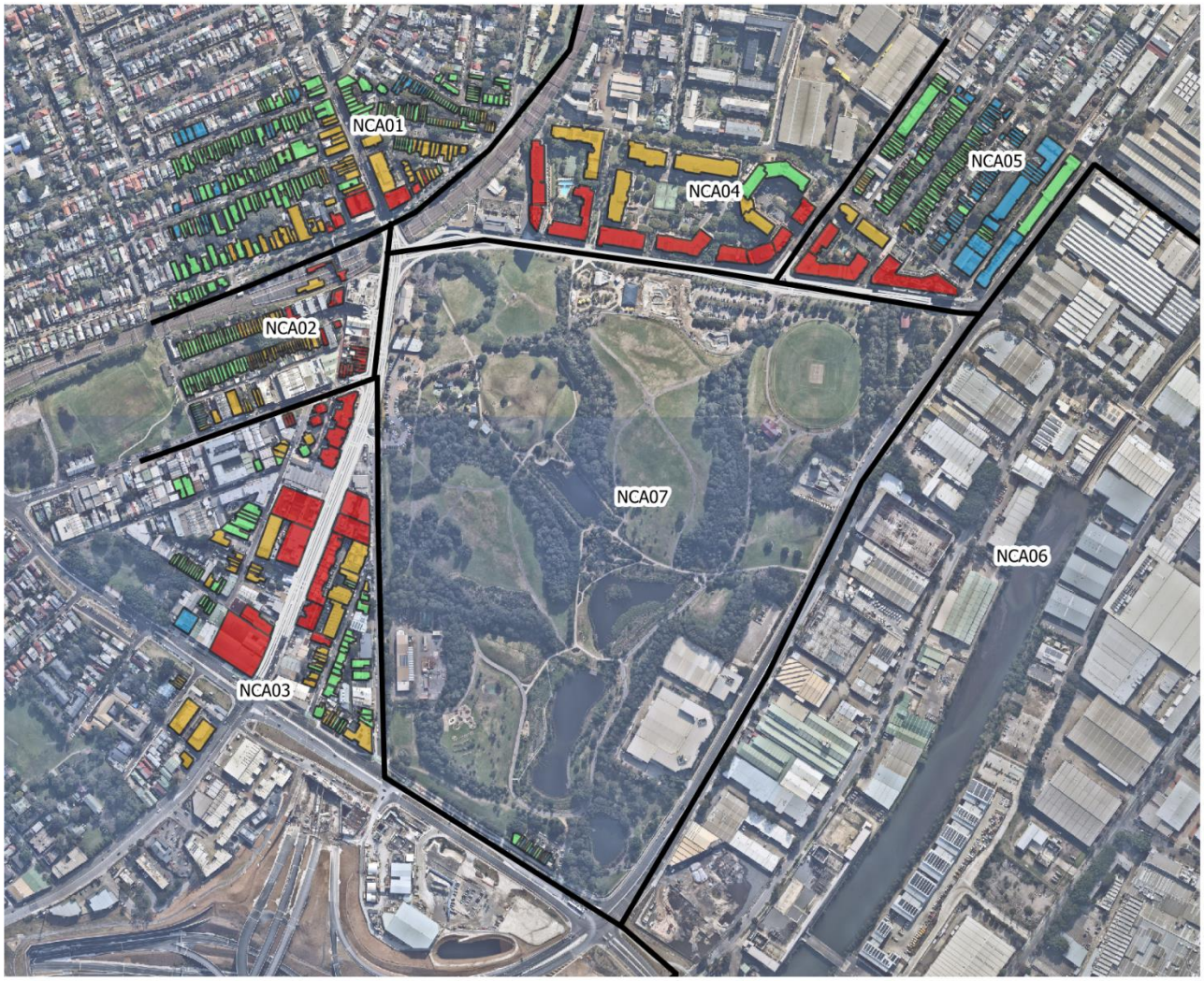
The requirement for 'additional mitigation measures' would be further evaluated as the proposal progresses and detailed construction scheduling information becomes available. A Construction Noise and Vibration Management Plan would be prepared prior to works commencing which would detail the approach to providing mitigation during construction.

Indicative Additional Mitigation Measures

Using the airborne noise construction predictions in **Section 4**, indicative worst-case 'additional mitigation measures' for all construction works on the project have been determined as per the requirements of the CNVG (see **Table 22**). The required 'additional mitigation measures' are shown for night-time construction noise in **Figure 7**.

The figure show the required 'additional mitigation measures' based on the CNVG 'perception' categories in **Table 22**.

Figure 7 Indicative Worst-case Additional Mitigation Measures for All Construction Activities during the Night-time



Note: The night-time 'Additional Mitigation Measures' are: Clearly Audible = V, N, R2, DR, Moderately Intrusive = V, IB, N, PC, SN, R2, DR, Highly Intrusive = AA, V, IB, N, PC, SN, R2, DR (see **Table 22** for requirement definitions).

6.2 Construction Vibration Impacts

The separation distance(s) between the proposed works and the nearest receivers are likely to fall below the safe working distances with regard to *'Cosmetic Damage*' for the proposed construction equipment.

Where works are within the minimum working distances and are considered likely to exceed the cosmetic damage objectives, construction works would not proceed unless a different construction method with lower source vibration levels is used, where feasible. This would include the use of smaller items of plant which would result in a lower level of vibration.

Attended vibration monitoring or vibration trials would be undertaken when the proposed works are below the safe working distances to ensure that levels remain below the criterion. If there is a risk that buildings may be impacted by the proposed works building condition surveys would be undertaken both before and after the works at all potentially affected properties to identify existing damage and any project related damage.

6.3 Recommended Operational Road Traffic Noise Mitigation Measures

No mitigation for operational road traffic noise is required as the increase in noise level is predicted to be less than 2.0 dB at all receivers.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

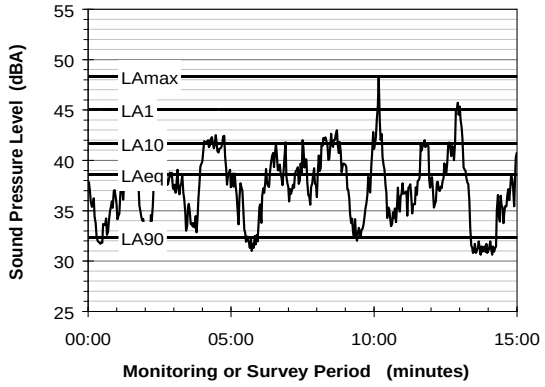
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

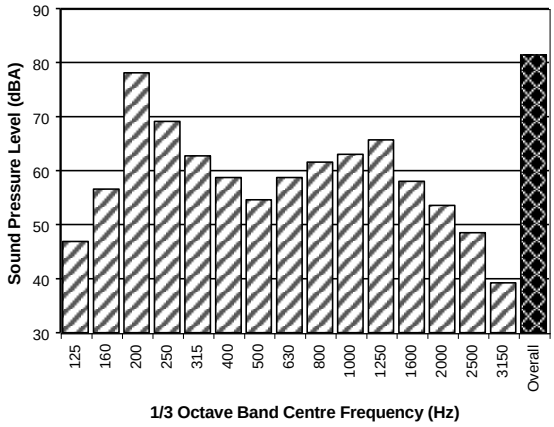
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

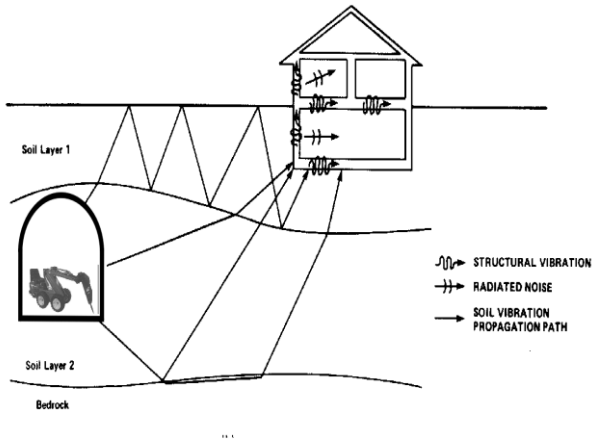
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

APPENDIX B

Ambient Noise Survey

Noise Monitoring Location	L.01
Noise Monitoring Address	**206/44-43 Princes Highway, St Peters**

Noise Monitor Device Type: Svantek 957, Noise Monitor Serial No: 23815
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3029485

Ambient noise logger deployed at residential address 206/44-43 Princes Highway, St Peters. Noise Monitor located with direct view of Princes Highway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Princes Highway. Frequent light and heavy-vehicle passbys on Princes Highway contribute to the LAeq at this location.

Recorded Noise Levels (LAmax) 1/04/2021:

Light-vehicle traffic on Princes Highway: 71 to 82 dBA
Heavy-vehicle traffic on Princes Highway: 74 to 84 dBA
Birds – 56 dBA
Aircraft – 62 dBA

Map of Noise Monitoring Location

Ambient Noise Monitor Results ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	54	70	71	76
Evening	52	69	72	76
Night-time	42	67	69	75

Ambient Noise Monitor Results RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	70	74
Night-time (10pm-7am)	67	74

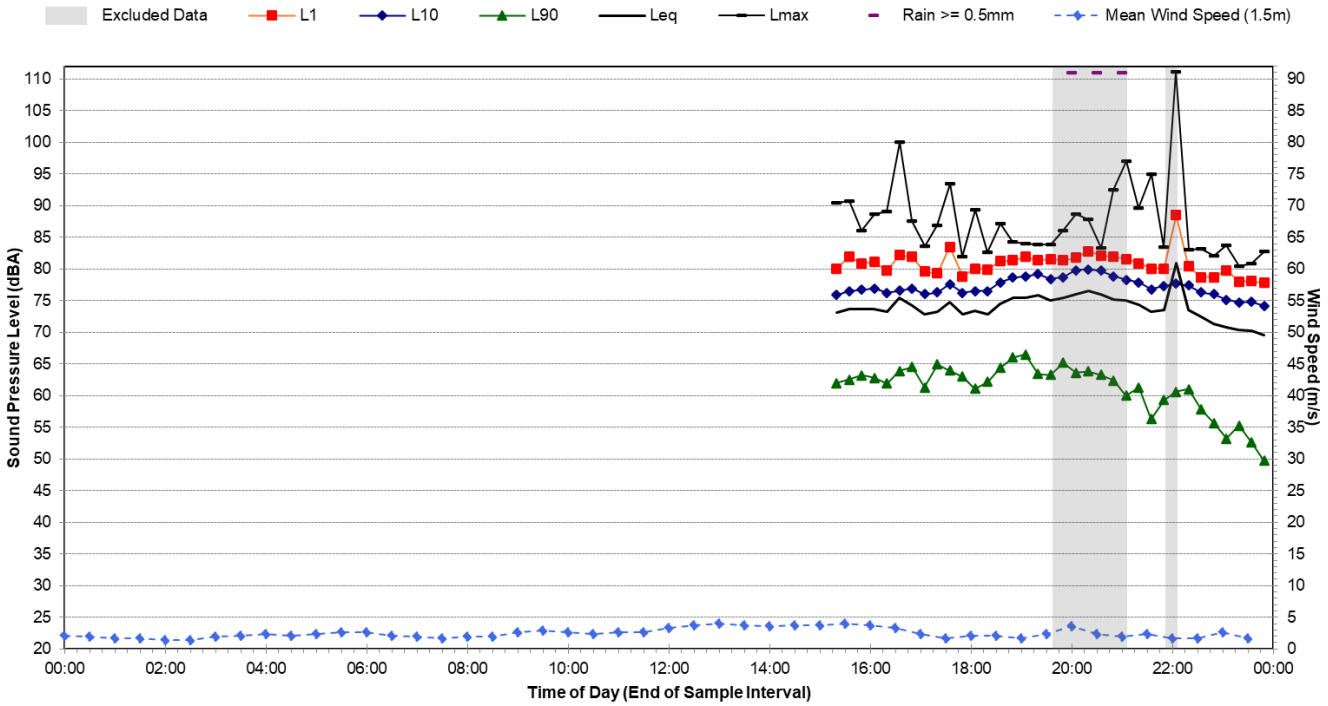
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
8/06/2021	15:08	70	58	84

Photo of Noise Monitoring Location

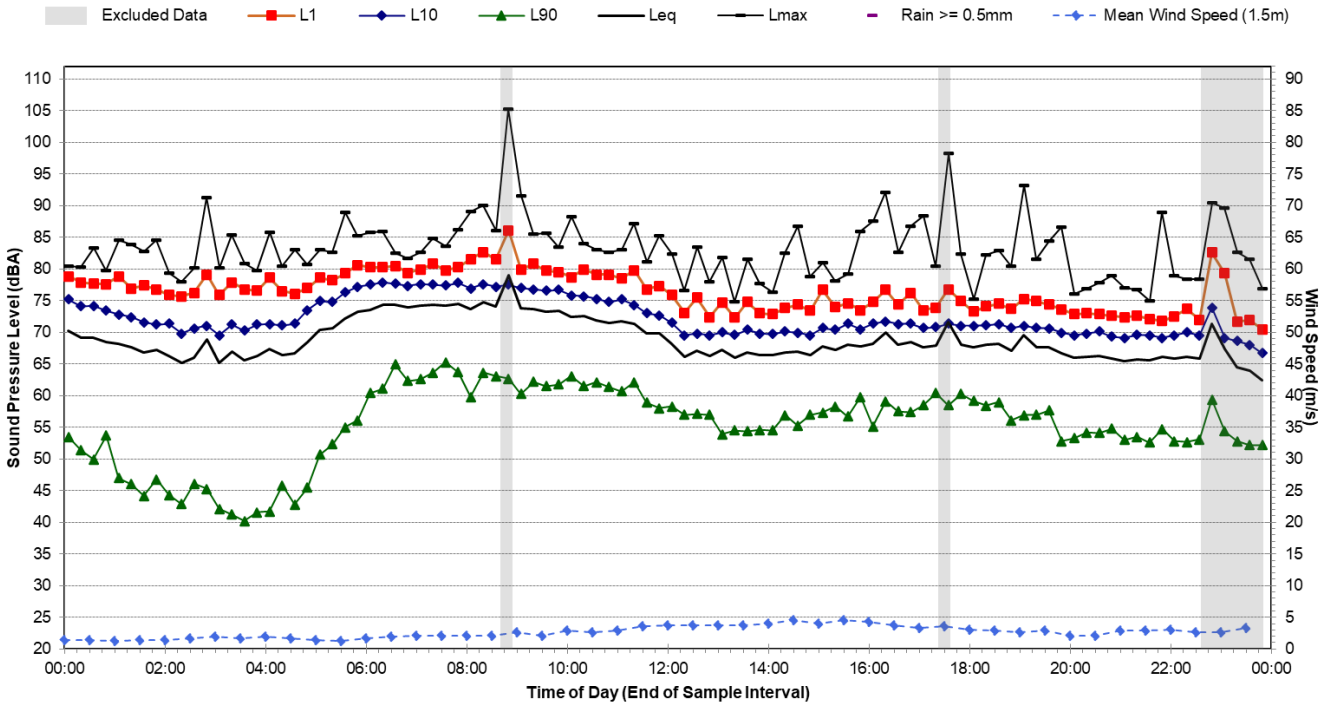
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Tuesday, 8 June 2021



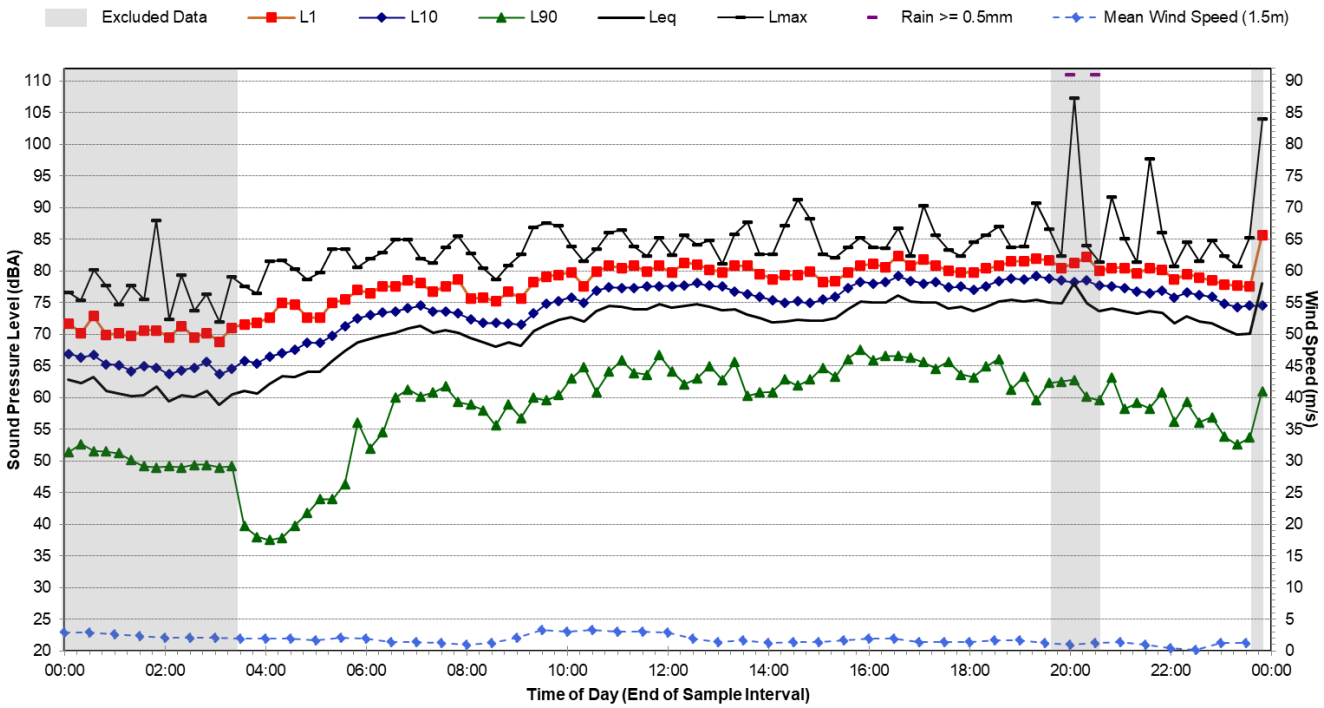
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Wednesday, 9 June 2021



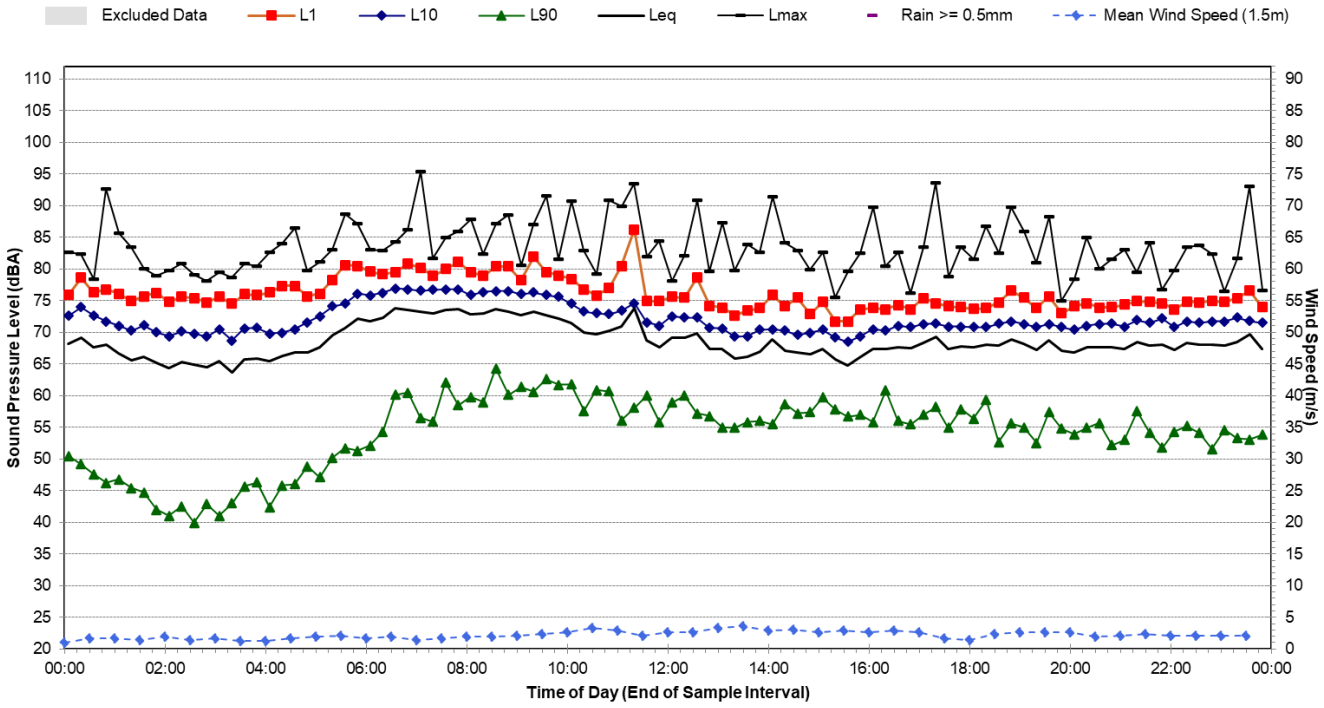
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Thursday, 10 June 2021



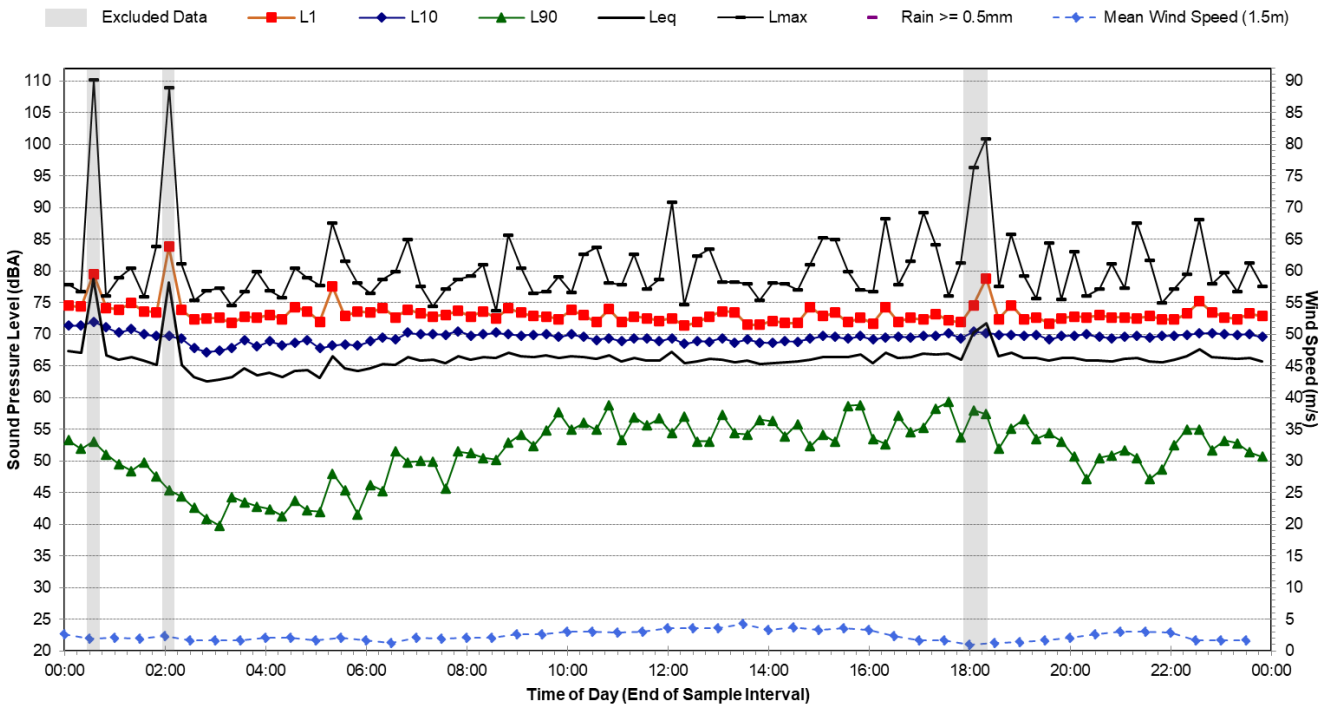
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Friday, 11 June 2021



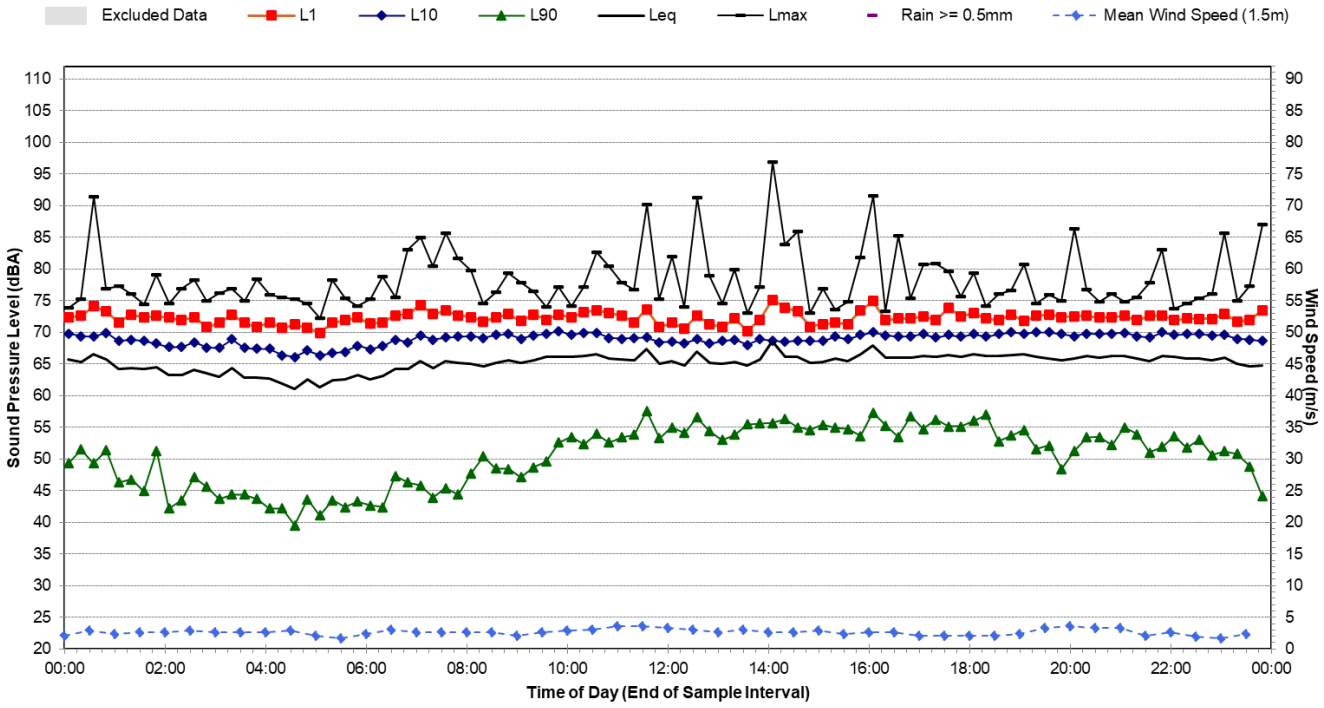
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Saturday, 12 June 2021



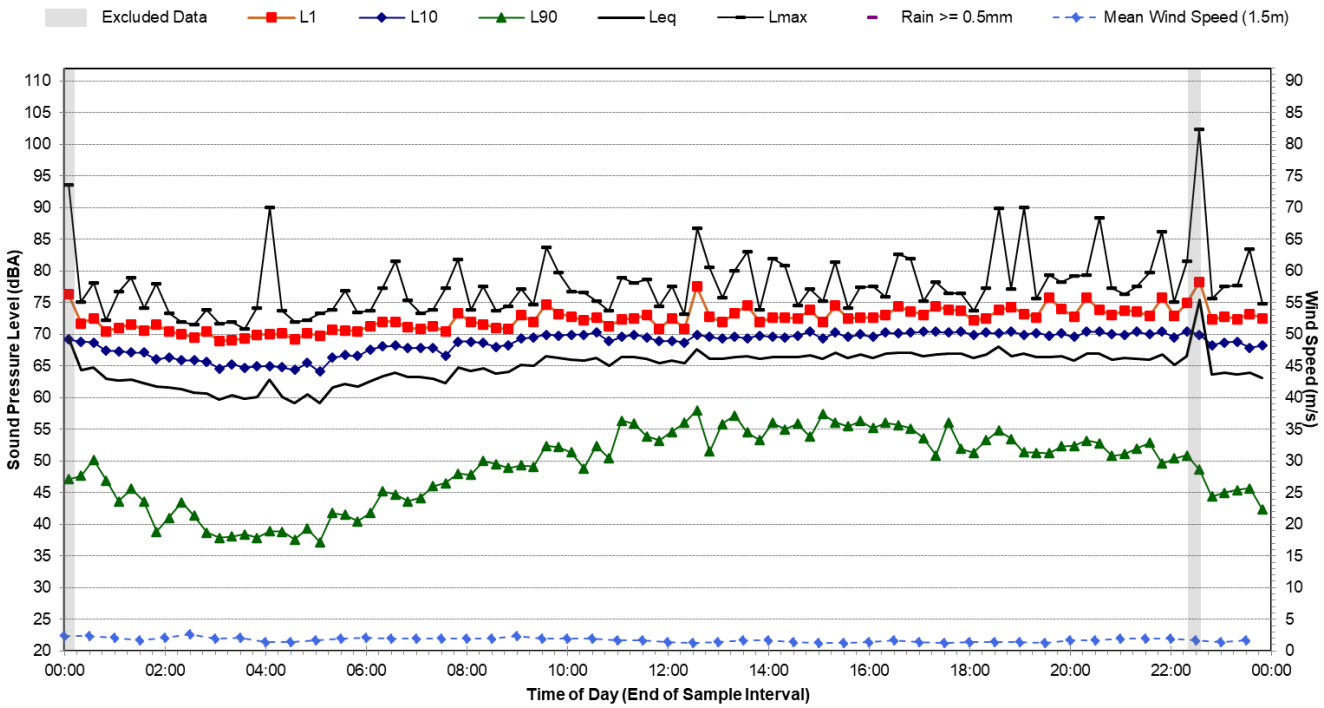
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Sunday, 13 June 2021



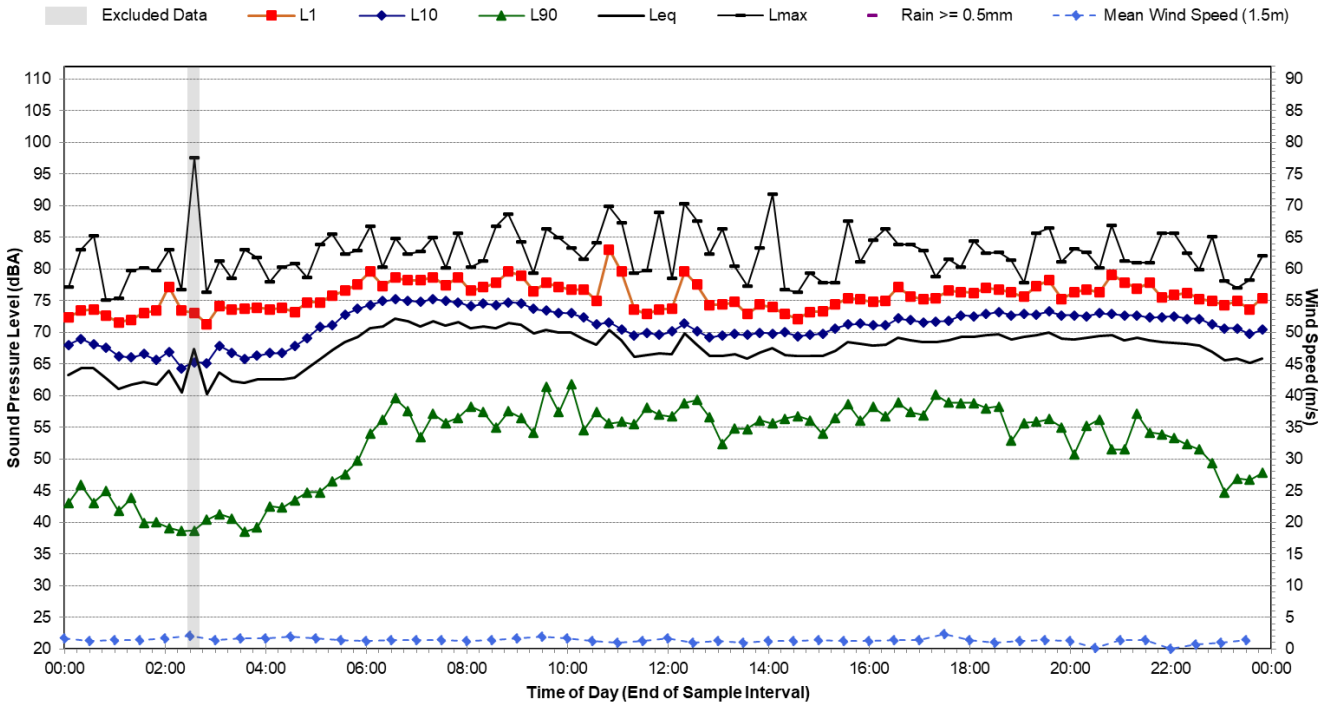
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Monday, 14 June 2021



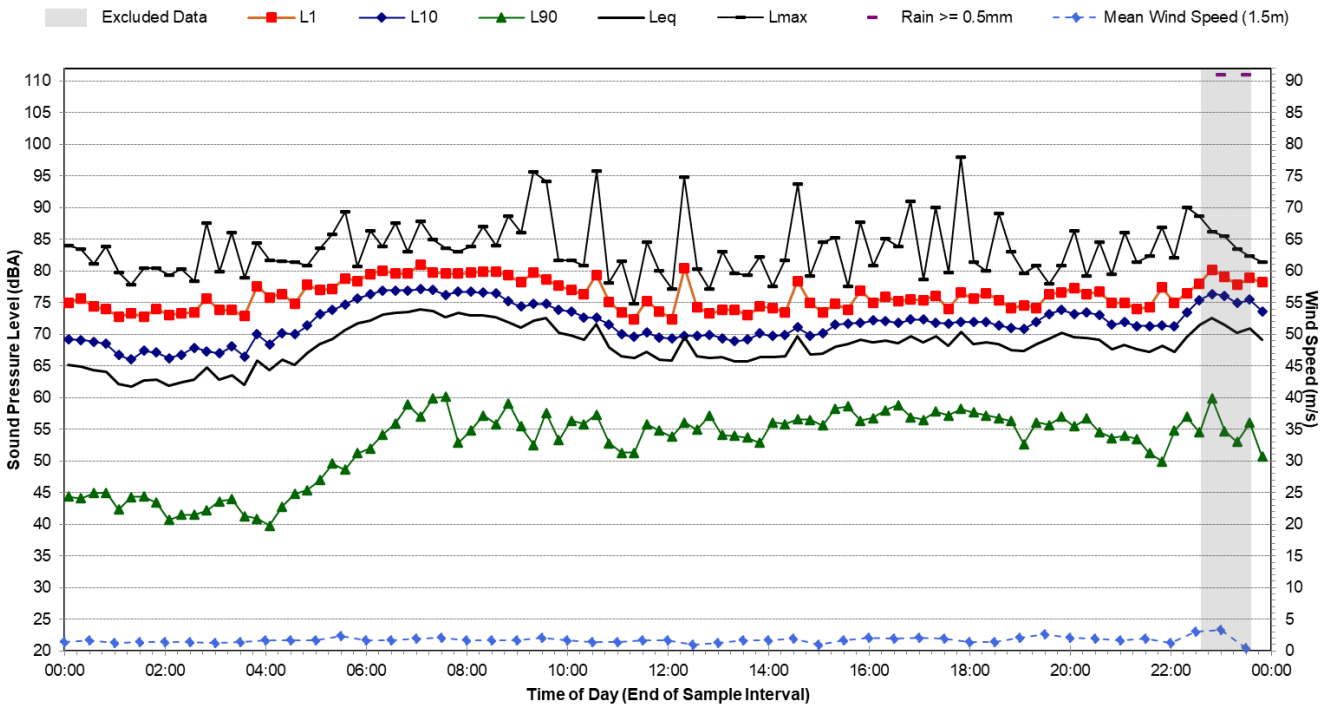
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Tuesday, 15 June 2021



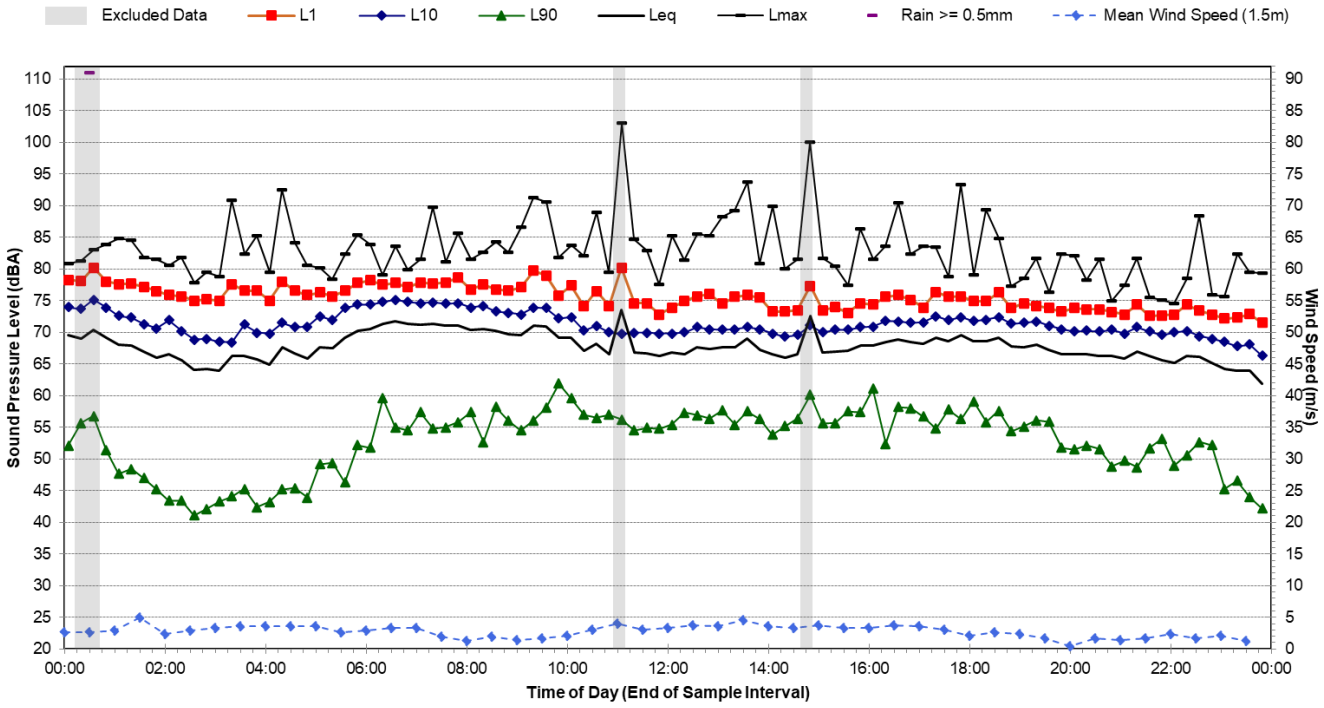
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Wednesday, 16 June 2021



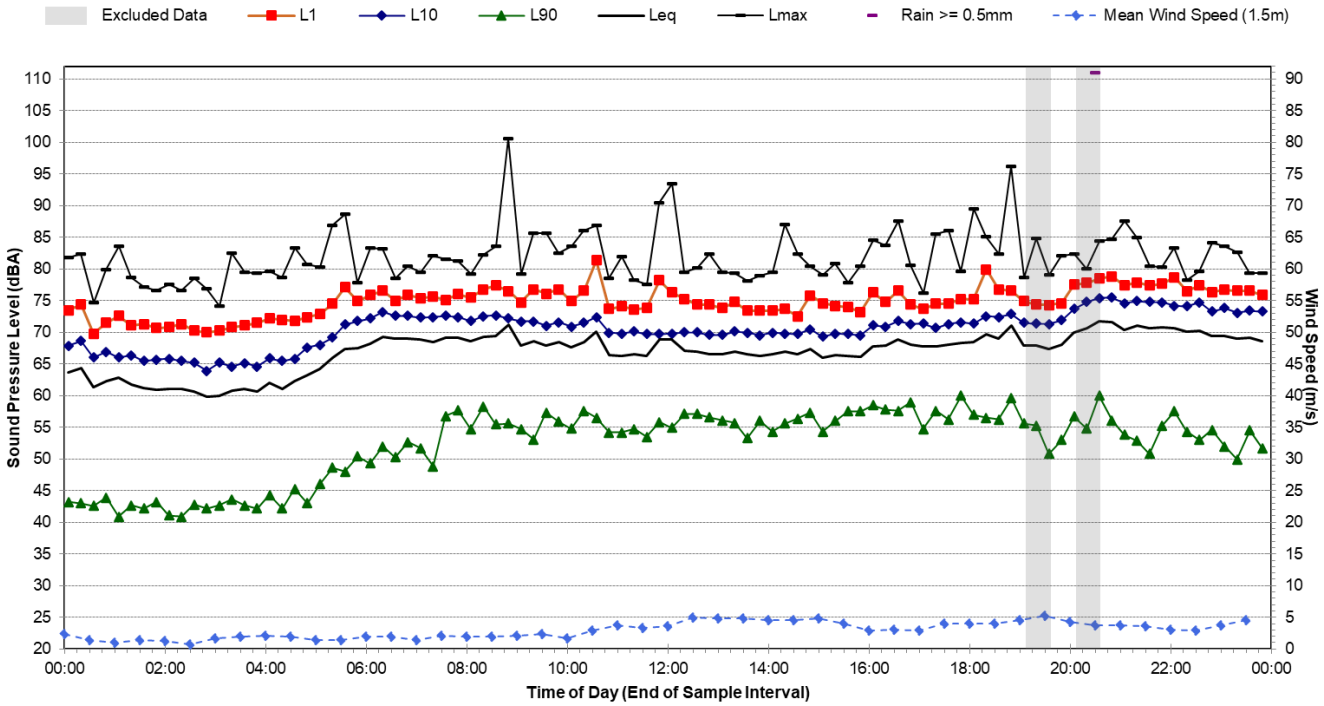
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Thursday, 17 June 2021



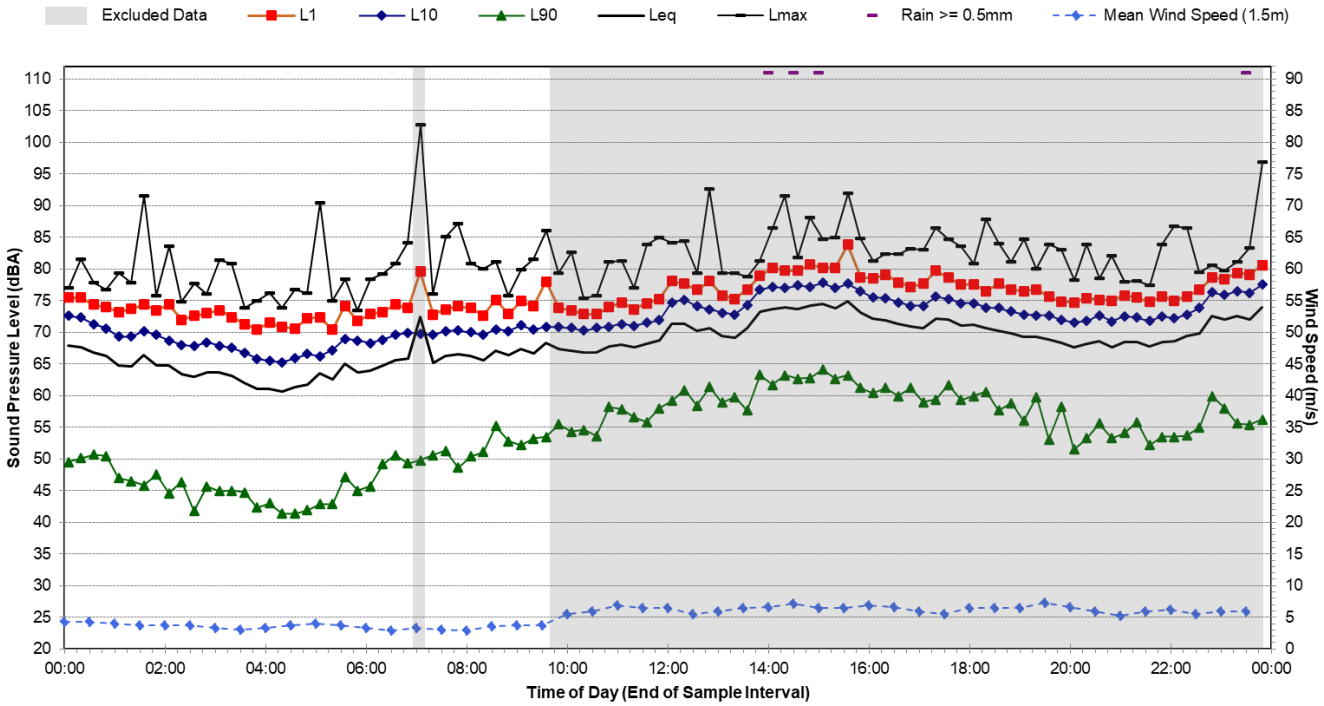
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Friday, 18 June 2021



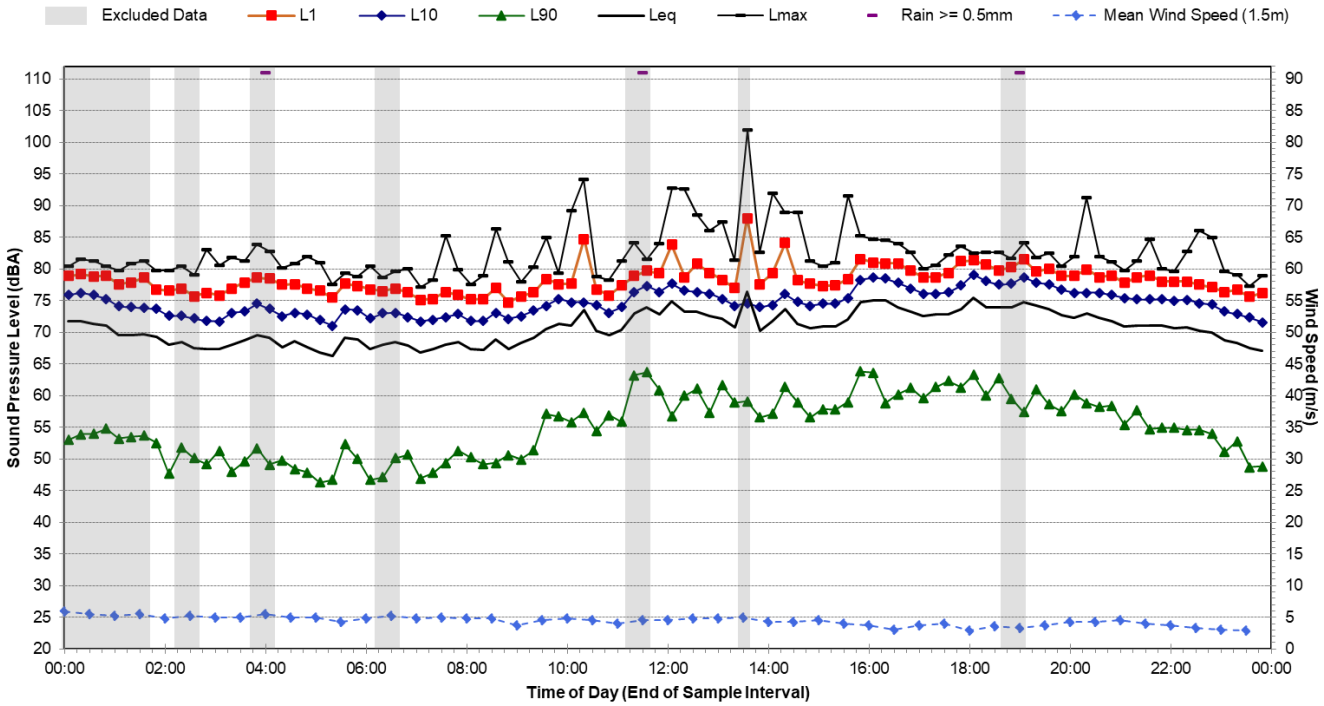
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Saturday, 19 June 2021



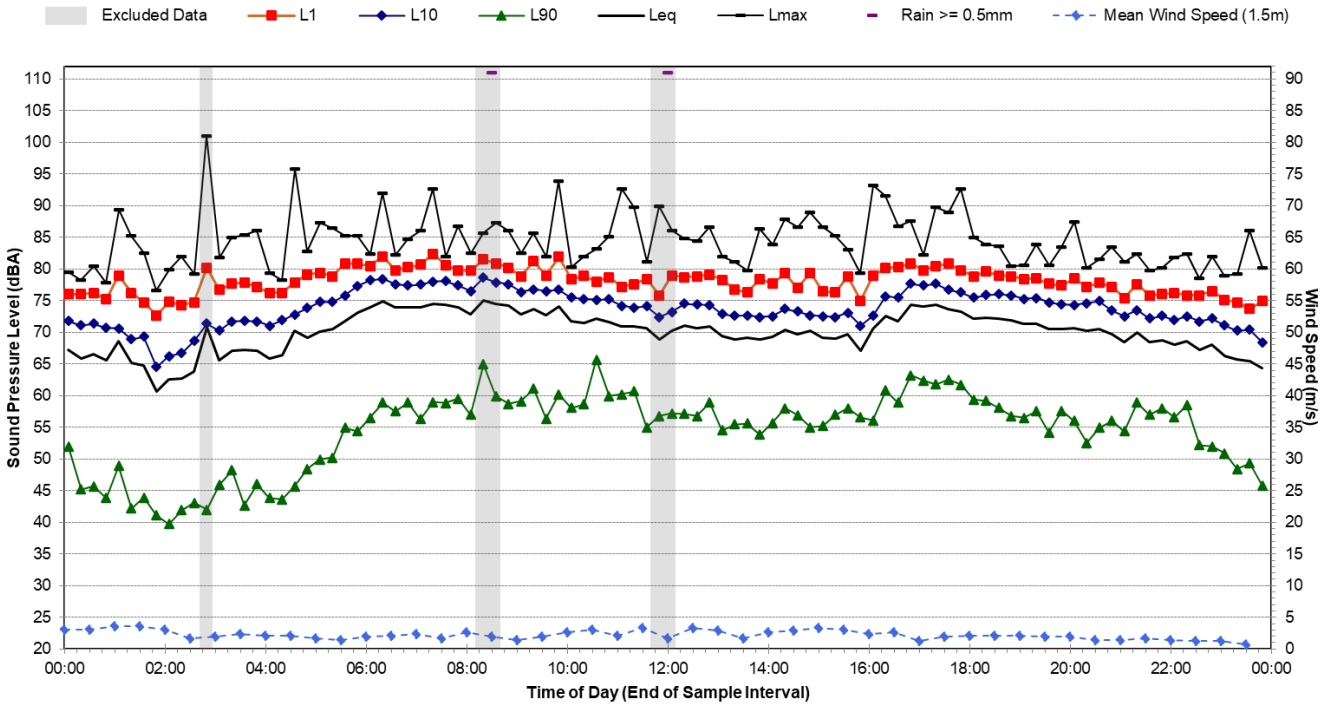
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Sunday, 20 June 2021



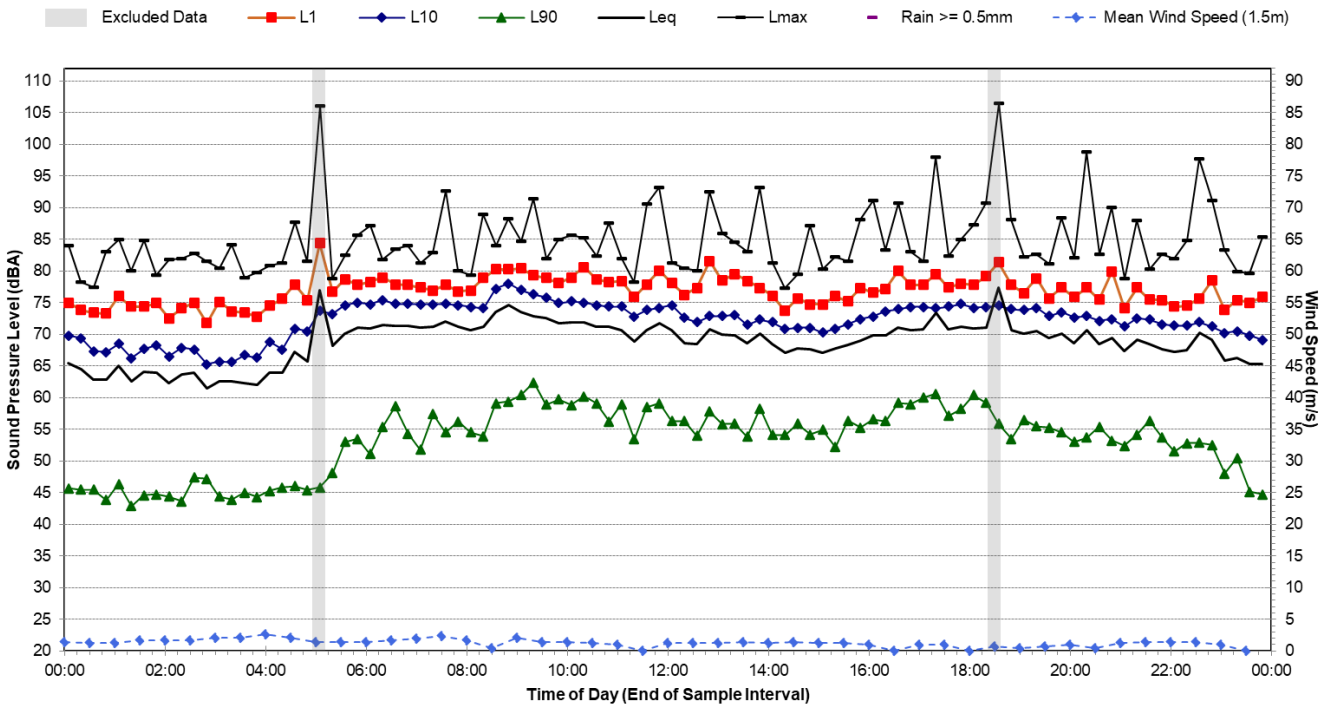
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Monday, 21 June 2021



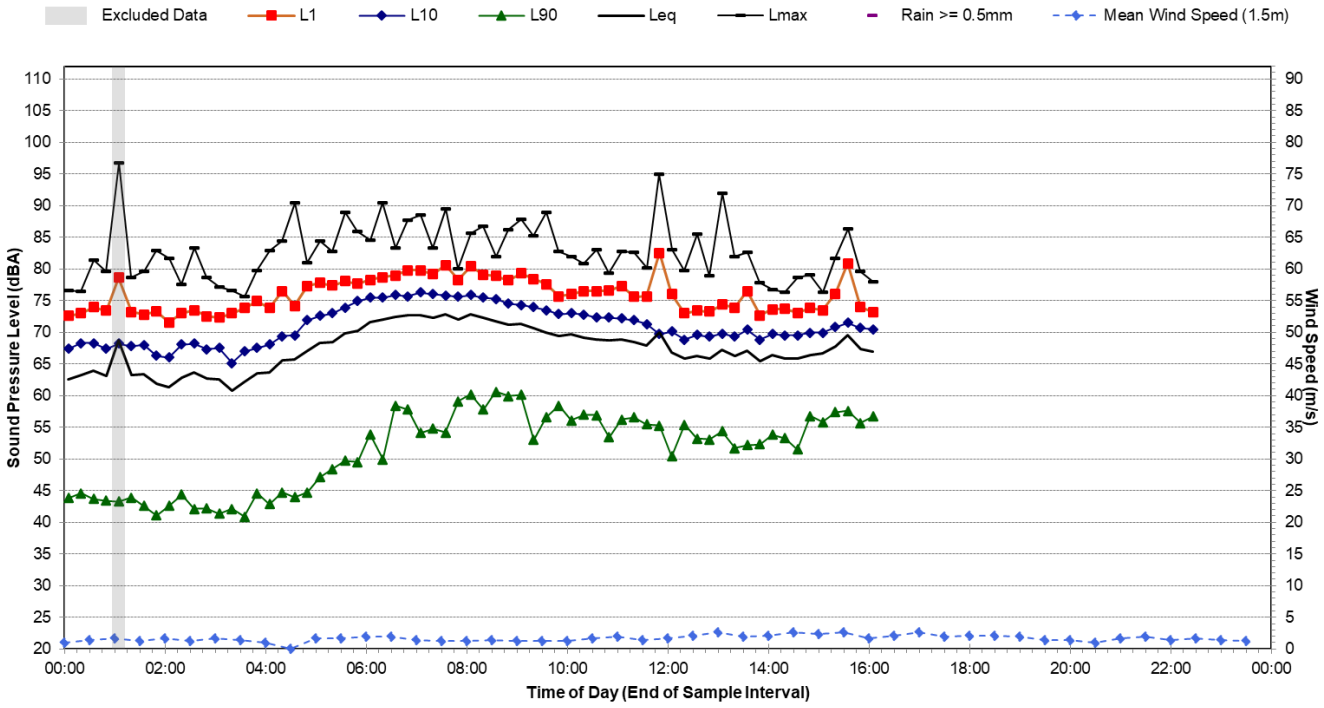
Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Tuesday, 22 June 2021



Statistical Ambient Noise Levels

206/44-46 Princes Highway, St Peters - Wednesday, 23 June 2021



APPENDIX C

Construction Information

Table 1 Equipment Lists and Sound Power Levels

Equipment		Auger Drill Rig	Back Hoe (7.5 tonne JCB)	Chainsaw[1]	Concrete Mixer Truck	Concrete Pump	Concrete Saw1	Concrete Vibrator	Elevated Working Platform	Excavator (Breaker Small)[1]	Excavator (22 tonne)	Generator	Hand Tools (5mins)	Hand Tools (electric)	Lighting Diesel Generator	Line Marking Plant	Line Marking Removal Plant	Mobile Crane Franna	Mobile Crane (35 tonne)	Paving Machine	Plate compactor	Road Profiler	Roller Smooth Drum	Roller Vibratory (12 tonne)[1]	Scissor Lift	Skidsteer Loaders (approx 1/2 tonne)	Suction Truck	Truck	Tub Grinder	Ute (5mins)
Sound Power Level[2]		111	102	114	103	106	119	102	97	117	105	102	94	96	98	108	109	98	98	114	108	117	107	109	92	97	109	107	116	98
Activity																														
W.01	Mobilisation and Site Establishment										X		X		X			X							X			X		X
W.02	Traffic Switches						X									X	X	X										X		
W.03	Tree Felling			X					X					X	X				X									X	X	
W.04	Utility Locating						X							X	X						X						X	X		
W.05	Utility Relocation (Noisy works)	X							X	X				X	X			X			X						X	X		
W.06	Utility Relocation										X			X	X						X					X		X		
W.07	Drainage Infrastructure		X		X		X				X							X			X									
W.08	Road Works – General Civil				X	X		X		X										X				X		X	X	X		
W.09	Road Works – Milling Works						X								X							X				X		X		
W.10	Paving Works – Pavement Works						X								X					X			X					X		
W.13	Finishing Works										X				X	X	X	X							X			X		

Note 1: Equipment classed as 'annoying' in the ICNG and requires an additional 5 dB correction.

Note 2: Sound power level data is taken from the DEFRA Noise Database, RMS *Construction and Vibration Guideline* and TfNSW *Construction Noise and Vibration Strategy*.

Table 2 CNVG Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures.	Airborne noise Ground-borne noise & vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.

Action Required	Applies To	Details
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration Airborne noise	See Appendix C of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.
Rental plant and equipment.	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.

Action Required	Applies To	Details
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor control		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C of the CNVG for additional measures	Airborne noise Ground-borne vibration	In some instances additional mitigation measures may be required.

Table 3 CNVG 'Additional Mitigation Measures'

Additional Mitigation Measure	Description
Notification (letterbox drop or equivalent)	Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of five working days prior to the start of works.
Specific notifications (SN)	Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops.
Phone calls (PC)	Phone calls detailing relevant information made to affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs.
Individual briefings (IB)	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
Respite Offers (RO)	Respite Offers should be considered where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects.
Respite Period 1 (R1)	Out of hours construction noise in 'out of hours period 1' shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than six evenings per month.
Respite Period 2 (R2)	Night time construction noise in 'out of hours period 2' shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and six nights per month. Where possible, high noise generating works shall be completed before 11pm.
Duration Respite (DR)	Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly. The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite.
Alternative Accommodation (AA)	Alternative accommodation may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels. The specifics of the offer should be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.
Verification (V)	Verification of construction noise and vibration levels should occur to ensure the actual impacts are consistent with the predicted levels. Appendix F of the CNVG contains further details about verification of Noise and Vibration levels as part of routine checks of noise levels or following reasonable complaints.

Table 4 Predicted NML Exceedances, All Receiver Types – NCA01

ID	Scenario	Number of Receivers																		
		Total	HNA [1]	With NML Exceedance[2]																
				Standard Daytime			Out of Hours Works[3]													
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	261	-	1	-	-	7	1	-	-	8	4	-	-	38	27	4	-	44	8	-
W.02	Traffic Switches – Zone A	261	1	18	1	-	26	18	1	-	36	20	3	-	108	101	20	3	170	57	12
W.03	Tree Felling – Zone A	261	1	21	1	-	31	21	1	-	38	27	4	-	88	120	27	4	148	38	6
W.04	Utility Locating – Zone A	261	1	18	1	-	26	18	1	-	36	20	3	-	108	101	20	3	170	57	12
W.05	Utility Relocation (Noisy Works) – Zone A	261	1	21	1	-	31	21	1	-	38	27	4	-	88	120	27	4	77	20	1
W.06	Utility Relocation – Zone A	261	-	3	-	-	9	3	-	-	10	5	-	-	41	33	5	-	44	8	-
W.07	Drainage Infrastructure – Zone A	261	1	15	1	-	23	15	1	-	31	20	1	-	117	77	20	1	170	57	12
W.08	Road Works – General Civil – Zone A	261	3	28	4	-	38	28	4	-	44	38	6	-	56	148	38	6	120	27	4
W.09	Road Works – Milling Works – Zone A	261	3	28	4	-	38	28	4	-	44	38	6	-	56	148	38	6	170	57	12
W.10	Paving Works – Pavement Works – Zone A	261	1	21	3	-	36	21	3	-	41	33	5	-	64	141	33	5	170	57	12
W.11	Finishing Works – Zone A	261	-	13	-	-	12	12	-	-	23	14	1	-	100	64	14	1	57	11	1
W.12	Mobilisation and Site Establishment – Zone B	261	-	-	-	-	4	-	-	-	8	2	-	-	51	21	2	-	52	4	-
W.13	Traffic Switches – Zone B	261	-	15	-	-	31	15	-	-	44	18	1	-	78	120	18	1	153	64	10
W.14	Tree Felling – Zone B	261	-	18	-	-	40	17	-	-	51	21	2	-	76	128	21	2	140	43	3
W.15	Utility Locating – Zone B	261	-	15	-	-	31	15	-	-	44	18	1	-	78	120	18	1	153	64	10
W.16	Utility Relocation (Noisy Works) – Zone B	261	-	18	-	-	40	17	-	-	51	21	2	-	76	128	21	2	102	17	-
W.17	Utility Relocation – Zone B	261	-	1	-	-	5	1	-	-	8	2	-	-	50	31	2	-	52	4	-
W.18	Drainage Infrastructure – Zone B	261	-	10	-	-	23	10	-	-	39	17	-	-	78	102	17	-	153	64	10
W.19	Road Works – General Civil – Zone B	261	1	22	2	-	52	21	2	-	53	43	3	-	57	140	43	3	128	21	2
W.20	Road Works – Milling Works – Zone B	261	1	22	2	-	52	21	2	-	53	43	3	-	57	140	43	3	153	64	10
W.21	Paving Works – Pavement Works – Zone B	261	1	19	1	-	45	18	1	-	50	31	2	-	68	136	31	2	153	64	10
W.22	Finishing Works – Zone B	261	-	6	-	-	13	6	-	-	23	10	-	-	86	73	10	-	64	10	-

Table 5 Predicted NML Exceedances, All Receiver Types – NCA02

ID	Scenario	Number of Receivers																		
		Total	HNA [1]	With NML Exceedance[2]																
				Standard Daytime			Out of Hours Works[3]													
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	124	7	11	8	-	4	11	8	-	5	3	11	-	43	31	3	11	52	5	12
W.02	Traffic Switches – Zone A	124	13	12	12	7	41	13	10	7	41	23	3	10	6	67	23	13	22	69	19
W.03	Tree Felling – Zone A	124	13	16	11	8	45	14	11	8	43	31	3	11	5	60	31	14	43	47	16
W.04	Utility Locating – Zone A	124	13	12	12	7	41	13	10	7	41	23	3	10	6	67	23	13	22	69	19
W.05	Utility Relocation (Noisy Works) – Zone A	124	13	16	11	8	45	14	11	8	43	31	3	11	5	60	31	14	76	13	13
W.06	Utility Relocation – Zone A	124	8	7	12	-	5	9	10	-	4	5	11	-	44	38	5	11	52	5	12
W.07	Drainage Infrastructure – Zone A	124	13	9	13	6	36	10	10	6	43	13	5	8	4	76	13	13	22	69	19
W.08	Road Works – General Civil – Zone A	124	13	35	6	14	45	33	9	11	39	47	5	11	6	43	47	16	60	31	14
W.09	Road Works – Milling Works – Zone A	124	13	35	6	14	45	33	9	11	39	47	5	11	6	43	47	16	22	69	19
W.10	Paving Works – Pavement Works – Zone A	124	13	26	7	12	43	24	9	10	44	38	5	11	6	51	38	16	22	69	19
W.11	Finishing Works – Zone A	124	12	6	19	-	19	9	15	-	34	7	7	6	7	78	7	13	69	6	13
W.12	Mobilisation and Site Establishment – Zone B	124	-	-	-	-	-	-	-	-	-	-	-	-	12	2	-	-	12	-	-
W.13	Traffic Switches – Zone B	124	-	2	-	-	5	1	-	-	13	1	-	-	38	56	1	-	85	14	-
W.14	Tree Felling – Zone B	124	-	2	-	-	12	1	-	-	12	2	-	-	36	61	2	-	84	5	-
W.15	Utility Locating – Zone B	124	-	2	-	-	5	1	-	-	13	1	-	-	38	56	1	-	85	14	-
W.16	Utility Relocation (Noisy Works) – Zone B	124	-	2	-	-	12	1	-	-	12	2	-	-	36	61	2	-	41	1	-
W.17	Utility Relocation – Zone B	124	-	-	-	-	-	-	-	-	1	-	-	-	20	5	-	-	12	-	-
W.18	Drainage Infrastructure – Zone B	124	-	1	-	-	4	1	-	-	11	1	-	-	52	41	1	-	85	14	-
W.19	Road Works – General Civil – Zone B	124	-	4	-	-	14	2	-	-	33	5	-	-	18	84	5	-	61	2	-
W.20	Road Works – Milling Works – Zone B	124	-	4	-	-	14	2	-	-	33	5	-	-	18	84	5	-	85	14	-
W.21	Paving Works – Pavement Works – Zone B	124	-	3	-	-	15	1	-	-	20	5	-	-	30	70	5	-	85	14	-
W.22	Finishing Works – Zone B	124	-	-	-	-	1	-	-	-	4	1	-	-	50	24	1	-	14	-	-

Table 6 Predicted NML Exceedances, All Receiver Types – NCA03

ID	Scenario	Number of Receivers																		
		Total	HNA [1]	With NML Exceedance[2]																
				Standard Daytime			Out of Hours Works[3]													
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	159	11	11	12	-	6	10	12	-	8	3	12	-	28	22	3	12	37	6	12
W.02	Traffic Switches – Zone A	159	13	15	12	11	25	17	9	11	28	16	2	12	4	69	16	14	38	42	23
W.03	Tree Felling – Zone A	159	13	16	11	12	28	16	10	12	28	22	3	12	2	64	22	15	52	34	17
W.04	Utility Locating – Zone A	159	13	15	12	11	25	17	9	11	28	16	2	12	4	69	16	14	38	42	23
W.05	Utility Relocation (Noisy Works) – Zone A	159	13	16	11	12	28	16	10	12	28	22	3	12	2	64	22	15	68	15	13
W.06	Utility Relocation – Zone A	159	12	12	12	-	6	11	12	-	6	5	12	-	35	27	5	12	37	6	12
W.07	Drainage Infrastructure – Zone A	159	13	10	16	7	21	15	11	7	27	15	1	12	7	68	15	13	38	42	23
W.08	Road Works – General Civil – Zone A	159	14	25	12	13	31	23	12	12	36	34	5	12	1	52	34	17	64	22	15
W.09	Road Works – Milling Works – Zone A	159	14	25	12	13	31	23	12	12	36	34	5	12	1	52	34	17	38	42	23
W.10	Paving Works – Pavement Works – Zone A	159	13	17	12	12	29	17	11	12	35	27	5	12	2	58	27	17	38	42	23
W.11	Finishing Works – Zone A	159	12	7	19	3	11	16	10	3	21	10	6	7	23	56	10	13	42	10	13
W.12	Mobilisation and Site Establishment – Zone B	159	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
W.13	Traffic Switches – Zone B	159	-	-	-	-	1	-	-	-	2	-	-	-	50	14	-	-	63	2	-
W.14	Tree Felling – Zone B	159	-	-	-	-	1	-	-	-	2	-	-	-	46	19	-	-	32	1	-
W.15	Utility Locating – Zone B	159	-	-	-	-	1	-	-	-	2	-	-	-	50	14	-	-	63	2	-
W.16	Utility Relocation (Noisy Works) – Zone B	159	-	-	-	-	1	-	-	-	2	-	-	-	46	19	-	-	10	-	-
W.17	Utility Relocation – Zone B	159	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
W.18	Drainage Infrastructure – Zone B	159	-	-	-	-	-	-	-	-	1	-	-	-	41	10	-	-	63	2	-
W.19	Road Works – General Civil – Zone B	159	-	-	-	-	2	-	-	-	4	1	-	-	45	32	1	-	19	-	-
W.20	Road Works – Milling Works – Zone B	159	-	-	-	-	2	-	-	-	4	1	-	-	45	32	1	-	63	2	-
W.21	Paving Works – Pavement Works – Zone B	159	-	-	-	-	2	-	-	-	2	-	-	-	48	24	-	-	63	2	-
W.22	Finishing Works – Zone B	159	-	-	-	-	-	-	-	-	-	-	-	-	22	2	-	-	2	-	-

Table 7 Predicted NML Exceedances, All Receiver Types – NCA04

ID	Scenario	Number of Receivers																		
		Total	HNA [1]	With NML Exceedance[2]																
				Standard Daytime			Out of Hours Works[3]													
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	19	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	3	-	-
W.02	Traffic Switches – Zone A	19	-	3	-	-	2	2	-	-	3	2	-	-	7	6	1	-	12	4	-
W.03	Tree Felling – Zone A	19	-	3	-	-	2	3	-	-	3	3	-	-	7	8	1	-	10	2	-
W.04	Utility Locating – Zone A	19	-	3	-	-	2	2	-	-	3	2	-	-	7	6	1	-	12	4	-
W.05	Utility Relocation (Noisy Works) – Zone A	19	-	3	-	-	2	3	-	-	3	3	-	-	7	8	1	-	4	1	-
W.06	Utility Relocation – Zone A	19	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	3	-	-
W.07	Drainage Infrastructure – Zone A	19	-	2	-	-	2	1	-	-	3	2	-	-	7	4	1	-	12	4	-
W.08	Road Works – General Civil – Zone A	19	-	2	1	-	3	3	-	-	2	4	-	-	5	10	2	-	8	1	-
W.09	Road Works – Milling Works – Zone A	19	-	2	1	-	3	3	-	-	2	4	-	-	5	10	2	-	12	4	-
W.10	Paving Works – Pavement Works – Zone A	19	-	3	-	-	2	3	-	-	3	3	-	-	6	9	1	-	12	4	-
W.11	Finishing Works – Zone A	19	-	2	-	-	3	-	-	-	3	-	-	-	6	4	-	-	4	-	-
W.12	Mobilisation and Site Establishment – Zone B	19	3	2	7	-	2	3	6	-	5	2	7	-	3	6	1	6	6	2	7
W.13	Traffic Switches – Zone B	19	7	5	4	5	3	5	5	4	4	5	3	6	1	4	5	7	1	4	12
W.14	Tree Felling – Zone B	19	7	5	2	7	3	5	3	6	3	6	2	7	1	3	6	7	2	6	9
W.15	Utility Locating – Zone B	19	7	5	4	5	3	5	5	4	4	5	3	6	1	4	5	7	1	4	12
W.16	Utility Relocation (Noisy Works) – Zone B	19	7	5	2	7	3	5	3	6	3	6	2	7	1	3	6	7	4	5	7
W.17	Utility Relocation – Zone B	19	5	2	7	-	3	2	7	-	3	3	8	-	2	5	3	6	6	2	7
W.18	Drainage Infrastructure – Zone B	19	7	5	5	4	2	5	6	3	3	5	3	6	1	4	5	7	1	4	12
W.19	Road Works – General Civil – Zone B	19	7	6	1	8	3	6	1	8	1	6	2	9	-	2	6	9	3	6	7
W.20	Road Works – Milling Works – Zone B	19	7	6	1	8	3	6	1	8	1	6	2	9	-	2	6	9	1	4	12
W.21	Paving Works – Pavement Works – Zone B	19	7	5	2	7	4	5	2	7	2	5	3	8	-	3	5	9	1	4	12
W.22	Finishing Works – Zone B	19	7	3	7	2	2	3	9	-	2	5	7	2	1	4	5	7	4	5	7

Table 8 Predicted NML Exceedances, All Receiver Types – NCA05

ID	Scenario	Number of Receivers																			
		Total	HNA [1]	With NML Exceedance[2]																	
				Standard Daytime			Out of Hours Works[3]														
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.02	Traffic Switches – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	22	-	-
W.03	Tree Felling – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	1	-	-
W.04	Utility Locating – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	22	-	-
W.05	Utility Relocation (Noisy Works) – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-
W.06	Utility Relocation – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.07	Drainage Infrastructure – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	22	-	-
W.08	Road Works – General Civil – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	64	1	-	-	-	-	-
W.09	Road Works – Milling Works – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	64	1	-	-	22	-	-
W.10	Paving Works – Pavement Works – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	46	1	-	-	22	-	-
W.11	Finishing Works – Zone A	161	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
W.12	Mobilisation and Site Establishment – Zone B	161	-	1	1	-	1	1	1	-	1	2	1	-	11	3	2	1	10	1	2
W.13	Traffic Switches – Zone B	161	2	3	2	-	6	3	2	-	10	3	1	1	70	39	3	2	112	13	4
W.14	Tree Felling – Zone B	161	2	3	1	1	8	3	1	1	11	3	2	1	74	49	3	3	83	8	3
W.15	Utility Locating – Zone B	161	2	3	2	-	6	3	2	-	10	3	1	1	70	39	3	2	112	13	4
W.16	Utility Relocation (Noisy Works) – Zone B	161	2	3	1	1	8	3	1	1	11	3	2	1	74	49	3	3	20	3	2
W.17	Utility Relocation – Zone B	161	1	1	1	-	1	1	1	-	2	2	1	-	14	4	2	1	10	1	2
W.18	Drainage Infrastructure – Zone B	161	2	3	2	-	2	3	2	-	8	3	1	1	78	20	3	2	112	13	4
W.19	Road Works – General Civil – Zone B	161	2	3	2	1	11	3	2	1	10	8	1	2	43	83	8	3	49	3	3
W.20	Road Works – Milling Works – Zone B	161	2	3	2	1	11	3	2	1	10	8	1	2	43	83	8	3	112	13	4
W.21	Paving Works – Pavement Works – Zone B	161	2	3	1	1	10	3	1	1	14	4	2	1	63	66	4	3	112	13	4
W.22	Finishing Works – Zone B	161	2	1	2	-	2	1	2	-	2	3	2	-	52	16	3	2	13	2	2

Table 9 Predicted NML Exceedances, All Receiver Types – NCA06

ID	Scenario	Number of Receivers																			
		Total	HNA [1]	With NML Exceedance[2]																	
				Standard Daytime			Out of Hours Works[3]														
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.02	Traffic Switches – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.03	Tree Felling – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.04	Utility Locating – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.05	Utility Relocation (Noisy Works) – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.06	Utility Relocation – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.07	Drainage Infrastructure – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.08	Road Works – General Civil – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.09	Road Works – Milling Works – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.10	Paving Works – Pavement Works – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.11	Finishing Works – Zone A	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.12	Mobilisation and Site Establishment – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.13	Traffic Switches – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.14	Tree Felling – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.15	Utility Locating – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.16	Utility Relocation (Noisy Works) – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.17	Utility Relocation – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.18	Drainage Infrastructure – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.19	Road Works – General Civil – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.20	Road Works – Milling Works – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.21	Paving Works – Pavement Works – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.22	Finishing Works – Zone B	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 10 Predicted NML Exceedances, All Receiver Types – NCA07

ID	Scenario	Number of Receivers																		
		Total	HNA [1]	With NML Exceedance[2]																
				Standard Daytime			Out of Hours Works[3]													
							Daytime OOH				Evening				Night time				Sleep Disturbance		
				1 10 dB	11 20 dB	>20 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	16 25 dB	>25 dB	1 5 dB	6 15 dB	>25 dB
W.01	Mobilisation and Site Establishment – Zone A	33	-	3	1	-	1	3	-	-	1	3	-	-	-	-	-	-	-	-	-
W.02	Traffic Switches – Zone A	33	-	2	3	1	2	2	2	-	2	2	2	-	13	-	-	-	13	-	-
W.03	Tree Felling – Zone A	33	-	2	3	1	2	1	3	-	2	1	3	-	13	-	-	-	6	-	-
W.04	Utility Locating – Zone A	33	-	2	3	1	2	2	2	-	2	2	2	-	13	-	-	-	13	-	-
W.05	Utility Relocation (Noisy Works) – Zone A	33	-	2	3	1	2	1	3	-	2	1	3	-	13	-	-	-	-	-	-
W.06	Utility Relocation – Zone A	33	-	3	1	-	1	2	1	-	1	2	1	-	-	-	-	-	-	-	-
W.07	Drainage Infrastructure – Zone A	33	-	3	2	1	2	2	2	-	2	2	2	-	10	-	-	-	13	-	-
W.08	Road Works – General Civil – Zone A	33	-	2	2	2	-	3	2	1	-	3	2	1	8	6	-	-	-	-	-
W.09	Road Works – Milling Works – Zone A	33	-	2	2	2	-	3	2	1	-	3	2	1	8	6	-	-	13	-	-
W.10	Paving Works – Pavement Works – Zone A	33	-	2	3	1	1	2	2	1	1	2	2	1	14	-	-	-	13	-	-
W.11	Finishing Works – Zone A	33	-	2	2	1	1	3	1	-	1	3	1	-	-	-	-	-	-	-	-
W.12	Mobilisation and Site Establishment – Zone B	33	-	1	3	-	1	2	1	-	1	2	1	-	-	-	-	-	-	-	-
W.13	Traffic Switches – Zone B	33	-	1	1	3	1	1	3	-	1	1	3	-	12	-	-	-	15	-	-
W.14	Tree Felling – Zone B	33	-	1	1	3	1	1	2	1	1	1	2	1	15	-	-	-	-	-	-
W.15	Utility Locating – Zone B	33	-	1	1	3	1	1	3	-	1	1	3	-	12	-	-	-	15	-	-
W.16	Utility Relocation (Noisy Works) – Zone B	33	-	1	1	3	1	1	2	1	1	1	2	1	15	-	-	-	-	-	-
W.17	Utility Relocation – Zone B	33	-	1	3	-	1	2	1	-	1	2	1	-	-	-	-	-	-	-	-
W.18	Drainage Infrastructure – Zone B	33	-	1	1	3	1	1	3	-	1	1	3	-	-	-	-	-	15	-	-
W.19	Road Works – General Civil – Zone B	33	-	4	1	3	4	1	-	3	4	1	-	3	15	-	-	-	-	-	-
W.20	Road Works – Milling Works – Zone B	33	-	4	1	3	4	1	-	3	4	1	-	3	15	-	-	-	15	-	-
W.21	Paving Works – Pavement Works – Zone B	33	-	2	1	3	2	1	2	1	2	1	2	1	15	-	-	-	15	-	-
W.22	Finishing Works – Zone B	33	-	1	2	1	-	1	3	-	-	1	3	-	-	-	-	-	-	-	-

Table 11 Predicted Worst-case Construction Noise Levels (dBA) – Residential Receivers

Period	ID	Scenario	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Daytime/Evening/Night-time	W.01	Mobilisation and Site Establishment – Zone A	68	68	79	55	42	-	41
	W.02	Traffic Switches – Zone A	77	87	88	64	51	-	50
	W.03	Tree Felling – Zone A	78	88	89	65	52	-	51
	W.04	Utility Locating – Zone A	77	87	88	64	51	-	50
	W.05	Utility Relocation (Noisy Works) – Zone A	78	88	89	65	52	-	51
	W.06	Utility Relocation – Zone A	69	79	80	56	43	-	42
	W.07	Drainage Infrastructure – Zone A	76	86	87	63	50	-	49
	W.08	Road Works – General Civil – Zone A	80	90	91	67	54	-	53
	W.09	Road Works – Milling Works – Zone A	80	90	91	67	54	-	53
	W.10	Paving Works – Pavement Works – Zone A	79	89	90	66	53	-	52
	W.11	Finishing Works – Zone A	74	84	85	61	48	-	47
	W.12	Mobilisation and Site Establishment – Zone B	64	57	51	77	75	-	39
	W.13	Traffic Switches – Zone B	73	66	60	86	84	-	48
	W.14	Tree Felling – Zone B	74	67	61	87	85	-	49
	W.15	Utility Locating – Zone B	73	66	60	86	84	-	48
	W.16	Utility Relocation (Noisy Works) – Zone B	74	67	61	87	85	-	49
	W.17	Utility Relocation – Zone B	65	58	52	78	76	-	40
	W.18	Drainage Infrastructure – Zone B	72	65	59	85	83	-	47
	W.19	Road Works – General Civil – Zone B	76	69	63	89	87	-	51
	W.20	Road Works – Milling Works – Zone B	76	69	63	89	87	-	51
	W.21	Paving Works – Pavement Works – Zone B	75	68	62	88	86	-	50
	W.22	Finishing Works – Zone B	70	63	57	83	81	-	45

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Daytime NML Exceedance Zone A - Mobilisation and Site Establishment

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Daytime NML Exceedance
Zone A - Traffic switches

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Night-time NML Exceedance
Zone A - Traffic switches

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Daytime NML Exceedance
Zone A - Tree Felling

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Night-time NML Exceedance Zone A - Tree Felling

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Daytime NML Exceedance
Zone A - Utility Locating

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Night-time NML Exceedance
Zone A - Utility Locating

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Daytime NML Exceedance
Zone A - Utility relocation (Noisy works)

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Night-time NML Exceedance Zone A - Utility relocation (Noisy works)

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Daytime NML Exceedance
Zone A - Utility relocation

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Night-time NML Exceedance
Zone A - Utility relocation

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Daytime NML Exceedance
Zone A - Drainage infrastructure

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Night-time NML Exceedance
Zone A - Drainage infrastructure

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Daytime NML Exceedance
Zone A - Road works – General Civil and Milling Works

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Night-time NML Exceedance
Zone A - Road Works - General Civil and Milling Works

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Daytime NML Exceedance
Zone A - Paving Works – Pavement works

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Night-time NML Exceedance Zone A - Paving Works – Pavement works

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Daytime NML Exceedance
Zone A - Finishing works

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Night-time NML Exceedance Zone A - Finishing works

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Daytime NML Exceedance Zone B - Mobilisation and Site Establishment

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Daytime NML Exceedance
Zone B - Traffic switches

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Zone B - Traffic switches

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Daytime NML Exceedance
Zone B - Tree Felling

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Night-time NML Exceedance
Zone B - Tree Felling

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Daytime NML Exceedance
Zone B - Utility Locating

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Night-time NML Exceedance
Zone B - Utility Locating

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Daytime NML Exceedance
Zone B - Utility relocation (Noisy works)

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Date:	30/06/2021
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Projection:	GDA 1994 MGA Zone 56

0 100 200 300 m

Sydney Park Junction

Night-time NML Exceedance Zone B - Utility relocation (Noisy works)

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Zone B - Drainage infrastructure

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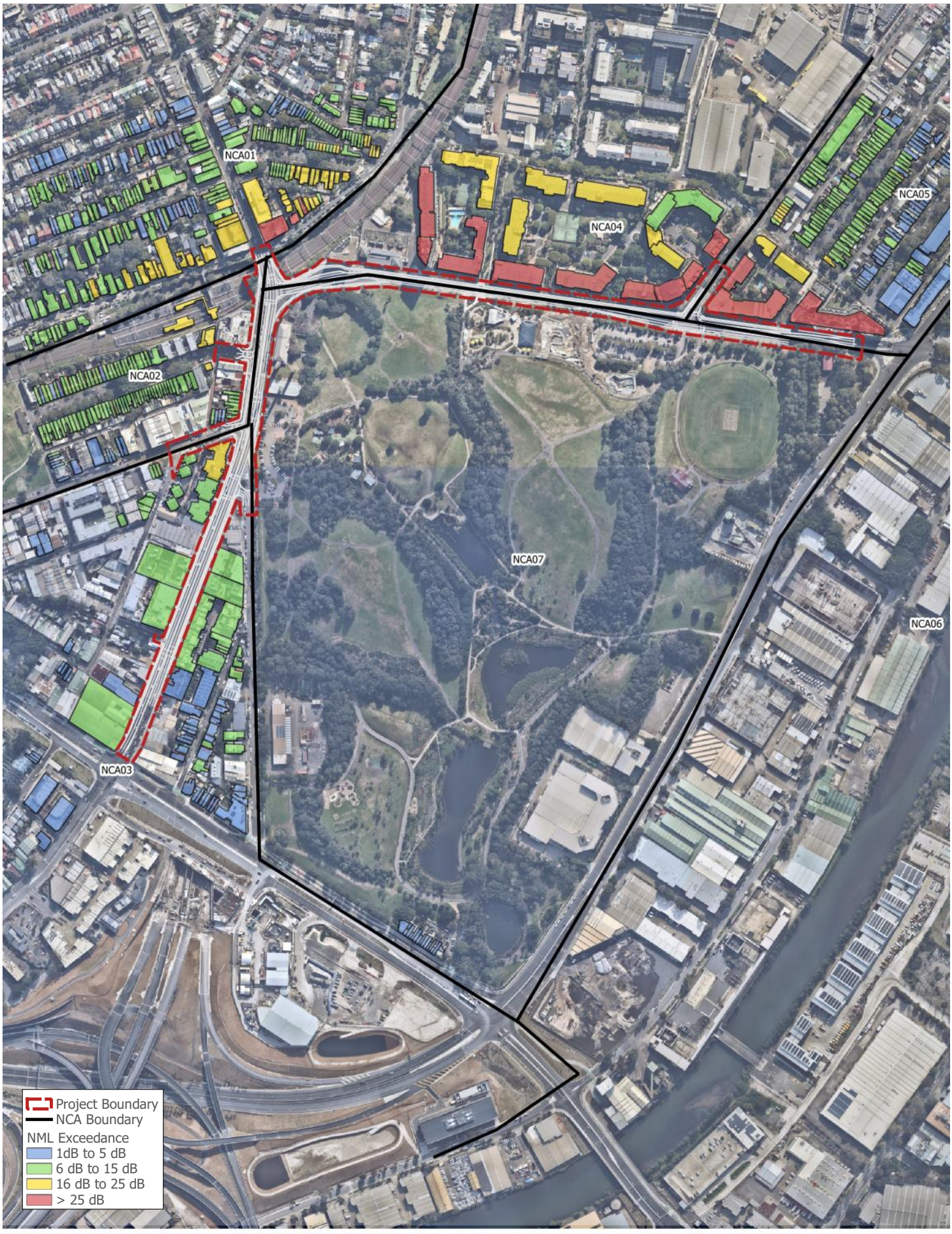
Sydney Park Junction

Daytime NML Exceedance
Zone B - Road works - General Civil and Milling Works



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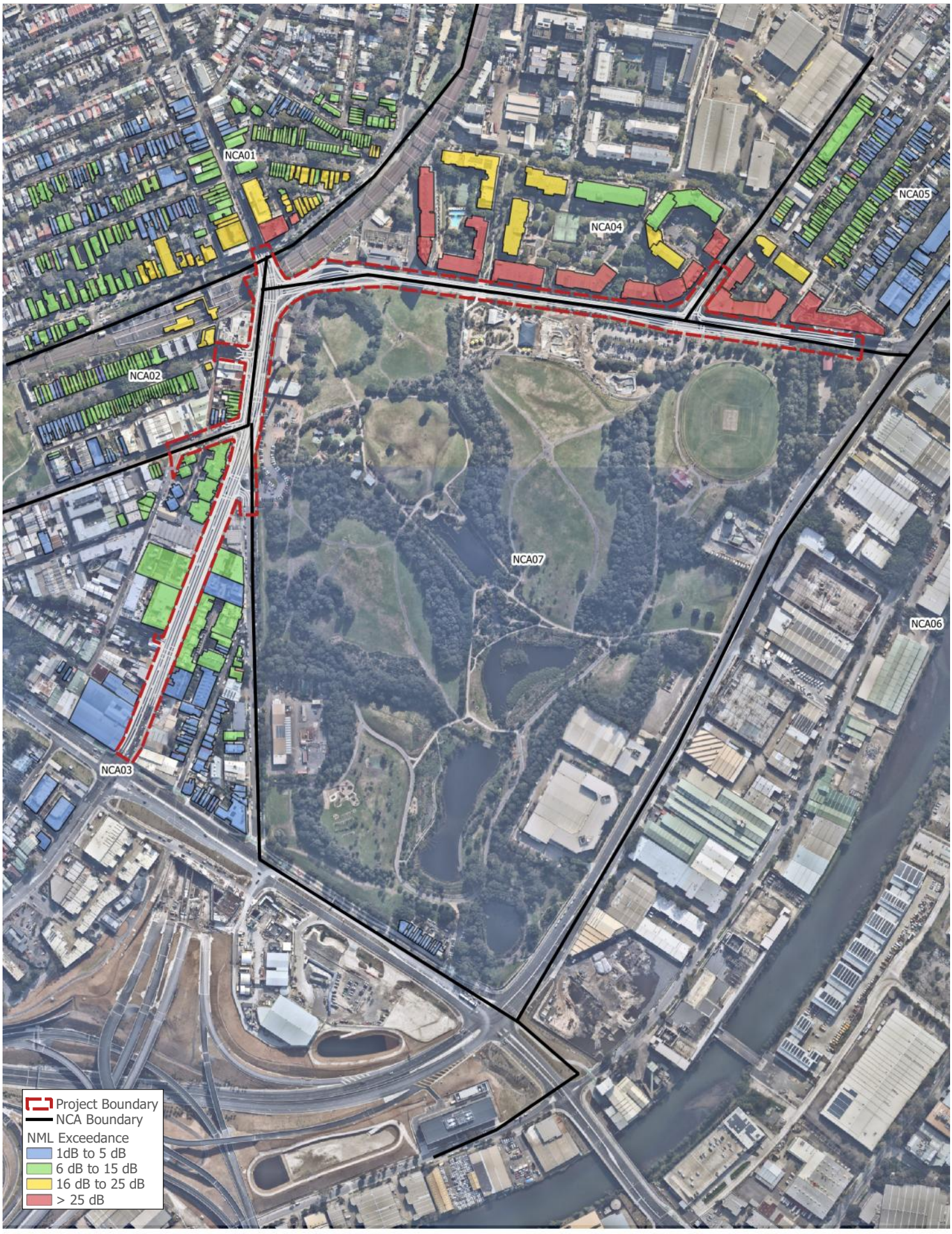
Sydney Park Junction

Daytime NML Exceedance
Zone B - Paving Works – Pavement works



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Sydney Park Junction

Night-time NML Exceedance Zone B - Paving Works – Pavement works

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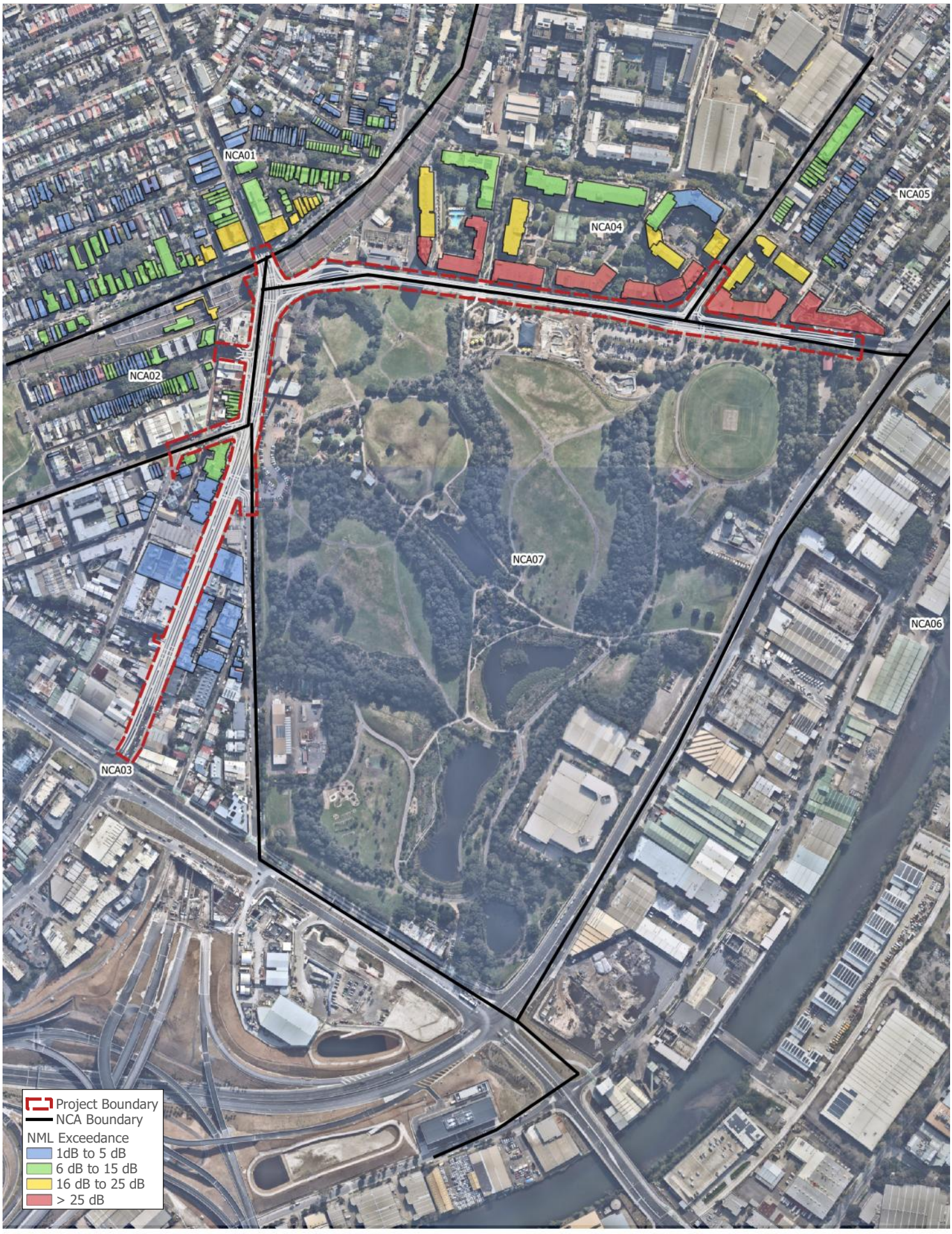
Sydney Park Junction

Daytime NML Exceedance
Zone B - Finishing works



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Sydney Park Junction

Night-time NML Exceedance
Zone B - Finishing works

APPENDIX D

Operational Assessment

Traffic Volumes – No Build (Without Project)

Section ID	2023				2033			
	Day Light	Day Heavy	Night Light	Night Heavy	Day Light	Day Heavy	Night Light	Night Heavy
King Street, north of Sydney Park Road Northbound	12202	492	2221	90	9019	349	1641	64
King Street, north of Sydney Park Road Southbound	7815	365	1422	66	6544	236	1191	43
Princes Highway, between Sydney Park Road and May Street Northbound	17065	545	3106	99	15360	475	2796	86
Princes Highway, between Sydney Park Road and May Street Southbound	8258	382	1503	70	7636	297	1390	54
Princes Highway, between May Street and Campbell Street Northbound	16208	710	2950	129	14753	564	2685	103
Princes Highway, between May Street and Campbell Street Southbound	8137	344	1481	63	7477	277	1361	50
Sydney Park Road, between Euston Road and Mitchell Road Eastbound	8370	303	1523	55	6563	226	1194	41
Sydney Park Road, between Euston Road and Mitchell Road Westbound	10013	445	1822	81	7669	463	1396	84
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Eastbound	13002	506	2366	92	12633	459	2299	84
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Westbound	8602	457	1566	83	7386	394	1344	72
Mitchell Road, north of Sydney Park Road Northbound	9154	363	1666	66	9010	436	1640	79
Mitchell Road, north of Sydney Park Road Southbound	6071	267	1105	49	6288	245	1144	45
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Northbound	16596	920	3020	167	12634	789	2299	144
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Southbound	14926	813	2717	148	15950	895	2903	163
Campbell Street / Campbell Road, between Euston Road and Princes Highway Eastbound	19433	1760	3537	320	16199	1965	2948	358
Campbell Street / Campbell Road, between Euston Road and Princes Highway Westbound	16284	1488	2964	271	13748	1295	2502	236
Huntley Street, east of Euston Road Eastbound	7213	570	1313	104	6691	446	1218	81
Huntley Street, east of Euston Road Westbound	8451	499	1538	91	6586	436	1199	79

Traffic Volumes – Build (With Project)

Section ID	2023				2033			
	Day Light	Day Heavy	Night Light	Night Heavy	Day Light	Day Heavy	Night Light	Night Heavy
King Street, north of Sydney Park Road Northbound	8421	397	1533	72	8387	356	1526	65
King Street, north of Sydney Park Road Southbound	7050	334	1283	61	4918	139	895	25
Princes Highway, between Sydney Park Road and May Street Northbound	10017	375	1823	68	5482	93	998	17
Princes Highway, between Sydney Park Road and May Street Southbound	4809	270	875	49	3495	102	636	19
Princes Highway, between May Street and Campbell Street Northbound	9544	469	1737	85	10172	451	1851	82
Princes Highway, between May Street and Campbell Street Southbound	4868	268	886	49	3518	99	640	18
Sydney Park Road, between Euston Road and Mitchell Road Eastbound	7975	269	1451	49	6573	176	1196	32
Sydney Park Road, between Euston Road and Mitchell Road Westbound	7723	463	1406	84	6095	419	1109	76
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Eastbound	7644	357	1391	65	7655	352	1393	64
Sydney Park Road, between Mitchell Road and King Street / Princes Highway Westbound	3692	343	672	62	3287	202	598	37
Mitchell Road, north of Sydney Park Road Northbound	6808	354	1239	64	6342	430	1154	78
Mitchell Road, north of Sydney Park Road Southbound	3552	197	646	36	3106	109	565	20
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Northbound	16780	890	3054	162	14405	778	2622	142
Euston Road, between Huntley Street / Sydney Park Road and Campbell Road Southbound	14097	744	2566	135	17427	943	3172	172
Campbell Street / Campbell Road, between Euston Road and Princes Highway Eastbound	17640	1516	3210	276	18332	1975	3336	359
Campbell Street / Campbell Road, between Euston Road and Princes Highway Westbound	15596	1365	2838	248	16427	1405	2990	256
Huntley Street, east of Euston Road Eastbound	7518	639	1368	116	6370	517	1159	94
Huntley Street, east of Euston Road Westbound	5809	521	1057	95	5960	488	1085	89