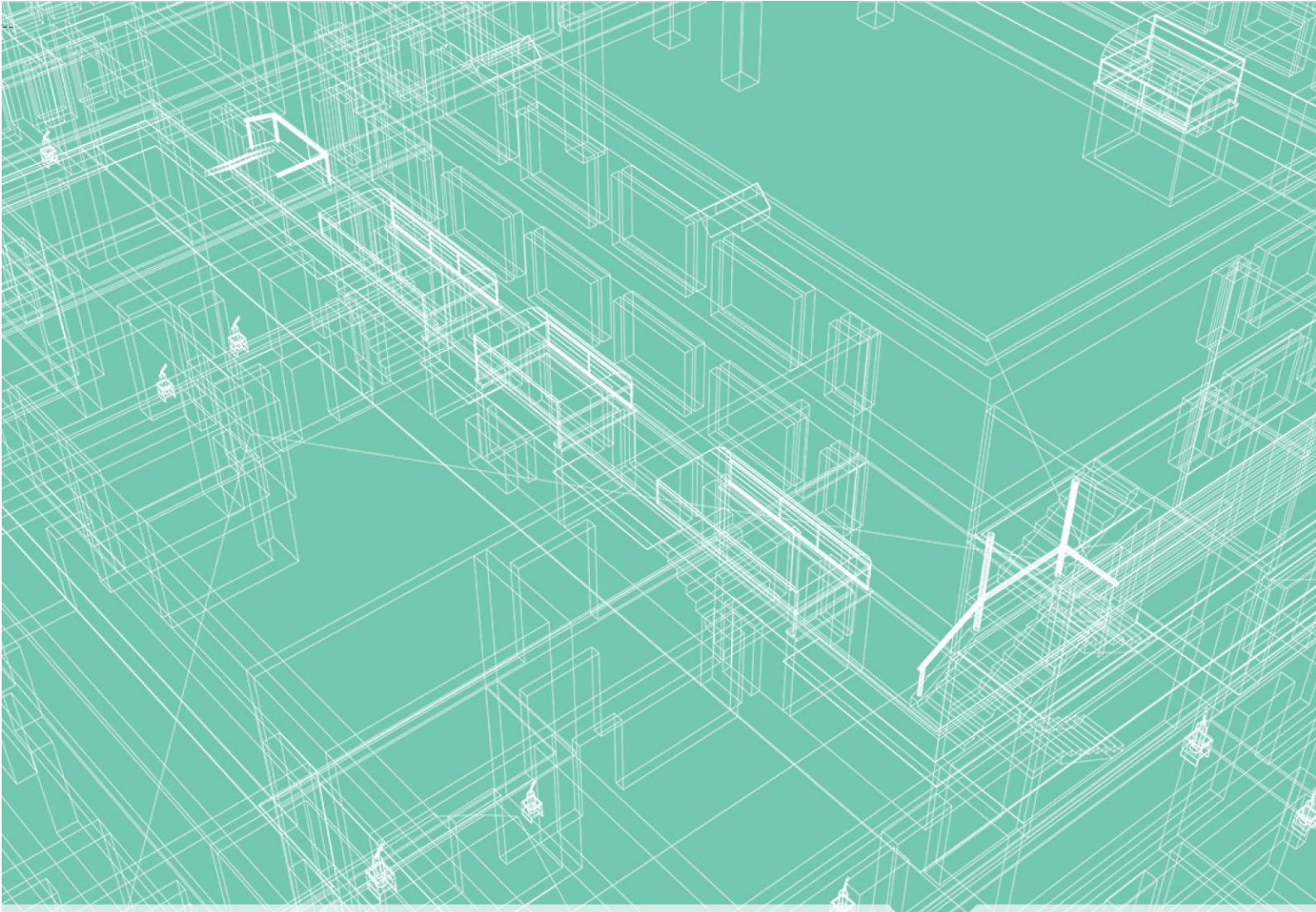

NOISE & VIBRATION IMPACT ASSESSMENT (SSD-96248991)

ROUSE HILL HOSPITAL
MAIN WORKS

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Key Contact	Gavin Statham

Prepared By

Company	JHA Consulting Engineers
Address	Level 2, 20 Market Street, Sydney NSW 2000
Phone	61-2-9437 1000
Email	Tom.Krikke@jhaengineers.com.au
Website	www.jhaservices.com
Author	Tom Krikke, MAAS
Checked	Joe Milton, MAAS
Authorised	Joe Mescall

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CONTENTS

1 INTRODUCTION

1.1 OVERVIEW

This Noise & Vibration Impact Assessment Report has been prepared by JHA Consulting Engineers to support a State Significant Development Application (SSDA) for the construction and operation of a new hospital campus at the Corner of Commercial Road and Windsor Road, Rouse Hill (SSD-96248991).

This report shall be read in conjunction with the planning documentation and other consultant design reports submitted as part of the application.

The objectives of this noise and vibration assessment are:

- Address the relevant Secretary Environmental Assessments Requirements (SEARs).
- Assess the potential transport (road and rail) noise and vibration impacts on the proposed development.
- Assess the potential noise impacts on the proposed development as a result of noise emissions from the adjacent substation.
- Assess the potential noise and vibration impacts that the proposed development may have on nearby sensitive receivers.
- Identify noise and vibration sensitive receivers that will potentially be affected by the operation of the Rouse Hill Hospital.
- Establish the appropriate noise levels and vibration criteria in accordance with the relevant standards, guidelines and legislations.
- Carry out noise assessments in order to assess the noise impacts from the operation of the development. Noise assessments consider the following noise sources:
  - Mechanical services noise
  - Traffic generation noise
  - Operational noise from ambulance movements, loading dock and use of the multi-storey carpark.
  - Transport impact noise
- Determine whether the relevant criteria can be achieved based on the anticipated operations and construction methods. Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure with the assessment criteria.
- Provide preliminary recommendations for Construction Noise and Vibration.

The following has been considered for the preparation of this report:

- Noise data collected on site through the use of noise loggers and a handheld spectrum analyser.
- Vibration data collected on site through the use of handheld spectrum analyser.
- Issued SEARs dated, 16th October 2025.

This document and related work have been prepared following JHA Consulting Engineers Quality and Environmental Management Systems, based on AS/NZS ISO 9001:2015 and ISO 14001:2015, respectively.

1.2 RESPONSE TO SEARS

This report has addressed the following matters within the Secretary's Environmental Assessment Requirements (SEARs) issued for the SSDA on 16th October 2025 (see Table 1).

Table 1: Summary of relevant SEAR's requirements.

SEARs Item	*Response*
12. Noise and Vibration *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.*	*This noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines.* *Construction noise and vibration impacts are assessed at Section 7 of this report.* *Operational noise and vibration impacts are assessed at Section 6 of this report.* *Recommended mitigation measures are outlined at Sections 6, 7 and 8 of this report.*

2 DESCRIPTION OF PROPOSAL

2.1 PROPOSED WORKS

The future Rouse Hill Hospital (RHH) will be located at the corner of Windsor Road and Commercial Road, Rouse Hill. RHH responds to the health care needs of the growing north-west region and will provide a modern, technologically connected hospital integrated with its surrounds and the community.

The proposed development comprises:

- Site preparation including earthworks and tree removal;
- Construction of internal roads with connection to Commercial Road;
- Incoming electrical and communications services
- Construction of hospital buildings up to eleven storeys;
- Construction of a ten storey above-ground car park;
- Pedestrian and cycle pathway connections;
- Landscaping; and
- Ancillary works to Commercial Road, comprising:
  - minor works (including realignment of existing median strip, kerb and gutter, footpath and lane marking) to provide access from Commercial Road into Hospital Road; and
  - associated tree removal along Commercial Road.

The scope of the proposed works includes:

- An emergency department and primary access clinic
- Comprehensive birthing services including birthing rooms and a maternity inpatient unit
- Inpatient beds and day surgery services
- Short stay medical assessment services
- Pathology, pharmacy, and medical imaging services
- Outpatient and ambulatory care services including paediatrics and renal dialysis and antenatal and postnatal services
- Virtual care and hospital in the home services
- Prehabilitation, rehabilitation and lifestyle medicine.
- Administration, staff support, loading dock and back-of-house services; and
- Ancillary commercial uses to support the hospital, including retail.

2.2 SITE DESCRIPTION

Rouse Hill is located within the North-West sector of Sydney, which has recently become an area of significant population growth, approximately 43km North-West of Sydney CBD. It belongs to the Local Government Area of The Hills Shire.

The proposed hospital site is located on the corner of Windsor Road and Commercial Road, approximately 0.5km North-West of the Rouse Hill metro station. The site contains two lots and covers approximately 2.2Ha. These sites are legally known as Lot 311/DP1274392 and Lot 312/DP1274392. The SSDA site will

extend to the full extent of works including the hospital site, footpath connection (Part Lot 229), construction compounds (Part Lot 229) and works to Commercial Rd (Lot 2011, DP 1131519 and Lot 101, DP1060353)

Figure 1 shows the proposed site plan and site boundary for the Rouse Hill Hospital.

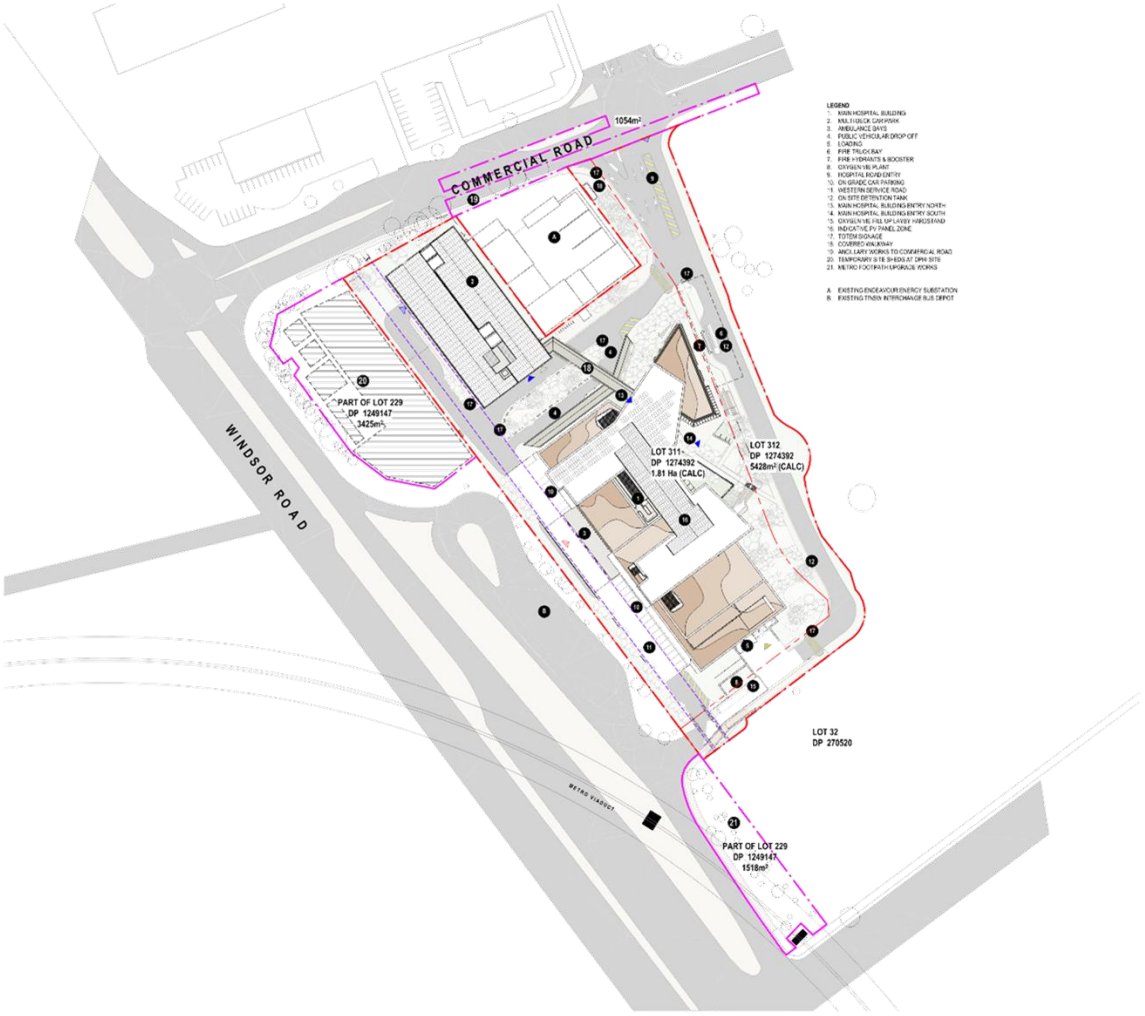


Figure 1: Proposed Rouse Hill Hospital site.

The Sydney Metro trainline runs along a decoupled bridge to the South-West of the site and the surrounding land includes a mixture of residential, commercial and industrial lots. The site is adjacent to a substation at the north and the surrounding land uses are as follows:

- *North*: Two business developments containing a mixture of hospitality and commercial.
- *East*: Land immediately to the East is undeveloped greenfield land designated for mixed use.
- *South*: Land immediately to the South is undeveloped greenfield land designated for mixed use. This land is bounded by Rouse Hill Drive which separates is from a commercial lot containing a shopping centre.
- *West:* Immediately to the West of the site is a bus interchange which is bounded by Windsor Road. Windsor Road separates the interchange from residential developments, mainly detached houses.

2.3 SURROUNDING RECEIVERS

A summary of the nearest noise sensitive receivers surrounding the site is shown in Table 2, including assumed approximate distances from the buildings with noise sources to the receiver boundaries, noting the type of noise receiver. Where multiple types of receivers exist at the same address, they have been classified as the receiver with the most stringent noise criteria.

Table 2: Nearest sensitive receivers surrounding the site.

ID	*Sensitive Receiver*	*Receiver Type*	*Approx. Distance, m*
1	Mungerie Park Zone Substation	Industrial	<5
2a	Bus interchange	Mixed use (Industrial)	<5
2b	Future Mixed Use / Residential development (new release area)	Mixed use (Commercial/Residential)	<5
3	Restaurant	Commercial	50
4	Centrelink and Medicare	Commercial	105
5	34 Spring Mill Ave	Residential	135
6	2 McCombe Ave	Residential	215
7	Caddies Boulevarde	Residential	240
8	Shopping Centre	Commercial	125
9	798 Windsor Rd	Residential	100

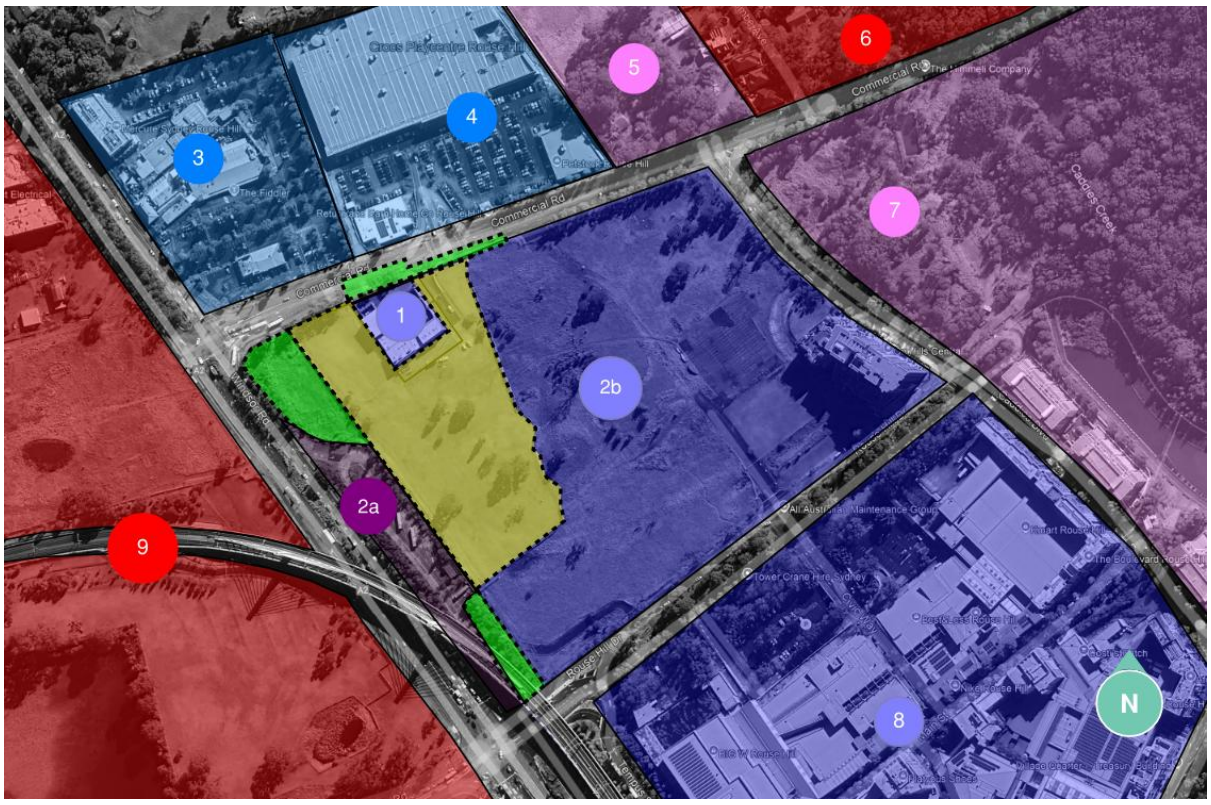


Figure 2: Nearest noise sensitive receivers surrounding the site location; with the Proposal Hospital site in Yellow and Ancillary works sites in Green.

3 SITE MEASUREMENTS

3.1 GENERAL

Attended and unattended noise surveys were conducted in the locations shown in Figure 3 to establish the ambient and background noise levels of the site and surrounds, in accordance with Fact Sheets A and B of the NSW Noise Policy for Industry (NPI). JHA Consulting Engineers carried out the noise surveys, in accordance with the method described in the AS/NZS 1055:2018 *'Acoustics – Description and measurement of environmental noise'*.

Figure 3: Long-term noise monitoring location (L1), short-term noise monitoring location (S1) and boundary of the site (black-dotted lines); with the Proposal Hospital site in Yellow and Ancillary works sites in Green.

From observations during the noise survey, it is noted that ambient noise levels are dominated by road noise from Windsor Road.

3.2 LONG-TERM NOISE MONITORING

Long-term noise monitoring was carried out at L1 from 31st May to 9th June 2022 with a Rion NL-52 noise logger (Serial Number 175549). The noise logger recorded L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise parameters at 15-minute intervals during the measurement period. The calibration of the noise logger was checked before and after use and no deviations were recorded. The noise logger microphone was mounted 1.5 metres above the ground and a windshield was used to protect the microphone.

The noise logger was located on the south-western side of the proposed site, 50 metres to the East of Windsor Road. This location was chosen as it was considered to be representative of the typical ambient and background noise levels at the site boundary and also representative of the levels at the nearest residential receiver, at 798 Windsor Rd (Receiver 9 in Figure 2). This location provided a secure location away from pedestrian areas and inaccessible areas to the South or East of the site.

Weather conditions were monitored during the duration of the noise survey. As stated in the NSW NPI methodology, any data likely to be affected by rain, wind or other extraneous noise has been excluded from the calculations. The detailed results of the long-term noise monitoring are presented graphically in Appendix A. These RBLs are shown in Table 3, together with the ambient noise levels (L_{Aeq}) measured for each time period.

Table 3: Long-term background and ambient noise levels measured on site.

Date	*Time of Day*		
	Day (0700-1800)	*Evening (1800-2200)*	*Night (2200-0700)*
Rating Background Levels; RBL dB(A)	56	54	43
Ambient Noise Levels; L_{eq} dB(A)	65	63	61

3.3 SHORT-TERM NOISE MONITORING

Short-term, attended noise monitoring was carried out to obtain representative third octave band noise levels of the site on Tuesday 31st May 2022. The short-term noise measurements were carried out during the daytime using a NTi XL-2 hand-held Sound Level Meter (SML) (Serial Number A2A-137420-E0). The calibration of the SLM was checked before and after each use and no deviations were recorded.

The SLM microphone was mounted 1.5 metres above the ground, and a windshield was used to protect the microphone. Measurements were undertaken in the free-field – i.e. more than 3 metres away from any building façade or vertical reflective surface. Weather conditions were dry during the attended noise monitoring, with occasional gusts of wind.

A summary of the results of the short-term noise monitoring is shown in Table 4.

Table 4: Results of short-term noise monitoring.

Location	*Date and Time*	*Parameter*	*Sound Pressure Level, dB (re 20µPa)*							
			Overall dB(A)	*Octave Band Centre Frequency, Hz*						
				63	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
S1	09/06/2022 13:40 – 13:55	$L_{90,15min}$	**59**	66	61	54	54	56	51	42	28
		$L_{eq,15min}$	**66**	75	72	66	62	62	58	51	40
		$L_{10,15min}$	**69**	78	74	67	65	65	61	53	42

3.4 TRAFFIC NOISE MONITORING

Based on the long-term noise monitoring results at location L1, the traffic noise levels are summarised below in Table 5.

Table 5: Measured traffic noise levels.

Location	*Measured Noise Levels, dB(A)*			
	Day period (7am-10pm)	*Day Noisiest 1h*	*Night period (10pm-7am)*	*Night Noisiest 1h*
L1	$L_{Aeq,15hour}$ 65	$L_{Aeq,1hour}$ 67	$L_{Aeq,9hour}$ 61	$L_{Aeq,1hour}$ 65

4 RELEVANT NOISE STANDARDS AND GUIDELINES

4.1 STANDARDS AND GUIDELINES

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise level criteria.

- Regulatory Framework:
  - Environmental Planning and Assessment (EP&A) Act 1979.
  - Protection of the Environmental Operations (POEO) Act 1997.
- Planning Framework:
  - The Hills Shire Local Environment Plan 2019.
  - The Hills Shire Development Control Plan 2012.
  - City of Blacktown Local Environment Plan 2015.
  - City of Blacktown Development Control Plan 2015.
- Noise Emissions and Intrusive Noise:
  - NSW Environment Protection Authority (EPA) – Noise Policy for Industry (NPI) 2017.
  - NSW Health Infrastructure Engineering Services Guideline (ESG), 2022.
- Transport Noise:
  - NSW EPA Road Noise Policy (RNP) 2011.
  - NSW (Transport and Infrastructure) State Environmental Planning Policy (T&ISEPP) 2021
  - NSW Department of Planning (DoP) – Development Near Rail Corridors and Busy Roads – Interim Guideline (DNRCBRIG) 2008.
  - NSW Department of Environment and Climate Change (DECC) Assessing Vibration: A Technical Guideline (AVTG) 2006.
- Construction Noise and Vibration:
  - NSW Department of Environment and Climate Change (DECC) – Interim Construction Noise Guideline (ICNG) 2009.
  - Australian Standard AS 2436:2010 "*Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites*".
  - British Standard BS 6472.1:2008 '*Guide to evaluation of human exposure to vibration in buildings – Vibration sources other than blasting*'.
  - British Standard BS 7358-2:1993 "*Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration*"
  - Transport for NSW EMF-NV-GD-0056 *Construction Noise and Vibration Guideline (Roads)* (CNVG-R) 2023.

4.2 REGULATORY FRAMEWORK

The Environmental Planning and Assessment Act 1979 (EP&A Act) provides the regulatory framework for environmental planning and assessment in NSW. The purpose of the EP&A Act is to ensure that "environmental impact" associated with the proposed development is properly considered and reasonable before granting development consent.

The assessment of "environmental impact" relies upon the identification of acceptable noise criteria which may be defined in a Development Control Plan or derived from principles using guidelines like NSW EPA Noise Policy for Industry (NPI 2017) or Noise Guide for Local Government (NGLG 2023).

The Protection of the Environment Operations (POEO) Act 1997 has the objective of protecting, restoring and enhancing the quality of NSW environment. Abatement of noise pollution is underpinned by the definition of "offensive noise" as follows:

"...

a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
    i. *is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
    ii. *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.*

..."

4.3 PLANNING FRAMEWORK

As the site is located within The Hills Shire LGA, and borders the City of Blacktown LGA (noting Windsor Road is the boundary between LGAs), relevant planning documents of both LGAs have been reviewed for any noise requirements or criteria. There are no specific noise level criteria, but rather sections of the DCPs provide general planning strategies.

4.4 ENVIRONMENTAL NOISE EMISSIONS

4.4.1 NSW EPA NOISE POLICY FOR INDUSTRY

The NSW EPA Noise Policy for Industry (NPI) 2017 assesses noise from industrial noise sources - scheduled under the POEO. Mechanical noise from the development shall be addressed following the recommendations in the NSW NPI.

The assessment is carried out based on the existing ambient and background noise levels addressing the following:

- Intrusiveness Criteria, to control intrusive noise into nearby sensitive receivers.
- Amenity Criteria, to maintain the noise level amenity for particular land uses.

These criteria are established for each assessment period (day, evening and night) and the more stringent of the two criteria sets the Project Noise Trigger Level (PNTL).

4.4.1.1 Intrusiveness Criteria

The NSW NPI defines the intrusiveness criteria as follows:

"The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15 minute period, and does not exceed the background noise level by more than 5 dB when beyond a minimum threshold."

Based on the intrusiveness criteria definition and the background noise levels on site shown in Table 3, Table 6 shows the intrusiveness criteria for the noise sensitive receivers.

Table 6: Determination of the intrusiveness criterion for residential noise sensitive receivers.

Noise Amenity Area	*Period*	*Measured Rating Background Level RBL, dB(A)*	*Intrusiveness Criterion, $L_{eq,15min}$ dB(A)*
Residential	Day	56	61
	Evening	54	59
	Night	43	48

It is noted that while background noise levels were measured in 2022, the intrusiveness criteria remain valid as per the NSW Noise Policy for Industry 2017 – Fact Sheet A: Determining existing noise levels - A1 Determining background noise for the intrusiveness noise level: "*Where a project intrusiveness noise level has been derived in this way, the derived level applies for a period of 10 years to avoid continuous incremental increases in intrusiveness noise levels. NPI*"

4.4.1.2 Amenity Criteria

The NSW NPI states the following to define the amenity criteria:

"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance."

As per Section 2.4.1 of the NSW NPI, when traffic noise is identified as the dominant noise source at the site and highly unlikely to decrease in the future, the amenity correction based on the measured $L_{Aeq,period(traffic)}$ can be applied.

Based on the amenity criteria definition and the land zoning, Table 8 shows the amenity criteria for the noise sensitive receivers.

Table 7: Determination of the amenity criterion for noise sensitive receivers.

Indicative Noise Amenity Area	*Period*	*Recommended Amenity Noise Level ($L_{Aeq, period}$), dB(A)*	*Project Amenity Noise Level ($L_{Aeq, period}$), dB(A)*	*Project Amenity Noise Criterion, $L_{Aeq,15min}$ dB(A)*
Residential	Day	55	50 (65-15)	53 (50+3)
	Evening	45	48 (63-15)	51 (48+3)
	Night	40	46 (61-15)	49 (46+3)
Commercial Premises)	When in use	65	60 (65-5)	63 (60+3)
Industrial premises	When in use	70	65 (70-5)	68 (65+3)

4.4.1.3 Project Noise Trigger Levels

The PNTL's are shown in Table 8 and have been obtained in accordance with the requirements of the NSW NPI. These shall be assessed to the most affected point on or within the noise sensitive receiver boundary.

Table 8: Determination of PNTL's (light grey highlight) for noise sensitive receivers.

Indicative Noise Amenity Area	*Period*	*Intrusiveness Criterion, $L_{Aeq,15min}$ dB(A)*	*Amenity Criterion, $L_{Aeq,15min}$ dB(A)*
Medium Density Residential (R3)	Day	61	53
	Evening	59	51
	Night	48	49
Commercial Premises (B4/B5/B6)	When in use	---	63
Industrial premises (B6)	When in use	---	68

The NPI defines the time of day as follows:

- Day – the period from 7am to 6pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
- Evening – the period from 6pm to 10pm.
- Night – the remaining periods.

4.4.2 SLEEP DISTURBANCE

The potential of sleep disturbance from short-duration noise events from the proposed development – i.e. ambulance arrivals and departures – during the night-time period needs to be considered. Sleep disturbance occurs through changes in sleep state and awakenings.

NSW EPA NPI recommends the following criteria:

"Where the subject development night-time noise levels at a residential location exceed:

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

A detailed maximum noise level event assessment should be undertaken.

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

Table 9 summarises the noise level criteria for sleep disturbance based on the NSW EPA NPI recommendations and highlight the criteria to apply.

Table 9: Sleep Disturbance screening noise level

	Screening noise level
Condition 1	$L_{Aeq,15min}$ 40dB(A) || RBL + 5 = 48dB(A)
Condition 2	L_{AFmax} 52dB(A) || RBL + 15 = 58dB(A)

These values shall be achieved external to the bedroom window of the noise residential sensitive receivers, as opposed to the receiver boundary – which is applied for most other criteria.

4.5 TRAFFIC IMPACTS

4.5.1 TRAFFIC GENERATED BY THE DEVELOPMENT

The NSW Road Noise Policy (RNP) establishes criteria for traffic noise from:

- Existing roads,
- New road projects,
- Road development projects,
- New traffic generated by developments.

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited up to 2.0dB (i.e. less than 2.1dB) above the existing noise levels. An increase of up to 2.0dB represents a minor impact that is considered barely perceptible to the average person.

4.5.2 TRAFFIC IMPACT ONTO THE DEVELOPMENT.

Per clauses 2.100 and 2.120 of the Transport & Infrastructure State Environmental Planning Policy (SEPP) 2021, when a development is adjacent to a rail corridor, a freeway, a toll-way, a transit-way or a road with an annual average daily traffic volume (AADT) of more than 20,000 vehicles, an acoustic assessment is required to determine compliance with the clauses.

The DOP Guideline Development Near Rail Corridors Or Busy Roads – Interim Guideline details the application of the SEPP.

The T&ISEPP specifies the internal noise level criteria for healthcare for both road and rail as shown in Table 10.

Table 10: Summary of the noise level criteria for road and rail noise break-in.

Type of occupancy	*Maximum Noise Level, dB(A)*
Hospitals – Wards	35
Hospitals – Other noise sensitive areas	45

4.5.2.1 Noise from Road

The development is situated adjacent to Windsor Rd (A2) which has an AADT over 20,000 vehicles as per TfNSW *Traffic Volume Maps for Noise Assessment* Map 11A. Therefore, the proposed development is subject to clause 2.120 of the Transport & Infrastructure SEPP. Refer to Table 10 for the maximum internal noise levels due to traffic.

4.5.2.2 Noise from Railway

The Acoustic Assessment Zones as defined in the guideline are summarised in Figure 4, with specialist acoustic advice required for 'Zone A', and assessment consideration for 'Zone B'. The rail corridor supports passenger services at speeds greater than 80km/h; therefore, the threshold distances for Zones A and B are 25m and 60m, respectively.

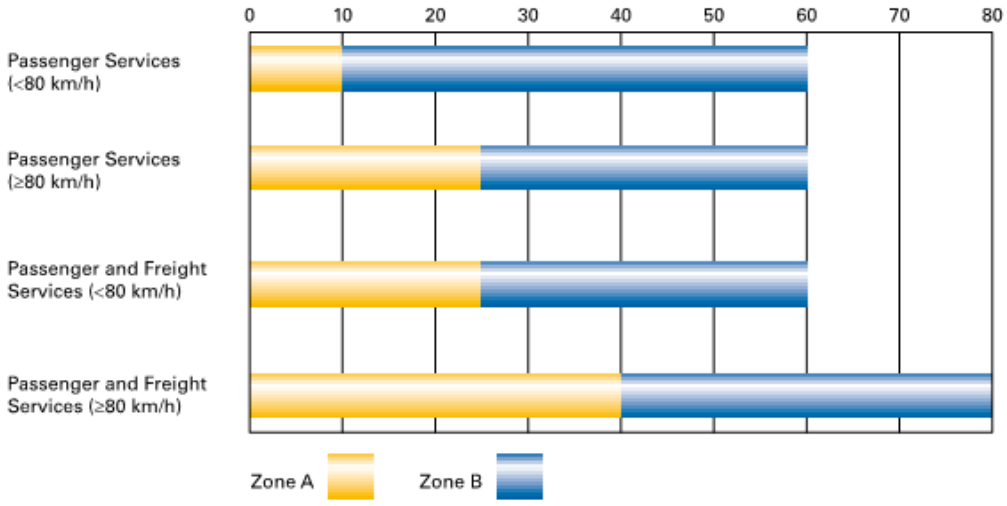


Figure 4: Acoustic Assessment Zones based on distance (m) of noise-sensitive develoment.

Based on the proposed site plan, the southern façade of the new hospital building will be approximately 70 – 80 metres set-back from the rail corridor. Therefore, the new hospital is located outside of the acoustic assessment zones and independent consideration of rail noise is not required.

4.5.2.3 Vibration from Railway

The guideline requires vibration to be assessed for vibration sensitive buildings within 60 metres of the nearest operational track of a rail corridor. A summary of the assessable zones for vibration based on proximity are shown below in Figure 5.

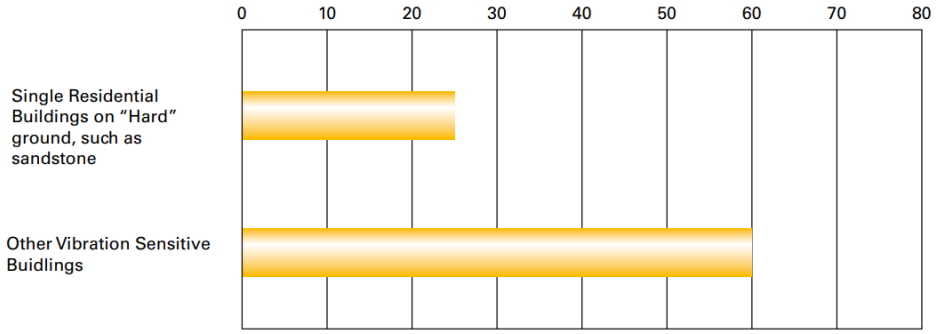


Figure 5: Acoustic Assessment Zones based on distance (m) of vibration sensitive develoment from operational track.

The train line runs along a decoupled bridge whose base support is approximately 80m from the nearest vibration sensitive hospital building. Therefore, the new hospital is located outside of the acoustic assessment zones for vibration sensitive development, and a detailed assessment of rail vibration is not required.

4.6 CONSTRUCTION NOISE AND VIBRATION

The NSW DECC *'Interim Construction Noise Guideline'* (ICNG 2009) provides mitigation strategies to reduce noise and vibration impacts to nearby sensitive receivers. In addition to the ICNG, guidance has been sought for out of hours road works from Transport for New South Wales (TfNSW) Construction Noise and Vibration Guideline – Roads (CNVG-R).

4.6.1 AIRBORNE NOISE MANAGEMENT LEVELS

The ICNG suggest construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receivers depending on the duration of works. The management levels for long-term duration works are as per Table 11.

Table 11: Management levels for construction noise at residences using quantitative assessment.

Time of day	*Noise Management level* $L_{Aeq\ (15\ min)}$ *	*How to apply*
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

ICNG suggests construction noise management levels for other sensitive land uses surrounding construction sites. Table 12 below summarises the airborne construction noise criteria for most affected noise sensitive

Table 12: ICNG construction airborne noise criteria for noise sensitive receivers surrounding the site.

Sensitive Receiver		*Airborne Construction Noise Management Levels, L_{Aeq} dB(A)*	
		Within Standard Hours	*Outside Standard Hours*
Residential	Noise affected / External	RBL+10	RBL+5
	Highly noise affected / External	75	N/A
Commercial Premises	External	70	70
Industrial premises	External	75	75

In addition to criteria provided by the ICNG, the development proposes the roadwork upgrades to the existing Commercial Rd. Construction related to road works is to comply with Transport for NSW (TfNSW) Construction Noise and Vibration Guideline – Roads (CNVG-R).

Roadworks to Commercial Rd intersection upgrade/ road widening works have the potential to be undertaken at nighttime. The CNVG-R classifies road works during the night as Out of Hours Work (OOHW) Period 2, specifically defined as:

- Mon – Fri (10 pm – 7 am),
- Sat (10 pm – 8 am),
- Sun/Public Holiday (6 pm – 7 am).

Based on the measured RBLs outlined in Table 3, Table 13 summarises the OOHW Period 2 construction noise criteria defined in the CNVG-R that would trigger additional mitigation measures.

Table 13: Airborne noise criteria for road works per CNVG-R.

Sensitive Receiver	*Time of day*	*Airborne Road Construction Noise Management Levels, $L_{Aeq(15\ min)}$ dB(A)*
Residential (External)	Standard Hours	66 (RBL+10) 48 (RBL+5)

Sleep disturbance caused by construction noise is addressed in Appendix E of the CNVG-R. The document provides guidance, defining an external noise level criteria of 65dBA L_{max} at a property's façade, with the windows open.

The magnitude of the exceedance of the above criteria influences the extent of additional mitigation measures required in accordance with Table C.1 of the CNVG-R.

4.6.2 VIBRATION CRITERIA

4.6.2.1 Structural Building Damage

Ground vibration from construction activities can damage surrounding buildings or structures. For occupied buildings, the vibration criteria given in previous section for Human Comfort shall generally form the limiting vibration criteria for the Project.

For unoccupied buildings, or during periods where the buildings are unoccupied, the vibration criteria for building damage suggested by British Standard BS 7358-2: "*Evaluation and measurement for vibration in*

buildings. Guide to damage levels from groundborne vibration" are to be adopted. Guideline values from BS 7358-2 are presented in Table 14.

Table 14: BS 7385.2:1993 Transient vibration guide values for cosmetic damage.

Structural type	*Peak component particle velocity in frequency range of predominant pulse, mm/s (Peak Particle Velocity - PPV)*	
	4Hz to 15Hz	*15Hz and above*
Reinforced or framed structures *Industrial and heavy commercial buildings*	50	
Unreinforced or light framed structures *Residential or light commercial type buildings*	15 @ 4Hz increasing to 20 @ 15Hz	20 @ 15Hz increasing to 50 @ 40Hz and above

4.6.2.2 Human Comfort

The Department of Environment and Climate Change (DECC) developed the document '*Assessing Vibration: A Technical Guideline*' in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. It is based on the guidelines contained in BS 6472.1:2008 '*Guide to evaluation of human exposure to vibration in buildings – Vibration sources other than blasting*'.

The guideline does not address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous (with magnitudes varying or remaining constant with time), impulsive (such as shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration criteria for continuous and impulsive vibration are presented in Table 15 below, in terms of vibration velocity levels.

Table 15: Continuous and impulsive vibration criteria applicable to the site.

Place	*Time*	*RMS velocity, mm/s [dB ref 10^{-6}mm/s]*			
		Continuous Vibration		*Impulsive Vibration*	
		Preferred	*Maximum*	*Preferred*	*Maximum*
Residences	Day-time	0.20 [106 dB]	0.40 [112 dB]	6.00 [136 dB]	12.00 [142 dB]
	Night-time	0.14 [103 dB]	0.28 [109 dB]	2.00 [126 dB]	4.00 [132 dB]
Offices, schools, educational and worship	When in use	0.40 [112 dB]	0.80 [118 dB]	13.00 [142 dB]	26.00 [148 dB]

When assessing intermittent vibration comprising a number of events, the Vibration Dose Value (VDV) it is recommended to be used. Table 16 shows the acceptable VDV values for intermittent vibration.

Table 16: Intermittent vibration criteria applicable to the site.

Place	*Time*	*Vibration Dose Values, m/s$^{1.75}$*	
		Preferred	*Maximum*
Residences	Day-time	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational and worship	When in use	0.40	0.80

4.6.3 CONSTRUCTION TRAFFIC NOISE

The NSW Road Noise Policy (RNP) establishes criteria for traffic noise generated by construction activity along existing roads.

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited up to 2.0dB (i.e. less than 2.1dB)[1] above the existing noise levels. An increase of up to 2.0dB represents a minor impact that is considered barely perceptible to the average person.

[1] NSW Roads and Maritime Service. Noise Criteria Guideline 2015. Page 10.

5 OPERATIONAL NOISE EMISSIONS ASSESSMENT

Noise emissions from the proposed hospital have the potential to impact on existing noise sensitive receivers. For the purpose of this noise impact assessment, the noise sources associated with the hospital are assumed as follows:

- Noise emissions from building services plant to the surrounding receivers.
- Noise emissions from traffic generated by the development.
- Noise emissions from Ambulance movements.
- Noise emissions from Ambulance Sirens.
- Noise emissions from the Multi-storey carpark.
- Noise emissions from operation of the loading dock.
- Noise emissions from waste removal.

Each of these noise sources has been considered in the noise impact assessment and the assessments have considered the following:

- The premises will operate 24 hours a day, seven days per week. Therefore, the worst-case scenario will be during night-time periods.
- Noise levels have been considered as continuous over the assessment time period to provide the worst-case scenario.
- Distance attenuation, building reflections and directivity.

5.1 BUILDING SERVICES

Noise from the proposed development building services plant should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of the sensitive receivers. The noise emissions from building services must meet the noise limits as set out in accordance with the NSW NPI.

Noise controls may need to be incorporated with the design of the building services to ensure that cumulative noise levels from plant to the nearest noise sensitive receivers meets the noise level criteria. Building services plant will operate continuously during all time periods and this has been considered for the noise assessment of the building services plant.

At this stage, final building services plant selections have not been made; therefore, it is not possible to undertake a detailed assessment of the building services plant noise emissions. However, a preliminary assessment has been carried out for the building services plant based on the locations of the proposed location of the building services plant rooms/areas.

5.1.1 GENERAL

Noise controls will need to be incorporated with the design of the building services to ensure that the cumulative noise levels from plant to the nearest noise sensitive receivers meets the NSW NPI noise level criteria – refer to Table 8.

Usual design noise controls that may need to be implemented will typically include, but are not limited to:

- Strategic location and selection of building services plant to ensure the cumulative noise levels at the receiver boundaries is met.

- Selection of appropriate quiet plant.
- Acoustic noise control measures to be put in place to minimise noise impacts such as:
  - In-duct attenuation
  - Noise enclosures as required
  - Sound absorptive panels
  - Acoustic louvres as required
  - Noise barriers as required

Acoustic assessment of all building services plant shall continue during the detailed design phase of the project in order to confirm any noise control measures to achieve the relevant noise criteria at the nearest noise sensitive receivers.

5.1.2 ON-FLOOR BUILDING SERVICES PLANTROOMS

Typical on-floor building services plant is proposed to be facing mainly internal courtyards on levels 6, 7, 8, and 9.

Based on the proposed location of the plantrooms, the nearest and most affected noise sensitive receivers do not have a direct line of sight to the plantrooms and are not expected to experience high levels of noise. Furthermore, mechanical equipment noise levels are unknown at this stage.

It is expected that on-floor plant can be controlled using either one of the following example options:

- Low noise equipment
- Internally lined duct
- Acoustic attenuators or louvres

5.1.3 LEVEL 4 BUILDING SERVICES PLANTROOM

The proposed level 4 plantrooms are located to the north, west and south of the hospital building on the façade, with open louvres on the façade as shown in Figure 6.

Based on the proposed location of the plantrooms, the nearest and most affected noise sensitive receivers are shown in Table 17 with approximate distances from the plantroom façade.

Table 17: Most affected noise sensitive receivers, noise level criteria plus approx. distances from the level 4 plantroom façade.

Receiver	*Receiver (Type)*	*Noise Level criteria, dB(A)*	*Distance from plantroom façade, m (Direction)*
1	Mungerie Park Zone Substation (*Industrial*)	68	30 (*North*)
2a	Bus interchange (*Industrial*)	68	20 (*West*)
2b	*Future development (Commercial / Residential)*	48	25 (*South*)
9	*798 Windsor Road (Future Residential)*	48	100 (*West*)

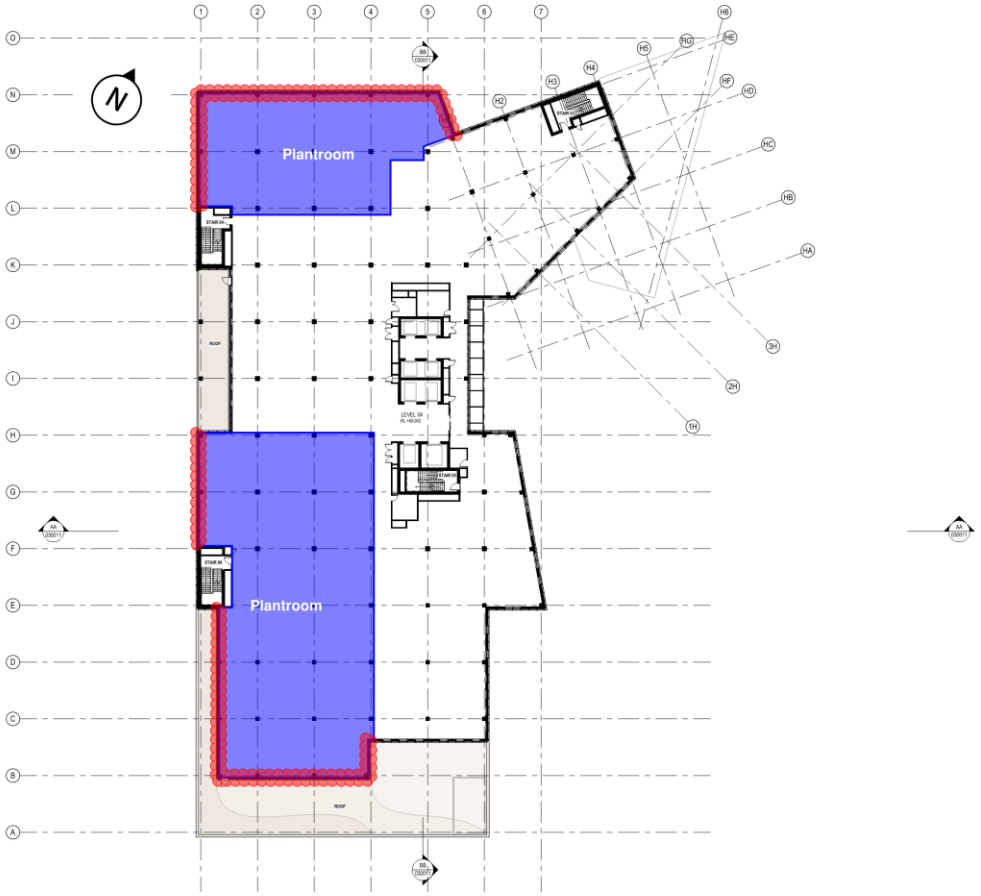


Figure 6: Level 4 plantroom locations plus locations of open louvres on the façade (shown clouded in red).

At this stage, mechanical equipment noise levels are unknown. A preliminary assessment has been conducted to nearest noise sensitive receivers and the maximum allowable noise level emissions from the level 4 plantrooms have been predicted to be 70dB(A) at 1 metre from the plantroom façades.

5.1.4 LEVEL 9 CHILLER PLANTROOM

The proposed level 9 chiller plantroom is located to the south of the hospital building on the façade, with open louvres on the façade as shown in Figure 7.

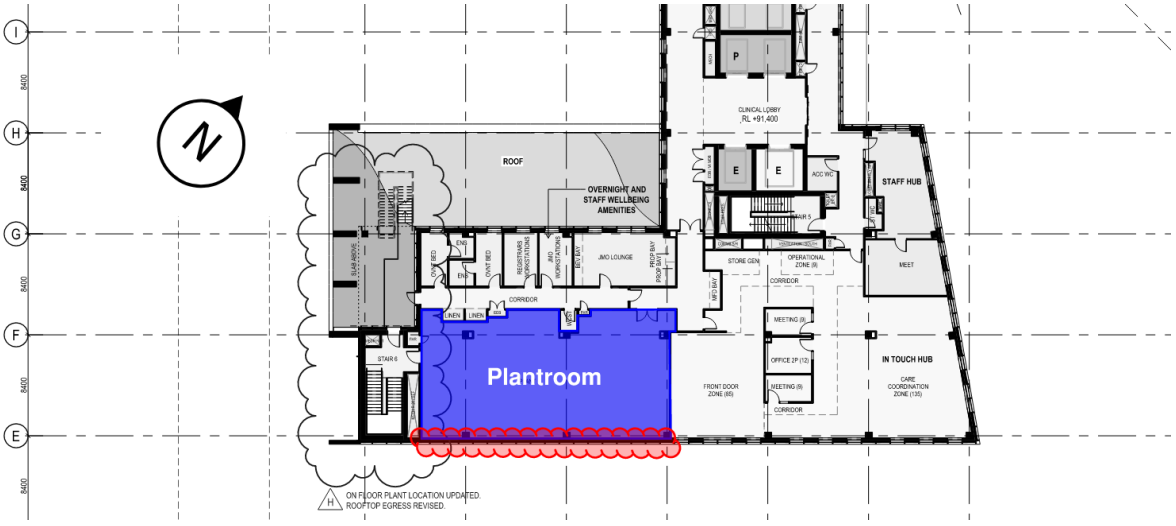


Figure 7: Level 9 chiller plantroom locations plus location of open louvres on the façade (shown clouded in red).

Based on the proposed location of the chiller plantroom, the nearest and most affected noise sensitive receivers are shown in Table 18 with approximate distances from the plantroom façade.

Table 18: Most affected noise sensitive receivers, noise level criteria plus approx. distances from the level 9 chiller plantroom façade.

Receiver	*Receiver (Type)*	*Noise Level criteria, dB(A)*	*Distance from plantroom façade, m* (Direction)
2b	*Future development (Commercial / Residential)*	48	25 (*South*)

At this stage, mechanical equipment noise levels are. A preliminary assessment has been conducted to nearest noise sensitive receivers and the maximum allowable noise level emissions from the level 9 chiller plantroom have been predicted to be 70dB(A) at 1 metre from the plantroom façade.

5.1.5 ROOFTOP BUILDING SERVICES PLANT

It has been proposed to locate cooling towers and heat pumps on the roof of the development as shown in Figure 8.

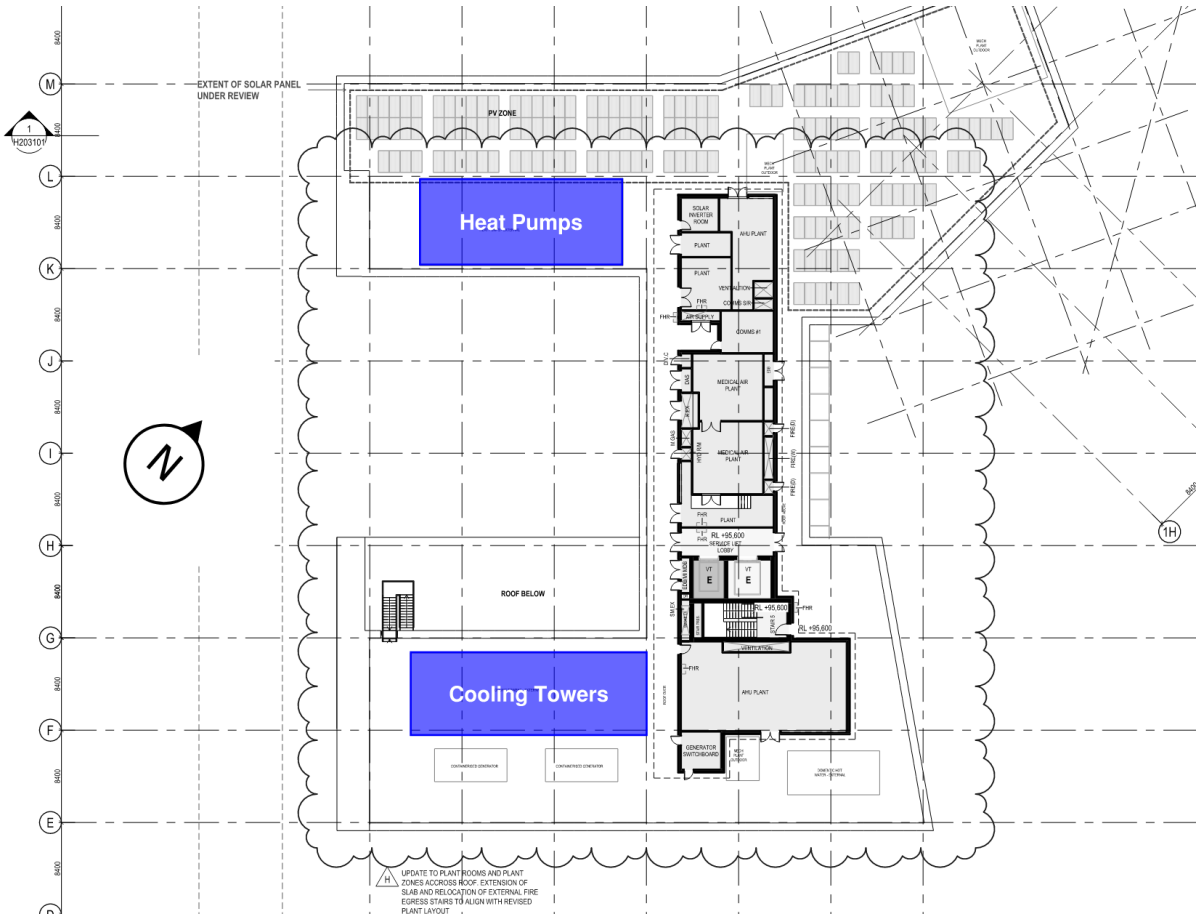


Figure 8: Rooftop plant area.

Based on the proposed location of the cooling towers and heat pumps, the nearest and most affected noise sensitive receivers are shown in Table 19 with approximate distances from the development.

Table 19: Most affected noise sensitive receivers, noise level criteria plus approx. distances from the plantroom façade.

Receiver	*Receiver (Type)*	*Noise Level criteria, dB(A)*	*Distance from nearest plantroom*
2a	Bus interchange (Industrial)	68	20 m from Cooling Towers and Heat pumps (*West*)
2b	*Future development (Commercial / Residential)*	48	72 m from Cooling Towers (*East & South*)
3	*Commercial*	63	75 m from Heat Pumps *(North)*

A preliminary assessment has been conducted based on the rooftop mechanical equipment cumulative Sound Power Levels (SWL) assumed as follows:

- Cooling Tower daytime 94 dB(A) SWL
- Cooling Tower Night-time 93 dB(A) SWL
- Heat Pumps: 96 dB(A) SWL

Based on the nominated distances to nearest noise sensitive receivers (including any shielding) and the nominated cumulative noise levels, compliance at all noise sensitive receivers have been predicted from rooftop mechanical plant.

Should noise levels of mechanical plant increase further acoustic assessment will be required and acoustic mitigation measures should be considered.

5.2 TRAFFIC NOISE GENERATION

A Draft Transport and Accessibility Impact Assessment (TAIA) has been prepared by Arup[2], which predicts that peak traffic flow volumes will increase by 233 vehicles/hour (AM peak traffic flow) and 327 vehicles/hour (PM peak traffic flow) as a result of the development. Existing measured peak hour traffic volumes as per the TAIA have been used for this assessment. Based on the predicted traffic generation along the existing roads, predicted noise level increases due to the development are presented in Table 20.

Table 20: Predicted traffic noise level increase along Windsor Road.

Road	*Time*	*Traffic Flow (vehicles/hour)*		*dB increase*	*Complies*
		Existing	*Future*		
Windsor Rd	*AM Peak*	3,700	3,823	0.1	Yes
	PM Peak	4,000	4,192	0.2	Yes
Commercial Rd	*AM Peak*	1,300	1,368	0.2	Yes
	PM Peak	1,400	1,474	0.2	Yes
Caddies Blvd	*AM Peak*	900	926	0.1	Yes
	PM Peak	1,000	1,067	0.3	Yes

[2] *Rouse Hill Hospital – Draft Transport and Accessibility Impact Assessment*, prepared by Arup, dated 27th June 2025.

As shown in Table 20, the increase of traffic noise levels due to the proposed development, are less than the maximum allowable increase of 2.1dB. Therefore, the traffic increase due to the proposed development will not result in any noticeable change in traffic noise levels and is expected to meet the NSW Road Noise Policy recommendations.

5.3 AMBULANCE NOISE

5.3.1 AMBULANCE BAY MOVEMENTS

An ambulance noise generation assessment has been undertaken in order to determine potential noise impacts to nearby receivers. For the noise assessment, departing and arriving ambulances noise levels are likely to generate the following noise level range.

Table 21: Typical assumed Noise level ranges for ambulances.

Noise Source	*Maximum Sound Power Level*
Ambulance vehicle accelerating	91 dB(A) L_{eq} 96 dB(A) L_{max}

The ambulance bay is proposed to be adjacent to Old Windsor Rd to the west of the site as shown in Figure 9.

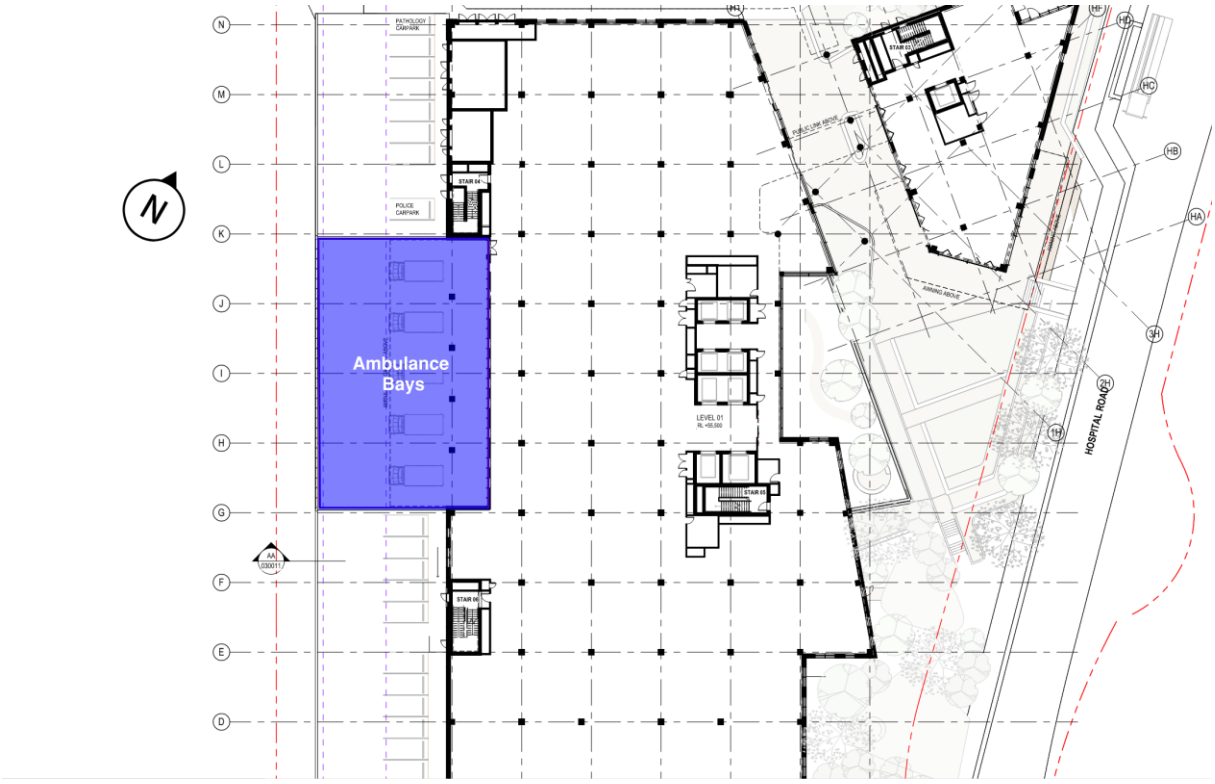


Figure 9: Proposed location of ambulance bay (blue highlight).

The noise assessment has considered the following assumptions:

- The hospital will operate 24 hours a day 7 days per week. Therefore, there will be ambulance movements at any time period.
- One Ambulance exit or arrival event is estimated to be 30 seconds.

- The assessment assumes one ambulance vehicle will be either exiting or arriving within a 15-minute assessment period.
- Ambulance noise levels are based on the highest value of the maximum sound power level range for a worst-case scenario.
- Noise predictions are based on the proposed location of the ambulance bay as shown in Figure 9.
- Noise predictions are based on distance attenuation, ground reflection, building reflections / shielding and directivity of the noise source to the nearest noise sensitive receiver – i.e. 798 Windsor Road.
- Noise level criteria are based on the sleep disturbance screening levels shown in Table 9.

The sleep disturbance assessment is provided in Table 22.

Table 22: Sleep disturbance screening assessment at nearest residential receiver for ambulance movements.

Calculation	*Condition 1*	*Condition 2.*
Ambulance Accelerating Sound Power Level, dB(A)	91 L_{Aeq}	96 L_{Amax}
Distance attenuation (100m), dB	-48	-48
Duration correction, dB	-15	-
Resulting at residential receiver, dB(A)	28 $L_{Aeq,15min}$	48 L_{Amax}
NPI Sleep Disturbance Night-time Screening Level / Complies?	48dB(A) $L_{eq,15min}$ /Yes	58dB(A) L_{max} / Yes

Based on the assessment above, the predicted noise levels are expected to comply with both Condition 1 and Condition 2 of the NPI Sleep Disturbance Screening level during the night-time period.

5.3.2 AMBULANCE SIRENS

The use of ambulance sirens when ambulances depart or arrive it is not specifically addressed in any relevant noise regulations. When in use, noise levels from ambulance sirens will be audible at the nearest residential receivers.

Events identified as Priority One events (Life Threating Emergencies), require that warning devices must be used, including warning lights and sirens. The NSW Ambulance *Emergency Driving and Use of Warning Police Directive 2016-033* states that:

"NSW Ambulance personnel who drive a vehicle under emergency response conditions shall use safety equipment provided by NSW Ambulance for that purpose which includes warning devices: lights and sirens. Lights can be used in isolation without the use of a siren if the driver of the vehicle deems the circumstances are safe to do so and can justify reasonable cause to do so."

Based on the above, we understand that ambulance drivers will make a judgement call on whether to use ambulance sirens on case-by-case basis. We further understand that it is the practice of Paramedics to minimise the use of sirens when it will cause a noise disturbance, and the sirens are deemed unnecessary.

5.4 MULTI-STOREY CARPARK

A multi-storey carpark with approximately 659 parking spaces is proposed to the north-west of the Site The proposed multi-storey carpark is situated adjacent to the existing substation as shown in the figure below.

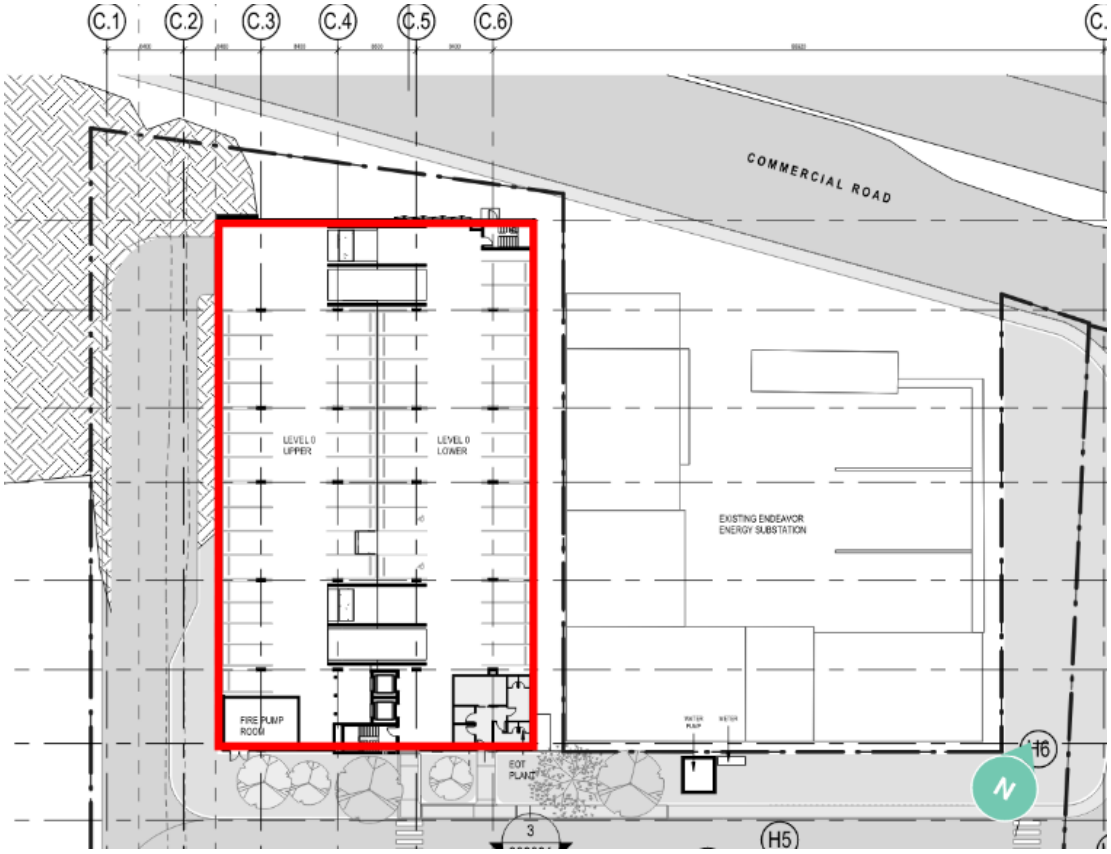


Figure 10: Location of the proposed multi-storey carpark (red outline).

Based on information in the TAIA the carpark is expected to reach 259 vehicles during peak hour. Based on the above, a car movement assessment has been conducted to predict noise impacts from the operation of the multi-storey carpark during peak hour. The assessment has been based on the following assumptions:

- Noise levels have been considered as continuous over a 15-minute assessment period to provide the worst-case scenario.
- Based on the predicted peak of 259 vehicles per hour, and as a worst-case scenario, the assessment assumes that 65 vehicles will be entering or leaving per 15 minutes during the night-time period (10pm to 7am).
- Car parking entrance and bays as per the Architectural drawings.
- Location of car park as indicated in Architectural drawings and Figure 10.
- This report has not considered the use of polished concrete, which is installed in some car park facilities. This floor type generates substantial tyre noise and is the source of most car park noise complaints. Due to the proximity of nearby residences and inpatient bays, it is recommended that polished concrete is not used in this facility.
- Noise predictions are based on distance attenuation, ground reflection, building reflections / shielding and directivity of the noise source to the nearest noise sensitive receiver.
- Noise impacts have been assessed to the hospital (approximately at 50m), the nearest existing residential receiver 9 (approximately 150m) and the nearest future proposed residential receiver 2b (approximately 80m).
- Typical sound power levels for vehicles as shown in Table 23.

Table 23: Sound Power Levels of vehicle movement.

Item	*Sound Power Level (dB re. 1pW, dB(A))*
Internal Car Movement (starting, idling and driving) (L_{Aeq})	74
Car door slam (L_{Amax})	93

Refer to Table 24 below for assessment of the operation of the multi-storey carpark during in night-time.

Table 24: Car park movements noise assessment from use of the multi-storey during peak hour.

Calculation	*Receiver 2b*	*Receiver 9*	*Hospital*
Sound Power Level Carpark movement (L_{Aeq}), dB(A)	74	74	74
Number correction 65 vehicle movements	+18	+18	+18
Distance attenuation, dB	-46	-51	-42
$L_{Aeq,15min}$ resulting at receiver, dB(A)	46	41	50
$L_{Aeq,15min}$ Night-time Target, dB(A) / Complies?	48 / Yes	48 / Yes	50 / Yes

Table 25: Car park movements noise assessment from use of the multi-storey during peak hour.

Calculation	*Receiver 2b*	*Receiver 9*	*Hospital*
Sound Power Level Car door slam (L_{Amax}), dB(A)	93	74	74
Distance attenuation, dB	-46	-51	-42
L_{Amax} resulting at receiver, dB(A)	47	41	51
L_{Amax} Night-time Sleep Disturbance Screening Level, dB(A) / Complies?	58 / Yes	58 / Yes	58 / Yes

Using the assumptions outlined in the report, the results show that noise levels are expected to result in compliance with the operational noise criteria and sleep disturbance screening levels as per the NPI.

Occasional events such as horns or aggressive driving around the site may generate higher noise levels than those outlined above, however these are expected to be very infrequent and as such are not expected to result in significant sleep disturbance impacts.

5.5 LOADING DOCK

Noise emissions from the operations of the loading dock are to comply with NPI operation noise criteria as specified in Section 4.4.1, noise associated with activities expected include trucks arriving, reversing, loading/unloading and departing.

The proposed loading dock is located on ground level towards the south of the site with entry and exits via Hospital Road as shown in the figure below.

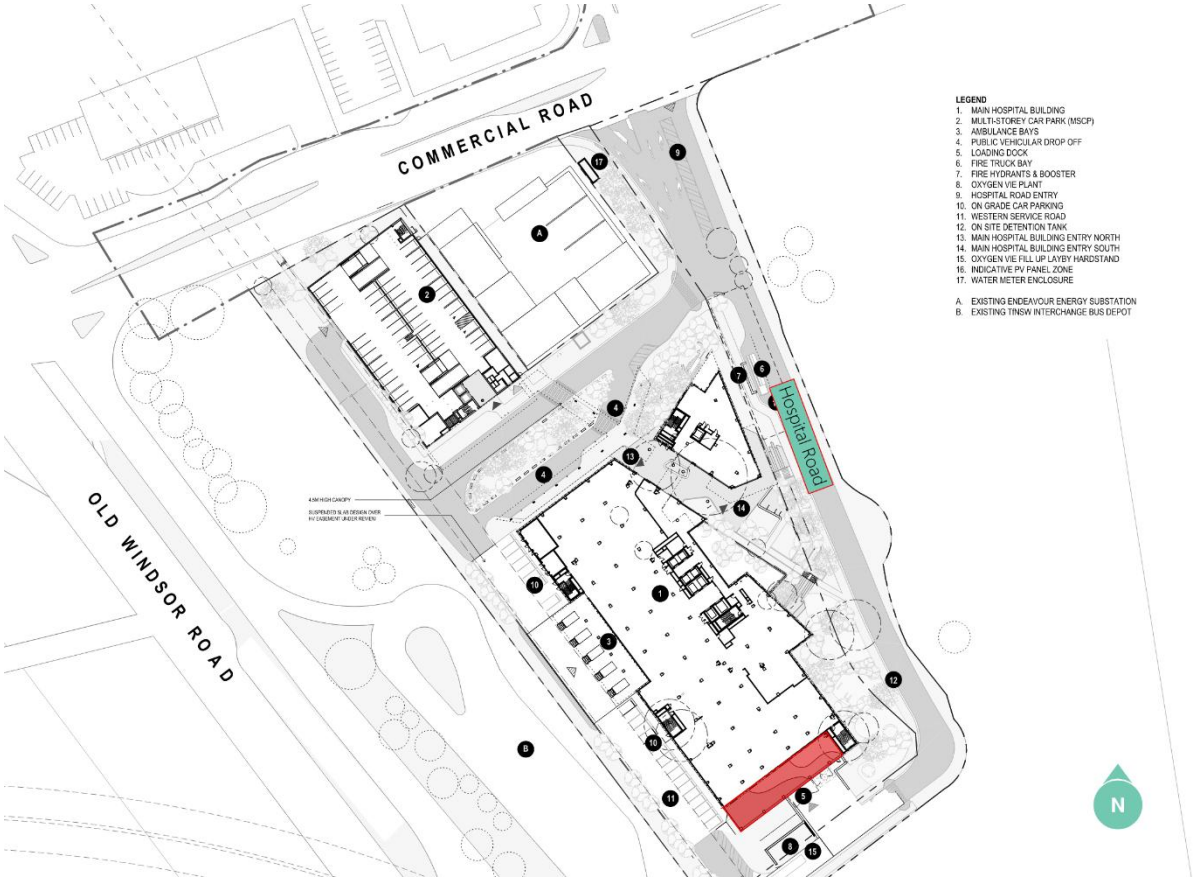


Figure 11: Location of proposed loading dock (red shaded).

An acoustic assessment for noise has been conducted to determine the noise levels to the nearest noise sensitive receivers; the proposed loading dock has allowance for the following:

- 2x HRV truck to be loading and unloading at any time.
- 1x HRV waiting bay.
- 2x Waste removal bays.
- 1x Oxygen tanker vehicle.

Operational noise emissions related to waste removal and oxygen tanker decanting is not expected to occur regularly and is also subject to night-time operations, this is addressed in Section 5.6. Table 26 below shows noise levels assumed for the assessment, these noise levels are based on noise monitoring results obtained to assess similar loading dock operations.

Table 26: Assumed noise source levels for loading dock activities.

Noise Source	*Overall Sound Power Level, L_{WA}, dB(A)*	*Duration, sec*
Truck arriving at the loading dock	92	15
Truck reversing	92	10
Truck idling	87	60
Load/Unload activities	80	800
Truck departing	92	15
Equivalent Sound Power Level	$L_{WAeq,15min}$ 83	900

In addition to the above assumed noise levels, the assessment also considers the following:

- Nearest noise sensitive receiver – 2b, approximately 25m away from loading dock entrance.
- No external operational use of the loading dock during night-time
- All sources operating over a 15-minute period.

The predicted noise levels are shown in the table below and assessed against the day and evening time NPI criteria.

Table 27: Predicted noise levels for loading dock operations

Calculation	*SWL, dB(A)*	*Duration correction, dB*	*Propagation Attenuation, dB*	*Predicted Sound Pressure Level, $L_{Aeq,15min}$*
Truck arriving at the loading dock	92	-18	-36	38
Truck reversing	92	-20	-36	37
Truck idling	87	-12	-36	39
Load/Unload activities	80	-1	-36	44
Truck departing	92	-18	-36	38
Equivalent Noise Level				47
Noise Level Criteria Day-time dB(A) / Complies?				53 / Yes
Noise Level Criteria Evening-time dB(A) / Complies?				51 / Yes

5.6 WASTE REMOVAL & OXYGEN DECANTING

Based on the architectural documentation, the development proposes 2x waste skip bins within the loading dock area and an external bulk oxygen enclosure. Waste removal and oxygen decanting services can occur during night-time and therefore, is subject to NPI sleep disturbance criteria (Refer to Section 4.4).

NPI sleep disturbance criteria is applicable to the nearest façade of a residential bedroom. However, the nearest noise sensitive receiver (i.e. receiver 2b) is not yet constructed therefore location of residential façade is not known. As a worst case, the distance used in this assessment is to the receiver boundary, approximately 25m away from loading dock entrance for waste removal services. As the oxygen tanks are proposed external to the loading dock, a worst-case distance of 7m to the receiver boundary.

As the proposed layout of the loading dock indicates that skip bins are in use and not individual garbage bins, typical removal does not involve emptying of the bin but rather a waste collection vehicle loading the skip and departing, therefore, it is not expected that waste removal services will occur for a full 15 minutes. Oxygen decanting however, involves the truck to sit idling whilst oxygen is pumped into the tanks and can be expected to be operational for an entire 15 minutes. Based on this, Table 28 below summarises noise sources used for the acoustic assessment.

Table 28: Assumed noise sources for waste removal and oxygen decanting activities.

Noise Source	*Overall Sound Power Level, L_W, dB(A)*		*Duration, sec*
	$L_{eq(15min)}$	*L_{max}*	
Waste collection vehicle arriving at the loading dock	92	102	15
Waste collection vehicle reversing	92	102	15
Waste collection loading skip bin	87	97	60
Waste collection vehicle departing	92	102	15
Oxygen tanker vehicle decanting	87	97	900
Equivalent Sound Power Level	81	107	---

Based on the above, predicted noise levels due to waste removal and oxygen decanting are shown in the Table 29 and Table 30, along with whether compliance is achieved for NPI sleep disturbance condition 1 and condition 2 respectively.

Table 29: Sleep disturbance noise assessment for residential receiver from waste removal and oxygen decanting - Condition 1.

Calculation	*SWL, dB(A)*	*Duration correction, dB*	*Propagation Attenuation, dB*	*Predicted Sound Pressure Level, dB(A) $L_{eq,15min}$*
Waste collection vehicle arriving at the loading dock	92	-18	-36	38
Waste collection vehicle reversing	92	-18	-36	38
Waste collection loading skip bin	87	-12	-36	39
Waste collection vehicle departing	92	-18	-36	38
Oxygen tanker vehicle decanting	87	---	-25	62
Equivalent Noise Level				62
NPI Condition 1 - Sleep Disturbance Screening Target / Complies?				48 / No

Table 30: Sleep disturbance noise assessment for residential receiver from waste removal and oxygen decanting- Condition 2.

Calculation	*SWL, dB(A)*	*Propagation Attenuation, dB*	*Predicted Sound Pressure Level, dB(A) L_{max}*
Waste collection vehicle arriving at the loading dock	102	-36	66
Waste collection vehicle reversing	102	-36	66
Waste collection loading skip bin	97	-36	61
Waste collection vehicle departing	102	-36	66
Oxygen tanker vehicle decanting	97	-25	72
Maximum Noise Level			72
NPI Condition 2 - Sleep Disturbance Screening target / Complies?			58 / No

Predicted results shown in the tables above indicate that sleep disturbance is expected to exceed NPI criteria for both screening target Condition 1 and Condition 2. For any future residential receiver '2b', it is recommended that, any waste removal activities undertaken before 7am (i.e. reversing and loading of skip bins) should be undertaken within the loading dock, with the door closed to minimise sleep disturbance to neighbouring residences. Waste removal during daytime can be undertaken outside the loading dock. Oxygen tanker decanting activities shall be scheduled during the day.

6 EXTERNAL NOISE INTRUSION

A noise assessment for external airborne noise intrusion has been undertaken in order to provide preliminary recommendations for the western façade of the Hospital Building.

Noise levels from Windsor Road have been predicted in accordance with the Calculation of Road Traffic Noise (CoRTN) methodology. This method is recognised by regulatory authorities around Australia and is endorsed by the NSW DPIE for use in projects of this scale.

The acoustic assessment has been based on the following:

- Detailed noise survey as presented in Section 3.2 and an existing measured noisiest 1 hour of 67dB(A) $L_{eq;1hr}$.
- Criteria as detailed in Section 4.5.
- Typical traffic speed of 80km/hr.
- 2% of traffic is from heavy vehicles.
- Receiver points at the boundary of the hospital site located 1.5m above floor level.
- Solid sections of the façade are assumed to have a minimum sound reduction index of R_W50.
- Information on existing traffic flows from the TAIA.

Noise modelling has been carried out using the predicted future traffic flow data presented in Table 20. The noise levels outside the western façade of the hospital due to traffic on Windsor Road are predicted to reach levels of 70dB(A) $L_{eq;1hr}$ during peak times.

Based on these predicted external noise levels, high performance sound insulating glazing will be required to meet the internal noise level criteria as per the Transport & Infrastructure SEPP. The minimum recommended glazed façade performance for noise sensitive areas facing Windsor Road are provided in Table 31. Examples of single glazed thickness to achieve the nominated ratings have been provided, however these may be substituted for alternative glazing selections that achieve an equivalent internal noise level. The acoustic performance of the glazing and building façade shall be reviewed during the design stages of the project once glazing and façade areas are defined.

Table 31: Predicted external traffic noise levels at the western façade and recommended façade glazing

Location	*Internal Noise Criterion $L_{Aeq,1h}$ dB(A)*	*Predicted External Noise Levels $L_{Aeq,1h}$ dB(A)*	*Minimum Performance*	*Example Double Glazing System*
Wards on western facade	35	70	Rw + Ctr 43	12mm float / 24mm airgap / 12.76mm laminated
Other noise sensitive areas on western facade	45		Rw + Ctr 35	6.38mm laminated / 12mm airgap / 10mm float

7 CONSTRUCTION NOISE AND VIBRATION PLANNING

Currently the construction methodologies, staging and plant are unknown as the Contractor has not yet been engaged. Therefore, it is not possible to accurately assess construction noise impacts to the nearby noise sensitive receivers. This section provides general recommendations only and provides applicable criteria together with best noise and vibration control practices to be observed during the construction of the proposed development.

This preliminary advice in relation to construction noise and vibration management shall form the basis for the Contractor's Construction Noise and Vibration Management Plan (CNVMP) which shall identify any noise criteria exceedance once construction methods and stages are known.

Any noise from demolition and construction activities to be carried out on site must not result in *'offensive noise'* to any noise sensitive receiver. To this end, the Contractor employed to undertake the demolition and/or construction works is responsible for ensuring that any site noise and, in particular, any complaints shall be monitored, investigated, managed and controlled.

7.1 RELEVANT STANDARDS FOR CONSTRUCTION NOISE AND VIBRATION CRITERIA

Section 4.6 of this report contains the relevant legislation, codes and standards plus construction noise and vibration criteria for this project.

7.2 WORKING HOURS

The standard construction hours as per the NSW EPA ICNG are as follows:

- Monday to Friday: 7am to 6pm.
- Saturday: 8am to 1pm.
- Sundays and Public Holidays: No excavation or construction works

7.3 PRELIMINARY NOISE ASSESSMENT

A preliminary construction noise assessment has been carried out based on typical plant and machinery expected throughout the construction stages. The preliminary noise assessment has been considered at the nearest noise sensitive receivers as identified in Table 2 and have been assessed to standard construction hours as defined in Section 7.2.

Typical noise levels of construction plant are based on the database published by the UK Department for Environmental, Food and Rural Affairs (DEFRA) & Australian Standard AS2436:2010 *'Guide to Noise Control on Construction, Maintenance & Demolition Sites'* for a 15-minute period.

7.3.1 MAIN HOSPITAL CONSTRUCTION WORKS

The expected construction noise sources and the predicted noise levels at the nearest receivers are shown below in Table 32, with exceedances to construction noise management levels within standard hours as shown in Table 12. This assessment considers the worst-case distance of the project boundary to the receiver. Refer to Table 2 for a description of the receivers. Only existing receivers have been included in the assessment.

Table 32: Predicted noise levels of typical construction plant at the nearest noise sensitive receivers, with exceedances to ICNG standard hours construction criteria shown in red.

Item	*Typical Noise Level L_{WA} dB*	*Predicted Noise Level $L_{Aeq,15m}$ at receiver*									
		1	*2a*	*2b*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Distance to main works boundary		5m	5m	220m	50m	50m	150m	260m	350m	160m	140m
Standard Hours Noise Management Level $L_{eq;15\ min}$, dB(A)		*75*	*75*	*66*	*70*	*70*	*66*	*66*	*66*	*70*	*66*
Highly noise affected $L_{eq;15\ min}$, dB(A)		-	-	*75*	-	-	*75*	*75*	*75*	-	*75*
Excavator	107	85	85	52	65	65	55	51	48	55	56
Rock Breaker	118	96	96	63	76	76	66	62	59	66	67
Bored Piling Rig	111	89	89	56	69	69	59	55	52	59	60
Concrete Truck	112	90	90	57	70	70	60	56	53	60	61
Concrete Pump	109	87	87	54	67	67	57	53	50	57	58
Vibratory Roller	114	92	92	59	72	72	62	58	55	62	63
Excavator with hammer	116	94	94	61	74	74	64	60	57	64	65
Truck (dump)	117	95	95	62	75	75	65	61	58	65	66

Based on the results of the preliminary assessment as shown above, the noise associated with the construction work is expected to exceed the Noise Management Levels (NML) at the industrial and commercial receivers 1 and 2a. Additionally, residential receivers are predicted to exceed the NML at receivers 2b, 9 and 10 for various construction activities. Receiver 2b exceeds the highly noise affected level of 75dBA for all indicative plant items.

7.3.2 OUT OF HOURS - ROAD WORKS

In some circumstances it may be necessary to undertake Out of Hours Works (OOHW) to minimise the disruption construction has on traffic. For the RHH project, this would include, for example, roadworks to Commercial Rd. At this stage, details of the construction program and duration are unknown, therefore, a detailed assessment cannot be undertaken. Nevertheless, a high level OOHW noise assessment has been undertaken based on typical plant.

The assessment considers the following:

- Typical plant noise levels and quantities as per Table F.1 of CNVG-R.
- Residential receivers have been assessed to CNVG-R OOHW – Period 2 criteria as a worst case (i.e. 48dB $L_{Aeq, 15min}$).
- Sleep disturbance is assessed against the L_{Amax} criteria as previously discussed in Section 4.6 (i.e. 65dB L_{Amax}), plant noise levels given in the CNVG-R are given as L_{Aeq} and therefore a +10dB correction to L_{Aeq} plant noise levels has been applied to assess sleep disturbance.
- The predictions assume continuous operation of the construction plant over the 15-minute assessment period.
- Worst-case distances to receiver boundaries have been assessed.

It should be noted that the predicted noise levels generated during construction works may vary depending on many factors including:

- Final selection of plant and equipment.
- Exact location of equipment and plant on site- relative to the noise sensitive receivers
- Shielding of noise provided by structures and hoardings on and around the works
- Reflections provided by existing structures on and around the site.

Based on the above, Table 33 and Table 34 present predicted noise levels due to OOHW road works, with exceedances of CNVG-R OOHW- Period 2 Noise management Level of 48 dB(A) $L_{eq;15\ min}$ and CNVG-R sleep disturbance screening level of 65 dB(A) L_{max} for existing residential receivers respectively.

Table 33: Predicted noise levels of typical construction plant at the nearest residential receivers, with exceedances to CNVG-R Standard hours NML in grey cells and OOHW – Period 2 NML shown in red.

Item	*Typical Noise Level L_{WA} dB*	*Predicted Noise Level $L_{eq,15min}$, dB(A) at receiver*				
		2b	*5*	*6*	*7*	*9*
Standard Hours NML, $L_{eq,15min}$, dB(A)				*66*		
OOHW – Period 2s NML, $L_{eq,15min}$, dB(A)				*48*		
Distance to OOHW boundary		250m	125m	285m	410m	210m
Pavement laying machine	114	58	64	57	54	60
Dump Truck	110	54	60	53	50	56
Asphalt truck & Sprayer	103	47	53	46	43	49
Concrete Truck	109	53	59	52	49	55
Smooth Drum Roller	107	51	57	50	47	53
Concrete saw	118	62	68	61	58	64

Table 34: Predicted noise levels for typical construction plant at nearest residential receivers with exceedances of CNVG-R sleep disturbance screening level of 65 dB(A) shown in red.

Item	*Typical Noise Level L_{WA} dB*	*Predicted Noise Level L_{max}, dB(A) (re. 20µPa) at receiver*				
		2b	*5*	*6*	*7*	*9*
	Distance to OOHW boundary	250m	240m	285m	410m	210m
Pavement laying machine	124	68	74	67	64	70
Dump Truck	120	64	70	63	60	66
Asphalt truck & Sprayer	113	57	63	56	53	59
Concrete Truck	119	63	69	62	59	65
Smooth Drum Roller	117	61	67	60	57	63
Concrete saw	128	72	78	71	68	74

Based on the results shown above, construction works during standard hours and is generally expected to be within NMLs and may only require local temporary noise barriers for noisy equipment. Night road works is predicted to exceed CNVG-R OOHW Period 2 and CNVG-R sleep disturbance Noise Management levels for all existing residential receivers. Mitigation measures recommended and detailed in the CNVG-R are recommended to be implemented as summarised in Section 7.6.3.

7.4 PRELIMINARY VIBRATION ASSESSMENT

The Transport for NSW Construction Noise and Vibration Guideline provides safe working distances for vibration intensive plant and are quoted for both 'cosmetic' damage (in accordance with BS 7385.2:1993) and human comfort (in accordance with DECC's *'Assessing Vibration: A Technical Guideline'*). The recommended safe working distances for typical construction plant are provided in Table 35.

Table 35: Recommended minimum working distances for vibration intensive plant from sensitive receivers.

Plant Item	*Description*	*Cosmetic Damage*	*Human Response*
Small Hydraulic Hammer	5-12 tonne	2m	7m
Medium Hydraulic Hammer	12-18 tonne	7m	23m
Large Hydraulic Hammer	18-34 tonne	22m	73m
Vibratory Pile Driver	Sheet piles	2-20m	20m
Pile Boring	<800mm	2m	N/A
Jackhammer	Hand held	1m	Avoid Contact with Structure

For any vibration intensive plant expected to be within close proximity of the minimum distances described above, the contractor must engage a qualified engineer to carry out a vibration survey in order to assess any potential risks.

The vibration survey and assessment will determine whether the vibration levels might exceed the relevant criteria, then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimized as far possible.

7.5 PRELIMINARY CONSTRUCTION TRAFFIC

The TAIA prepared by Arup provides proposed construction routes along Windsor Rd and Schofield Rd. The TAIA note that construction is expected to be within standard hours, however, in some instances night works might be required, the following is noted:

> *"...All night works would be undertaken in accordance with the TfNSW Environmental Noise Management Manual (2001): Practice Note vii – Roadworks outside normal hours, as well as the Office of Environmental and Heritage Interim Construction Noise Guideline (DECC 2009). All construction activities are expected to occur within the standard permissible hours set by The Hills Shire Council..."*

The TfNSW Environmental Noise Management Manual noted has been superseded by the CNVG-R, both the ICNG and CNVG-R refers to NSW Road Noise Policy (RNP) for criteria regarding the assessment of construction traffic on public roads.

Table 36 summarises the overall expected traffic flows during construction as per the TAIA report.

Table 36: Overall peak traffic flows per Table 14 of the TAIA Report.

Type	*Overall number of vehicles during peak hour*	
	AM Peak hour	*PM Peak hour*
Heavy Vehicles	10	10
Construction light vehicles	50	50
Total	**60**	**60**

Based on the above and the existing peak traffic flows along Windsor Rd (i.e. 3,700-4,000 peak vehicles per hour), the expected 60 vehicles per hour increase in traffic due the construction of the proposed development will be 0.1dB for both periods. Therefore, the traffic increase due to the proposed construction works will not result in any noticeable change in traffic noise levels. It is therefore concluded that the construction traffic for the development will meet the RNP limit of less than 2.1dB increase in traffic noise.

7.6 MITIGATION MEASURES

It is recommended that a detailed Construction Noise & Vibration Management Plan is prepared prior to Crown Certificate to further detail any required mitigation measures based on the project specific construction stages and equipment. All reasonable feasible measures shall be applied based on the recommendations from the ICNG to further reduce any adverse noise impacts.

In order to meet the noise and vibration requirements of the site, the Contractor is recommended to engage a qualified acoustic consultant to assist in the compilation of a Construction Noise and Vibration Management Plan. The report shall document acoustic measures required to minimise any adverse noise impacts to the nearby affected receivers. The acoustic measures detailed within the report may include fixed and/or mobile acoustic screens, scheduling of works including any respite periods and identifying noisy works that can be further managed. Further to this, a noise and vibration survey is recommended to be defined for any noisy and/or vibration intensive works.

7.6.1 GENERAL MITIGATION MEASURES

It is noted that the reduction of noise and vibration at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise minimisation. Providing treatments at the affected receivers should only be considered as a last resort. Construction noise and vibration shall be managed by implementing the strategies listed below:

- *Plant and equipment*. In terms of both cost and results, controlling noise and vibration at the sources is one of the most effective methods of minimising the impacts from any work site activities. Work practices that will reduce noise and vibration at the source include:
  - Employing quieter techniques for all high noise activities such as rock breaking, concrete sawing, and using power and pneumatic tools.
  - Use quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
  - Selecting plant and equipment with low vibration generation characteristics.
  - Operate plant in a quietest and most effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Regularly inspecting and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.
- *On site noise management.* Practices that will reduce noise from the site include:
  - Maximising the distance between noise activities and noise sensitive receivers. Strategically locate equipment and plant.
  - Undertaking noisy fabrication work off-site where possible.
  - Avoid the use of reversing beeping alarms or provide for alternative systems, such as broadband reversing alarms, particularly during night or out-of-hours works.
  - Maintaining any pre-existing barriers or walls on a demolition or excavation site as long as possible to provide optimum sound propagation control.
  - Constructing barriers that are part of the project design early in the project to afford mitigation against site noise.
  - Using temporary site building and material stockpiles as noise barriers. These can often be created using site earthworks and may be included as a part of final landscape design.
- *Work scheduling.* Scheduling work during periods when people are least affected is an important way of reducing adverse impacts. The following scheduling aspects may reduce impacts:
  - Provide respite periods, including restricting very noisy activities to daytime, restricting the number of nights that after-hours work is conducted near residences, or by determining any specific requirements, particularly those needed for noise sensitive receivers.
  - Scheduling activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events.
  - Scheduling work to coincide with non-sensitive periods.
  - Scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive.
  - Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from sensitive receivers.
  - Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
  - Designating, designing and maintaining access routes to the site to minimise impacts.

  - Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.
- *Consultation, notification and complaints handling.*
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised when noise goals cannot be met due to safety or space constraints.

7.6.2 ADDITIONAL NOISE AND VIBRATION CONTROL MEASURES

If, during construction, an item of equipment exceeds ether the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices, shall be considered to minimise the noise impacts on the neighbourhood.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix C of AS 2436:2010.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc.) not specifically identified in this plan incorporates silencing/shielding equipment as required to meet the noise criteria.

Implementation of all reasonable and feasible mitigation measures for all internal and underground works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

7.6.3 NIGHT-TIME ROAD WORKS MITIGATION MEASURES

Table C.1 of the CNVG-R provides typical mitigation measures for OOHW – Period 2 based on the level of exceedance to NML criteria, this is shown in the table below, along with identification of residential receivers likely affected.

Table 37: Triggers for out of hours mitigation measures, per Table C.1 of the CNVG-R

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			*Affected residential receivers*	*Mitigation measures*
Perception	*dB(A) above RBL*	*For this project*		
OOHW Period 2: Mon-Fri (10pm – 7am), Sat (10pm-8am), Sun/Pub Holidays (6pm-7am)				
Noticeable	5 to 10	Up to 53 dB(A)	--	N
Clearly Audible	10 to 20	53 to 63 dB(A)	2b, 6 and 7	V, N, R2, DR
Moderately intrusive	20 to 30	63 to 73 dB(A)	5 and 9	V, IB, N, PC, SN, R2, DR
Highly intrusive	>30	73 dB(A) and above	--	AA, V, IB, N, PC, SN, RN, DR

*Note:

AA = Alternative accommodation

V = Validation of predicted noise levels

IB = Individual briefings

N = Notification box drops

PC = Phone calls

R1 = Respite period 1

R2 = Respite period 2

DR = Duration respite

RO = Project specific respite offer

SN = Specific notifications

Based on predicted noise emissions as shown in Section 7.3.2 residential receivers are predicted to be within the "Clearly audible" and "Moderately intrusive" perception levels. Typical mitigation measures to be implemented during the road night works are:

- V = Validation of predicted noise levels
- N = Notification box drops
- IB = Individual briefings
- PC = Phone calls
- R2 = Respite period 2
- DR = Duration respite

A detailed noise management plan, which would include further detailed assessment, justification for the out of hours work and proposed mitigation measures as per the CNVG-R shall be undertaken by the appointed contractor when detailed requirements are known.

8 CONCLUSION

This noise & vibration impact assessment for State Significant Development Application (SSD-96248991) has been carried out for the new Rouse Hill Hospital. This report forms part of the documentation package to be submitted to the Department of Housing and Infrastructure.

This report establishes relevant noise level criteria, details the acoustic assessment and provides comments and recommendations for the proposed development. The noise assessment has adopted methodology from relevant guidelines, standards and legislation to assess noise impact. The noise impacts have been predicted at the nearest noise sensitive receiver boundaries.

At this stage the building services plant selections have not been made; therefore, a detailed assessment has not been able to be carried out. A preliminary review has been carried out, and based on the locations, distance to noise sensitive receivers and the most restrictive criteria. Noise emissions from the development shall be limited noise levels detailed in Section 5.1 of this report. Acoustic assessment of all building services plant shall continue during the detailed design phase of the project in order to confirm any noise control measures.

An assessment of traffic noise generation has been carried out for Windsor Road. Based on the assessment, additional traffic movements will not result in any noticeable change in traffic noise levels and is expected to meet the NSW Road Noise Policy recommendations.

An operational acoustic assessment has been undertaken to determine the impact of the loading dock to the nearest noise sensitive receivers, based on the assessment, operational noise related to use of the loading dock is predicted to meet NPI criteria during the day and evening periods.

A sleep disturbance screening assessment has been conducted for impacts from the proposed ambulance bay, waste removal and oxygen decanting activities to the closest residential receiver. Based on the results of the assessments, the operational noise from ambulance movements are below the screening criteria of the NPI, whilst waste removal activities are recommended to be undertaken within the loading dock to minimise impacts to residential receivers. Oxygen decanting activities are expected to exceed sleep disturbance criteria and is recommended to be scheduled during day periods to minimise impacts to nearby receivers.

Peak hour vehicle noise impacts from the proposed multi-storey carpark have been assessed to the nearest noise sensitive residential receiver plus the proposed hospital. Based on the results of the assessment, the multi-storey carpark is not expected to have any adverse impact on residential receivers and the hospital due to the vehicle movements during peak hour.

An acoustic assessment of the external airborne noise intrusion has been carried out. Based on the results of the assessment, recommendations have been provided for the minimum sound insulation performance of the external glazing likely required to meet the internal noise levels for the spaces, in accordance with Transport & Infrastructure SEPP.

A preliminary construction noise and vibration assessment has been carried out based on typical equipment. The assessment indicates potential construction noise and vibration impacts on the nearest noise sensitive receivers have been presented in this report and general recommendations based on the relevant guidelines are provided.

Noise emissions related to traffic generation during construction have been assessed based on peak hour vehicles quantities provided by Arup. Based on the results, additional traffic due to construction is not expected to have any adverse impact on nearby receivers in accordance with NSW RNP.

Night works related to the upgrade of Commercial Rd are predicted to be perceived as Moderately intrusive for existing residential receivers. Mitigation measures as per the CNVG-R shall therefore be implemented by the appointed contractor.

Detailed assessment of impacts is recommended to be undertaken by the Contractor to engage a qualified acoustic consultant to assist in the compilation of a Construction Noise and Vibration Management Plan. If during any construction work, equipment exceeds the established noise and / or vibration level criteria at any sensitive receiver, the additional noise and vibration control measures shall be considered to minimise the noise and vibration impacts.

The information presented in this report shall be reviewed and developed as plans for the hospital mature, including and not restricted to selection of equipment and plant, and introduction of any additional noise sources. Based on the information presented in this report, relevant objectives will be satisfied and therefore approval is recommended to be granted.

APPENDIX A – UNATTENDED NOISE MONITORING

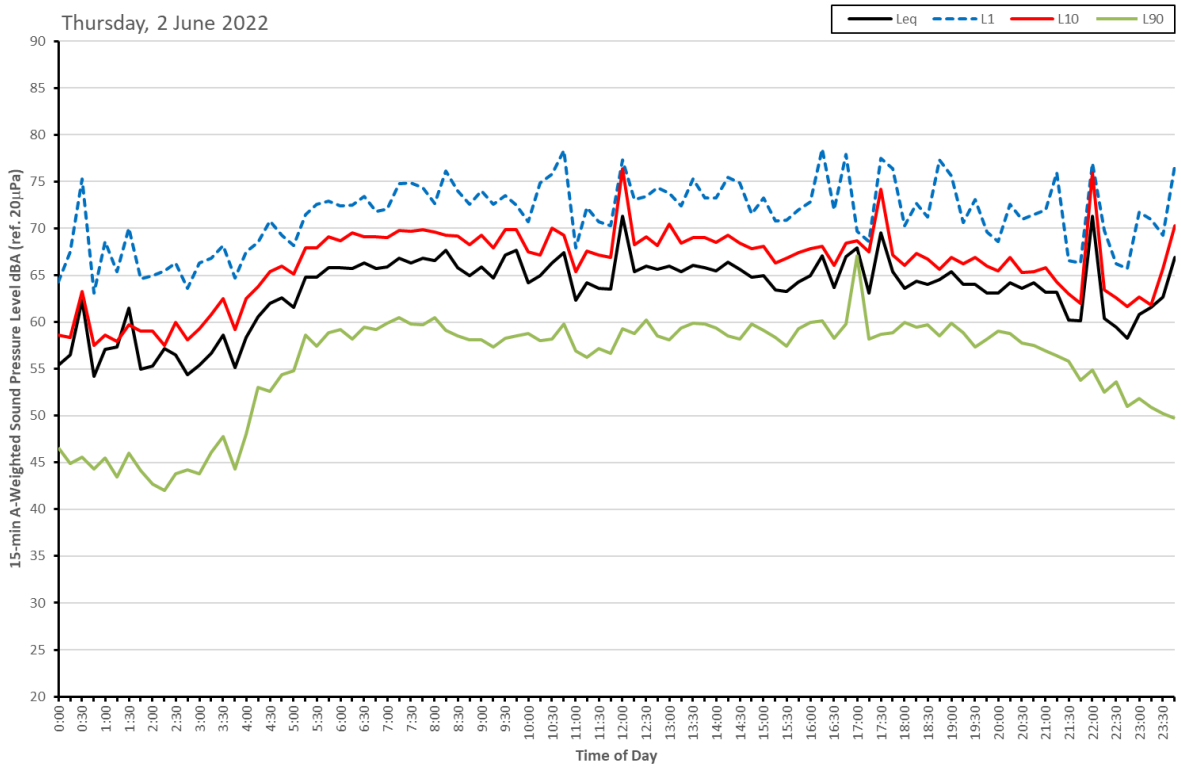
ACOUSTIC TERMS

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

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

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

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.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Leq
L1
L10
L90
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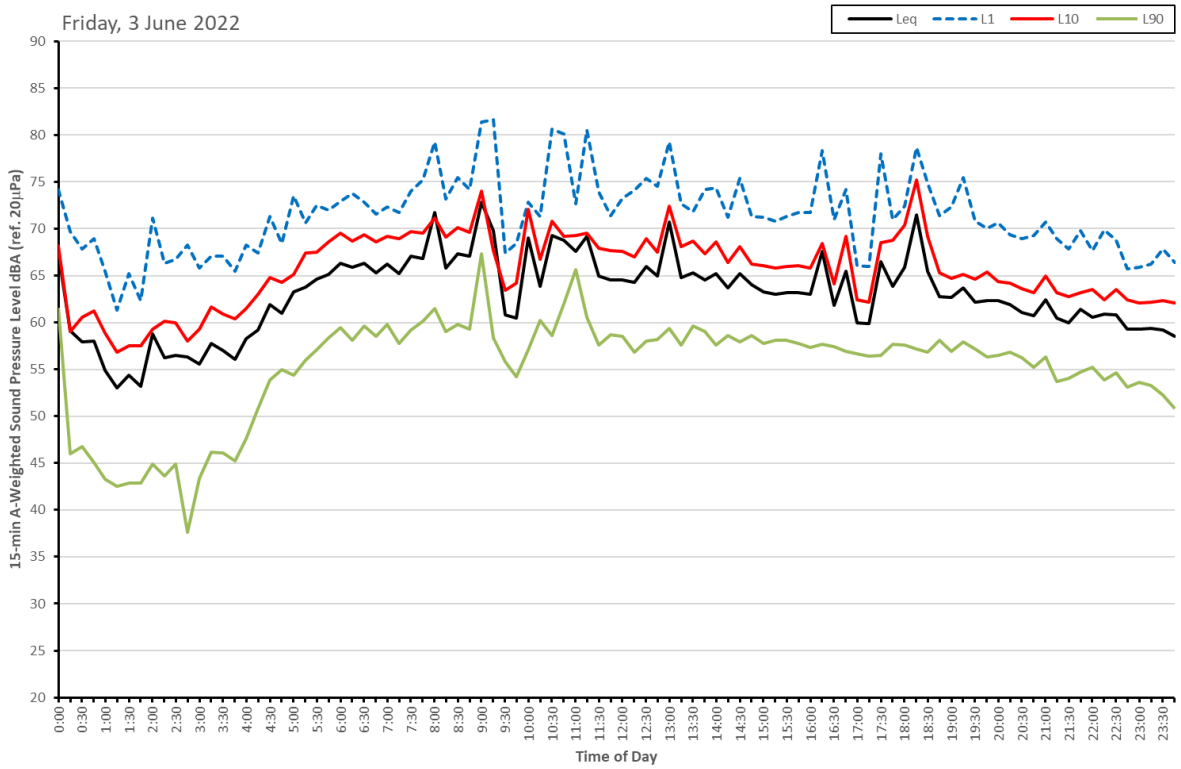
Time of Day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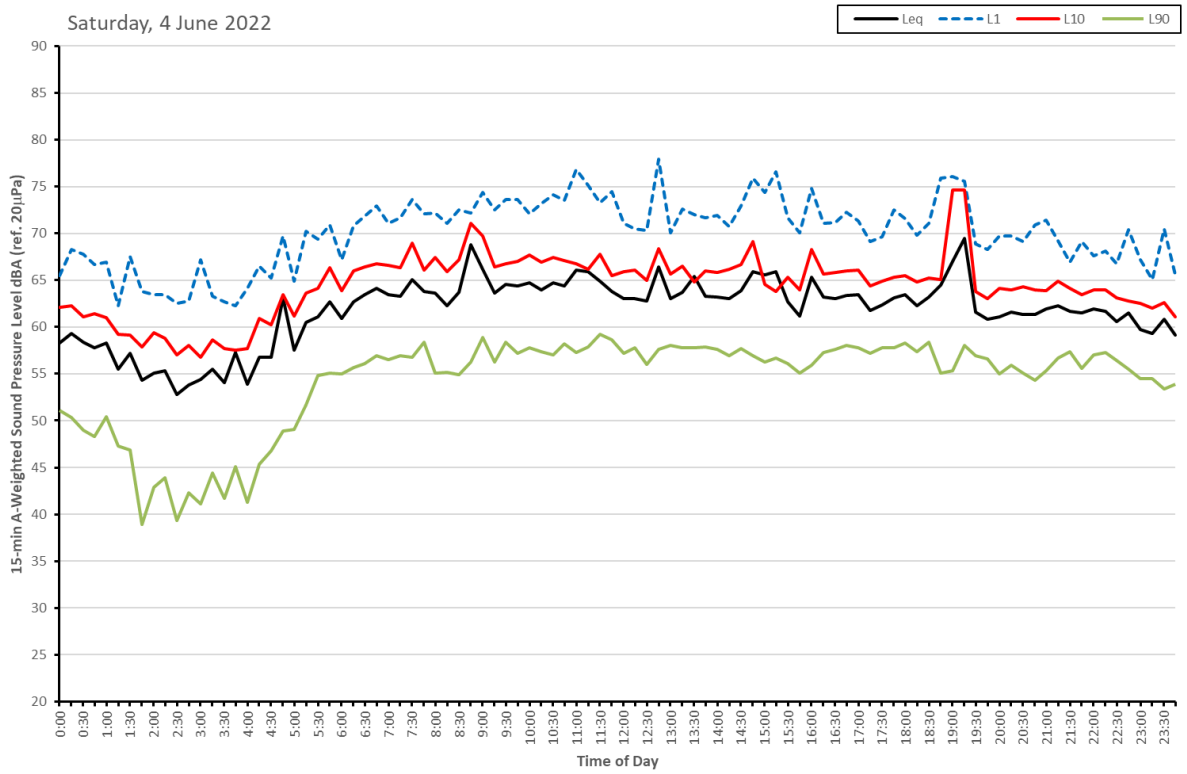
Time of Day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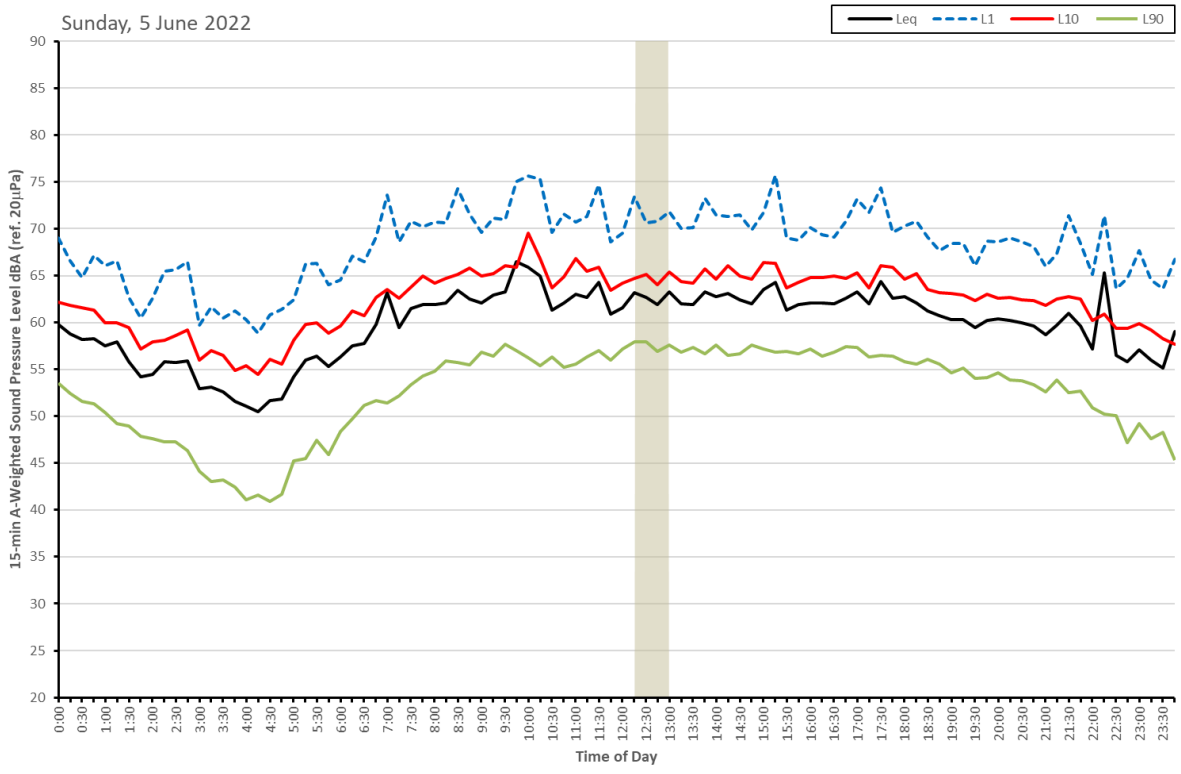
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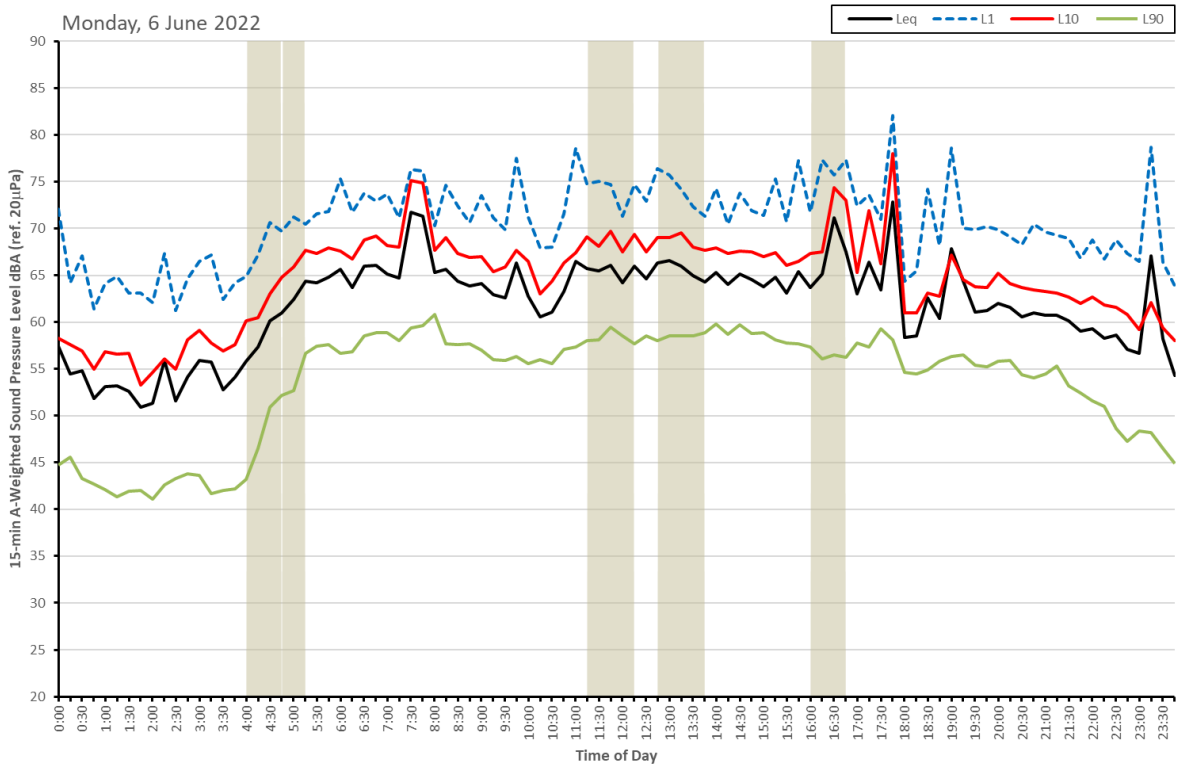
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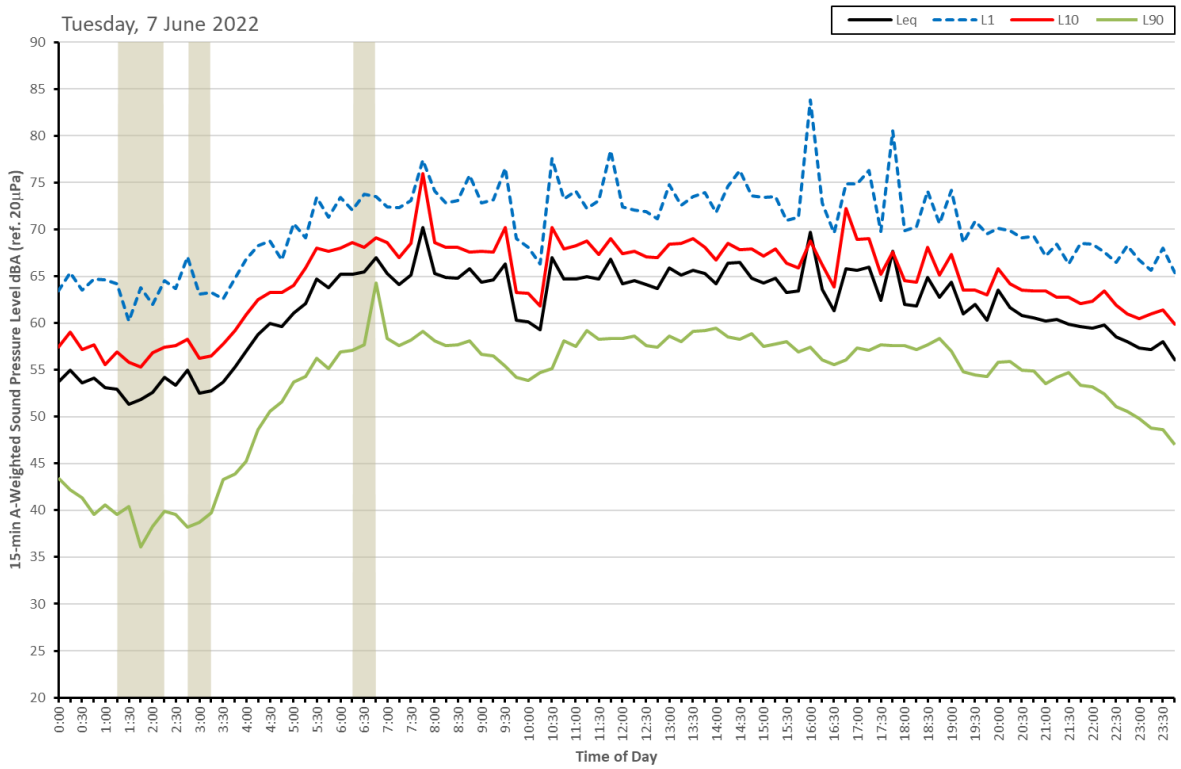
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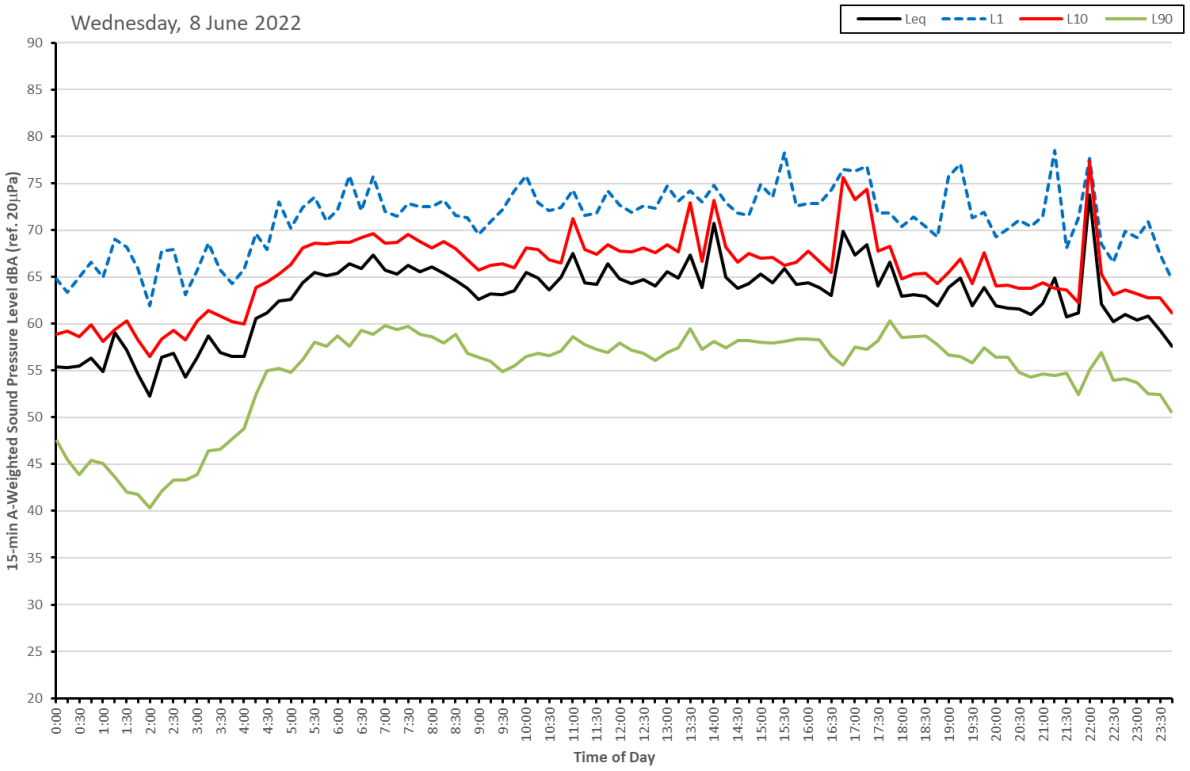
Time of Day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