Westmead South Masterplan

Acoustic and Air Quality Impact Assessment

Cumberland City Council

5 October 2023

→ The Power of Commitment

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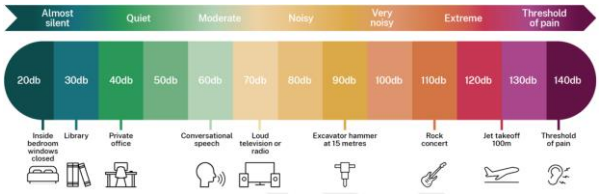
Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.

Glossary of terms

Item	Description
µg/m^3	Micrograms per cubic metre
A-frequency weighting (dBA)	An adjustment made to sound level measurement, by means of an electronic filter, in line with international standards. This approximates the response of the human ear at lower sound pressure levels.
ADT	Average daily traffic refers to the total volume of vehicle traffic on a road for a period of one day or other relevant short-term period. This value is usually derived from either a short-term traffic count or by estimating based on other data
AADT	Annual average daily traffic or total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year
AQMS	Air Quality Monitoring Station
BoM	Bureau of Meteorology
Buffer	An area of land between a roadway or rail corridor and a noise-sensitive land use, used as open space or for some other noise-tolerant land use.
Busy road	A busy road is defined as: – Roads specified in Clause 102 of the Infrastructure SEPP: a freeway, tollway or a transitway or any other road with an average annual traffic (AADT) volume of more than 40,000 vehicles (based on the traffic volume data provided on the website of the RTA). – Any other road – with an average annual daily traffic (AADT) volume of more than 20,000 vehicles (based on the traffic volume data published on the website of the RTA) – Any other road – with a high level of truck movements or bus traffic.
CLPP	Cumberland Local Planning Panel
CO	Carbon Monoxide
Council	Refers to Cumberland City Council
dB	Decibel, which is 20 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a measure of sound.
DCP	Development Control Plan
Habitable room	Any room other than a garage, storage area, bathroom, laundry, toilet or pantry
Heavy vehicle	A truck, transport or other vehicle with a gross vehicle weight greater than 4.5 tonnes.
$L_{Aeq(period)}$	Equivalent A-weighted sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring. Typical sound pressure levels are provided below for reference: 
$L_{Aeq(15hour)}$	The L_{Aeq} noise level for 7 am to 10 pm or the ‘day period’
$L_{Aeq(9hour)}$	The L_{Aeq} noise level for 10 pm to 7 am or the ‘night period’
$L_{Aeq(1hour)}$	The noise level representing the ’average maximum‘ one-hour noise level to the AM / PM peak
L_{A1}	The percentile sound pressure level exceeded for 1% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A1} is typically used to describe maximum noise events.
L_{A10}	The percentile sound pressure level exceeded for 10% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A10} road traffic noise levels are typically 3 dBA above L_{Aeq} road traffic noise levels.

Item	Description
L_{A90}	The percentile sound pressure level exceeded for 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis. L_{A90} typically describes the background noise level.
L_{AFmax}	The maximum of the sound pressure levels recorded of a measurement period.
Local road	A road handling local traffic and characteristically having low or intermittent traffic flows.
LEP	Local Environmental Plan
NO_2	Nitrogen Dioxide
PM_{10}	Particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less
$PM_{2.5}$	Particulate matter with an equivalent aerodynamic diameter of 2.5 micrometres or less
Rail corridor	as defined in the SEPP (Transport and Infrastructure): – Land that is owned, leased managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities, or – Land that is zoned under an environmental planning instrument predominantly or solely for the development for purpose of a railway or rail infrastructure facilities, or – Land in respect of which the Minister has granted approval under Part 3A or (before its repeal) Division 4 of Part 5 of the Act for the carrying out of development (or for a concept plan for a project comprising or including development) for the purpose of a railway or rail infrastructure facilities.
Road corridor	as defined in the SEPP (Transport and Infrastructure): – land that is used for the purposes of a road or road infrastructure facilities and owned or managed by a public authority, or – any land in respect of which the Minister has granted approval under Part 3A or Division 5.2 or (before its repeal) Division 4 of Part 5 of the Act, or consent under Part 4 of the Act, for the carrying out of development for the purpose of a road or road infrastructure facilities
Setback	The distance between the building alignment or face and the corresponding land boundaries of a property, which are controlled through planning regulation
Sensitive development	Development for any of the following purposes that is on land that is in or immediately adjacent to a rail corridor or busy road and the consent authority considers development is likely to be adversely affected by rail noise or vibration: i.e. a building for residential use, a place of public worship, a hospital or an educational establishment or childcare centre
SEPP	State Environmental Planning Policy

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Aerial photo facing north
Milton Kent - 1935-45
State Library NSW

Introduction

Strategic planning framework to Westmead South and the purpose of this report

1. Introduction

1.1 Project background

Located within the Cumberland Local Government Area (LGA), Westmead South comprises the southern section of the Westmead Precinct, known as Australia's premier health and innovation district. Westmead South sits on the Cumberland LGA's northern border as it adjoins Parramatta LGA along the Main Western line. A mostly residential neighbourhood, Westmead South is a key centre of Cumberland City. Cumberland City Council is widely considered the geographic heart of the Greater Sydney area. It is located 1.7 kilometres from the Parramatta Central Business District (CBD) and 25 kilometres from the Sydney CBD.

The Greater Cities Commission (GCC) adopted *The Greater Sydney Region Plan, A Metropolis of Three Cities* in 2018 providing a new strategic direction for Greater Sydney over the next 40 years. The Plan provides a vision of three cities where most residents live within 30 minutes of their jobs, education and health facilities, services and great places including:

– The Eastern Harbour City
– The Central River City (where Westmead South is located)
– The Western Parkland City

This plan together with the GCC's *Central City District Plan*, Transport for NSW's *Future Transport 2056*, Infrastructure NSW's *State Infrastructure Strategy 2018-36* and the *Westmead 2036 - Place Strategy* has set the scene for major planning, investment and development in the Central City District of Sydney.

Cumberland City Council (Council) anticipates changes for Westmead South in the coming decades, due to significant infrastructure investment in the area, including the Metro Station, Parramatta Light Rail, and the rapidly growing health, education and innovation precinct. As the southern section of the Westmead Precinct, Westmead South will be crucial in supporting diverse housing opportunities, retail, and commercial uses, in the planned transformation of the wider precinct.

Council is aiming to prepare a planning framework based on the outcomes of this and other studies.

1.2 Purpose of this report

Excessive noise from nearby transportation noise including road, rail and aircraft can disrupt daily activities, sleep disturbances, and result in other health issues. Poor air quality can affect human health, amenity and quality of life. GHD has been engaged to assess the potential for acoustic and air quality amenity and health impacts on sensitive receivers for the following scenarios:

– **base-case**: existing built form and traffic volumes (this "Stage 1" report)
– **future development scenarios**: potential future built form resulting from the new planning framework for Westmead South and the forecast traffic volumes ("Stage 2 report", once the Masterplan has been developed)

The key aims of the study are to investigate the following:

– The noise and air pollution sources within Westmead South that have potential to result in health or amenity impacts
– Opportunities to provide outcomes that protect the health or amenity of the community whilst enabling future development
– Appropriate and achievable controls to amend the Cumberland Local Environmental Plan 2021 and the Cumberland Control Plan 2021 in line with the relevant legislation, applicable guidelines and policies

1.3 Study area

The Westmead South study area is bound by a railway line to the north, the Great Western Highway to the south, Mays Hill Precinct (Parramatta Park) to the east and Bridge Road to the west as shown in Figure 1.1.

Westmead South is characterised by predominantly low to medium rise housing with a pocket of apartment development to the northeast of the site. Hawkesbury Road is currently the major north/south connection through the area, providing access onto the Great Western Highway and Western Motorway, which provides regional links across Greater Sydney. Oakes Centre, the neighbourhood shops provides some local services and amenities, however regional scale retail is located in Parramatta.

Figure 1.1 Westmead South study area

1.4 Strategic background

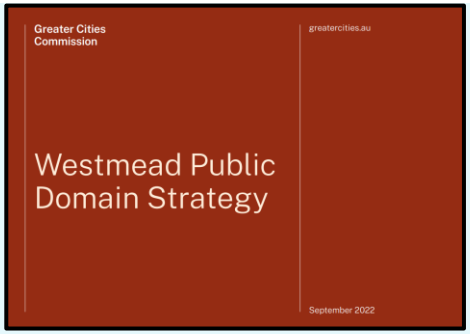
A literature review of the strategies, technical studies and major projects relevant to the assessment of acoustics and air quality in Westmead South has been undertaken. The relevant documents and projects have been summarised below and include:

– NSW government strategies
– NSW government projects.
– Cumberland City Council Local Strategic Planning Statement (LSPS) and Draft Westmead South Concept Land Use Plan (CLUP)
– Westmead South technical studies

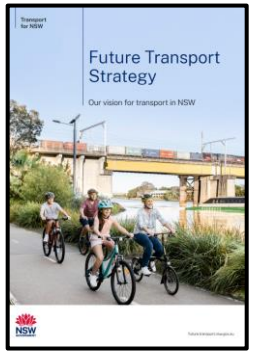
»NSW government strategies«

Westmead Place Strategy 2036

Westmead Place-based Transport Strategy



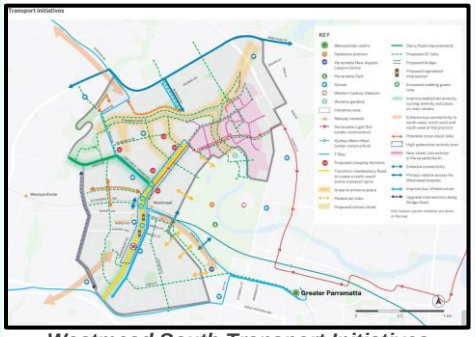
Westmead Public Domain Strategy



Future Transport Strategy 2056

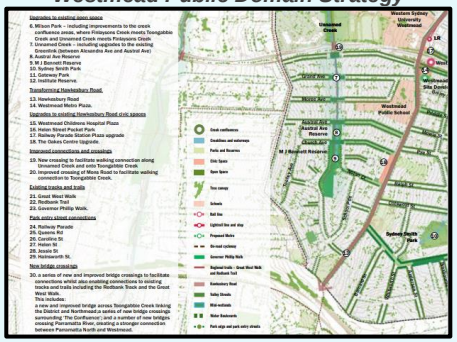
Westmead South sub-precinct plan

- Vision and planning framework for land in Westmead
- Structure plan demonstrating how land use, public domain improvements and future development will deliver this vision
- The Westmead Place Strategy has a Ministerial 9.1 Direction which requires any future rezoning to be consistent with the Place Strategy.



Westmead South Transport Initiatives

- An active transport spine on Hawkesbury Road, with improved pedestrian amenity, improved bus infrastructure and new signalised intersections.
- Enhanced connectivity across the railway
- Enhanced bus connectivity
- A 'school street' on Moree Avenue
- New active transport links



Westmead South District Plan

- 'Valley Streets' with 'Mini-wetlands' on sloping streets.
- 'Water Boulevards' along most other streets
- Detailed proposals for Hawkesbury Road, varying along its length.
- Detailed designs for the mid-block link between Austral Ave and Alexandra Ave.

Vision and outcomes

- P4.2a Integrate air quality into strategic decision making, including at the assessment, strategic plan and design stages of projects.
- P4.2b Partner across Government to develop a transport network emissions model to identify high exposure areas and track changes.
- P4.2c Work with the Australian Government to introduce cleaner vehicle emissions and fuel quality standards. P4.2d Improve noise standards for monitoring and measuring

»NSW Government projects«

Parramatta Light Rail Stage 1 (Westmead to Carlingford)

- Stage 1 of the Parramatta Light Rail will connect Westmead to Carlingford via the Parramatta CBD and Camellia with a two-way track spanning 12 kilometres, and is expected to open in 2024.
- The route will link Parramatta's CBD and train station to the Westmead Health Precinct, Cumberland Precinct, CommBank Stadium, the Camellia Town Centre, the private and social housing redevelopment at Telopea, Rosehill Gardens Racecourse and three Western Sydney University campuses.

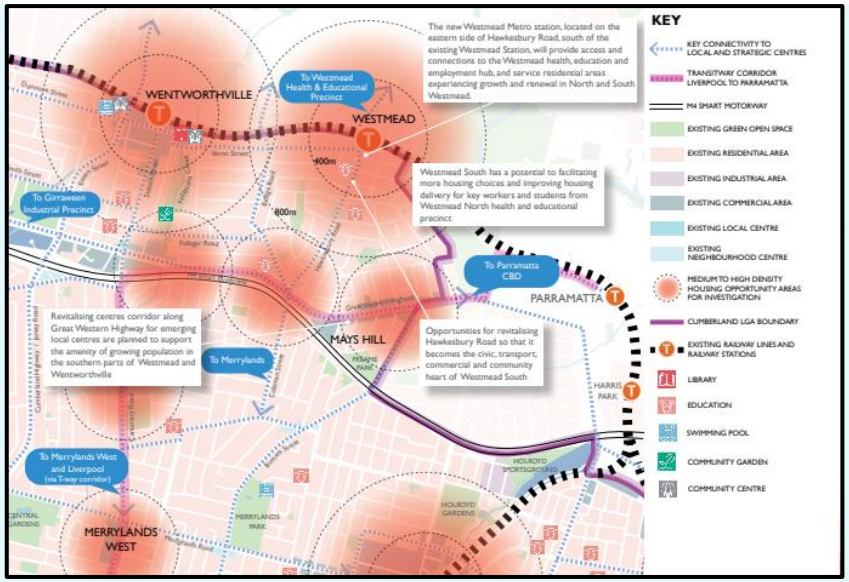
Sydney Metro West Stage 1 (Westmead to Sydney CBD)

- Westmead metro station will be located on the eastern side of Hawkesbury Road, south of the existing Westmead Station.
- Approximately 24-kilometres of twin tunnels between Westmead and the Sydney CBD
- New metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays and Sydney CBD
- A turn-up-and-go metro service operating between Westmead and Sydney CBD.

Westmead Health and Innovation Precinct

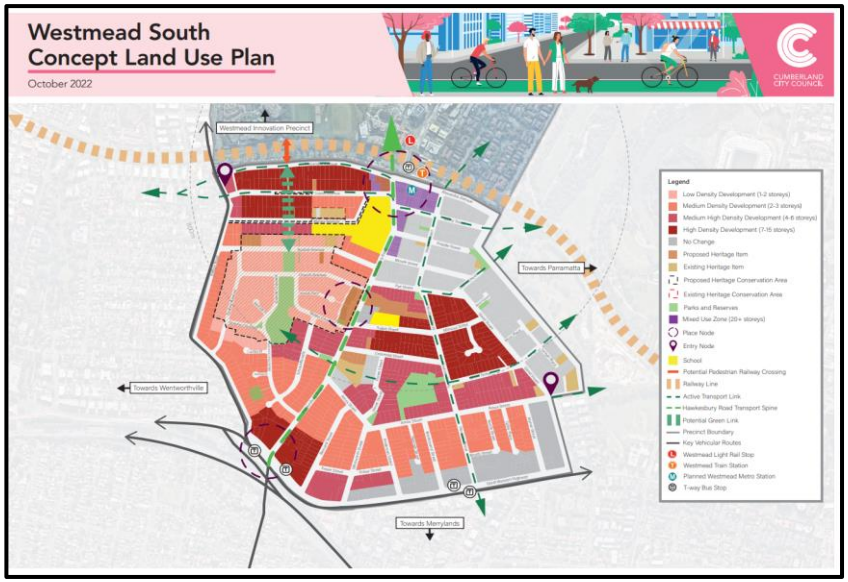
- The NSW Government is accelerating development at what is already one of Australia's largest health and research zones. The Westmead Health and Innovation District will soon be a global centre for new discoveries, commercialisation, treatment, education and training.
- The district includes 4 major hospitals, 4 world-leading medical research institutes, 2 university campuses and the largest research-intensive pathology service in NSW.
- By 2036, the number of full-time staff will increase to more than 50,000 and the number of students will expand to more than 10,000

»Cumberland City Council LSPS and Draft Westmead South CLUP«



Cumberland 2030: Our Local Strategic Planning Statement (Strategic Precinct: Westmead South)

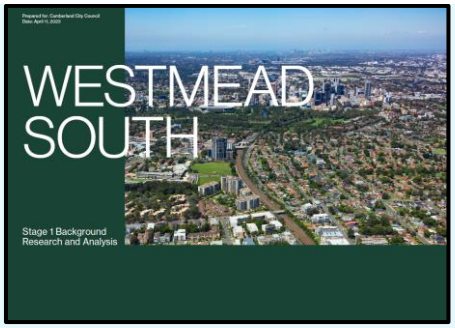
- Advocating for the future extension of light rail to the south of Westmead onto Hawkesbury Road
- Revitalising Hawkesbury Road (South) to become the civic, transport, commercial and community heart of Westmead South. Delivering diverse housing opportunities to support the needs of the Westmead health and educational precinct
- Revitalising the B6 Enterprise Corridor along Great Western Highway to support the needs and amenity of the growing population in the southern parts of Westmead and Wentworthville
- Improving urban amenity and applying pedestrian safety design to mitigate high traffic volumes on major road network such as Great Western Highway and Hawkesbury Road
- Improving urban canopy cover to mitigate urban heat island effects.



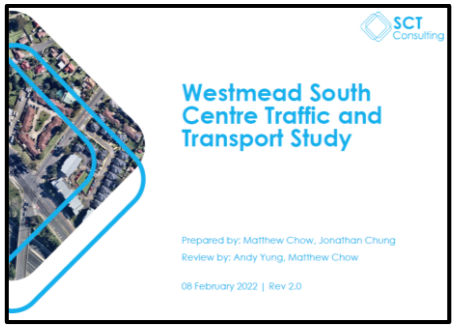
Draft Westmead South Concept Land Use Plan 2022

- Mixed Use Zone near the new Sydney Metro Westmead Station
- High Density Development along Grand Avenue and Moree Avenue
- New Active Transport Links
- Revitalisation of the Hawkesbury Road Transport Spine
- Medium Density Development along Hawkesbury Road
- High Density Development near the Hawkesbury Road and Great Western Highway intersection
- Potential Green Link from Austral Avenue to Westmead Innovation Precinct

»Westmead South Technical Studies«

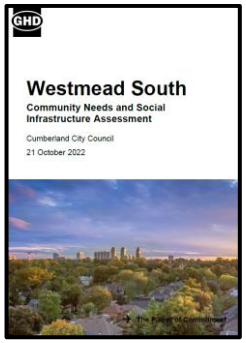


Westmead South Urban Design reports



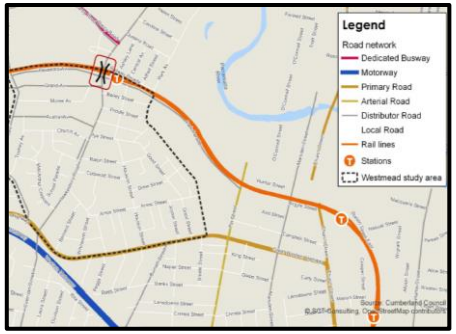
Westmead South Centre Traffic and Transport Study

Westmead South Land Use Capability Study

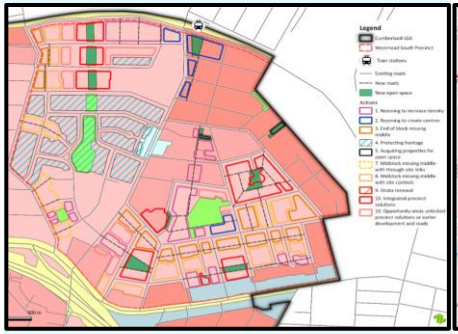


Westmead South Community Needs and Social Infrastructure Assessment

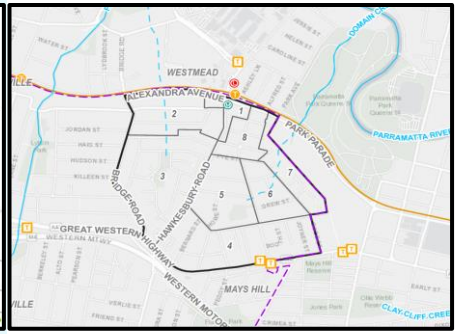
Westmead South Draft Concept



Westmead South Road Hierarchy



Westmead South Mixed Density Scenario



Westmead South sub-precincts

- Focus on Hawkesbury Road High Street
- Connecting station and Oaks Centre
- Development within walking distance of Station, Westmead North and Parramatta CBD
- Improve east-west and north-south link
- Built form typologies for high rise, mis-rise and low-rise buildings
- Public domain approach

- High traffic volumes along Hawkesbury Road, Great Western Highway, Grande Avenue, Bridge Road and Alexandra Avenue
- Trip modelling and trip generation analysis for base-case, low density, medium density and high density scenarios indicate other sustainable transport initiatives may be required
- Transport for NSW place-based transport plan to be developed

- Lower density: A greater focus on medium density dwellings.
- Mixed density. a mix of medium and high density development.
- High density. A focus on apartments, higher densities at the metro station and Westmead South centre, and targeted renewal of existing strata apartments

- Existing land uses are predominantly low-density residential dwellings with some medium and high-density dwelling in the east and south of the precinct
- Overview of existing social infrastructure including, education, health, emergency services, community facilities, childcare, aged care, sport and recreation, and parks and open space

1.5 Report structure and methodology

The structure of the report and the key tasks undertaken to assess the potential acoustic and air quality impacts within the Westmead South Precinct are summarised in Table 1.1.

Table 1.1 Report structure and assessment methodology

Report chapter	Task	Report section
Chapter 1: Introduction and strategic background	Identify literature, previous technical studies, policies and guidelines relevant to the acoustic and air quality impact assessment	1.4 (literature review)
Chapter 2: Planning and policy context	Summarise the policy context for the acoustic and air quality assessment	2 (T&I SEPP and SEPP 65)
Chapter 3: Existing environment analysis	Undertake a site visit to Westmead South and undertake noise surveys of road and rail infrastructure to quantify the existing noise environment	3.3 (Noise survey results)
	Describe the existing environment with respect to: – Existing land uses, the local topography and the location of sensitive receivers – The key air pollutant, noise and vibration sources within the study area – Prevailing noise levels and background air quality concentrations – The climate and meteorological conditions – Existing road traffic volumes and rail movements along transport corridors	3.1(Existing LEP controls) 3.2 (Land uses, topography and built form) 2.4(Key pollutants) 3.3 (Existing noise levels) 3.4 (Local meteorology) 3.5 (Background air quality)
Chapter 4: Preliminary impact assessment on base-case	Determine whether the existing emission levels are acceptable based on current legislation, policies and guidelines	4.1 (acoustics) 4.2 (air quality)
	Assess the potential acoustic and air quality impacts on existing development within the study area	
Chapter 5: Recommendations for future development	Provide broad recommendations for the future development scenarios with respect to acoustic and air quality	5 (Recommendations)

1.6 Limitations

This report: has been prepared by GHD for Cumberland City Council and may only be used and relied on by Cumberland City Council for the purpose agreed between GHD and Cumberland City Council as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Cumberland City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.7 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.7 Assumptions

The Westmead South acoustics and air quality study is based on the following inputs provided by others and key assumptions:

- Mid-block traffic counts undertaken by Traffic Survey between 2 August 2023 and 9 August 2023 and supplied by SCT consulting
- Long-term unattended noise monitoring undertaken at four (4) locations within Westmead South as part of the *Westmead to the Bays and Sydney CBD Environmental Impact Assessment: Technical Paper 2 Noise and Vibration* (SLR, 2019)
- Existing buildings have been based on data including the building footprint, building height, estimated number of floors and addresses purchased from Geoscape PSMA
- 2 metre LiDAR elevation data was sourced from NSW Government – Spatial Services
- Road traffic noise levels were modelled at receivers using the algorithm Calculation of Road Traffic Noise 1988 (CoRTN)
- Rail traffic movements were modelled at receivers using the Nordic Prediction Method (NMT) 1996
- Vehicle air emissions were calculated from outputs from the *Computer program to calculate emissions from road transport* (COPERT 2014), using the 2010 NSW fleet characteristics, and surveyed vehicle counts.
- Local meteorology was modelled using GRAMM with input from DPE's Parramatta North Air Quality Monitoring Station
- Air dispersion modelling was undertaken using the Graz Lagrangian Model (GRAL)
- The vibration assessment zone for typical development sites adjacent to rail corridors or above (built) rail tunnels is 25 metres for residential buildings on hard ground such as sandstone (*Development Near Rail Corridors and Busy Roads - Interim Guideline,* DoP 2008). No existing sensitive receivers have been identified within 25 metres of an operational rail track. Given this, vibration from rail movements is not considered to be an acoustic amenity issue for the Westmead South study area. For the receivers near the rail track, this study focuses on the dominant noise sources being airborne noise from rail and road traffic.
- Existing planning controls were extracted from ArcGIS Feature Service spatial datasets of NSW environmental planning instruments (EPI)

Planning and policy context

Key legislation and design principles informing the assessment

2. Planning and policy context

2.1 Relevant documents

This study primarily focuses on the potential air, noise and vibration pollution impacts on existing sensitive land uses within the Westmead South Precinct to inform the development of the Westmead Masterplan and relevant planning controls. The key legislation, design guidance and policies relevant to this study are highlighted in light blue in Table 2.1. Other relevant NSW legislation and guidelines pertaining to acoustics and air quality are summarised in Table 2.1, however have not been specifically considered in this study.

Table 2.1 Relevant legislation, guidelines and policies

Type	Document	Section
Key legislation and policies	– Cumberland LEP 2021 – EP&A Act 1979 and EP&A Regulation 2000 – Transport and Infrastructure SEPP 2021 – SEPP No 65—Design Quality of Residential Apartment Development – National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021 (the Air NEPM)	Section 2.2 (overview) Section 2.4 (Transport and Infrastructure SEPP) Section 2.5 (Air NEPM)
Key design guidance for future development within Westmead South Precinct	– Cumberland DCP 2021 – Development Near Rail Corridors and Busy Roads - Interim Guideline – NSW Apartment Design Guide – Low Rise housing Diversity Design Guide for DAs and CDCs	Section 2.3 (overview) Section 2.6 (Design Principle 6: Amenity)
Relevant NSW legislation	– Protection of the Environment Operations Act 1997 – Protection of the Environment Operations (Noise Control) Regulation 2017 – NSW Protection of the Environment Operations (Clean Air) Regulation 2021 (POEO Clean Air Regulation) – Liquor Act 2007 and Liquor Regulation 2018 – Local Government Act 1993 – Strata Schemes Management Act 2015	Summarised in Appendix B
Relevant noise and vibration specific guidelines	– Noise Policy for Industry (EPA 2017) – Interim Construction Noise Guideline (DECCW 2009) – Noise Guide for Local Government – NSW Road Noise Policy (DECCW 2011) – NSW Rail Infrastructure Noise Guideline (EPA 2013) – Assessing Vibration: A technical guideline (DEC 2006) – AS2107:2016 Acoustics Recommended design sound levels and reverberation times for building interiors – Building Code of Australia – AAAC Guidelines of acoustic assessments	Summarised in Appendix B
Relevant air quality specific guidelines	– NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2022) (the Approved Methods)	Summarised in Appendix B

2.2 Key legislation and policies

The Environmental Planning and Assessment Act 1979 (EP&A Act) and associated Regulation establishes the planning and environmental assessment system for NSW, including the step and procedures for preparing LEPs and establishes the legislative framework for the bulk of the planning system.

The EP&A Act is followed closely by State Environmental Planning Policies (SEPP), which establish planning controls for specific areas or types of development. The State Government prepares the EP&A Act and SEPPs and Councils prepare Local Environmental Plans (LEP) and Development Control Plans (DCP) to regulate development and land use within a particular local government area.

The relevant legislation and planning instruments that apply to the Westmead South Precinct are presented in Table 2.2 along with the key objectives pertaining to acoustics and air quality.

Table 2.2 Key legislation and planning policies

Key legislation	Objectives relevant to acoustics and air quality	Relevant requirements
Environmental Planning and Assessment (EP&A) Act 1979 and Environmental Planning and Assessment Regulation 2000	The Act establishes the framework for the assessment and determination of development applications. LEPs provides the legal basis for evaluating proposed developments against the land use and development controls outlined in the LEPs and ensure consistency with state-level policies and guidelines.	Under the EP&A Act 1979, local councils and planning authorities may consider noise impacts when assessing development applications. They may require noise impact assessments, impose conditions on development consents related to noise management, and set noise control standards or guidelines in planning instruments. The EP&A Regulation 2000 provides a regulatory framework for the specific content and requirements of planning instruments including LEPs and DCPs.
State Environmental Planning Policy (Transport and Infrastructure) 2021	A planning policy in NSW that provides requirements for land use development adjacent to busy roads and rail corridors, such as: – Residences – Hospitals – Educational institutions – Places of worship – Child care centres Specific guidance is provided in the *Development Near Rail Corridors and Busy Roads - Interim Guideline* (DoP 2008)	The State Environmental Planning Policy (Transport and Infrastructure) 2021 provides a consistent planning regime for infrastructure and the provision of services across NSW. If the consent authority considers that land that is in or adjacent to a rail corridor or a busy road is likely to be adversely affected by noise or vibration, the consent authority must not consent to a residential development unless it is satisfied that appropriate measures will be taken to ensure that the internal L_{Aeq} noise levels prescribed in the SEPP can be achieved (see Table 2.7)
State Environmental Planning Policy No 65 - Design Quality of Residential Apartment Development (SEPP 65).	A planning policy in NSW that provides design guidance for the development of residential apartments. The design principle most relevant to air quality and acoustics is Design Quality Principle 6 Amenity. Specific guidance is provided in the NSW Apartment Design Guide (DoP&E 2015)	SEPP 65 sets out design quality principles and objectives to ensure well-designed residential apartment buildings in NSW. It includes provisions that encourage the incorporation of noise mitigation measures to minimise the impact of noise on apartment occupants and also includes guidance for natural ventilation. The policy recognises the need to address both external noise sources, such as traffic or industrial activities, and internal noise sources within the building, such as sound transmission between apartments.
Cumberland Local Environmental Plan (LEP) 2021	Details the controls for the Local Government Area, including: – Land zoning – Permissible land uses – Building heights – Floor space ratios – Setback and building lines	LEPs are statutory planning documents that guide and control land use and development within the Cumberland LGA. They are prepared by local councils in accordance with the Environmental Planning and Assessment Act 1979 (EP&A Act) and relevant state planning policies.

2.3 Design guidance

New sensitive land use development within the Westmead South Precinct would be required to consider the relevant Council planning instruments (Cumberland LEP and DCP). The relevant objectives and controls within Part B of the Cumberland DCP 2021 are reproduced in Appendix A. A Development Control Plan would be developed for the Westmead South Masterplan and the planning controls relevant to amenity (noise and air quality) would be informed by the outcomes of this study.

Where development is proposed near rail corridors or busy roads, the supporting Transport and Infrastructure SEPP guideline (*Development Near Rail Corridors and Busy Roads - Interim Guideline*) would need to be considered to ensure potential health and amenity impacts from air and noise pollution are adequately addressed prior to approval.

NSW DPE have also developed design guidelines that support for the development of SEPP 65 residential apartments and also low-rise housing through the development application pathway or through the SEPP (Exempt and Complying Development Codes) 2008 pathway.

Each of these documents (summarised in Table 2.3) promote '**Design Principle 6: Amenity**' being:

> *"Good design positively influences internal and external amenity for residents and neighbours. Achieving good amenity contributes to positive living environments and resident well being.*
>
> *Good amenity combines appropriate room dimensions and shapes, access to sunlight, natural ventilation, outlook, visual and acoustic privacy, storage, indoor and outdoor space, efficient layouts and service areas, and ease of access for all age groups and degrees of mobility."*

These planning instruments and design guidelines are summarised in Table 2.3.

Table 2.3 Planning and new development guidelines

Planning control / development guideline	Objectives relevant to acoustics and air quality	Relevant guidance
Cumberland Development Control Plan (DCP) 2021	Includes objectives and controls for sensitive land use development relating to: – Acoustic privacy – Air and noise pollution – Natural and cross ventilation	The DCP compliments the LEP by providing more detailed site specific requirements. Part B1, Part B2, Part B3 and Part B4 provide objectives and controls for residential development and other sensitive land uses relating to acoustic privacy, air and noise pollution and ventilation requirements.
Development Near Rail Corridors and Busy Roads - Interim Guideline (DoP 2008)	Provides design guidance supporting the Transport and infrastructure SEPP to reduce health and amenity impacts for land use development near busy roads and rail corridors. For instance: – Great Western Highway – Hawkesbury Road – Alexandra Avenue – Main West rail corridor	This guideline assists in the planning, design and assessment of development in, or adjacent to, rail corridors and busy roads. It supports specific rail and road provisions in the Transport and Infrastructure SEPP by ensuring adjacent development achieves an appropriate acoustic amenity by meeting the internal noise criteria specified. It specifically addresses: – Airborne noise pollution from busy roads – Airborne and groundborne noise pollution from rail corridors – Vibration impacts due to railway operations – Air quality health impacts from air pollution adjacent to busy roads and rail corridors
NSW Apartment Design Guide (DPE, 2015)	Provides design guidance supporting SEPP 65 (Principle 6: Amenity) for residential apartments.	These design guides have been prepared to: – assist developers, planners, urban designers, architects, building designers, landscape architects, builders and other professionals when designing and preparing DAs for low rise diverse housing – assist planning professionals in local government with preparing local controls and in assessing development applications for low rise diverse housing – inform the community of what is required to achieve good design and planning practice for diverse low rise residential dwellings, as a development application. They provide design guidance to support Principle 6 – Amenity for residential development, including: – Acoustic privacy – Air and noise pollution – Natural and cross ventilation
Low rise housing Diversity Design Guide for Development Applications (NSW DPE, 2020)	Provides design guidance for complying developments for dual occupancies, manor houses, terraces and multi dwelling housing	
Low rise housing Diversity Design Guide for Complying Developments (NSW DPE, 2020)	Provides design guidance for complying developments for dual occupancies, manor houses and terraces	

2.4 SEPP (Transport and Infrastructure) 2021

The State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) provides a consistent planning regime for infrastructure and the provision of services across NSW. If the consent authority considers that land that is in or adjacent to a rail corridor or a busy road is likely to be adversely affected by noise, vibration or vehicle emissions, the consent authority must not consent to a residential development unless it is satisfied that appropriate measures will be taken to ensure that the internal L_{Aeq} noise levels prescribed in the SEPP can be achieved (see Table 2.7) and that vehicle emissions can be adequately controlled .

The construction of sensitive developments such as residential dwellings, churches, hospitals, and schools on land in or immediately adjacent to a rail corridor or busy road triggers the requirement to consider air and noise pollution under the Transport and Infrastructure SEPP.

Clause 2.119 notes that proposed developments with frontage to classified roads must not be sensitive to traffic noise or vehicle emissions or must be located and adequately designed to ameliorate potential traffic noise and vehicle emissions from adjacent classified roads.

The definition of a 'rail corridor' and a 'busy road' as defined in the Transport and Infrastructure SEPP are provided below in Table 2.4. The key roads requiring assessment under the T&I SEPP are presented in Table 2.5 along with the estimated (weekday) traffic volumes. The key rail corridor is the Western Line connecting Parramatta to Wentworthville (along the northern edge of the Westmead South study area). The estimated passenger and freight rail movements along this rail corridor have been estimated based on long-term noise monitoring surveys undertaken near Parramatta station in 2017 by GHD.

The T&I SEPP road and rail corridors are shown in Figure 2.1 along with the lots within the Westmead South study area that would require assessment with consideration to the *Development Near Rail Corridors and Busy Roads - Interim Guideline*.

Table 2.4 Clause 2.100 and Clause 2.120 of the T&I SEPP

Corridor	Clause	Assessment requirement	
		Mandatory	**Non-mandatory**
	**Clause 2.100 (see Table 2.5)** Rail corridor: as defined by clause 2.100 of the Infrastructure SEPP. – Land that is owned, leased managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities, or – Land that is zoned under an environmental planning instrument predominantly or solely for the development for purpose of a railway or rail infrastructure facilities, or – Land in respect of which the Minister has granted approval under Part 3A or (before its repeal) Division 4 of Part 5 of the Act for the carrying out of development (or for a concept plan for a project comprising or including development) for the purpose of a railway or rail infrastructure facilities.	**25 metres from the nearest track line (noise and vibration):** Main West Line (between Parramatta and Wentworthville)	**60 metres from the nearest track line (noise):** Main West Line (between Parramatta and Wentworthville)
	**Clause 2.120 (see Table 2.6)** A busy road is defined as: – freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW)	**Freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles:** – Great Western Highway (Map 11D) – Hawkesbury Road (Map 11D) – Bridge Road (Map 11D)	**Road corridors carrying between 10,000 and 20,000 AADT:** Alexandra Avenue (2023 traffic counts)

Table 2.5 Key roads within Westmead South and estimated traffic volumes

Street name	T&I SEPP assessment requirement	ADT (*AADT)	Ratio Day/ADT	HV%		Source
				Day	Night	
M4 Motorway[1]	Mandatory[2]	127,698*	83%	10.0%	10.0%	RMS, 2009
Great Western Highway[1]	Mandatory	32,922*	86%	5.7%	7.0%	RMS, 2023
Hawkesbury Road[1]	Mandatory	14,048	88%	6.1%	6.6%	TrafficSurvey, 2023
Bridge Road[1]	Mandatory	9,860	87%	7.7%	6.3%	TrafficSurvey, 2023
Alexandra Avenue (east)	Non-mandatory	10,373	94%	5.9%	9.9%	TrafficSurvey, 2023
Alexandra Avenue (west)	Non-mandatory	6,707	91%	5.9%	9.9%	TrafficSurvey, 2023
Good Street / Pye Street	-	3,350	90%	6.8%	7.9%	TrafficSurvey, 2023
Amos Street	-	2,495	91%	4.4%	5.8%	TrafficSurvey, 2023
Houison Street / Hassall Street	-	1,972	94%	4.9%	4.3%	TrafficSurvey, 2023
Austral Avenue	-	1,726	92%	2.2%	4.2%	TrafficSurvey, 2023
Grand Avenue	-	996	93%	2.1%	0.0%	TrafficSurvey, 2023

1) Mandatory road identified in the traffic volume maps (Map 11D) for noise assessment for building on land adjacent to busy roads (Transport for NSW, 2021)

2) The M4 Motorway is outside the Westmead South study area. However, this road has been included in the modelling as it has the potential to result in cumulative emissions at sensitive receivers within the study area.

Table 2.6 Rail corridors within Westmead South and estimated volumes

Street name	No. of tracks	Passenger		Passenger trains		Freight trains		Source
		AM peak	PM peak	Day	Night	Day	Night	
Railway (Western line)	4	33	33	397	87	18	12	GHD, 2017

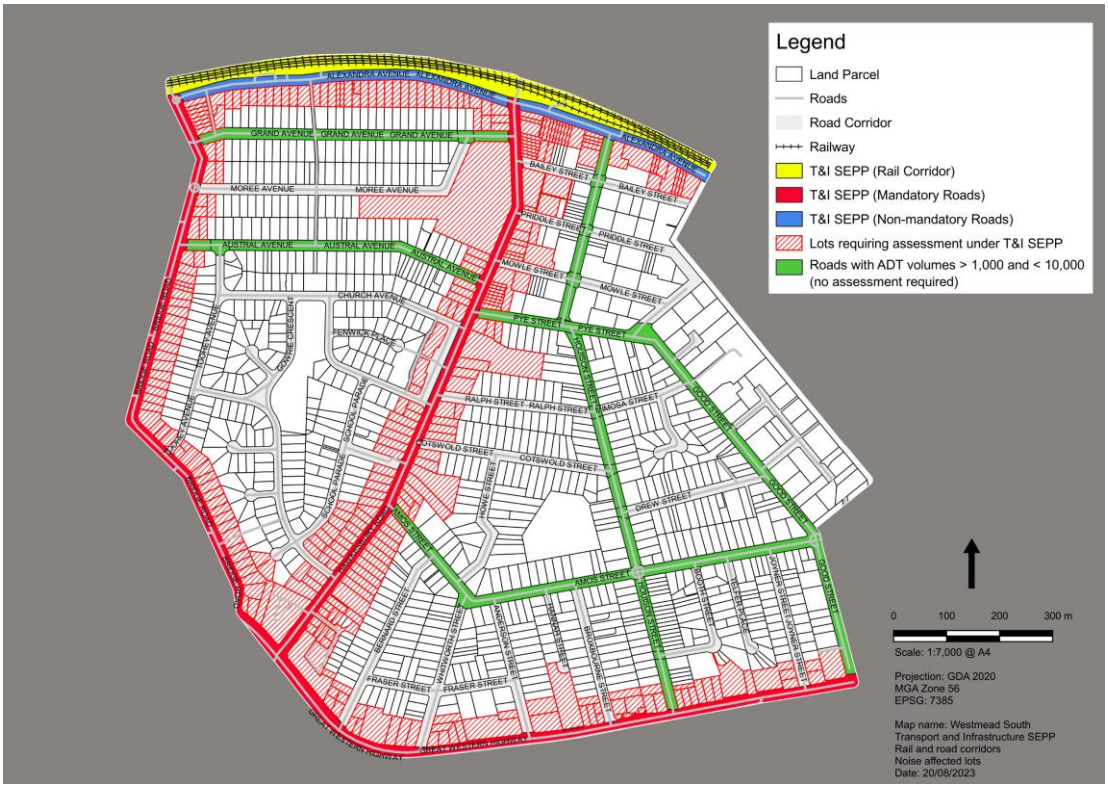


Figure 2.1 Westmead South – T&I SEPP rail and road corridors

The *Development Near Rail Corridors and Busy Roads - Interim Guideline* is a document prepared by the Department of Planning to reduce the health impacts of rail and road noise and emissions to air on sensitive adjacent developments. The Transport and Infrastructure SEPP refers to the guidelines that must be considered where development is proposed in, or adjacent to, specific roads and railway corridors under clauses 2.100 (rail) and 2.120 (road). The internal noise levels from the Interim Guideline to be achieved are provided in Table 2.7.

Table 2.7 Transport and Infrastructure SEPP internal noise levels

Development type	Room type	Internal noise level	Time period
Residential	Bedrooms	35 dBA (45 dBA with open windows)[1]	Night
	Other habitable rooms	40 dBA (50 dBA with open windows)[1]	Day / 24 hours
Hospitals	Wards	35 dBA	When in use
	Other noise sensitive areas	45 dBA	When in use
Place of worship	Internal areas (learning spaces)	40 dBA	When in use
Educational institutes and child care centres	Internal areas (learning spaces)	40 dBA	When in use

Notes:

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

The Interim Guideline provides the following instances when air quality should be a design consideration:

– Within 10 metres of a congested collector road (traffic speeds of less than 40 km/hr at peak hour) or a road grade > 4% or heavy vehicle percentage flows > 5%,
– Within 20 metres of a freeway or main road (with more than 2500 vehicles per hour, moderate congestions levels of less than 5% idle time and average speeds of greater than 40 km/hr),
– Within 60 metres of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources), or
– As considered necessary by the approval authority based on consideration of site constraints, and associated air quality issues.

While the points above provide situations in which air quality should be considered, no quantitative objectives are provided in the guideline to assess to and as such numerical objectives have been sourced from The *National Environment Protection (Ambient Air Quality) Measure (*National Environment Protection Council (NEPC), 2021*).*

2.5 Air quality objectives

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) and the *National Environment Protection (Air Toxics) Measure* (Toxics NEPM) were developed to provide benchmark standards for ambient air quality to allow for the adequate protection of human health and well-being (National Environment Protection Council, 2021). These measures provide criteria for a range of pollutants and VOCs that would be expected from vehicle emissions. Table 2.8 provides a summary of the air quality objectives for key pollutants of concern, nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$), as discussed in section 4.2. Objectives for $PM_{2.5}$ are

expected to change from 1 January 2025 as outlined in the Air NEPM and are shown in brackets beside the current objective.

Table 2.8 Air quality assessment objectives

Pollutant	Averaging period	Statistic	Maximum concentration	
			µg/m^3	ppm
$PM_{2.5}$	1 day	Maximum	25 (20)	-
	1 year	Average	8 (7)	-
NO_2	1 hour	Maximum	164	0.08
	1 year	Average	31	0.015

2.6 SEPP 65 Design Principle 6: Amenity

Residential flat buildings

The NSW Apartment Design Guide (Department of Planning and Environment, 2005) details how residential apartment development proposals can meet these principles (including acoustic amenity) through good design and planning practice. This Apartment Design Guide is a resource to improve the planning and design of residential apartment development in NSW. The Apartment Design Guide is to be used in conjunction with State Environmental Planning Policy No 65 – Design Quality of Residential Apartment Development (SEPP 65) which sets out the NSW Government's policy direction for residential apartment development in NSW.

The relevant objectives of the Apartment Design Guide are reproduced in Table 2.9. For each objective the ADG, provides design guidance and design criteria (where relevant).

Table 2.9 Apartment Design Guide objectives (natural ventilation and noise and pollution)

Type	Objective no.	Objectives
Natural ventilation	4B-1	All habitable rooms are naturally ventilated
	4B-2	The layout and design of single aspect apartments maximises natural ventilation
	4B-3	The number of apartments with natural cross ventilation is maximised to create a comfortable indoor environment for residents
Acoustic privacy	4H-1	Noise transfer is minimised through the siting of buildings and building layout
	4H-2	Noise impacts are mitigated within apartments through layout and acoustic treatments
Noise and pollution	4J-1	In noisy or hostile environments the impacts of external noise and pollution are minimised through the careful siting and layout of buildings
	4J-2	Appropriate noise shielding or attenuation techniques for the building design, construction and choice of materials are used to mitigate noise transmission

SEPP 65 development in locations adjacent to rail corridors and busy roads must have regard to the *Development Near Rail Corridors and Busy Roads - Interim Guideline*

2.7 Low rise housing

The Low Rise housing Diversity Design Guide for Development Applications (NSW DPIE, 2020) and Low rise housing Diversity Design Guide for Complying Development (NSW DPIE, 2020) applies to development that contains two or more dwellings and is no more than two storeys in height, including:

– Dual occupancies (Section 2.1 of the Design Guide)
– Main houses and 'one above the other' dual occupancies (Section 2.2 of the Design Guide)
– Multi-dwelling houses (terraces) (Section 2.3 of the Design Guide)
– Multi-dwelling houses (town houses and villas) (Section 2.4 of the Design Guide)

Table 2.10 Low rise housing diversity design objectives (natural ventilation and noise and pollution)

Rype	Objective no.	Design Criteria
Acoustic privacy	2.1P-1	Electrical, mechanical, hydraulic and air conditioning equipment is housed so that it does not create an 'offensive noise' as defined in the *Protection of the Environment Operations Act 1997* either within or at the boundaries of any property at any time of the day.
Natural ventilation	2.1I	All habitable rooms are naturally ventilated
		Each dwelling is naturally cross ventilated
Noise and pollution	2.1Q-1	Any development within the 20 ANEF contour is to be constructed to comply with AS 2021:2015 Acoustics – Aircraft Noise Intrusion.
		Dwellings that are within 100m of a classified road or 80m from a rail corridor are to have LAeq measures not exceeding: – In any bedroom: 35dB(A) between 10pm-7am. – Anywhere else in the building (other than a kitchen, garage, bathroom or hallway): 40dB(A) at any time. This is achieved by: – Providing a full noise assessment prepared by a qualified acoustic engineer; and – Complying with relevant noise control treatment for sleeping areas and other habitable rooms in Appendix C of RMS *Development Near Rail Corridors and Busy Roads - Interim Guideline.*

Note: Development that is on land immediately adjacent to a rail corridor and development that involves penetration of the ground to a depth of 2m within 25m of a rail corridor may be integrated development and *State Environmental Planning Policy (Infrastructure) 2007* applies.

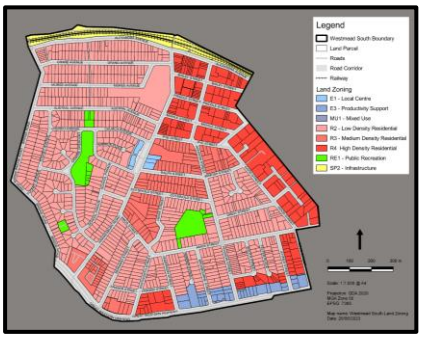
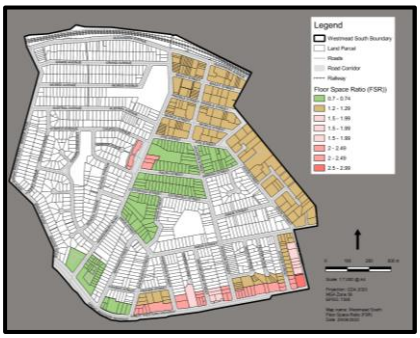
Existing environment

Summary of existing planning controls and a description of the existing built environment with respect to air quality and acoustics

3. Existing environment

3.1 Existing LEP controls

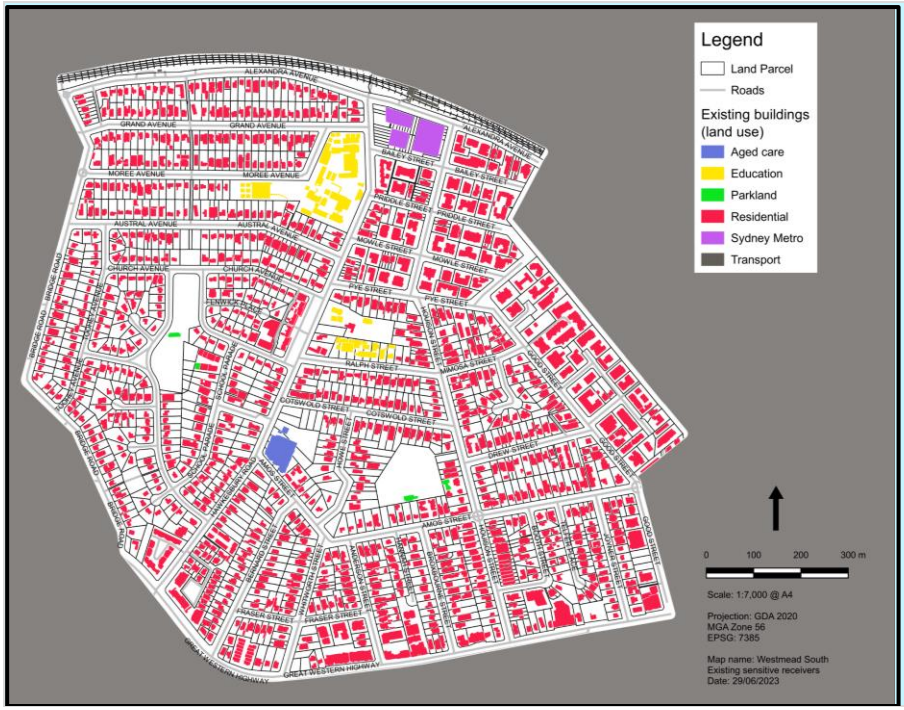
A review of the existing land use zones and principal development standards in the Cumberland Local Environmental Plan 2021 for the Westmead South study area and are summarised below.

Zone ID	Land zoning	Floor Space Ratio (FSR)
		
R2	Low density residential - typically houses	-
E1	Local centre – Oakes Centre shops and petrol station	2:1
E3	Productivity support - houses and RFB developments	1.8 – 2.2:1
R4	High Density residential – RFB developments	1.2 to 1.5:1
R3	Medium density residential – typically houses	0.1:1
Zone ID	**Height of Buildings (HOB)**	**Minimum Lot size**
		
R2	9 m	450 – 474 m^2
E1	17 m	-
E3	12.5 to 23 m	-
R4	15 m to 21 m	900 – 999 m^2
R3	8 m	900 – 999 m^2

3.2 Receivers, topography and built form

The sensitive receivers identified in the study area are shown in Figure 3.1 and shows that the study is predominantly residential. The local topography and existing built form are shown in Figure 3.2 and Figure 3.3, respectively. Multi-storey residential buildings are typically located within R4 and E3 land zones and single and double-storey dwellings are typically located within R2 and R3 land zones.

Figure 3.4 shows the majority of buildings are setback from the lot boundary facing the road by 6 metres or more. Parts of buildings that are within 6 metres of the lot boundary facing the road are highlighted in yellow.



Places of worship:

– Sacred Heart Parish

– St. Barnabas Anglican Church

Residential:

– Low, medium and high density residential development

Commercial:

– Oakes Centre

– Businesses along Great Western Highway

Schools:

– Sacred Heart Primary School

– Westmead Public School

Transport (non-sensitive):

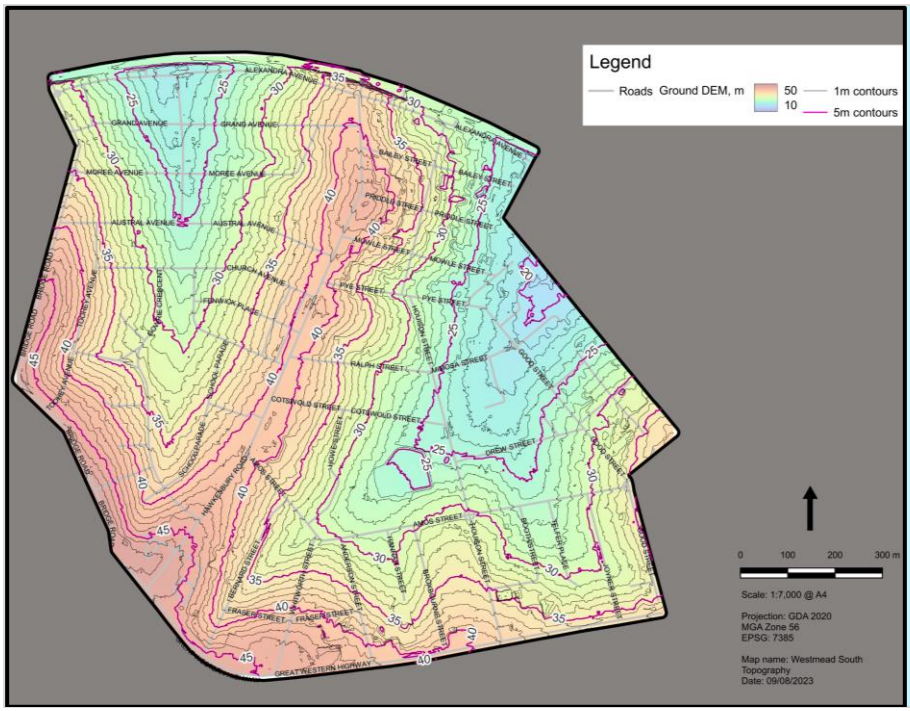
– Transport corridors

– Westmead train station

– Westmead Sydney Metro Station

– Westmead Bus Interchange

Figure 3.1 Westmead South – sensitive receivers

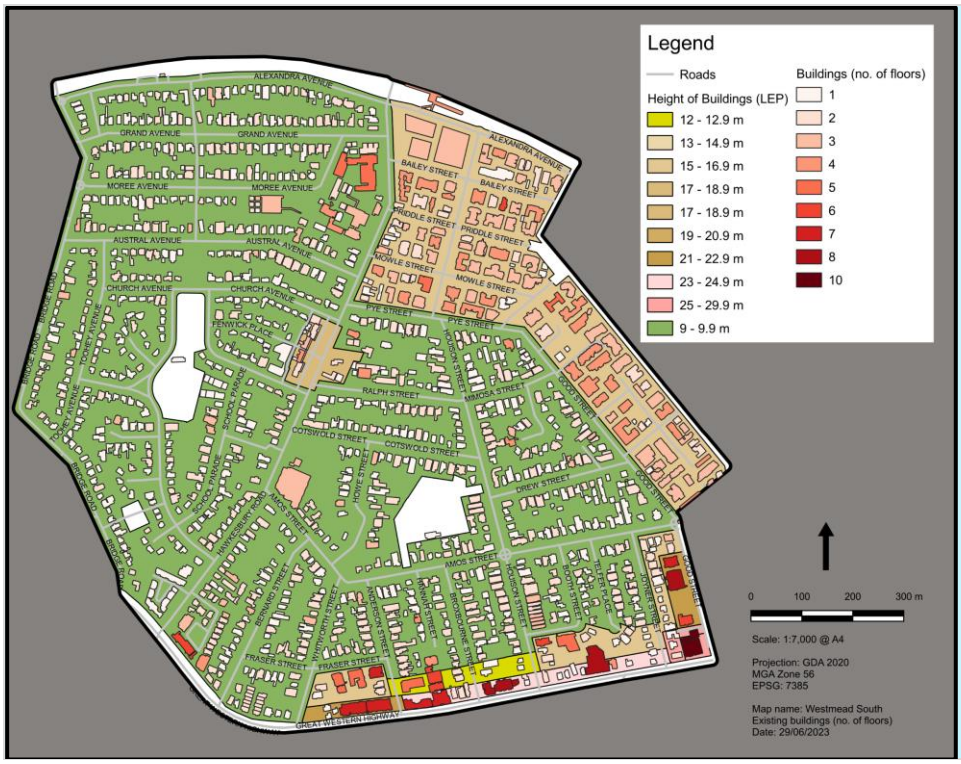


Ground elevations (2 metre resolution LiDAR data) have been sourced from the Department of Customer Service (DCS) Spatial services.

Ground elevation ranges between Reduced Level (RL) 18 metres to RL 48 metres within the study area.

Generally, the highest ground elevation areas are around Hawkesbury Road, Bridge Road and Great Western Highway

Figure 3.2 Westmead South – Local topography

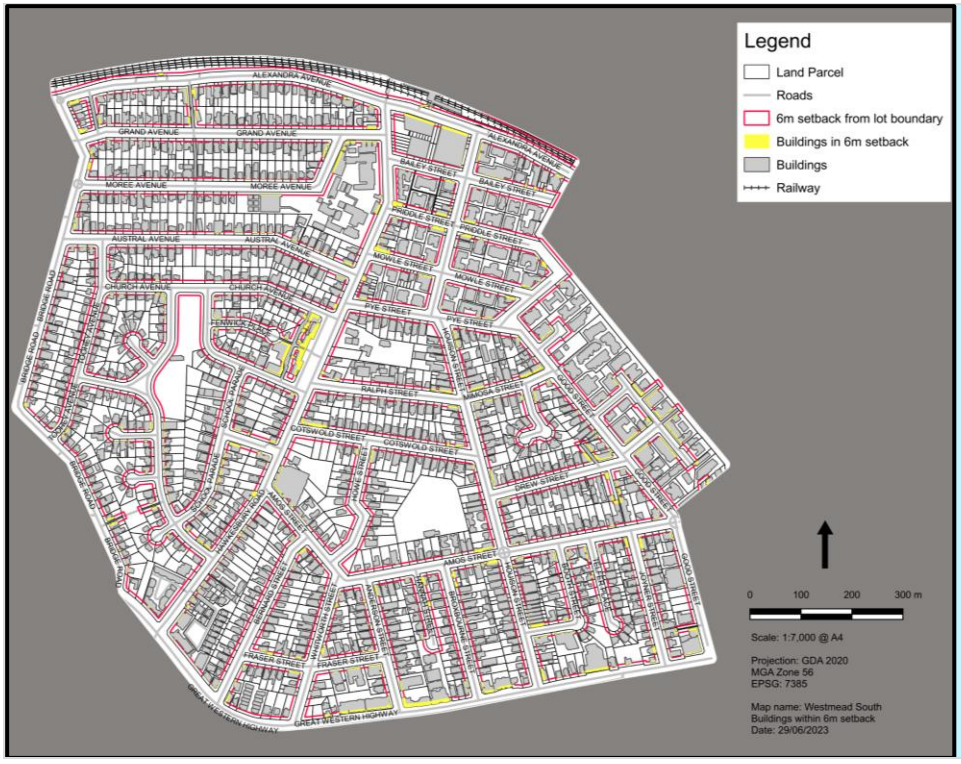


The existing built form of the study area is based on building footprints and building heights sourced from Geoscape PSMA.

The majority of residential buildings are one or two storeys high and the tallest buildings approximately 10 storeys high and fronting Great Western Highway (east of Hawkesbury Road).

The majority of buildings are one or two-storey residential dwellings.

Figure 3.3 Westmead South – Built form (existing)



Existing buildings within the study area are generally setback from the lot boundary (facing the road) by 6 metres or more.

There are various buildings that (highlighted in yellow in Figure 3.4) where the building footprint is within 6 metres of the lot boundary including a few multi-storey buildings along Great Western Highway (east of Hawkesbury Road).

Generally, existing buildings are setback from the road edge by a distance of 10 metres or more.

Figure 3.4 Westmead South – Building lines and setbacks)

3.3 Existing noise levels

Attended noise monitoring and traffic count survey (GHD, 2023)

To quantify existing transport noise levels across the study, attended noise monitoring was undertaken on Thursday 3 August 2023 between hours of 2:30 pm and 7:00 pm at ten (10) locations within the Westmead South study area. 30-minute measurements were undertaken at each location and have been used to compare against the modelled $L_{Aeq(1hour)}$ noise levels in this study. The results of the noise model validation are provided in Section 4.1. Mid-block traffic counts were also undertaken by Traffic Survey between 2 August 2023 and 9 August 2023 and supplied by SCT Consulting (shown in Figure 3.5). The results of the attended noise monitoring survey (2023) are presented in Table 3.1.

The methodology for the noise monitoring program included the following:

– Noise monitoring was undertaken using Svan 977 Type 1 environmental noise loggers (Serial no. 36871 and Serial no. 45744). All noise loggers were programmed to accumulate L_{AFmax}, L_{A90}, L_{A10} and L_{Aeq} noise descriptors continuously over a 30-minute period at each location

– A calibration check was performed on the noise monitoring equipment using a sound level calibrator. At completion of the measurements, the meter's calibration was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dBA.

– All monitoring activities were undertaken with consideration of the specifications outlined in Australian Standard AS1055 (1997) *Description and Measurement of Environmental Noise.*

Unattended noise monitoring survey (SLR, 2019)

Long-term unattended noise monitoring was undertaken at four (4) locations within Westmead South as part of the *Westmead to the Bays and Sydney CBD Environmental Impact Assessment: Technical Paper 2 Noise and Vibration* (SLR, 2019). The unattended noise monitoring results have been used to quantify the day and night period noise levels within the Westmead South area and to compare against the modelled $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise levels in this study. The results of the noise model validation are provided in Section 4.1.

The results of the unattended noise monitoring survey (2019) are presented in Table 3.2.

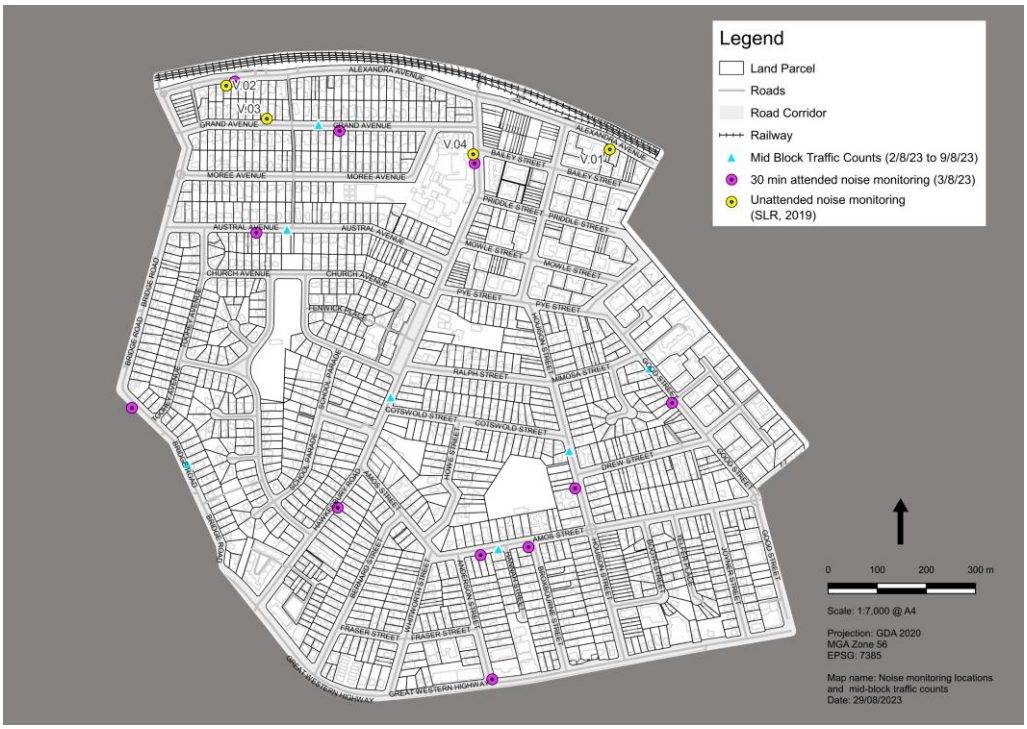


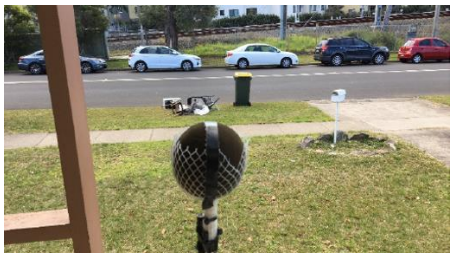
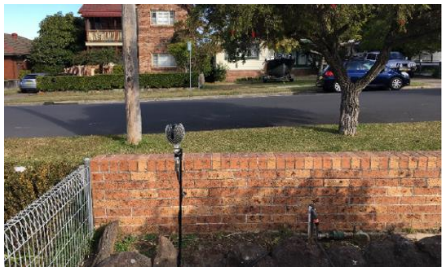
Figure 3.5 Attended and unattended noise monitoring locations and mid-block traffic counts

Table 3.1 Attended noise monitoring results 3/08/2023

Street	Distance to kerb, metres	Photo	Measurement start time	Noise measurement results, dBA (30 minutes)				
				LAeq	LAmax	LA1	LA10	LA90
Alexandra Avenue	3 (road edge)		5:45:00 PM	**65**	81	75	68	49
Amos Street	3 (road edge)		3:45:00 PM	**63**	91	72	66	43
Austral Avenue	3 (road edge)		6:30:00 PM	**58**	78	70	62	43
Bridge Street	3 (road edge)		4:45:00 PM	**64**	88	71	67	50
Good Street	3 (road edge)		2:45:00 PM	**61**	80	71	66	46

Street	Distance to kerb, metres	Photo	Measurement start time	Noise measurement results, dBA (30 minutes)				
				LAeq	LAmax	LA1	LA10	LA90
Grand Avenue	3 (road edge)		6:15:00 PM	54	78	66	55	42
Great Western Highway	5 (road edge)		4:00:00 PM	70	86	77	74	55
Hawkesbury Road	3 (road edge)		5:00:00 PM	67	83	74	71	53
Hawkesbury Road	3 (road edge)		5:45:00 PM	67	86	74	71	52
Houison Street	3 (road edge)		3:15:00 PM	60	78	69	64	45

Table 3.2 Unattended noise monitoring results - Sydney Metro West EIS, 2019 (SLR)

Street	Distance to kerb, metres	Photo (source: SLR, 2019)	RNP periods				Rating Background Level (RBL)		
			Period		1 hour peak				
			Day	Night	Day	Night	Day	Evening	Night
V.01 **1/7 Alexandra Avenue**	16 (road edge) 35 (closest rail)		**66**	61	69	63	49	47	38
V.02 **57 Alexandra Avenue**	11 (road edge) 33 (closest rail)		**61**	58	62	60	44	46	39
V.03 **47 Grand Avenue**	8 (road edge)		**52**	47	54	51	36	40	37
V.04 **150 Hawkesbury Road**	5 (road edge)		**64**	60	65	64	50	46	39

3.4 Local meteorology

The local climate and prevailing meteorology (weather) within the study area is of critical importance when assessing the potential for air quality impacts at sensitive receivers, particularly the wind environment which informs the air dispersion modelling.

The meteorological environment relevant to a project site is best understood through review of data collected from long-running monitoring weather stations, most commonly operated by the Bureau of Meteorology (BoM) as well as state authorities (such as the DPE). Simulation of the meteorological environment (modelling) is a useful tool in understanding the environment where suitable meteorological observations are not available.

Available observations

The BoM operates a network of Automatic Weather Stations (AWS) across NSW. A BoM AWS typically measures critical meteorological parameters including wind speed, wind direction, temperature, relative humidity, and pressure, with some stations also measuring cloud coverage.

The nearest AWS to the precinct include:

– Sydney Olympic Park (station number: 066212) – approximately 7.5 km southeast of the precinct
– Bankstown Airport (station number: 066137) – approximately 10 km south of the precinct
– Horsely Park (station number: 067119) – approximately 12 km southwest of the precinct

Additionally, the DPE operate a network of Air Quality Monitoring Stations (AQMS) across NSW that, in addition to monitoring air quality, measure meteorological parameters. The nearest AQMS of the precinct is the Parramatta North station, located approximately 1.2 km north of the precinct. This station is considered the most representative of the meteorological environment within the precinct.

Wind environment

Figure 3.6 shows the average annual wind rose and Figure 3.7 shows the average seasonal wind roses, both measured at DPE Parramatta North AWS for the period 2018 through 2022. Figure 3.6 shows the following features:

- The predominant annual average wind direction is from the northwest.
- The average wind speed measured was 1.1 metres per second.
- Calm conditions (wind speeds less than 0.5 m/s) occurred 22.7% of the time.
- High wind speeds (winds greater than 5 m/s) mostly occur from the southeast and northwest.

Figure 3.7 extends these observations, showing that:

- The winds from the northwest mainly occur during winter and autumn, while the winds from the southeast mainly occur during summer
- Spring and summer have slightly higher average wind speeds than autumn and winter
- Summer has the smallest proportion of calm conditions.

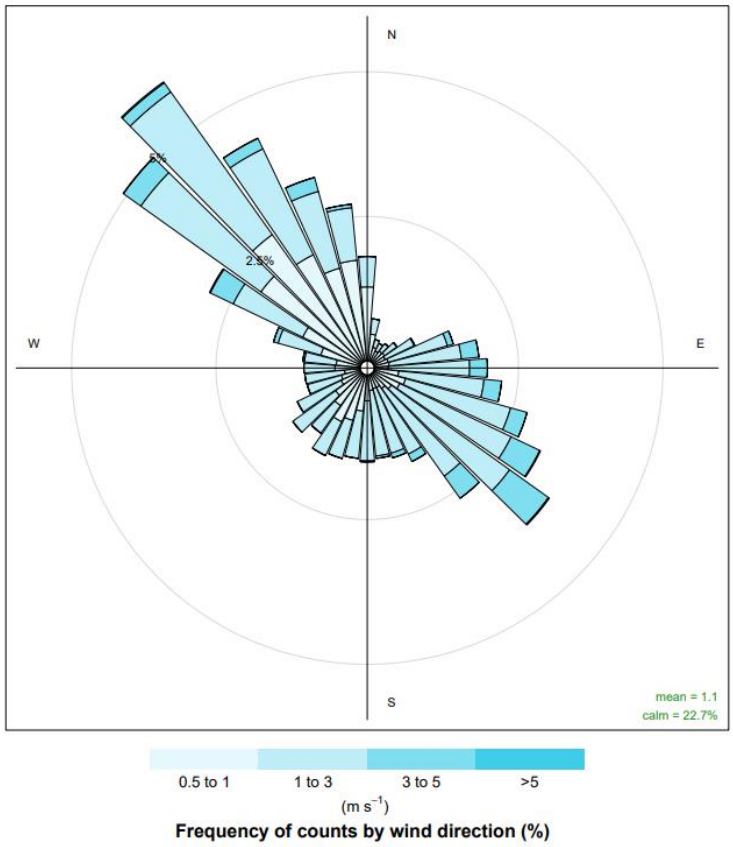


Figure 3.6 *Average annual wind rose from DPE Parramatta North AWS (2018-2022)*

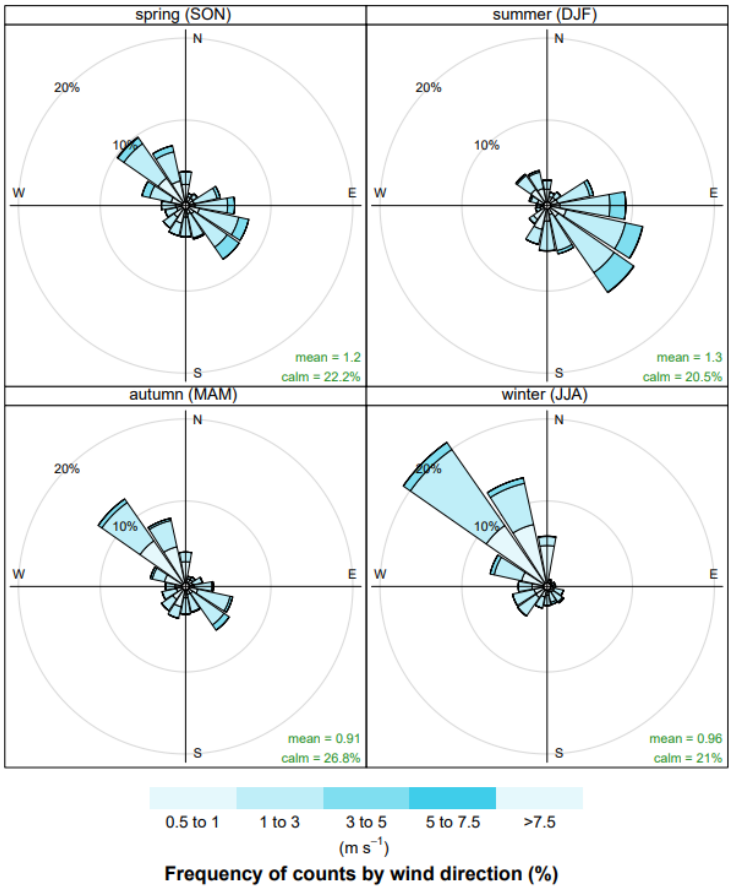


Figure 3.7 *Average seasonal wind roses from DPE Parramatta North AWS (2018-2022)*

3.5 Background air quality

Air quality in the Sydney basin is influenced by a number of natural (fires, windblown dust, etc.) and anthropogenic (industry, road traffic, etc.) sources. Due to the large variety of sources, the air quality can fluctuate year on year. A number of events in the past five years, both natural and anthropogenic, have led to ambient air quality that may not be considered representative, including the 2019-20 black summer bushfires, COVID-19 lockdown procedures and extended strong La Niña conditions.

Measurement and reporting of air quality is a requirement of the Air NEPM and as such air quality is monitored across Sydney. Additionally, the National Pollutant Inventory (NPI) requires facilities emitting air pollutants report emissions yearly. A review of the available data is summarised below.

Air quality monitoring data

The Department of Planning and Environment (DPE) operates air quality monitoring stations (AQMS) across NSW. Within 15 kilometres of the precinct are five compliance grade AQMS, including:

– Parramatta North – approximately 2 km north
– Prospect – approximately 6.5 km west
– Chullora – approximately 11 km southeast
– Macquarie Park – approximately 13.5 km northeast
– Liverpool – approximately 15 km south

A summary of ambient air quality data recorded over the last 10 years at these sites is provided in Appendix C. The following general trends are observed:

– Maximum 24-hour PM_{10} concentrations exceeded the criterion of 50 µg/m^3 for all years except for 2014, 2021 and 2022 at most stations. Annual average PM_{10} concentrations complied with the criterion of 25 µg/m^3 for all years except for 2019, likely due to the intense bushfire season in this year.
– Maximum 24-hour $PM_{2.5}$ concentrations exceeded the criterion of 25 µg/m^3 for all years except for 2014 and 2022 at most stations. Annual average $PM_{2.5}$ concentrations exceeded the criterion of 8 µg/m^3 for all years except for 2022 at most stations.
– Maximum 1-hour NO_2 concentrations ranged from 29% to 88% of the criterion of 164 µg/m^3 across all years and locations. No exceeding NO_2 concentrations were observed.
– Maximum 1-hour SO_2 concentrations ranged from 15% to 44% of the criterion of 286 µg/m^3 across all years and locations. No exceeding SO_2 concentrations were observed.
– Maximum 8-hour CO concentrations were less than 1 µg/m^3 across all years and locations.
– Maximum 1-hour ozone concentrations ranged from 49 to 377 µg/m^3 across all years and locations.

The ambient concentrations from the previous 10 years for the key pollutants, $PM_{2.5}$ and NO_2, are shown on Figure 3.8 and Figure 3.9 respectively.

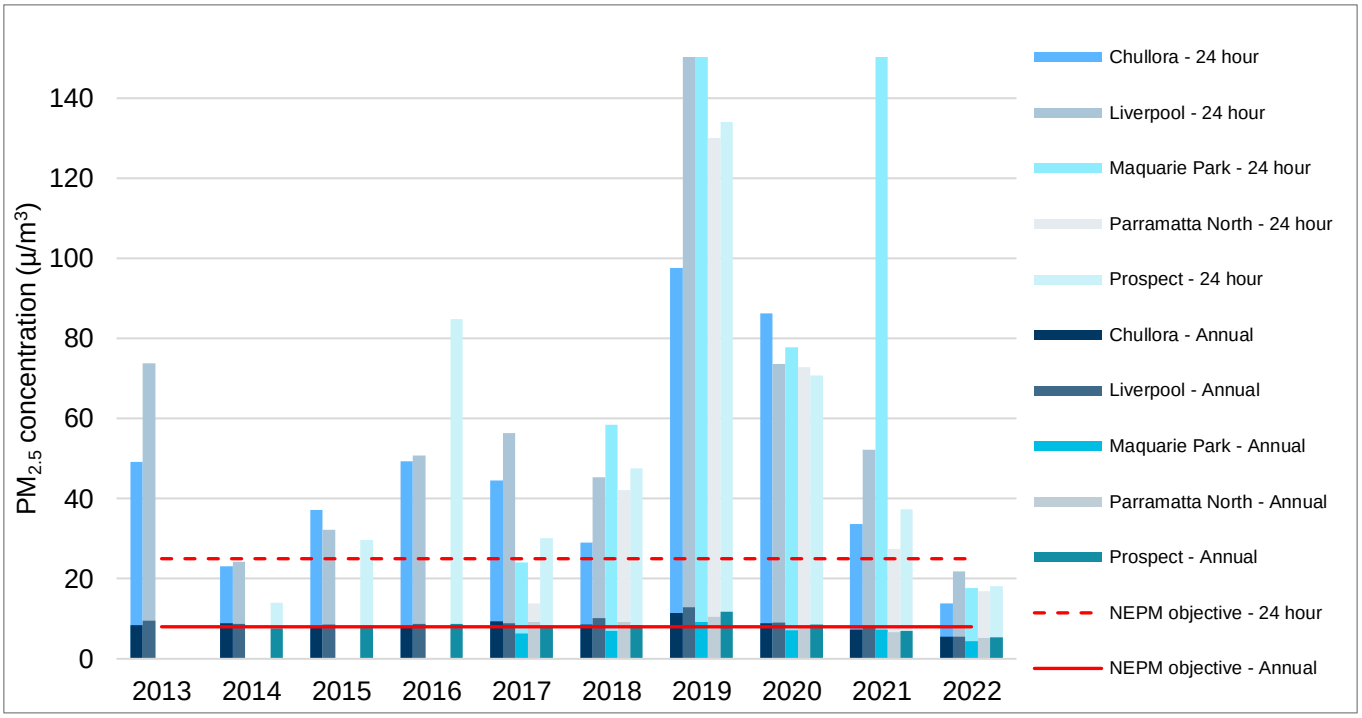


Figure 3.8 Ambient $PM_{2.5}$ for the previous 10-year period

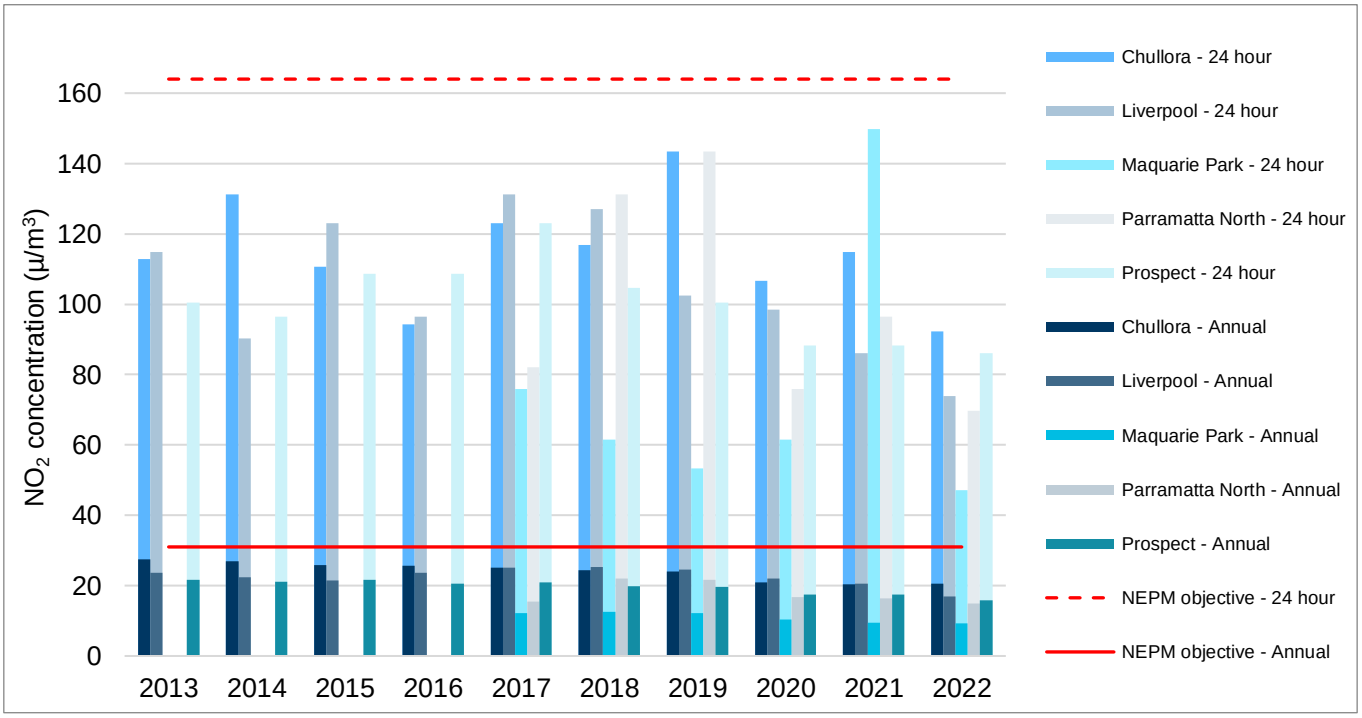


Figure 3.9 Ambient NO_2 for the previous 10-year period

Facilities reporting to the NPI

The NPI, operated under the *National Environment Protection (National Pollutant Inventory) Measure 1998*, provides publicly available information about emissions of 93 pollutants throughout Australia. Facilities that exceed prescribed threshold values are required to report their emissions to the NPI on a yearly basis.

Emissions from the 2 facilities reporting to the NPI within approximately 3 km of the site are summarised in Table 3.3.

Table 3.3 Existing operations reporting emissions to the NPI

Name of operation	Approximate distance and direction from the site	Description of operation	Reported pollutants
Coca-Cola Amatil Northmead	1.1 km north	Manufacture and distribution of non-alcoholic beverages	CO, NO_x, PM_{10}, PAH, SO_2, VOCs, $PM_{2.5}$, metals and metal compounds
Westmead Private Hospital	550 m north	Health care hospital	CO, NO_x, PM_{10}, PAH, SO_2, VOCs, $PM_{2.5}$

Preliminary assessment

An assessment of the current air quality and noise levels against the relevant guidance and criteria

4. Preliminary assessment

4.1 Noise assessment

Noise modelling

Noise modelling was undertaken using the SoundPLAN 8.2 software package to predict façade noise levels at existing buildings within Westmead South. It is typically recognised in NSW that noise prediction modelling has some accuracy limitations and will commonly produce acceptable errors of around 2 dBA. The median difference in noise level across the 10 attended noise monitoring sites ($L_{Aeq(1hour)}$) is +0.3 dBA and the median difference in noise level for the 4 unattended noise monitoring sites is -0.2 dBA and +1.6 dBA for the day and night periods, respectively. It should be noted that a minus 2 dBA correction was applied to the modelled road traffic noise levels to calibrate the noise model to the measured results for both the 1 hour, 15 hour and 9 hour periods.

Given this, the noise model is considered to be calibrated to the measured noise levels for both the attended noise monitoring survey in 2023 and the unattended noise monitoring undertaken by SLR in 2019 for the Sydney Metro West EIS. Detailed results are presented in Appendix D.

Table 4.1 Difference in noise levels – modelled vs. measured noise levels (day and night periods)

ID	Calibration point	Difference in noise level (measured minus modelled)	
		Day, $L_{Aeq(15hour)}$	Night, $L_{Aeq(9hour)}$
V.01	Alexandra Avenue (East)	-1.1	+1.9
V.02	Alexandra Avenue (West)	-0.6	+1.1
V.03	Grand Avenue	+0.2	+3.1
V.04	Hawkesbury Road	+0.8	+1.2
Difference in noise level (median), dBA		**-0.2**	**+1.6**

The 3D SoundPLAN noise model is shown in Figure 4.1 showing Westmead South from the northwest.

Figure 4.1 SoundPLAN 8.2 noise model – Westmead South from the northwest

Existing transport noise levels

The maximum façade noise level per sensitive receiver building is shown as a box and whisker lot for the key roads modelled within Westmead South, where:

– The **box** represents the interquartile range (upper quartile, median and lower quartile) of façade noise levels for receivers along the road
– The **whiskers** indicative the 'minimum' and 'maximum' façade noise level for receivers along the road
– The **'X**' presents the mean façade noise level for receivers along the road
– **Points** indicate outliers (NB: outliers on local roads generally indicate they are at intersection of busier roads)

The distribution of façade noise levels for the day and night period at key roads within Westmead South are shown in Figure 4.2 and Figure 4.3, respectively.

Each figure also shows the dwellings or developments where more than standard construction would likely be required to achieve the T&I SEPP internal noise levels for the day and night periods. This assumes that the noise reduction provided by a standard construction façade is 24 dBA (equivalent to masonry or light weight external wall with 5 mm thick standard glazing). Results for the most-affected residences (Highest 90th percentile noise levels) are also shown in Table 4.2

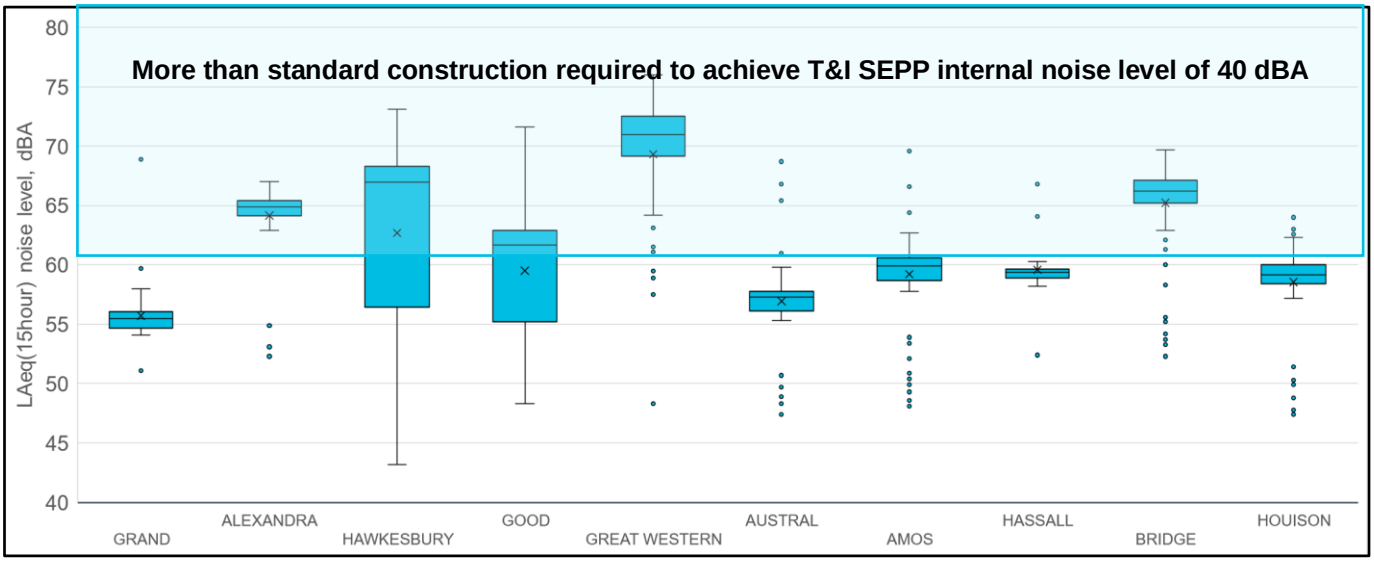


Figure 4.2 Day period façade noise levels at sensitive receivers (maximum noise level per building)

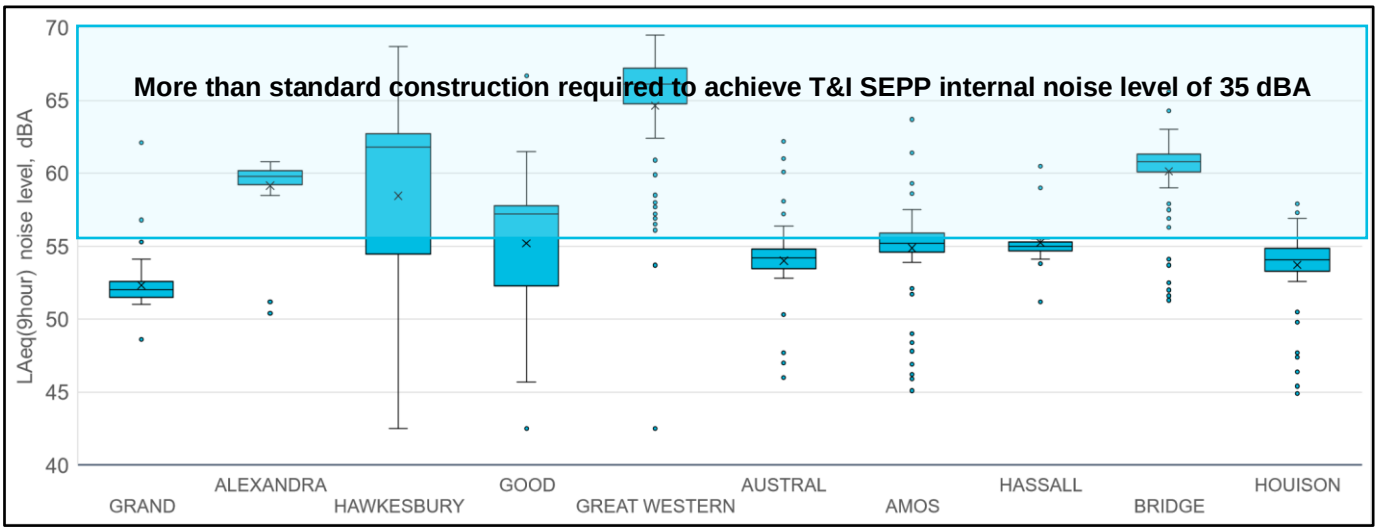


Figure 4.3 Night period façade noise levels at sensitive receivers (maximum noise level per building)

Table 4.2 Worst-case façade noise levels at residential receivers and indicative internal noise levels, dBA

Street name	Day (T&I SEPP internal design noise level of 40 dBA) Habitable rooms other than bedrooms					Day (T&I SEPP internal design noise level of 35 dBA) Bedrooms				
	Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)			Statistical external façade noise levels		Most-affected residences (Highest 90th percentile)		
	Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA	Median noise level, dBA	Maximum noise level, dBA	External noise level, dBA	Estimated internal noise level, dBA[1]	Additional reduction required, dBA
Grand Avenue	56	69	57	33	-	52	62	53	29	-
Alexandra Avenue	65	67	67	43	3	60	61	61	37	2
Hawkesbury Road	67	73	70	46	6	62	69	64	40	5
Good Street	62	72	64	40	-	57	67	58	34	-
Great Western Highway	71	76	73	49	9	66	72	68	44	9
Austral Avenue	57	69	59	35	-	54	62	56	32	-
Amos Street	60	70	61	37	-	55	64	56	32	-
Hassal Street	59	67	62	38	-	55	61	57	33	-
Bridge Street	66	70	68	44	4	61	66	62	38	3
Houison Street	59	64	61	37	-	54	58	56	32	-

1) Internal noise levels cannot be accurately determined without knowing the exact construction of the building's façade. The internal noise level has been estimated assuming the façade provides an indicative noise reduction of 24 dBA and is considered representative of a masonry or lightweight wall with standard 5 mm thick glazing.

Acceptability of current noise levels

The acceptability of current transport noise levels would be dependent on the construction of individual buildings along the busy roads to assess whether noise levels exceed 35 dBA in bedrooms during the night at 40 dBA for other habitable rooms during the day (T&I SEPP internal noise levels). The most-affected receivers along Great Western Highway, Hawkesbury Road, Bridge Road and Alexandra Avenue would generally require more than standard construction (i.e. acoustic treatment implemented) to comply with the desired internal noise levels in the T&I SEPP.

It is not possible to assess internal noise levels without understanding the construction of the building envelope for every individual building. As such, indicative façade construction categories have been used to identify a qualitative risk level for affected facades within Westmead South.

Façade noise maps in this report present the existing (modelled) noise levels at existing buildings and have been colour coded based on indicative façade construction considerations (see Table 4.3 and Table 4.4) and Building Code of Australia (BCA) ventilation requirements.

Table 4.3 Indicative façade construction considerations

Indicative category	Construction type	Indicative glazing	Consider BCA ventilation requirements[1]
Category A	Standard construction	5 mm thick glazing	-
Category B	Standard construction	5 mm thick glazing	Yes
Category C	Acoustic treatment	6.38 mm laminated glazing	Yes
Category D	Acoustic treatment	10.38 mm laminated glazing	Yes
Category E	Acoustic treatment	12.5 mm Vlam Hush glazing	Yes
Category F	Acoustic treatment	Specialised double glazing	Yes

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

Residential buildings where daytime noise levels are $L_{Aeq(15hour)}$ 61 or greater are shown in Figure 4.4 and have been considered medium or high risk. The colour code legend for the façade noise maps is presented in Table 4.4 (day period).

Table 4.4 Façade noise map legend – Day period (habitable rooms other than bedrooms)

Risk level	None		Low		Medium		Risk	
Noise level	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F

The results of the risk analysis indicate that:

– sensitive receivers along Great Western Highway, Hawkesbury Road, Bridge Street and Alexandra Avenue would require special acoustic consideration to ensure the T&I SEPP noise levels could be achieved. An acoustic assessment during the DA stage for development along these roads would be a mandatory requirement under the requirements of the T&I SEPP.

– sensitive receivers along Good Street, Pye Street and sections of Amos Street would likely require more than standard construction methods to achieve the day period internal noise levels in the T&I SEPP.

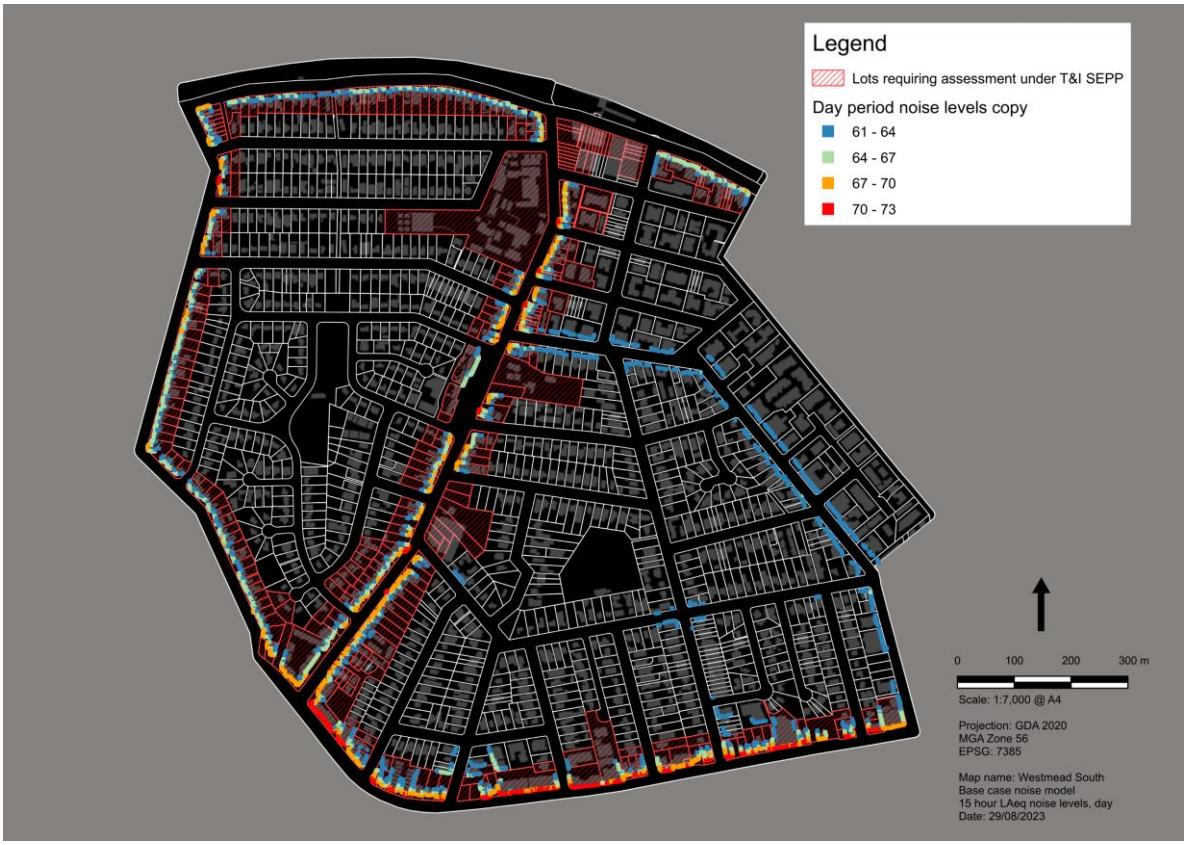


Figure 4.4 Façade noise levels $L_{eq(15hour)}$ 61 dBA or greater (more than standard construction required)

Residential buildings where night period noise levels are $L_{Aeq(9hour)}$ 55 or greater are shown in Figure 4.5 and are considered to be medium or high risk. The colour code legend for the façade noise maps is presented in Table 4.5 (night period).

Table 4.5 Façade noise map legend – Night period (bedrooms)

Risk level	**None**		**Low**		**Medium**		**High**	
Noise level	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

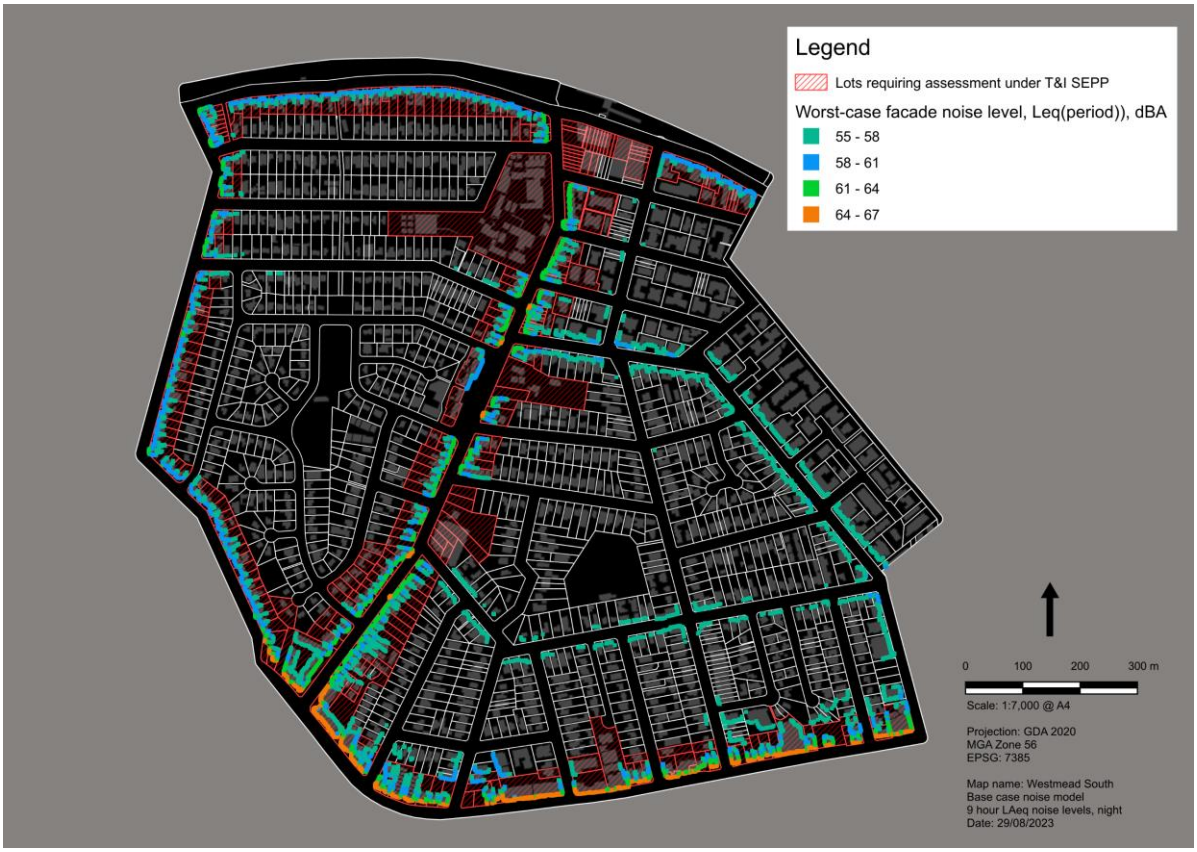


Figure 4.5 Façade noise levels $L_{eq(9hour)}$ 55 dBA or greater (more than standard construction required)

The results of the risk analysis indicate that:

- sensitive receivers along Great Western Highway, Hawkesbury Road, Bridge Street and Alexandra Avenue would require special acoustic consideration to ensure the T&I SEPP noise levels could be achieved. An acoustic assessment during the DA stage for development along these roads would be a mandatory requirement under the requirements of the T&I SEPP.
- sensitive receivers along Good Street, Pye Street, Amos Street and sections of Houison Street, Hassal Street and Austral Avenue would likely require more than standard construction methods to achieve the day period internal noise levels in the T&I SEPP.

DA acoustic assessment requirements

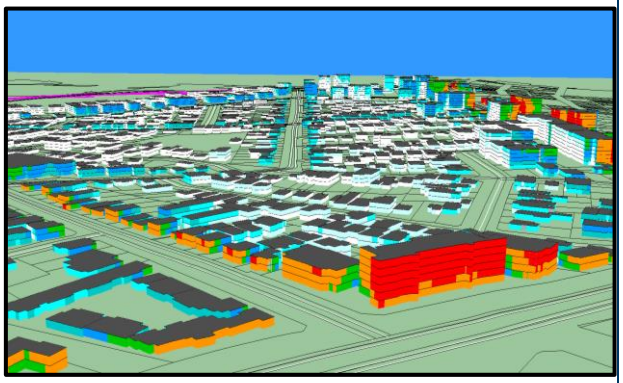
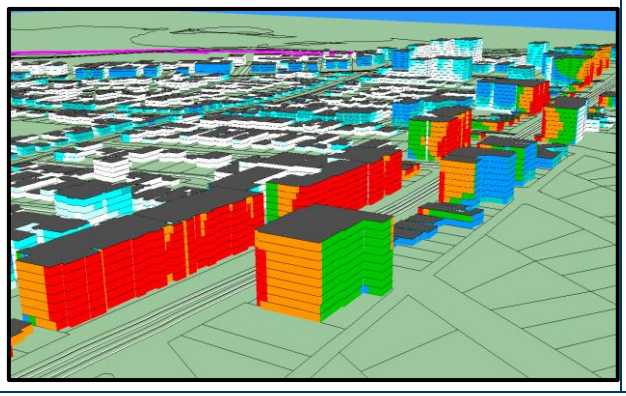
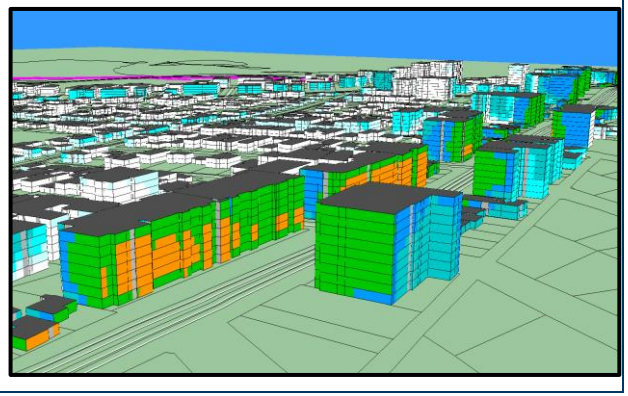
An acoustic assessment for new sensitive development along Good Street, Pye Street, Amos Street, Houison Street, Hassal Street and Australia Avenue would not be considered a mandatory requirement under the T&I SEPP. Based on the outcomes of the risk assessment, it is recommended that an acoustic assessment be prepared in the DA stage for any future development along these roads even though it is not a mandatory requirement.

3D façade noise maps along key roads

Façade noise maps along key roads within Westmead South are provided below:

- Table 4.6: Great Western Highway (near Anderson Road and near Hawkesbury Road)
- Table 4.7: Hawkesbury Road (near Westmead Public School and near the Oakes Centre)
- Table 4.8: Alexandra Avenue (east of Hawkesbury Road and west of Hawkesbury Road)
- Table 4.9: Bridge Road (near Great Western Highway and near Austral Avenue)
- The colour code legends for the façade noise maps are presented in Table 4.4 (day period) and Table 4.5 (night period).

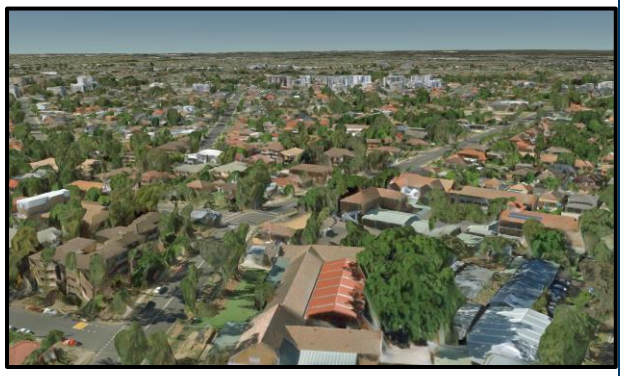
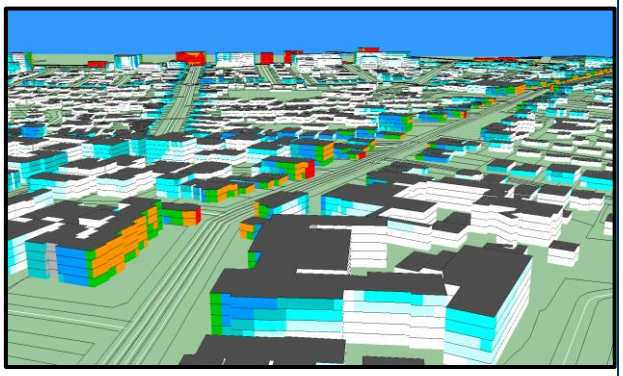
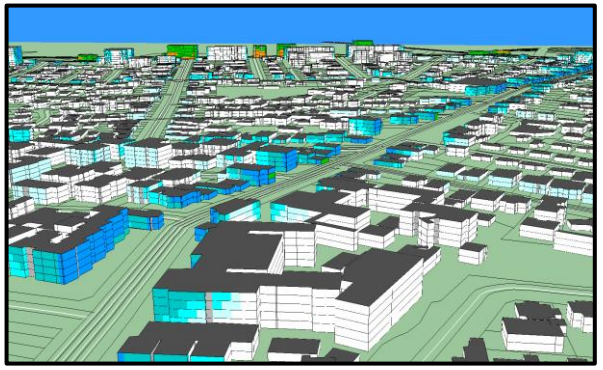
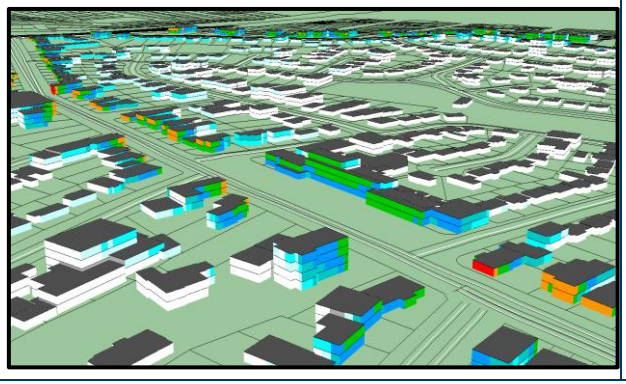
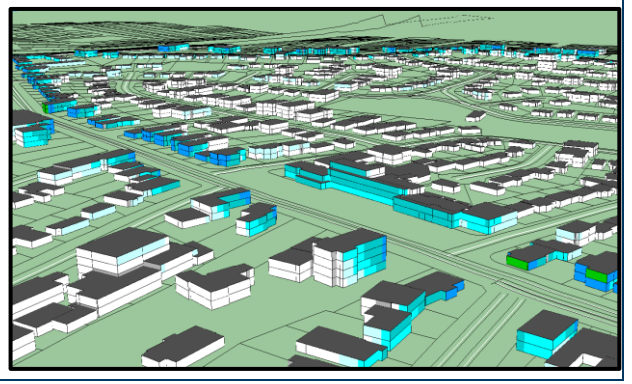
Table 4.6 Great Western Highway – façade noise maps

Metromap 3D view	SoundPLAN noise model – façade noise levels	
	Day period	Night period
		
		

Legend

Risk level	**None**		**Low**		**Medium**		**Risk**	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

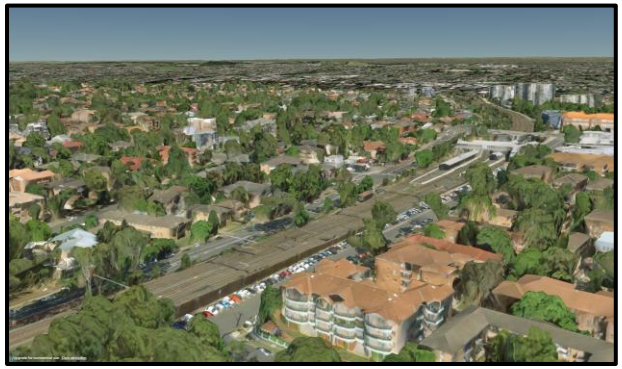
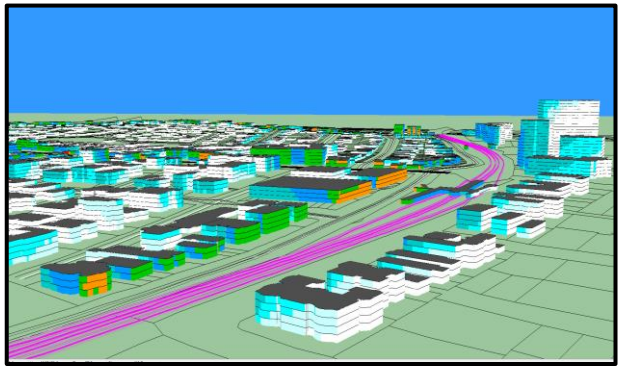
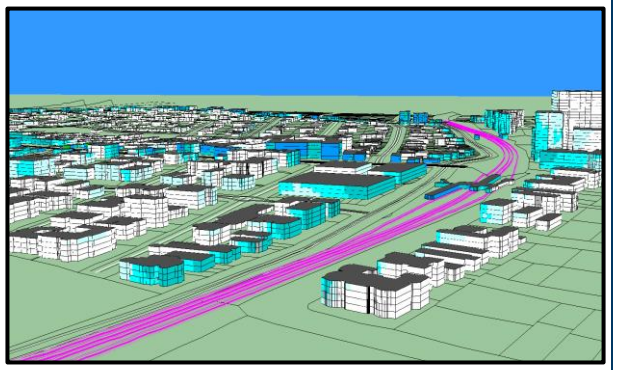
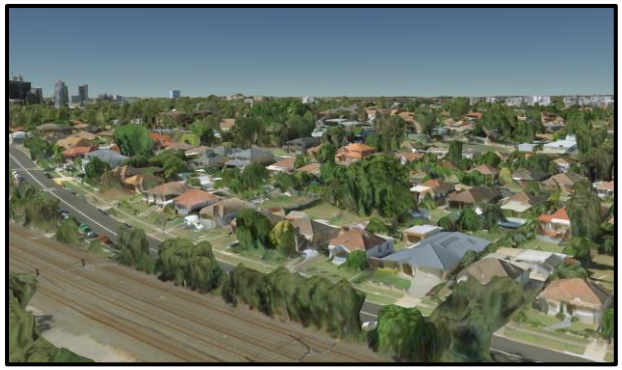
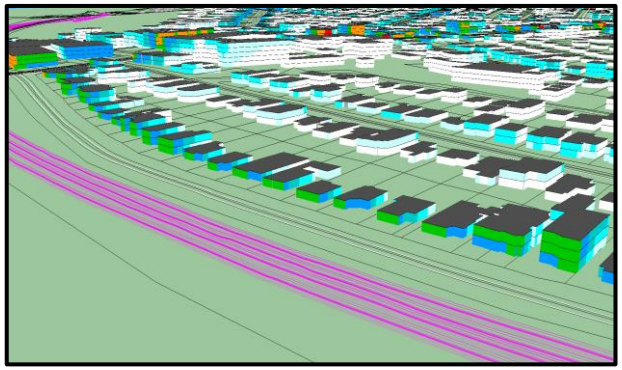
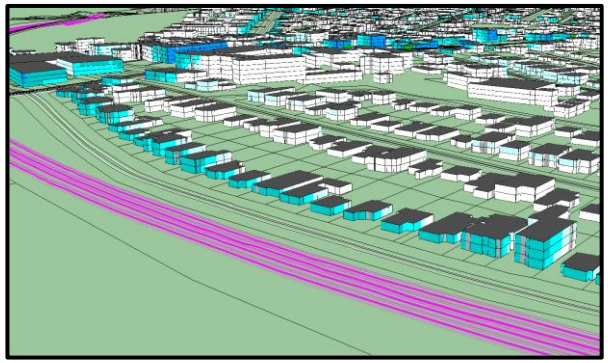
Table 4.7 Hawkesbury Road – façade noise maps

Metromap 3D view	SoundPLAN noise model – façade noise levels	
	Day period	Night period
		
		

Legend

Risk level	**None**		**Low**		**Medium**		**Risk**	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

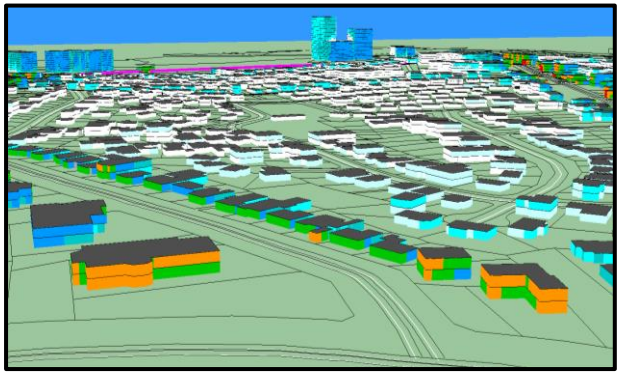
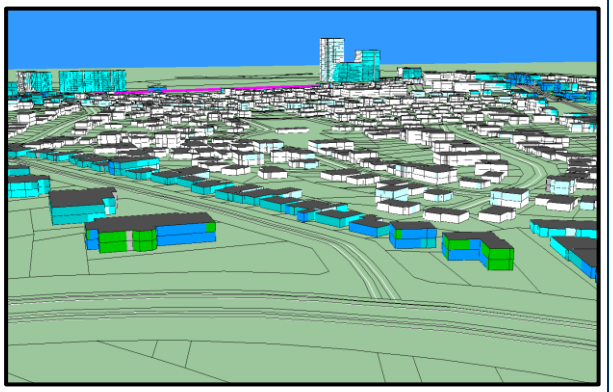
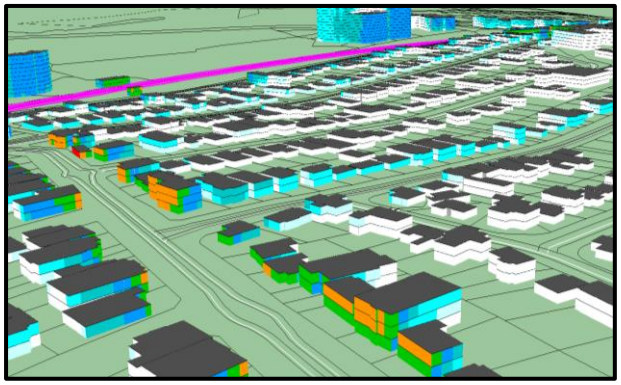
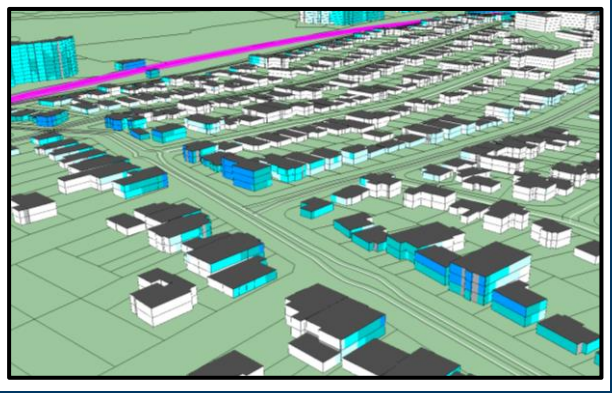
Table 4.8 Alexandra Avenue – façade noise maps

Metromap 3D view	SoundPLAN noise model – façade noise levels	
	Day period	Night period
		
		

Legend

Risk level	None		Low		Medium		Risk	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

Table 4.9 Bridge Road – façade noise maps

Metromap 3D view	SoundPLAN noise model – façade noise levels	
	Day period	Night period
		
		

Legend

Risk level	**None**		**Low**		**Medium**		**Risk**	
Noise level (day)	<= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67	>67 & <= 70	>70
Colour code	A	A	B	B	C	D	E	F
Noise level (night)	<= 49		>49 & <= 52	>52 & <= 55	>55 & <= 58	>58 & <= 61	>61 & <= 64	>64 & <= 67
Colour code	A	A	B	B	C	D	E	F

4.2 Air quality assessment

Air quality modelling methodology

Dispersion modelling was undertaken using the Graz Lagrangian Model (GRAL) to predict concentrations of key air quality pollutants from road vehicle emissions at existing buildings within Westmead South. Additional modelling methodology detail is outlined in Appendix E.

Assessed pollutants

The major vehicle pollutants include products of combustion, such as carbon monoxide (CO), particulate matter (PM), oxides of nitrogen (NO_x), and volatile organic compounds (VOCs). The human health effects of these air pollutants range from mild airway irritations to major organ damage. Many of the emissions from motor vehicles react together and with pollutants from other sources to form secondary pollutants, such as photochemical oxidants (ozone; O_3), which can also have significant effects (Main Roads, 2004).

For the purpose of this assessment, emission estimation and dispersion modelling of NO_2 and $PM_{2.5}$ only have been undertaken. Based on past experience of local road projects, NO_2 or $PM_{2.5}$ are typically the pollutants with the highest impact, and thus are considered the constraining pollutants. Impacts of CO, SO_2 and VOCs are not typically the constraining pollutants due to the emissions from road traffic and background concentrations being comparatively lower. The air assessment for the project estimates pollution generated by vehicles using projected traffic volumes and vehicle emission rates as inputs to an air dispersion model.

Vehicle emission rates

The vehicle emission factors were calculated from outputs from the *Computer program to calculate emissions from road transport* (COPERT 2014), using the NSW fleet characteristics. The amount of pollutant emitted from a vehicle depends on the type of vehicle, fuel type (petrol, diesel or LPG), and driving conditions (grade of slope, road speed, congestion and road conditions).

The COPERT NSW input file includes the NSW 2010 fleet characteristics such as vehicle type, technology and fuel type. NSW-specific population of each vehicle type and average mileage are also included in this input file. Light vehicles and heavy vehicles were run separately so that the link-specific light and heavy vehicle split could be applied. The light vehicle fleet is made up of petrol and diesel passenger cars (PCs) and light commercial vehicles (LCVs). The light vehicle fleet distribution derived from the NSW COPERT input file is presented in Table 4.10.

Table 4.10 COPERT-derived light vehicle fleet distribution

Vehicle type	Fleet proportion
PC petrol	76%
PC diesel	5%
LCV petrol	8%
LCV diesel	11%

COPERT was run for the appropriate road speeds to provide the tonnes emitted per year for each vehicle type and pollutant These outputs were then used to calculate an emission factor for each pollutant, as presented in Table 4.11.

Table 4.11 COPERT-derived emission factors

Pollutant	Vehicle type	Emission factors (g/km/veh)				
		20 km/hr	40 km/hr	50 km/hr	60 km/hr	80 km/hr
NO_2	Light Vehicles	0.124	0.084	0.070	0.065	0.069
	Heavy Vehicles	1.372	0.991	0.873	0.792	0.737

Pollutant	Vehicle type	Emission factors (g/km/veh)				
		20 km/hr	40 km/hr	50 km/hr	60 km/hr	80 km/hr
$PM_{2.5}$	Light Vehicles	0.044	0.035	0.031	0.028	0.025
	Heavy Vehicles	0.400	0.274	0.226	0.190	0.149

Hourly traffic volumes have been estimated on observed data surveyed by Traffic Survey between 2 August 2023 and 9 August 2023 and supplied by SCT consulting. Figure 4.6 shows an example of diurnal profiles, using data collected for Hawkesbury Road. The plot shows that the estimated light vehicle traffic volumes have a morning and evening peak while heavy vehicle traffic is consistent throughout the day with very low levels at night. Details of hourly traffic volumes used for modelling are provided in Appendix E-1. The hourly diurnal emission profiles were then calculated for each link based on the hourly traffic counts and the relevant emission factor based on speed for each link.

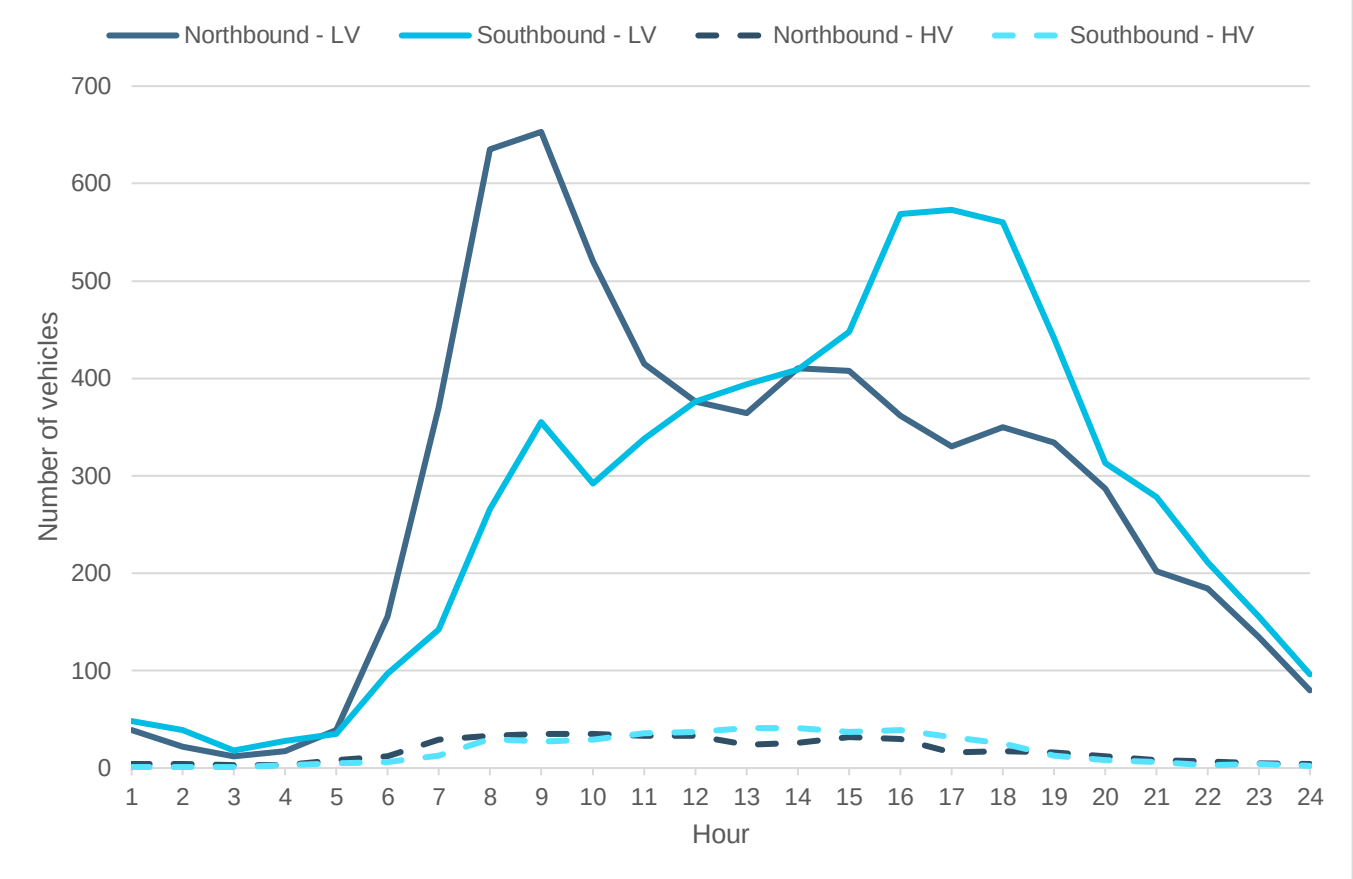


Figure 4.6 Modelled hourly vehicle numbers on Hawkesbury Road

Evaluation of air quality levels

Dispersion modelling using the GRAL model was undertaken to determine concentrations of $PM_{2.5}$ and NO_2 at receivers representing the current built form of the area. GRAL modelling was completed using a 1-hour modelling time step, and was used to predict concentrations for four levels (heights) above the ground at the receiver locations. Maximum short-term (hourly and daily for NO_2 and $PM_{2.5}$ respectively) and annual averages at the first floor, as a worst-case, for each pollutant have been analysed.

The modelled distribution of NO_2 and $PM_{2.5}$ exposure in the community due to the existing road traffic volumes are represented in the Box and Whisker Plots Figure 4.7, Figure 4.8, Figure 4.9 and Figure 4.10. The plots, for each pollutant and statistic, show the range of predicted concentrations which are predicted at all modelled receiver buildings on the key roads within Westmead South.

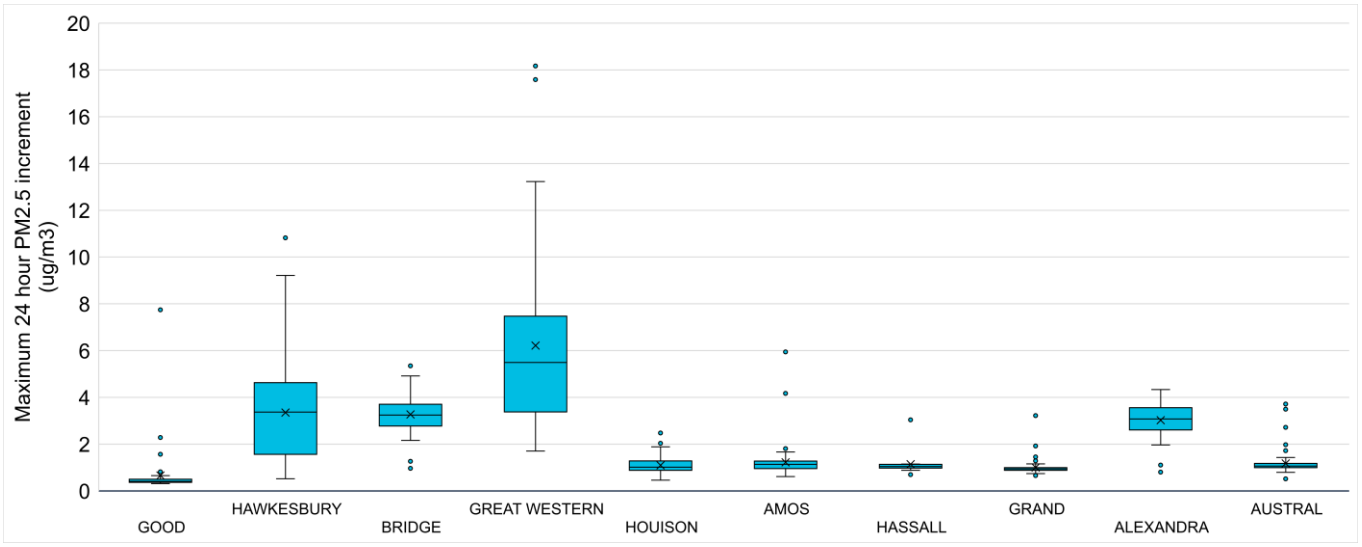


Figure 4.7 Maximum 24 hour $PM_{2.5}$ concentrations from road traffic emissions

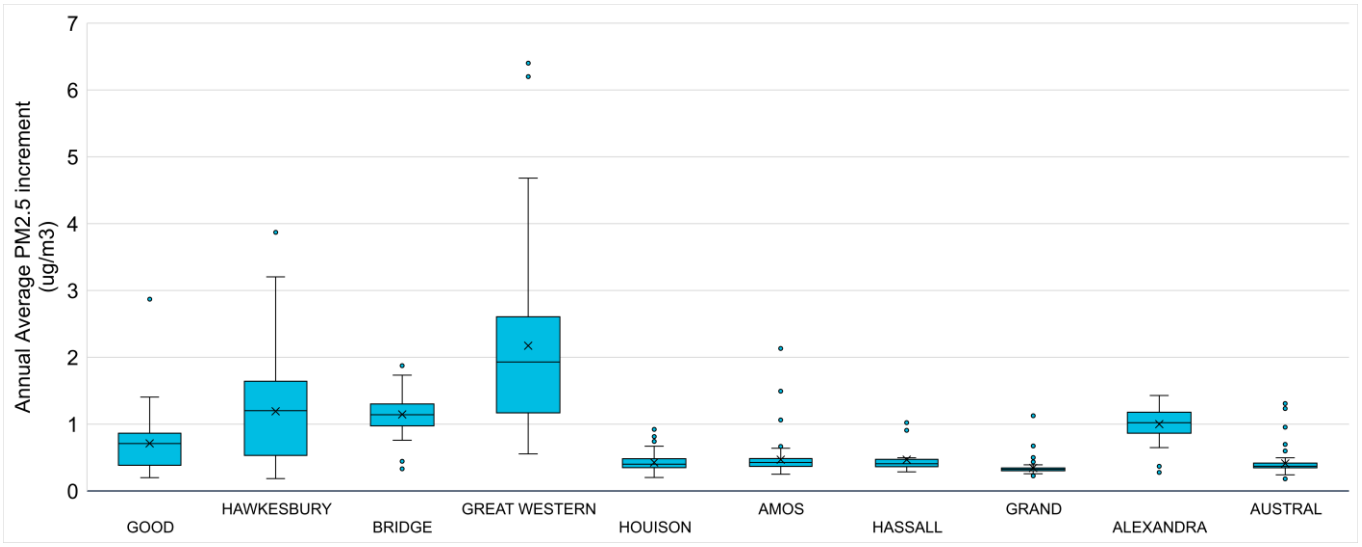


Figure 4.8 Annual average $PM_{2.5}$ concentrations from road traffic emissions

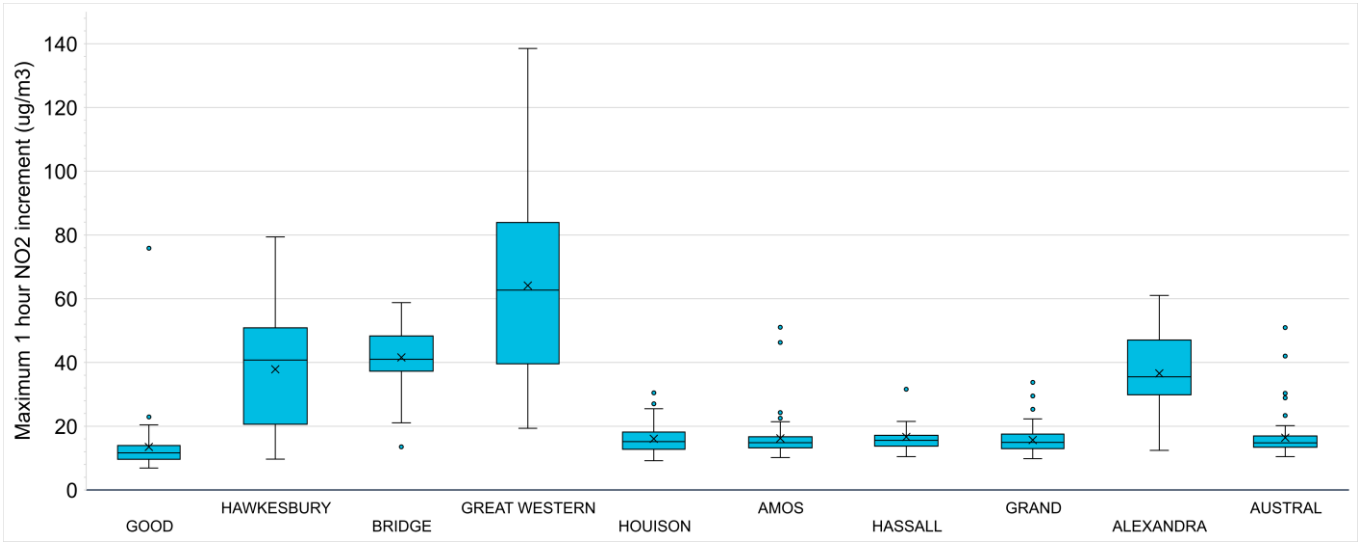


Figure 4.9 Maximum 1 hour NO_2 concentrations from road traffic emissions

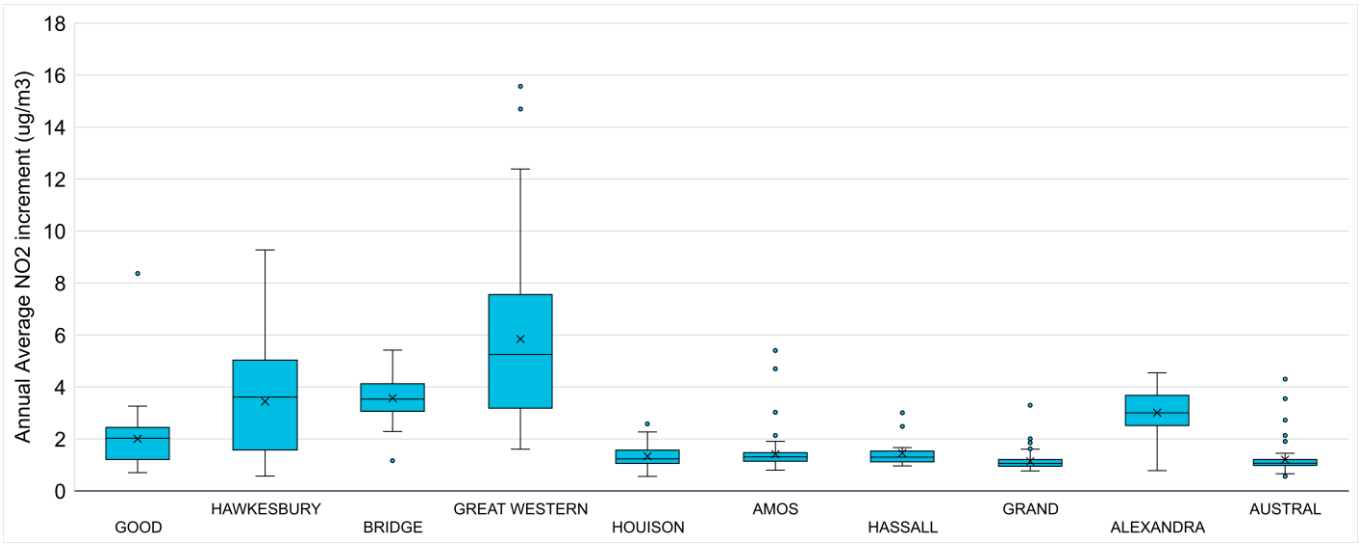


Figure 4.10 Annual average NO_2 concentrations from road traffic emissions

The Air NEPM and Approved methods provide air quality objectives for both short-term and long-term averaging periods for both $PM_{2.5}$ and NO_2. Short-term air quality objectives are provided to mitigate against the potential for acute air quality impacts to be experienced within the community, whereas long-term air quality objectives are provided to mitigate against the potential for long-term, chronic air quality impacts.

Assessment against the long-term air quality objectives is a straightforward process, where the average concentration predicted at receivers along each road in the precinct is added to the average background concentration, and compared directly to the objective level. Notwithstanding uncertainties associated with the emission and dispersion modelling process, the assessment against the annual average air quality objectives can be considered a robust estimate of community exposure. Conversely, assessment against the short-term air quality objectives can be a complex process, requiring the consideration of highly variable project impacts with highly variable background concentrations. To overcome these challenges, a very conservative approach may be taken where it is assumed that worst-case impacts (driven by specific worst case traffic and meteorological conditions for each receiver location) are aligned with the worst case background concentrations.

When interpreting assessment results, receivers experiencing the highest annual average concentrations are those which are expected to have comparatively consistent exposure to air pollutants. It is considered that assessment of annual average impacts is the most effective method in the context of urban design activities.

As discussed in Section 3.5, background air quality in Sydney fluctuates year on year due to meteorological and other natural causes as well as evolving industrial and transport emissions which places challenges on conducting cumulative assessment for a representative modelled year. To demonstrate this variability, an average incremental value for each of the major roads in the precinct has been cumulatively assessed for the previous six years (2017-2022) and is shown on Figure 4.11 and Figure 4.12 for $PM_{2.5}$ and NO_2 respectively. These plots demonstrate that while incremental concentrations may be below the Air NEPM criteria, years of poor ambient air quality may still lead to non-compliance of the Air NEPM objectives.

Results demonstrate that the ambient air quality (background) is the predominant contributor to cumulative air quality and that out of the last six years, only 2021 and 2022 achieve compliance of the annual average $PM_{2.5}$ criteria at a majority or all receivers. Predicted cumulative NO_2 concentrations are below the criteria for all years.

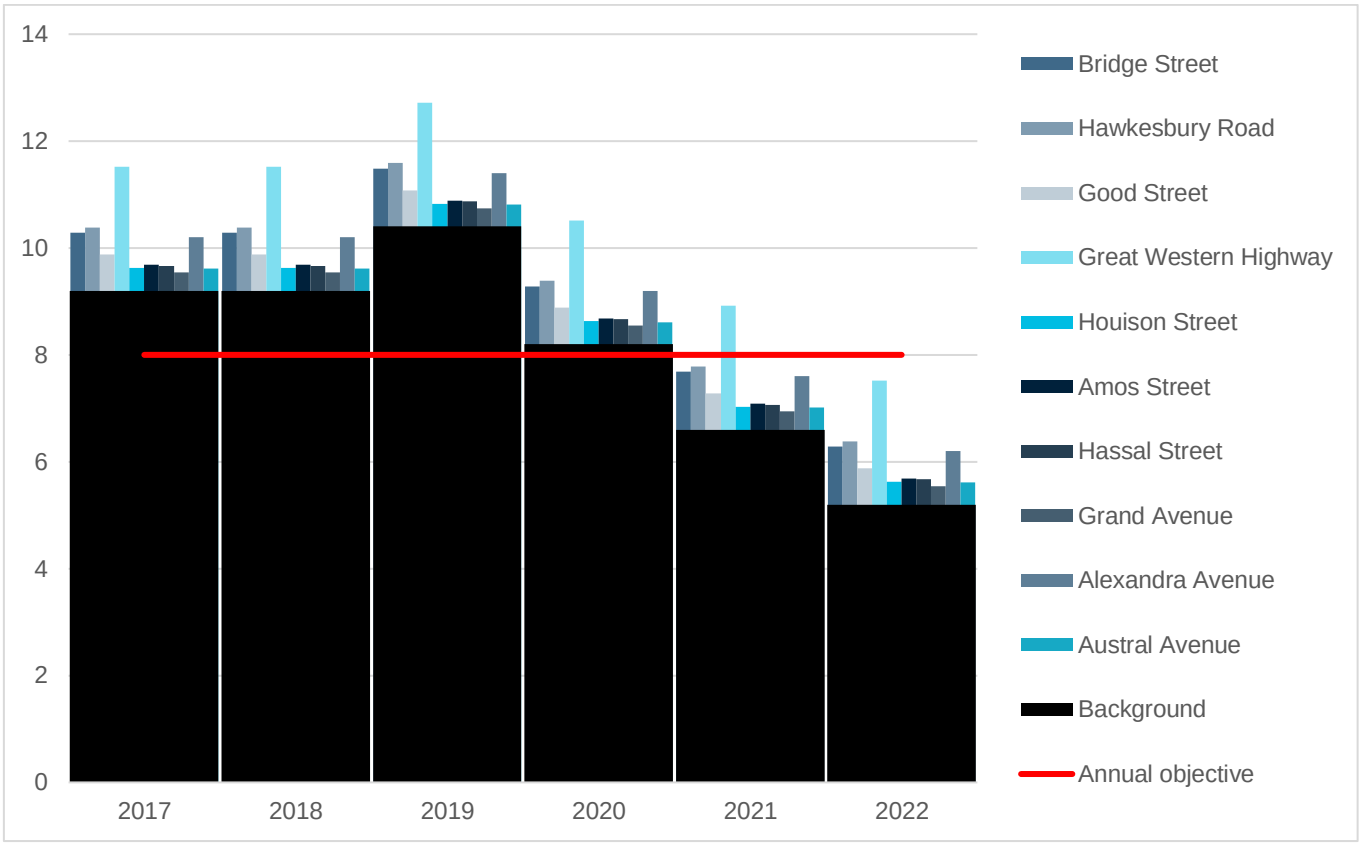


Figure 4.11 Cumulative assessment of annual average $PM_{2.5}$

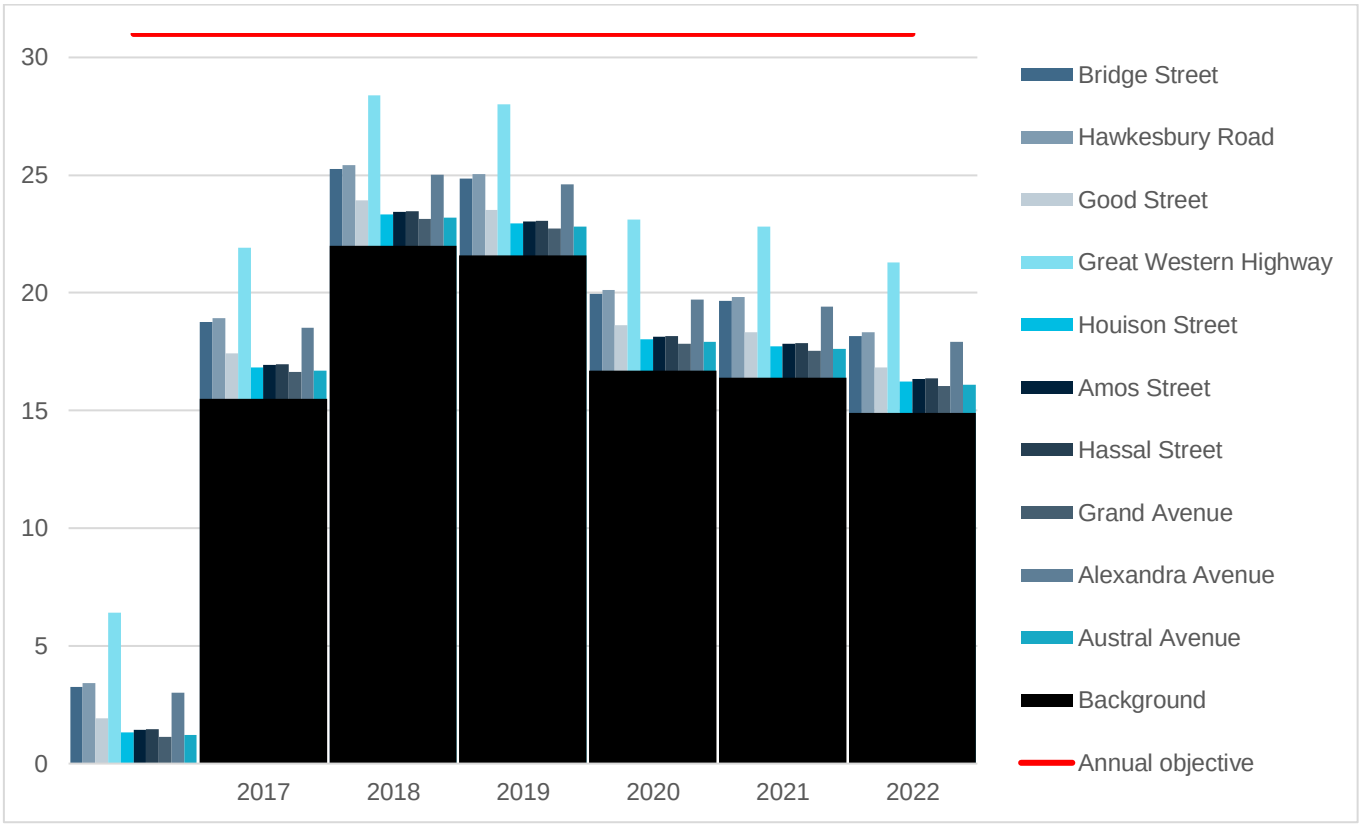


Figure 4.12 Cumulative assessment of annual average NO_2

Transport air quality risk assessment

As discussed above, there are instances where the ambient air quality exceeds NEPM objectives and therefore an alternate methodology has been developed to assess the health risk of incremental emissions from the assessed roads.

A Framework has been developed based on a review of the background air quality available at the Parramatta North AQMS and the methodology proposed in *An Australian incremental guideline for particulate matter (PM2.5) to assist in development and planning decisions* (Capon & Wright, 2019). Based on this methodology, a level of 1.8 µg/m^3 has been adopted as the level at which the risk of impacts to health due to incremental $PM_{2.5}$ is high and cumulative levels are likely to exceed the objectives of the NEPM. A similar approach has been taken for annual NO_2 with a high-risk level of 15 µg/m^3 adopted. At this level it is expected that mitigation would be required (no sensitive receptors exposed to unmitigated air).

The locations of high-risk receivers, as defined above, are shown in Figure 4.13 and Figure 4.14 for $PM_{2.5}$ and NO_2 respectively. Additionally, low and medium risk categories have been defined as being exposure of up to 33% and 66% of the adopted objective respectively. Table 4.12 outlines the adopted risk categories and objective levels for each pollutant. Receivers exposed to levels less than 33% of the objective are deemed to be very low risk.

These maps are provided to inform design considerations for the Westmead South Precinct Masterplan. For areas where large numbers of medium and high-risk receivers are present, notably along Great Western Highway, Hawkesbury Road, Bridge Road and Alexandra Parade, design considerations provided in Section 5 should be considered. The risk assessment methodology would be refined for the assessment of future receptors.

Table 4.12 Air quality risk categories and map legend

Risk level	Very low	Low	Medium	High
Colour code				
$PM_{2.5}$ concentration (μ/m^3)	<= 0.6	>0.6 & <= 1.2	>1.2 & <= 1.8	>1.8
NO_2 concentration (μ/m^3)	<= 5	>5 & <= 10	>10 & <= 15	>15

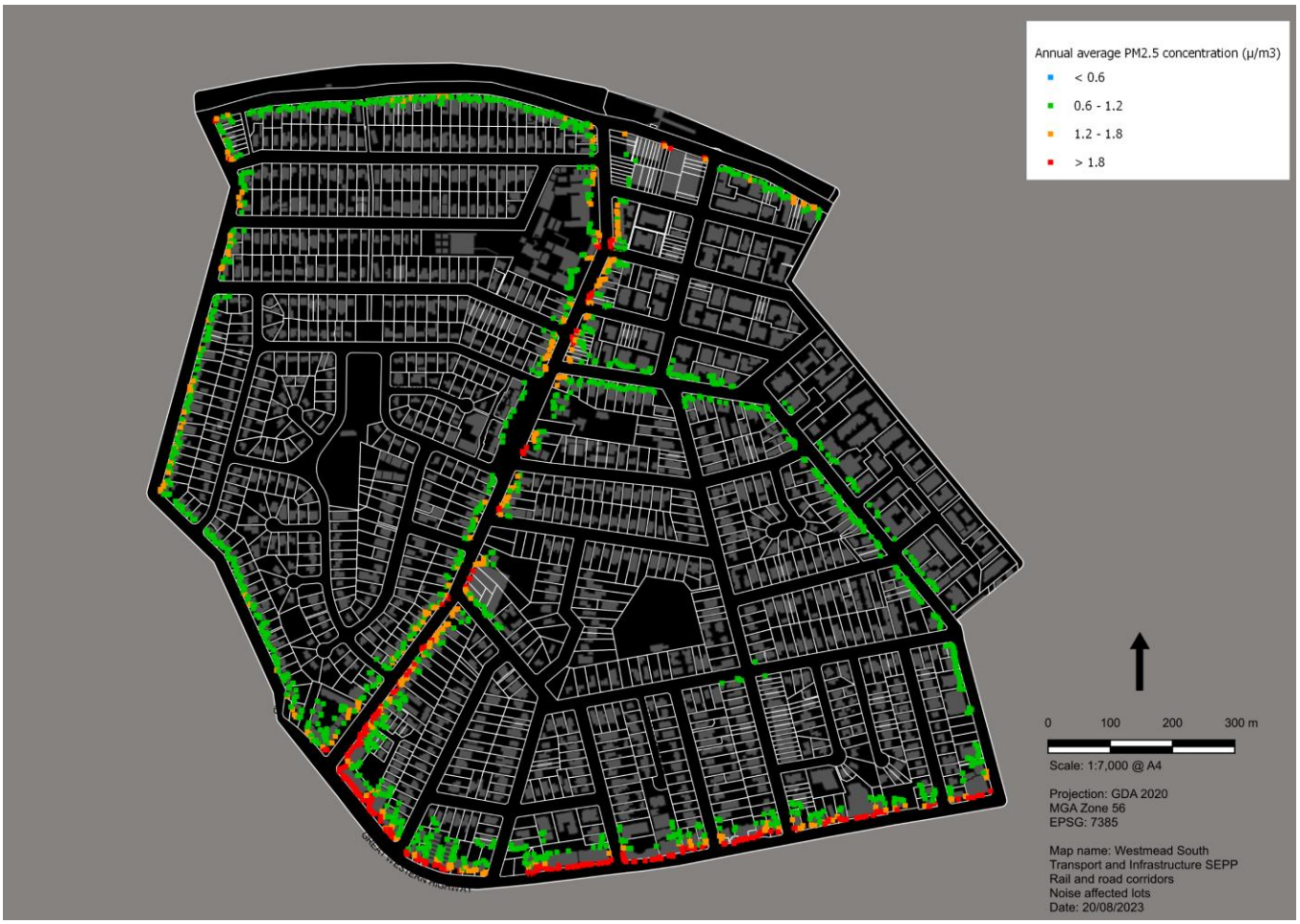


Figure 4.13 Annual risk level of exceedance of $PM_{2.5}$ objectives

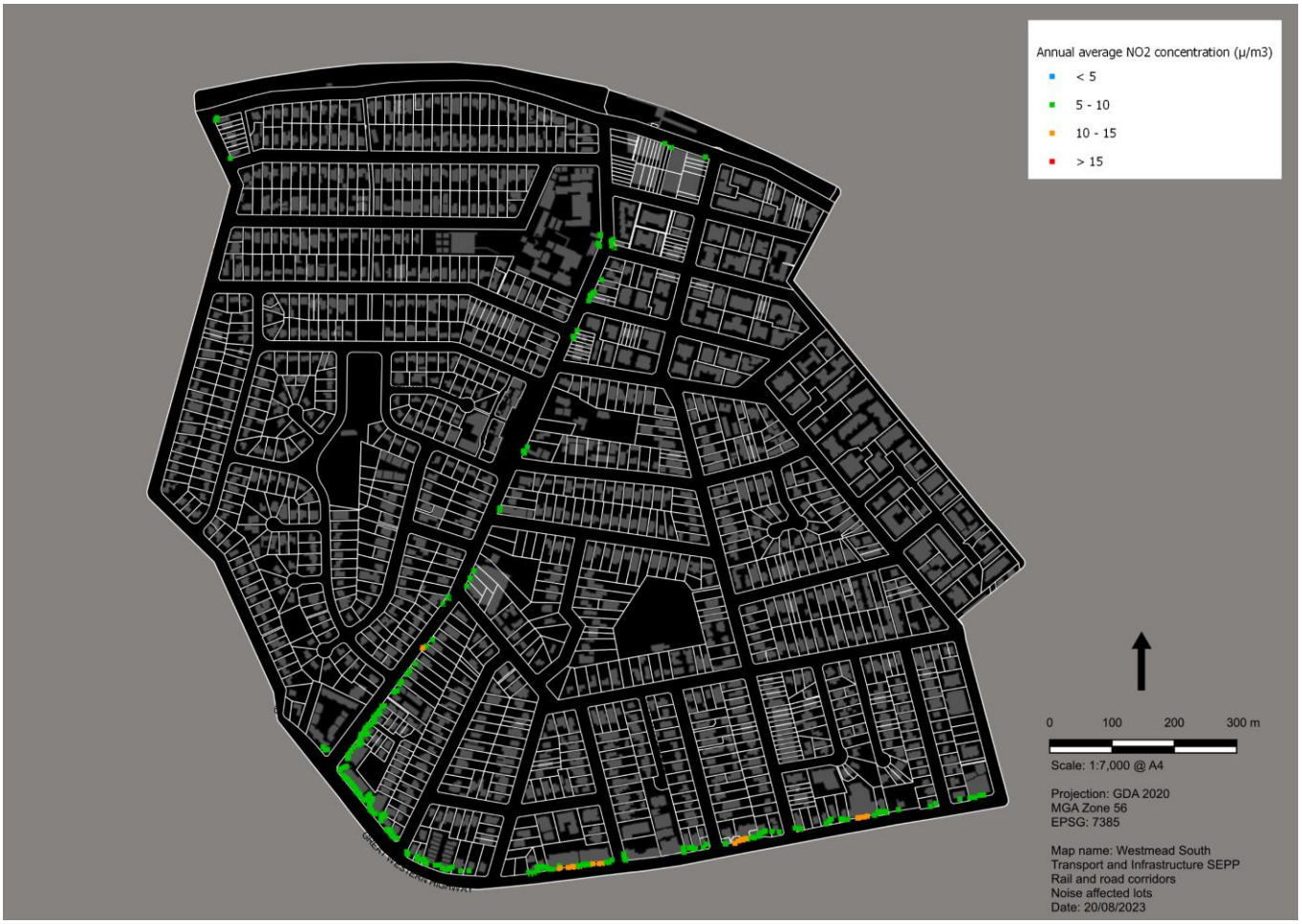


Figure 4.14 Annual risk level of exceedance of NO_2 objectives

5. Recommendations and next steps

5.1 DA assessment

New sensitive development along the T&I SEPP road and rail corridors would require a detailed acoustic assessment to accompany the development application to ensure the building is designed to achieve the relevant internal noise levels for bedrooms and other habitable spaces. These roads are listed as the T&I SEPP mandatory roads in Table 5.1. It is recommended that an air quality impact assessment is also prepared for any new sensitive development adjacent to these roads.

The outcomes of the air and noise modelling also indicate that new sensitive development along other key roads within Westmead South would also need to be designed to ensure the air quality and noise objectives in the Interim Guideline (DoP, 2008) can be achieved. It is recommended that an air quality and an acoustic assessment accompany the DA for new sensitive development along these roads (see Table 5.1).

Table 5.1 DA assessment requirements (mandatory and recommended)

T&I SEPP Mandatory	Recommended air quality and acoustic assessment	
– Great Western Highway (road noise)	– Good Street	– Houison Street
– Hawkesbury Road (road noise)	– Pye Street	– Hassall Street
– Bridge Road (road noise)	– Amos Street	– Austral Avenue
– Alexandra Avenue (rail + road noise)		

5.2 In-principle recommendations

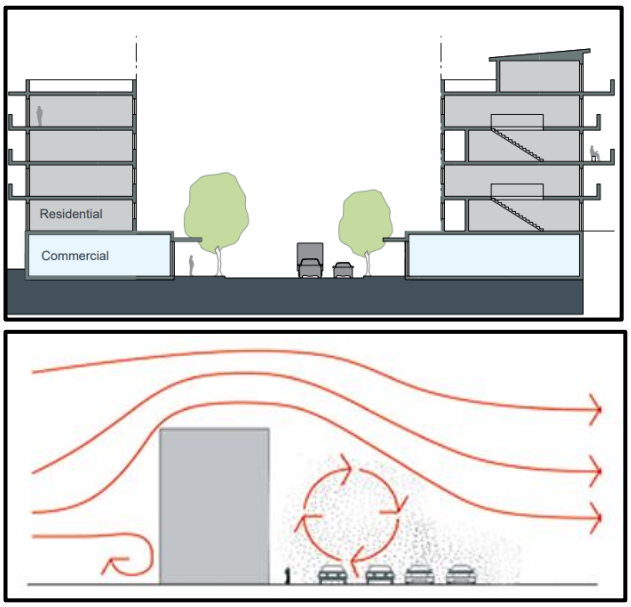
In-principle recommendations that should be considered new sensitive development along the relevant transport corridors identified in Table 5.1 are provided below.

The recommendations are based on design principles and illustrations sourced from *Development Near Rail Corridors and Busy Roads - Interim Guideline* (DoP, 2008) and the NSW Apartment Design Guide (DPE, 2015).

These principles would be workshopped with the urban design and other relevant consultants and stakeholders to identify opportunities to provide better acoustic and air quality amenity outcomes for the Master Plan and for future sensitive receivers within Westmead South.

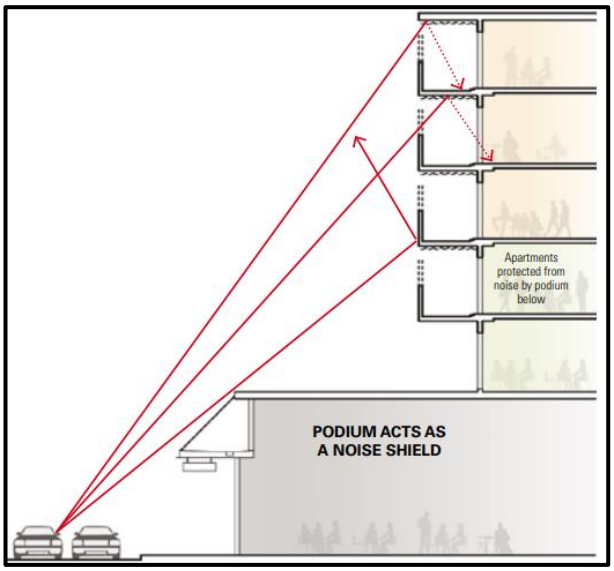
»Non-residential uses as a buffer«

- The podium levels fronting the pollution source would be exposed to the highest emission levels. Non-residential land uses (e.g. commercial) should be encouraged at lower floors, where appropriate.
- Orientating private open space and windows that provide natural ventilation to habitable rooms away from the busy road or rail corridor.
- Buildings, landscaping and vegetation can be used to shield sensitive areas from high emissions zones.
- Sensitive land uses should be positioned behind buildings such that they are shielded from emissions from busy roads. The bottom figure shows how buildings can be used as a buffer to separate high emissions zones (i.e. roadway) from sensitive land uses (left side of building).



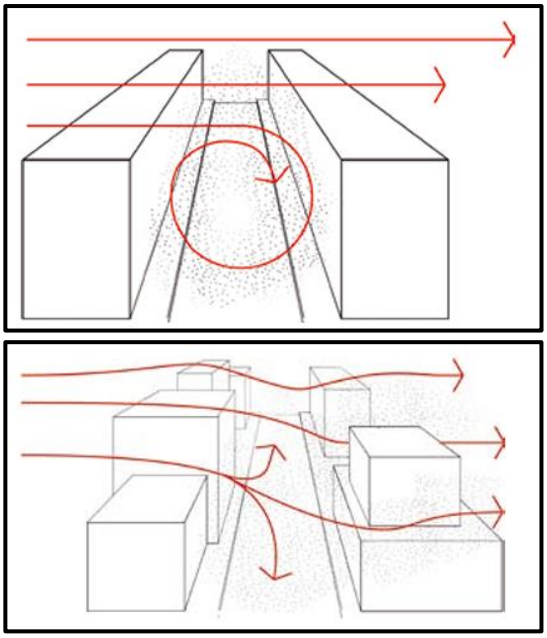
» Upper level setbacks / balconies«

- A podium can act as a noise shield to residential apartments above.
- Upper levels should be setback to block the line-of-sight between the road and the upper level apartments to increase the acoustic shielding benefits from the lower floor podium.
- This can provide both vertical separation to noise and pollution sources and horizontal separation when residential uses are set back from the source of noise or pollution.
- Solid balustrades on balconies can act as a noise shield to reduce internal noise levels. However, the underside of the balcony above should be lined with sound absorptive material to reduce the reflection of noise to the façade.



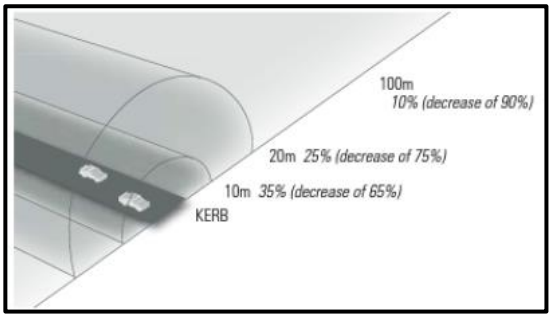
»Urban Canyons / Air flow around buildings«

- Urban canyons consist of similarly height buildings that are tightly packed in a uniform structure (refer top figure). Design should aim to minimise the creation of urban canyons as they can form 'pockets' of recirculating air which exhibit poor dispersion (i.e. the air becomes trapped and does not mix well ambient air). This leads to the accumulation of air pollutants resulting in poor air quality (effectively 'trapping' air quality pollutants within the urban canyon).
- Building spacing and use of differentiate buildings heights should be encouraged to promote air flow between buildings and minimise urban canyoning (refer bottom figure). This enables air pollutants to be readily mixed with ambient air and quickly dispersed to minimise pollutant concentrations.



»Building lines / setbacks«

- Generally, highest air pollutant concentrations exist adjacent to the road (at the kerb) and decrease with distance away from the road as shown in the figure.
- Setback distances should be implemented to maximise the distance between the road and sensitive land uses.
- Building lines should be set back a minimum distance of 6 metres from the front of the boundary lot facing the road/rail.
- Verges and footpaths should be used/maximised between road corridors and lot boundaries .



5.3 Next steps

Future development scenarios would be assessed based on the potential future built form resulting from the new planning framework for Westmead Suth and the forecast traffic volumes ('Stage 2 report', once the Masterplan has been developed). The key tasks would be undertaken:

– Receive feedback from other key consultants and stakeholders for consideration in the Stage 2 report
– Workshop the key recommendations in the Stage 1 AAQIA report with the urban design consultants to identify opportunities to provide better acoustic and air quality amenity outcomes for the Master Plan
– Undertake acoustic and air quality modelling of the Westmead South Master Plan development
– Prepare a future Master Plan acoustic and air quality impact assessment
– Develop draft development controls (relevant to air quality and acoustics) in consultation with key stakeholders to facilitate the mitigation strategies.

6. Conclusion

Purpose of the report

GHD has been engaged to assess the potential for acoustic and air quality amenity impacts on sensitive receivers for the following scenarios:

– **base-case**: existing built form and traffic volumes (this 'Stage 1' report)
– **future development scenarios**: potential future built form resulting from the new planning framework for Westmead South and the forecast traffic volumes ('Stage 2 report', once the Masterplan has been developed)

The key focus of this study (Stage 1) was to provide an analysis of the existing environment pertaining to air pollution, noise and vibration and provide a preliminary impact assessment on the 'base-case' scenario with respect to current legislation, policies and guidelines.

Outcomes of the noise and vibration impact assessment

No existing sensitive receivers were identified within 25 metres of an operational rail track. Given this, vibration from rail movements is not considered to be a significant acoustic amenity issue for receivers within the Westmead South study area.

Existing noise levels at key roads within Westmead South were quantified with 30-minute attended noise measurements (3 August 2023) and supplemented by previous unattended (long-term) noise monitoring undertaken by SLR in 2019. Simultaneous traffic counts were also undertaken at key roads and used as inputs into the noise model. A validated 3D noise model (SoundPLAN 8.2) was then used to predict façade noise levels across the study area.

The key areas of concern within the Westmead South were identified to be receivers exposed to transport noise sources along:

– Great Western Highway (road)
– Hawkesbury Road (road)
– Bridge Road (road)
– Alexandra Road (road and rail)

New development along these roads would require an acoustic assessment to accompany the development application under the T&I SEPP mandatory requirements. The outcomes of the assessment also indicate that an acoustic assessment should be accompany development application for new sensitive development along the following roads (non-mandatory) to ensure the T&I SEPP internal noise levels can be achieved:

– Good Street
– Pye Street
– Amos Street
– Houison Street
– Hassall Street
– Austral Avenue

The acceptability of current transport noise levels would be dependent on the construction of individual buildings along the key roads to assess whether noise levels exceed 35 dBA in bedrooms during the night at 40 dBA for other habitable rooms during the day (T&I SEPP internal noise levels). Receivers along the roads listed above would require more than standard construction (i.e. acoustic treatment) to comply with the desired internal noise levels in the T&I SEPP.

New development along these roads would be required to be designed to achieve the internal noise levels in the T&I SEPP. The Westmead South Master Plan (future development scenario) would be assessed for the Stage 2 report and would include draft development controls relevant to noise pollution.

Outcomes of the air quality assessment

Dispersion modelling was used to quantify the existing level of key air pollutants from road traffic. An assessment method was developed to determine the risk that incremental concentrations of $PM_{2.5}$ and NO_2 from road traffic would lead to human health impacts at the receivers within the Westmead South Precinct study area. Areas with existing high and medium risk air quality include:

– Great Western Highway ($PM_{2.5}$ and NO_2)
– Hawkesbury Road ($PM_{2.5}$)
– Bridge Road ($PM_{2.5}$)
– Alexandra Road ($PM_{2.5}$)

Design considerations for reducing air quality impacts, outlined in Section 5.2, should be considered for new developments the precinct, particularly in those areas where existing air quality has been identified as high risk. Stage 2 of this assessment will assess the future development scenario for the Westmead South Master Plan and provide draft development controls relevant to air quality.

Appendices

Appendix A

Existing DCP objectives and controls

A-1 Part B1 - Development within land zoned 'Residential'

Part B1 applies to development types detailed within this Part within land zoned Residential under *Cumberland Local Environmental Plan 2021*. This Part is intended to guide the assessment of the development of a dwelling house, secondary dwelling and associated outbuildings. The relevant objectives and controls pertaining to acoustic privacy and natural ventilation are reproduced below.

Table A.1 Cumberland City Council Development Control Plan Part B – Development in Residential Zones

Section	Reference	Description
2.10 Visual and acoustic privacy		
Objectives	01	Ensure the siting and design of buildings/dwelling house provides visual and acoustic privacy for residents and neighbours in their dwellings and private open spaces.
Controls	C11	Where dwellings or dwelling house additions are proposed within close proximity to busy roads and rail corridors, non-habitable rooms should be located on the noise affected side of each dwelling house and should be able to be sealed off by doors from living areas and bedrooms where practicable, whilst maintaining good housing design and building appearance. Alternative design solutions incorporating noise attenuation measures may be considered in these circumstances.
	C12	Air conditioners, swimming pool pumps and the like are not to exceed 5dba above background noise levels and should not be audible from habitable rooms of neighbouring dwellings.
	C13	For development adjacent to a rail corridor, or major road corridor with an annual average daily traffic volume of more than 40,000 vehicles, applicants must consult *State Environmental Planning Policy (Infrastructure) 2007* and the relevant NSW guidelines. Where acoustic reports are required by the SEPP and Guidelines, the building is to be designed and detailed to comply with the recommendations of that report.
2.12 Cross ventilation		
Objectives	O1	The design of development is to utilise natural breezes for cooling and fresh air during summer and to avoid unfavourable winter winds.
	O2	All dwelling houses are designed to maximise natural ventilation.
Controls	C1	Rooms with high fixed ventilation openings such as bathrooms and laundries shall be situated on the southern side to act as buffers to insulate the dwelling house from winter winds. Garages may also useful as buffers on the southern and western sides.
	C2	Dwelling houses shall be designed with bathrooms, laundries and kitchens sited in a position that allows natural ventilation of the room through an openable window.

A-2 Part B2 - Low rise dual occupancy development

This Part applies to low rise dual occupancy development under the *Cumberland Local Environment Plan 2021.* The relevant objectives and controls pertaining to acoustic privacy and natural ventilation are reproduced in below.

Table A.2 Low rise dual occupancy developments within R2 and R3 zones

Section	Reference	Description
2.1Q Noise and pollution		
Objective	2.1Q-1	Ensure outside noise levels are controlled to acceptable levels in living and bedrooms of dwellings.
Controls	57	Any development within the 20 ANEF contour is to be constructed to comply with AS 2021:2015 Acoustics – Aircraft Noise Intrusion.

Section	Reference	Description
Controls	C11	Dwellings that are within 100m of a classifed road or 80m from a rail corridor are to have LAeq measures not exceeding: – In any bedroom: 35dB(A) between 10pm-7am. – Anywhere else in the building (other than a kitchen, garage, bathroom or hallway): 40dB(A) at any time. This is achieved by: – Providing a full noise assessment prepared by a qualified acoustic engineer; and • Complying with relevant noise control treatment for sleeping areas and other habitable rooms in Appendix C of RMS *Development Near Rail Corridors and Busy Roads - Interim Guideline*

A-3 Part B3 - Residential flat buildings

This Part applies to residential flat building development under the *Cumberland Local Environment Plan 2021*. *State Environmental Planning Policy 65 Design Quality of Residential Apartment Development* (SEPP 65) provides a state-wide framework for detailed planning guidance of residential apartments in NSW. SEPP 65 is supported by the objectives, design criteria and design guidance set out in the *Apartment Design Guide* (ADG), which guide the siting, design and amenity of residential flat building development.

All residential flat building development in the Cumberland City are to be assessed in accordance with SEPP 65 and the ADG and must be consistent with the design quality principles outlined in SEPP 65 and the objectives, design criteria and design guidance outlines in the ADG (or equivalent). The ADG takes precedence over a DCP. Therefore, the DCP provisions do not repeat or seek to vary any controls under the ADG. Where there are inconsistencies between the controls set out in this DCP and the ADG, the ADG shall prevail. In some cases, Council has chosen to provide additional objectives and controls for criteria such as setbacks, basements, site area and site frontage. These objectives and controls are to be considered in addition to the SEPP 65 and ADG requirements. SEPP 65 development in locations adjacent to rail corridors and busy roads must also have regard to the *Development Near Rail Corridors and Busy Roads - Interim Guideline* to satisfy the requirements of the Transport and Infrastructure SEPP.

A-4 Part B4 - Boarding houses

This Part applies to development of land for the purposes of a boarding house under the *Cumberland Local Environmental Plan 2021.* The relevant objectives and controls pertaining to acoustic privacy and natural ventilation are reproduced below.

Table A.3 Cumberland City Council Development Control Plan Part B – Development in Residential Zones

Section	Reference	Description
2.6 Acoustics		
Objectives	O1	Ensure an acceptable level of amenity in boarding house premises to meet the needs of residents whilst minimising potential noise adverse impacts to surrounding development
Controls	C1	Boarding house design should attempt to locate bedrooms away from significant internal and external noise sources.
	C2	During the design of a boarding house consideration must be given to the potential acoustic impact upon adjoining neighbours. The following noise minimisation measures should be considered at the design stage: – offsetting the location of windows in respect to the location of windows on neighbouring properties; – appropriate building separation and setbacks to neighbouring properties; – sensitive location of communal outdoor areas away from main living areas or bedroom windows of any adjoining dwelling; – the use of screen fencing or acoustic barriers as a noise buffer to external noise sources; – incorporation of double glazing for windows; and – locate similar building uses (such as bedrooms or bathrooms) back to back internally within the building, to minimise internal noise transmission.

Appendix B

Literature review and other relevant policies and guidelines

Table B.4 Key legislation relevant to acoustics and air quality

Legislation	Key objectives	Aim of the legislation
Protection of the Environment Operations Act 1997 and Protection of the Environment Operations (Noise Control) Regulation 2017 Protection of the Environment Operations (Clean Air) Regulation 2021	– Manage noise pollution and offensive noise in NSW – Manage air pollution in NSW	The POEO Act 1997 provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as air and noise pollution control. The POEO (Noise Control) Regulation 2017 (Noise Control Regulation) provide the main legal framework and basis for managing noise in NSW. It also makes certain agencies the appropriate regulatory authority (ARA) responsible for various premises/activities (e.g. local councils, the EPA, or Transport for NSW). The POEO Act also defines 'noise' and 'offensive noise'. The POEO Act has a subjective test for offensive noise, and defines it as any noise that because of its nature, level, character, quality, or time: – could be considered as harmful or likely to be harmful to a person outside the premises or – interferes unreasonably with or is likely to interfere unreasonably with the comfort or repose of a person who is outside the premises. The POEO Regulation controls noise from motor vehicles and marine vessels and sets community standards on acceptable noise intrusion in homes from such appliances as intruder alarms, music amplifiers, air conditioners and powered garden tools. The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. For point source emissions where no standard of concentration and/or rate has been set, and for non-point source emissions, the operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act). The POEO Act includes the concept of 'offensive odour' (section 129) and states it is an offence for scheduled activities to emit 'offensive odour', subject to limited defences. The Protection of the Environment Operations (Clean Air) Regulation 2021provides regulatory measures to control emissions from motor vehicles, fuels, and industry.
National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021	Manage air pollution in NSW	The National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021 set uniform national standards for ambient air quality. The document containing these standards is known as the Air NEPM, which also contains goals for air quality pollutants inclusive of particulates and concentration limits, averaging periods and number of allowed exceedances for various pollutant.
Liquor Act 2007 and Liquor Regulation 2018	Manage noise from licensed venues in NSW, including standard conditions of consent	Section 79 of the Liquor Act 2007 provides an informal mechanism for complaints to be made (by residents, Police, local consent authorities and others) where the amenity of local neighbourhoods is unduly disturbed by the conduct of licensed premises and registered clubs (or their patrons). Liquor and Gaming NSW may impose temporary or permanent noise conditions on the licence, where it is deemed appropriate. The Liquor Regulation prescribes matters necessary for the effective operation of the *Liquor Act 2007*
Local Government Act 1993	Provides governance to local councils in NSW	This Act principally deals with the governance of councils in New South Wales. It provides the legal framework for the system of local government in NSW.
Strata Schemes Management Act 2015	Empowers owners corporations to enforce by-laws within strata schemes	The Strata Schemes Management Act recognises the importance of maintaining a peaceful and quiet living environment for strata residents. It sets out guidelines and regulations to address noise-related issues that may arise within strata schemes. The act empowers owners corporations, which are the governing bodies of strata schemes, to enforce rules and by-laws related to noise control

Table B.5 Air Quality specific guidelines

Policy / Guideline	Scope	Aim of the guideline
NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2022) (the Approved Methods)	Provides guidance for the modelling and assessment of air pollutants	To list the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW.

Table B.6 Noise and vibration specific guidelines

Policy / Guideline	Scope	Aim of the guideline
Noise Policy for Industry (EPA 2017)	Provides guidance and trigger levels for the assessment of: – Industrial noise – Commercial noise – Mechanical noise	Assessment of industrial, commercial and mechanical noise emission to sensitive receivers under the POEO Act and EP& Act, including noise trigger levels for sensitive land uses
Interim Construction Noise Guideline (DECCW 2009)	Provides guidance for the assessment and management of construction noise	To provide guidance for construction works regulated by the EPA under the POEO Act or local council as the ARA from non-scheduled activities including recommended noise management levels for sensitive land uses and recommended work practices to mitigation impacts
Noise Guide for Local Government (EPA, 2023)	Provides guidance for local councils for noise related issues, including: – Residential noise – Music/entertainment noise – Noisy motor vehicles – Industrial and commercial noise – Construction noise – Transport noise	This noise guide provides practical advice for Council officers on planning, assessment, managing and preventing local noise problems including: – Legal framework for noise control – The assessment of 'offensive noise' – Noise management principles – Regulating noise impacts
NSW Road Noise Policy (DECCW 2011)	Provides guidance for the assessment and management of road traffic noise, including assessment trigger levels.	Identifies strategies that addresses road noise impacts from existing roads, new words, road redevelopment projects and new traffic-generating developments including criteria to assess these impacts.
NSW Rail Infrastructure Noise Guideline (EPA 2013)	Provides guidance for the assessment and management of heavy and light rail noise and vibration, including assessment trigger levels.	A guideline that applies to proposed rail infrastructure projects that would be assessed and determined under the EP&A Act or that are likely to be licensed under the POEO Act. The guidelines specifies noise and vibration trigger levels for, residential land affected by heavy and light rail developments and sensitive land uses near heavy and light rail developments
Assessing Vibration: A technical guideline (DEC 2006)	Provides guidance and trigger levels for the assessment of vibration related impacts such as: – Continuous vibration (e.g. tunnel boring) – Impulsive vibration (e.g. blasting) – Intermittent vibration (e.g. railway and road traffic, construction activities, weight drops in gyms etc)	This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. Criteria is recommended for continuous vibration, impulsive vibration and intermittent vibration.
AS2107:2016 Acoustics Recommended design sound levels and reverberation times for building interiors	Provides design criteria for internal spaces to control: – Building services noise – External noise intrusion (nearby transport noise) – Reverberation times	This Standard recommends design criteria for conditions affecting the acoustic environment within occupied space, specifically in background noise and reverberation times.
Building Code of Australia	Provides acoustic privacy criteria and deemed-to-satisfy constructions to control noise transfer between sole occupancy units and building services	The Building Code of Australia (BCA) regulates minimum acceptable construction standards for buildings and sets minimum standards for privacy for Class 2, Class 3 and Class 9a buildings. Part F of the BCA sets minimum requirements for party walls and floors between apartments and for ducts or bulkheads enclosing hydraulic waste pipes. However, it does not deal with other issues such as noise intrusion from outside or noise generated by building services

The Association of Australasian Acoustical Consultants (AAAC) has developed several guidelines with input from AAAC members, to provide guidance for developers, operators, practitioners and local councils. The guidelines are not statutory documents and the guidance within them may be modified to meet specific requirements:

– AAAC Guideline for Child Care Centre Acoustic Assessment
– AAAC Guideline for Apartment and Townhouse Acoustic Rating
– AAAC Guideline for Selection of an Acoustical Consultant
– AAAC Guideline for Commercial Building Acoustics
– AAAC Guideline for Educational Facilities Acoustics
– AAAC Guideline for Health Care Building Acoustics
– AAAC Guideline for Gymnasium and Exercise Facility Assessment

Appendix C

Background DPE AQMS

Table C.7 10 year summary of available background air quality data recorded by the DPE

Pollutant	Averaging Period	Recorded background concentration by year (ug/m^3)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Chullora											
PM_{10}	24 hour maximum	69.4	40.0	64.6	63.5	63.0	90.7	140.4	168.0	40.3	29.6
	Maximum 24 hour (below assessment criteria)	49.2	40.0	48.2	44.9	48.0	49.7	48.4	50.0	40.3	29.6
	70th percentile	20.9	20.8	20.5	21.1	22.4	24.8	26.0	22.5	19.3	16.0
	Annual average	18.3	18.1	17.5	18.1	20.0	21.8	24.6	20.5	16.4	13.6
$PM_{2.5}$	24 hour maximum	49.1	23.1	37.2	49.4	44.6	29.1	97.6	86.2	33.7	13.9
	Maximum 24 hour (below assessment criteria)	22.0	23.1	18.4	22.3	24.7	23.1	24.9	24.6	19.9	13.9
	70th percentile	10.0	11.1	10.1	9.5	10.9	10.2	11.9	9.8	8.6	7.1
	Annual average	8.4	8.9	8.1	8.1	9.4	8.6	11.5	8.8	7.2	5.6
NO_2	1 hour maximum	112.8	131.2	110.7	94.3	123.0	116.9	143.5	106.6	114.8	92.3
	Annual average	27.5	26.9	25.8	25.7	25.1	24.3	24.1	21.0	20.3	20.6
SO_2	Hourly maximum	34.3	54.3	40.0	40.0	40.0	60.1	74.4	42.9	48.6	37.2
	24 hour maximum	9.0	10.3	8.7	9.0	8.5	9.1	10.7	10.5	12.2	6.2
CO	8 hour maximum	0.003	0.002	0.000	0.002	0.002	0.004	0.002	0.002	0.001	0.001
Ozone	1 hour maximum	224.7	169.1	199.0	192.6	244.0	196.9	376.6	229.0	173.3	132.7
Liverpool											
PM_{10}	24 hour maximum	98.5	40.8	68.6	68.7	74.0	101.5	178.9	195.1	82.8	36.1
	Maximum 24 hour (below assessment criteria)	47.9	40.8	45.5	39.5	43.1	49.7	48.3	46.0	44.4	36.1
	70th percentile	24.3	22.3	22.0	23.6	24.3	27.7	29.2	23.3	21.2	17.6
	Annual average	21.0	19.0	18.4	19.5	20.6	24.2	27.8	20.9	18.1	14.7
$PM_{2.5}$	24 hour maximum	73.8	24.3	32.2	50.8	56.4	45.4	156.0	73.6	52.2	21.9
	Maximum 24 hour (below assessment criteria)	24.8	24.3	23.9	22.3	24.8	23.2	23.6	24.8	24.6	21.9

Pollutant	Averaging Period	Recorded background concentration by year (ug/m^3)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	70th percentile	11.2	10.6	10.2	10.7	10.7	12.1	12.7	10.7	9.3	7.0
	Annual average	9.5	8.7	8.5	8.7	8.9	10.1	12.9	9.1	7.9	5.5
NO_2	1 hour maximum	114.8	90.2	123.0	96.4	131.2	127.1	102.5	98.4	86.1	73.8
	Annual average	23.7	22.3	21.5	23.7	25.1	25.2	24.6	22.0	20.6	17.0
SO_2	Hourly maximum	0.0	0.0	0.0	20.0	31.5	57.2	45.8	42.9	48.6	37.2
	24 hour maximum	0.0	0.0	0.0	7.9	8.0	10.6	12.1	7.8	8.5	6.5
CO	8 hour maximum	0.003	0.000	0.000	0.002	0.002	0.002	0.002	0.003	0.002	0.001
Ozone	1 hour maximum	250.4	220.4	186.2	203.3	288.9	237.5	336.0	218.3	199.0	149.8
Macquarie Park											
PM_{10}	24 hour maximum	-	-	-	-	49.6	85.6	187.3	146.7	532.1	25.9
	Maximum 24 hour (below assessment criteria)	-	-	-	-	49.6	48.2	46.7	49.4	31.4	25.9
	70th percentile	-	-	-	-	18.0	19.8	20.9	17.0	15.4	13.7
	Annual average	-	-	-	-	15.2	17.3	19.9	15.7	13.2	11.4
$PM_{2.5}$	24 hour maximum	-	-	-	-	24.1	58.4	152.0	77.8	213.1	17.6
	Maximum 24 hour (below assessment criteria)	-	-	-	-	24.1	22.0	24.5	24.2	23.6	17.6
	70th percentile	-	-	-	-	7.7	8.3	9.1	8.0	7.2	5.9
	Annual average	-	-	-	-	6.3	7.0	9.2	7.1	7.3	4.4
NO_2	1 hour maximum	-	-	-	-	75.9	61.5	53.3	61.5	149.7	47.2
	Annual average	-	-	-	-	12.2	12.6	12.1	10.3	9.4	9.3
SO_2	Hourly maximum	-	-	-	-	65.8	125.8	82.9	100.1	97.2	88.7
	24 hour maximum	-	-	-	-	10.1	18.9	25.7	11.6	17.7	9.3
CO	8 hour maximum	-	-	-	-	0.001	0.003	0.004	0.003	0.006	0.001
Ozone	1 hour maximum	-	-	-	-	49.2	94.2	62.1	74.9	72.8	66.3
Parramatta North											
PM_{10}	24 hour maximum	-	-	-	-	35.1	107.4	195.3	188.9	42.5	42.7

Pollutant	Averaging Period	Recorded background concentration by year (ug/m^3)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Maximum 24 hour (below assessment criteria)	-	-	-	-	13.9	24.9	24.3	24.6	23.0	16.9
	70th percentile	-	-	-	-	28.3	24.7	26.9	21.6	20.1	16.6
	Annual average	-	-	-	-	23.8	21.6	25.5	19.3	17.0	14.1
$PM_{2.5}$	24 hour maximum	-	-	-	-	13.9	42.1	130.1	72.9	27.4	16.9
	Maximum 24 hour (below assessment criteria)	-	-	-	-	13.9	24.9	24.3	24.6	23.0	16.9
	70th percentile	-	-	-	-	12.3	12.0	10.7	8.9	7.5	6.3
	Annual average	-	-	-	-	9.2	9.2	10.4	8.2	6.6	5.2
NO_2	1 hour maximum	-	-	-	-	82.0	131.2	143.5	75.9	96.4	69.7
	Annual average	-	-	-	-	15.5	22.0	21.6	16.7	16.4	14.9
SO_2	Hourly maximum	-	-	-	-	37.2	60.1	85.8	57.2	42.9	42.9
	24 hour maximum	-	-	-	-	22.9	14.4	18.0	14.5	8.1	6.8
CO	8 hour maximum	-	-	-	-	0.000	0.001	0.004	0.003	0.001	0.001
Ozone	1 hour maximum	-	-	-	-	175.5	218.3	336.0	199.0	173.3	149.8
Prospect											
PM_{10}	24 hour maximum	81.8	44.3	68.7	110.1	61.1	113.3	182.8	245.8	44.6	29.3
	Maximum 24 hour (below assessment criteria)	49.2	44.3	48.0	41.2	40.2	47.9	49.1	48.7	44.6	29.3
	70th percentile	21.9	20.6	20.7	22.0	22.1	25.2	27.3	22.3	20.5	16.1
	Annual average	19.2	17.6	17.6	18.9	19.0	21.8	25.9	20.1	17.2	13.4
$PM_{2.5}$	24 hour maximum	-	14.0	29.6	84.9	30.1	47.5	134.1	70.8	37.3	18.2
	Maximum 24 hour (below assessment criteria)	-	14.0	24.9	24.5	24.3	23.2	24.6	24.9	24.9	18.2
	70th percentile	-	9.9	9.9	9.7	9.4	10.1	11.9	9.5	8.2	6.9
	Annual average	-	7.6	8.2	8.7	7.8	8.4	11.8	8.6	6.9	5.3
NO_2	1 hour maximum	100.5	96.4	108.7	108.7	123.0	104.6	100.5	88.2	88.2	86.1

Pollutant	Averaging Period	Recorded background concentration by year (ug/m^3)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Annual average	21.7	21.1	21.7	20.6	21.0	19.8	19.6	17.5	17.4	15.9
SO_2	Hourly maximum	57.2	54.3	77.2	60.1	65.8	71.5	60.1	51.5	42.9	48.6
	24 hour maximum	12.2	13.7	8.8	10.7	28.9	14.5	11.7	11.7	9.2	9.1
CO	8 hour maximum	0.002	0.002	0.000	0.002	0.001	0.001	0.004	0.002	0.001	0.001
Ozone	1 hour maximum	237.5	220.4	181.9	222.6	263.2	224.7	282.5	218.3	190.5	158.4
"-" indicates no data available.											

Appendix D

Detailed methodologies (noise)

D-1 Noise modelling methodology

To predict road traffic noise levels at the facades at buildings within the Westmead South Study area, the CoRTN road traffic noise modelling method has been used and is considered the industry standard prediction method in NSW. The modelling parameters and assumptions for the CoRTN model are detailed in Table D.8.

The results of the noise model validation for the 1 hour and 15/9 hour noise models is presented in Table D.10. .

Table D.8 Noise modelling parameters – CoRTN noise model

Variable	Parameter used
Software	SoundPLAN 8.2
Calculation method	Calculation of Road traffic Noise Levels (CoRTN) method Vehicle heights split into 3 being: Cars at 0.5 metres – 0 dB correction HV engines at 1.5 metres - -0.6 dB correction HV exhausts at 3.6 metres - -8.6 dB correction
Topography	2 metre LiDAR elevation data was sourced from NSW Government – Spatial Services
Receiver heights	1.5 m above the ground floor and +3.0 metres for every storey above on the eastern façade of each building (most-affected)
Ground absorption	G = 0.5 for all areas Where G = 0 represents hard non-porous ground (road, pedestrian paths) and g= 1 represents porous ground such as grass
Building footprints and heights	Sourced from PSMA Geoscape
Weather	20 deg Celsius and 80% humidity
Number of reflections	2 number of reflections
Validation correction	Minus 2.0 dBA applied to all modelled noise levels. Modelled noise levels across the study area were typically higher than those measured for both the attended and unattended noise monitoring. This could be attributed to low-noise buses in the study area being counted/modelled as heavy vehicles.
Traffic volumes	1 hour traffic volumes: Table D.5 15 / 9 hour traffic volumes: Table 2.5
Model speeds	Modelled speeds were based on the signposted speeds except where the measured traffic speeds were measured to be lower than the signposted speed. See Table D.2.

Table D.9 1 hour validation volumes

Road	Modelled speed, km/hr	Direction	1 hour volumes		Direction	1 hour volumes	
			LV	HV		LV	HV
M4 Motorway	80	EB	4384	487	WB	4384	487
Great Western Highway	60	EB	912	41	WB	1357	77
Hawkesbury Road	50	SB	560	25	NB	350	17
Houison Street	45*	SB	158	11	NB	39	3
Amos Street	50	EB	79	3	WB	98	6
Bridge Road	45*	SB	338	28	NB	376	19
Good Street	40*	SB	124	7	NB	105	7
Austral Avenue	40*	EB	80	1	WB	69	0
Grand Avenue	40*	EB	14	0	WB	59	0
Alexandra Avenue	40*	EB	207	13	WB	270	10
Alexandra Avenue	40*	EB	432	16	WB	331	21
Local Roads	50	EB	5	0	WB	5	0
1) Speeds of vehicles have been modelled slower than the signposted speeds where speeds were measured to be lower							

Table D.10 Noise model validation (-2 dBA correction applied to all modelled noise levels)

ID	Calibration point	Period	Modelled (SP 8.2)			Measured			Difference in noise level		
			1hr	15 hr	9hr	1hr	15 hr	9hr	1hr	15 hr	9hr
L1/L2	Good Street	3 pm to 4 pm 3-8 Aug 23	61.8	-	-	61.5	-	-	**+0.3**		
L3/L4	Amos Street	3 pm to 4 pm 3-8 Aug 23	62.4	-	-	62.8	-	-	**-0.4**		
L7/L8	Bridge Street	5 pm to 6 pm 3-8 Aug 23	65.7	-	-	63.8	-	-	**+1.9**		
L9/L10	Hawkesbury Road	5 pm to 6 pm 3-8 Aug 23	67	-	-	66.6	-	-	**+0.4**		
L11/L12	Grand Avenue	6 pm to 7 pm 3-8 Aug 23	53.9	-	-	53.7	-	-	**+0.2**		
T2/T3	Houison Street	3 pm to 4 pm 3-8 Aug 23	60.8	-	-	59.5	-	-	**+1.3**		
T4/T5	Great Western Highway	4 pm to 5 pm 3-8 Aug 23	70.7	-	-	70.5	-	-	**+0.2**		
T6/T7	Hawkesbury Road	5 pm to 6 pm 3-8 Aug 23	67.5	-	-	66.7	-	-	**+0.8**		
T9/T10	Alexandra Avenue	6 pm to 7 pm 3-8 Aug 23	64.0	-	-	64.6	-	-	**-0.6**		
T11/T12	Austral Avenue	6 pm to 7 pm 3-8 Aug 23	57.9	-	-	58.4	-	-	**-0.5**		
V.01	Alexandra (East)	24 hour data 3-8 Aug 23	-	63.3	60.1	-	66.9	60.7		**-1.1**	**+1.9**
V.02	Alexandra (West)	24 hour data 3-8 Aug 23	-	60.9	58.4	-	61.5	57.3		**-0.6**	**+1.1**
V.03	Grand Avenue	24 hour data 3-8 Aug 23	-	53.2	51.7	-	53.0	48.6		**+0.2**	**+3.1**
V.04	Hawkesbury Road	24 hour data 3-8 Aug 23	-	65.8	61.8	-	65.0	60.6		**+0.8**	**+1.2**
Difference in noise level (median)									**+0.3**	**-0.2**	**+1.6**

Appendix E

Air quality modelling methodology

E-1 Emissions inventory

The road links described in Table E.6 were included in the air quality dispersion model.

Table E.11 Modelled road links

Road	Length (m)	Speed (km/hr)
Western Motorway	700	80
Great Western Hwy	1830	60
Bridge Rd	1110	40
Hawksbury Rd	1180	40
Houison St	1130	40
Amos St	1000	40
Austral Ave	580	20
Grand Ave	730	20
Alexandra Ave and Park Pd	1910	20
Good St	1100	20

Hourly light and heavy vehicle traffic counts used to estimate emissions for each road link are presented in Table E.7 and E.8 respectively.

Table E.12 Hourly diurnal light vehicle traffic counts

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave Park Pd	Alexandra Ave Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	354	232	191	125	23	41	39	48	2	3	11	6	3	3	2	1	28	12	12	10
1	202	141	109	76	19	21	22	39	2	2	4	4	2	3	2	2	7	7	5	7
2	141	109	76	59	16	14	12	18	1	1	4	2	1	2	1	1	4	4	2	1
3	150	121	81	65	16	19	17	28	0	1	3	3	1	3	0	1	6	4	4	4
4	213	206	115	111	30	32	39	35	0	2	8	5	1	3	3	1	14	17	8	8
5	467	640	252	345	83	109	155	97	6	10	19	13	9	9	5	7	27	47	18	13
6	788	1241	425	669	123	240	370	142	13	22	28	25	23	22	9	4	53	112	54	39
7	1052	1671	567	901	223	367	635	266	41	58	63	51	39	50	21	14	100	273	98	76
8	1332	1988	718	1072	245	412	653	355	102	147	121	95	69	95	53	74	146	442	220	170
9	1241	1769	669	954	217	300	520	292	29	82	70	62	42	47	33	15	116	244	84	95
10	1411	1556	761	839	209	228	415	338	23	46	59	59	32	36	22	14	119	178	61	58
11	1614	1556	870	839	202	228	376	376	26	45	69	59	31	35	24	13	137	175	52	59
12	1838	1554	991	838	219	237	364	394	27	60	76	61	33	44	28	16	159	185	57	63
13	1946	1554	1049	838	218	270	410	409	25	47	70	60	42	38	25	17	166	170	72	59
14	2159	1578	1164	851	310	297	408	448	47	71	92	74	41	47	32	41	198	184	118	79
15	2415	1634	1302	881	321	332	362	569	39	158	98	79	63	67	68	22	234	240	105	124
16	2517	1692	1357	912	352	310	330	573	34	124	90	74	72	66	66	22	264	228	113	115
17	2550	1890	1375	1019	309	367	350	560	42	155	102	86	77	91	77	21	282	245	136	137
18	2168	1716	1169	925	298	332	334	441	37	103	97	86	69	80	59	14	270	207	109	117
19	1551	1308	836	705	219	261	287	313	27	59	74	66	45	59	31	14	166	171	87	96
20	1389	1022	749	551	147	229	202	278	20	43	59	45	27	51	26	13	142	121	72	72
21	1228	874	662	471	116	188	184	211	15	34	41	34	25	34	20	12	108	81	60	50
22	1024	638	552	344	91	141	134	155	8	19	30	21	13	22	13	8	67	56	39	35
23	610	414	329	223	62	79	80	96	6	12	19	11	7	11	6	4	41	32	23	23

Table E.13 Hourly diurnal heavy vehicle traffic counts

Road	Western Motorway	Western Motorway	Great Wstn Hwy	Great Wstn Hwy	Bridge Rd	Bridge Rd	Hawksbury Rd	Hawksbury Rd	Houison St	Houison St	Amos St	Amos St	Austral Ave	Austral Ave	Grand Ave	Grand Ave	Alexandra Ave Park Pd	Alexandra Ave Park Pd	Good St	Good St
Hour	WB	EB	WB	EB	SB	NB	NB	SB	NB	SB	WB	EB	WB	EB	WB	EB	WB	EB	NB	SB
0	26	23	8	7	0	1	4	1	0	0	0	0	0	0	0	0	1	1	0	0
1	20	20	6	6	0	2	4	1	0	0	0	0	0	0	0	0	2	1	0	1
2	20	20	6	6	0	0	3	1	0	0	0	0	0	0	0	0	2	1	1	0
3	23	30	7	9	1	0	3	3	0	0	0	0	0	0	0	0	3	1	0	0
4	46	43	14	13	5	3	8	5	0	0	0	1	0	0	0	0	3	3	0	1
5	82	99	25	30	7	9	12	6	0	1	1	0	1	0	0	0	3	6	1	1
6	151	270	46	82	11	23	29	13	2	1	1	1	2	1	0	0	6	16	5	5
7	197	247	60	75	20	32	33	30	3	3	3	2	0	1	1	1	8	23	9	4
8	197	247	60	75	30	34	35	27	5	4	7	4	2	4	1	2	10	35	17	14
9	217	234	66	71	16	30	35	29	5	4	6	8	1	2	0	2	9	17	5	10
10	240	201	73	61	17	23	33	36	1	3	4	4	0	1	1	1	10	16	7	6
11	250	197	76	60	17	20	33	37	1	4	5	2	0	0	0	0	10	15	5	4
12	260	184	79	56	20	18	24	41	1	4	4	2	1	2	1	1	11	11	6	5
13	270	171	82	52	16	28	26	41	1	4	5	3	1	0	0	0	12	11	7	6
14	273	155	83	47	25	23	32	37	2	5	4	2	1	2	1	0	13	16	6	5
15	286	151	87	46	44	35	30	39	3	11	6	3	1	2	1	0	13	16	7	7
16	253	135	77	41	34	28	16	32	2	7	4	3	2	4	2	1	15	13	6	9
17	204	128	62	39	35	25	17	25	2	6	4	4	0	1	1	0	14	11	7	11
18	148	105	45	32	20	20	16	13	2	3	2	2	0	1	0	0	10	13	5	8
19	92	66	28	20	9	16	12	8	1	1	2	1	2	1	0	0	5	6	4	6
20	82	53	25	16	6	8	8	6	1	1	2	1	1	1	1	0	5	4	5	5
21	72	43	22	13	4	7	7	3	0	1	1	0	1	0	1	0	4	3	4	5
22	56	33	17	10	3	5	5	4	0	1	1	0	1	1	0	0	3	2	4	3
23	36	26	11	8	4	4	4	2	0	0	1	1	0	0	0	0	2	3	2	2

E-2 GRAMM model settings

GRAMM settings are summarised in Table E.10.

Table E.14 Parameters used in GRAMM for meteorological modelling

Parameter	Value
General	
Number of wind speeds	17
Wind speeds (m/s)	0.25, 0.75, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5, 9.5, 11, 13, 15, 17, 19, 21
Number of wind direction sectors	36
Number of classified weather situations	2088
Horizontal grid resolution	100 m
Vertical thickness of first layer	10 m
Number of vertical layers	15
Vertical stretching factor	1.4
Relative top layer height	3874
Maximum time step	10 s
Modelling time	3600 s
Relaxation velocity	0.15
Relaxation scalars	0.15
GRAMM dmain constraints	
North	6265800 m
East	328300 m
South	6240800 m
West	296200 m

E-3 GRAL model settings

The GRAL model was set up to predict maximum 1-hour average concentrations across the modelling domain based on a Cartesian grid of points with an equal spacing of 4 m in the x and y directions at four elevations (1.5m, 4.5m, 7.5m and 10.5 m), to represent the breathable zone for human sensitive receptors. A GRAMM model was prepared as described above with match to observations performed at Parramatta North AQMS and was used as the meteorological input to the model to simulate all possible weather conditions.

GRAL settings are summarised in Table E.11.

Table E.15 Parameters used in GRAL for dispersion modelling

Parameter	Value
General	
Dispersion time	3600 s
Particles per second	100
Obstacles	Buildings
Concentration grid	
Horizontal grid resolution	4 m

Parameter	Value
Vertical thickness of first layer	3 m
Number of horizontal slices	4
Internal flow field grid	
Horizontal grid resolution	2 m
Vertical thickness of first layer	2 m
Vertical stretching factor	1.01
Number of cells in z-direction	40
GRAL domain constraints	
North	6257552 m
East	314676 m
South	6255792 m
West	312764 m

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