Appendix S

Noise and Vibration Impact Assessment

Sydney Metro West

Hunter Street East Over Station Development Noise and Vibration Impact Assessment

Appendix S

November 2022

NSW GOVERNMENT

sydney METRO

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FUNCTION	POSITION	NAME	DATE
Author	Principal Acoustic Engineer Technical Director – Acoustics	Moharis Kamis Michael Allan	27/10/2022
Technical Checker	Technical Director – Acoustics	Simon Lappas	27/10/2022
Technical Reviewer	Technical Director – Acoustics	Graham Brown	27/10/2022
Coordinator	Senior Environmental Advisor	Jonathon Cook	02/11/2022
Approver	Sydney Metro EDA Lead	Adrian Garnero	07/11/2022

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Mott MacDonald Australia Pty Ltd

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Glossary

Term	Definition
'A'-Weighted	Frequency adjustment to account for the relative loudness perceived by the human ear. Indicated by the units dB(A).
'C'-Weighted	Frequency adjustment for noise measurements to account for loudness or bass noise. Indicated by the units dB(C).
ABL	Assessment Background Level, the lowest 10th percentile of the background noise (the L_{A90}) over the defined period for each day.
AS 2187.2	Australian Standard AS 2187.2-2006 Explosive-Storage and use Part 2: Use of explosives
AS 2436	Australian Standard AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites
AVATG	Assessing Vibration: A technical guideline, NSW Department of Environment and Conservation, February 2006.
BS 7385.2	British Standard BS 7385.2-1993 Evaluation and measurement for vibration in Buildings Part 2
CBD	Central business district
CNVG	Construction Noise and Vibration Guideline, NSW Department of Road and Maritime Services, August 2016
CNVMP	Construction Noise and Vibration Management Plan
Concept and Stage 1 CSSI Application	Application SSI 10038, including all major civil construction works between Westmead and The Bays, including station excavation and tunnelling, associated with the Sydney Metro West line
Concept SSDA	A concept development application as defined in Section 4.22 of the EP&A Act, as a development application that sets out concept proposals for the development of a site, and for which detailed proposals for the site or for separate parts of the site are to be the subject of a subsequent development application or applications.
Council	City of Sydney
CSSI	Critical Stage Significant Infrastructure
dB	decibel, unit used to measure the loudness of sound
dB(A)	'A'-weighted decibel
DCP	Development Control Plan
DPE	Department of Planning and Environment
EIS	Environmental Impact Statement
EPA	NSW Environment Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPI	Environmental planning instrument
FSR	Floor space ratio
GFA	Gross floor area
ICNG	Interim Construction Noise Guideline, NSW Department of Environment and Climate Change, July 2009
IGU	Insulated glass unit
Infrastructure SEPP	State Environmental Planning Policy (Transport and Infrastructure) 2021

Term	Definition
L_{A1}	The noise level which is exceeded for 1 per cent of the measurement period.
L_{A10}	The noise level which is exceeded for 10 per cent of the measurement period.
L_{A90}	The noise level which is exceeded for 90 per cent of the measurement period, commonly used to indicate the background noise level.
$L_{Aeq,T}$	The energy average noise level over the measurement period, T
L_{AFmax}	The maximum noise level over the measurement period. This level is the maximum noise level due to an individual noise event.
LEP	Local Environmental Plan
LGA	Local Government Area
NCA	Noise catchment area
NML	Noise Management Level(s)
NPfI	Noise Policy for Industry, NSW EPA, October 2017
OSD	Over Station Development
POEO Act	*Protection of the Environment Operations Act 1997*
RBL	Rating Background Level, the median ABL over an entire noise monitoring period
RNP	Road Noise Policy, NSW Department of Climate Change, Environment and Water 2011
RL	Reduced level
SEARs	Secretary's Environmental Assessment Requirements
SSDA	State Significant Development Application
SSI	State Significant Infrastructure
Stage 2 CSSI Application	Application SSI-19238057, including major civil construction works between The Bays and Hunter Street Station
Stage 3 CSSI Application	Application SSI-22765520, including rail infrastructure, stations, precincts and operation of the Sydney Metro West line
Sydney Metro West	Construction and operation of a metro rail line and associated stations between Westmead and the Sydney CBD as described in section 1.1
TfNSW	Transport for New South Wales
The site	The site which is the subject of the Concept SSDA
VDV	Vibration Dose Value(s)

Executive Summary

This Noise and Vibration Report supports a Concept State Significant Development Application (Concept SSDA) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Concept SSDA is made under section 4.22 of the EP&A Act.

Sydney Metro is seeking concept approval for a commercial tower above the Hunter Street Station eastern site (the site), otherwise known as the over station development (OSD).

The Concept SSDA seeks consent for a building envelope and its use for a commercial and retail premises, a maximum building height of 58 storeys (257.7m, reduced level 269.10m), a maximum gross floor area (GFA) of 84,223m^2, pedestrian and vehicular access, circulation arrangements and associated car parking in addition to the strategies and design parameters for the future detailed design of development.

This Noise and Vibration Report responds specifically to the Secretary's Environmental Assessment Requirements (SEARs) and provides an assessment of operational and construction acoustic impacts for the Hunter Street East OSD (referred to hereafter as the 'proposed development').

A construction noise and vibration impact assessment has been completed based on the worst-case (highest noise level) construction scenario. The nearest residential receiver is approximately 100m south from the construction works, so construction noise impacts will be limited. An exceedance of up to 23 dB has been predicted at some of the nearest commercial receivers. These impacts would need to be managed throughout the construction phase of the project through the implementation of a Construction Noise and Vibration Management Plan which will accompany the subsequent Detailed SSDA.

Operational noise and vibration impacts from the mechanical plant have been considered and it is anticipated that typical mitigation measures would be able to achieve compliance with the assessment criteria. Indicative design solutions have been provided based on a preliminary assessment of the mechanical plant. Indicative mitigation measures, suitable for the impacts and type of buildings have been included to attenuate noise levels and achieve compliance with the design criteria.

Indicative glazing construction has been provided for the proposed development to control road traffic noise intrusion. The acoustic façade glazing requirements can be refined as the design develops. Ground-borne noise and vibration generated by the metro underneath the proposed development would be controlled through suitable track-form design.

1 Introduction

1.1 Sydney Metro West

Sydney Metro West will double rail capacity between Greater Parramatta and the Sydney Central Business District (CBD), transforming Sydney for generations to come. The once in a century infrastructure investment will have a target travel time of approximately 20 minutes between Parramatta and the Sydney CBD, link new communities to rail services and support employment growth and housing supply.

Stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont, and Hunter Street.

Sydney Metro West station locations are illustrated in Figure 1-1.

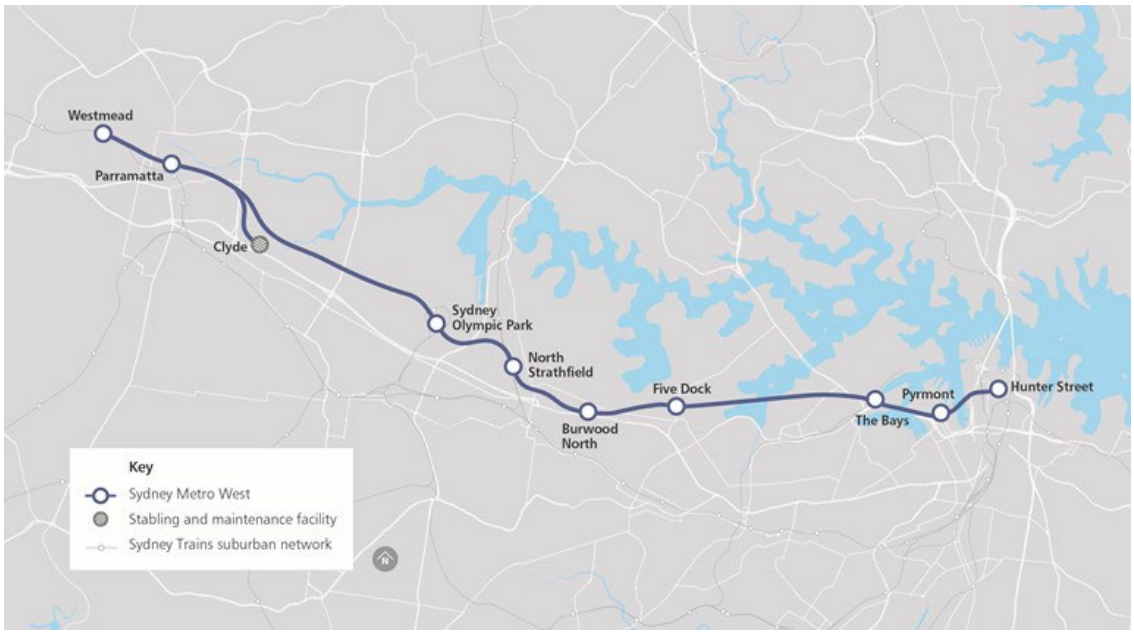

Figure 1-1 Sydney Metro West

1.2 Background and planning context

Sydney Metro is seeking to deliver Hunter Street Station under a two-part planning approval process. The station fit out infrastructure is to be delivered under a Critical State Significant Infrastructure (CSSI) application subject to provisions under Division 5.2 of the EP&A Act, while the over station developments are to be delivered under a State Significant Development (SSD) subject to the provisions of Part 4 of the EP&A Act. It is noted a Planning Proposal request has been submitted to the City of Sydney Council to amend the planning controls on the site (refer to section 1.2.3).

1.2.1 Critical State Significant Infrastructure

The State Significant Infrastructure (SSI) planning approval process for the Sydney Metro West metro line, including delivery of station infrastructure, has been broken down into several planning application stages, comprising the following:

- Concept and Stage 1 CSSI Approval (SSI-10038) – All major civil construction works between Westmead and The Bays including station excavation, tunnelling, and demolition of existing buildings (approved 11 March 2021).
- Stage 2 CSSI Application (SSI-19238057) – All major civil construction works between The Bays and Hunter Street Station (approved 24 August 2022).

- Stage 3 CSSI Application (SSI-22765520) – Tunnel fit-out, construction of stations, ancillary facilities, and station precincts between Westmead and Hunter Street Station, in addition to operation and maintenance of the Sydney Metro West line (under assessment).

1.2.2 State Significant Development Application

The SSD will be undertaken as a staged development with the subject concept state significant development application (Concept SSDA) being consistent with the meaning under section 4.22 of the EP&A Act and seeking conceptual approval for a building envelope, land uses, maximum building heights, a maximum gross floor area, pedestrian and vehicle access, vertical circulation arrangements and associated car parking. A subsequent Detailed SSDA is to be prepared by a future development partner which will seek consent for detailed design and construction of the development.

1.2.3 Planning Proposal

A Planning Proposal request has been submitted to the City of Sydney Council to amend the planning controls that apply to the Hunter Street Station under the Sydney Local Environmental Plan 2012 (LEP). Hunter Street Station includes both an eastern site (this application) and western site.

The Planning Proposal request seeks to enable the development of a commercial office building on the site that would:

- comprise a maximum building height of between reduced level (RL) 257.7m and RL 269.10m (as it varies to comply with the relevant sun access plane controls).
- deliver a maximum GFA of 84,287m^2 (resulting in a maximum floor space ratio (FSR) of 22.82:1), measured above ground level.
- facilitate the adaptive reuse of the existing Former Skinners Family Hotel within the overall development.
- include site specific controls which ensure the provision of employment and other non-residential land uses.
- require the mandatory consideration of a site-specific Design Guideline.
- allow for the provision of up to 70 car parking spaces.
- establish an alternative approach to design excellence.

The Planning Proposal request was submitted to the City of Sydney in May 2022 and is currently under assessment.

1.3 Purpose of the Report

This Noise and Vibration Impact Assessment report supports a Concept SSDA submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the EP&A Act. The Concept SSDA is made under section 4.22 of the EP&A Act.

The report has been prepared to specifically respond to the Secretary's Environmental Assessment Requirements (SEARs) issued for the Concept SSDA on 08 August 2022 which states that the environmental impact statement is to address the following requirement.

Key issue	SEARs	Addressed in
11. Noise and Vibration	Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed manage and mitigation measures that would be implemented.	Covered throughout this report

The report assesses the acoustic impact from the proposed development at the nearest sensitive receivers. It also assesses the impact from the environmental factors such as road and rail traffic on the proposed development. Predicted acoustic impacts are then assessed against the stipulated local and international guidelines and standards. Feasible mitigation measures are considered to reduce the impact and ensure to contain any adverse effect of noise and vibration due to the proposed project. These measures will be further developed as the design progresses as part of the subsequent Detailed SSDA for the proposed development.

2 The site and proposal

2.1 Site location and description

Hunter Street Station is in the northern part of the Sydney CBD, within the commercial core precinct of Central Sydney and within the Sydney Local Government Area (LGA). The Hunter Street Station includes two sites – the eastern site and western site. This report relates to the eastern site only.

The Hunter Street Station eastern site (the site) is on the corner of O'Connell Street, Hunter Street and Bligh Street adjacent to the existing CBD and Southeast Light Rail that extends from Circular Quay to Moore Park, Kensington, and Kingsford. The east site is adjacent to the new Martin Place Station which forms part of the Sydney Metro City and Southwest, Australia's biggest public transport project connecting Chatswood to Sydenham and extending to Bankstown. The remainder of the site is currently occupied by commercial office buildings and a range of ground floor business premises including retail, restaurants, and cafes.

The site area is 3,694 m^2 and will be cleared of all buildings and utilities prior to commencement of station construction activities. The site location is shown in Figure 2-1.

Figure 2-1 Location of the site

Table 2-1 sets out the address and legal description of the parcels of land that comprise the site.

Table 2-1 Site legal description

Address	Lot and DP
28 O'Connell Street, Sydney	Lot 1, DP217112
28 O'Connell Street, Sydney	Lot 1, DP536538
28 O'Connell Street, Sydney	Lot 1, DP1107981
48 Hunter Street, Sydney	Lot 1, DP59871
48 Hunter Street, Sydney	Lot 2, DP217112
33 Bligh Street, Sydney	Lot 1, DP626651
37 Bligh Street, Sydney	CP and Lots 1-14, 21-31, 33-36, and 40, SP58859
37 Bligh Street, Sydney	CP and Lots 41-49, SP61852
37 Bligh Street, Sydney	CP and Lots 50-57, SP61922
37 Bligh Street, Sydney	CP and Lots 58-65, SP61923
37 Bligh Street, Sydney	CP and Lots 66 and 67, SP63146
37 Bligh Street, Sydney	CP and Lots 67-70, SP63147
37 Bligh Street, Sydney	CP and Lot 72, SP74004
37 Bligh Street, Sydney	CP and Lots 75-82, SP87437
37 Bligh Street, Sydney	CP and Lots 73-74, SP87628
	Total Area: 3,694 m^2

2.2 Overview of the proposal

The Concept SSDA will seek consent for a building envelope above the site (the proposed development). As detailed in Table 2-2 and Figure 2-2.

Table 2-2 Proposed development overview

Built form component	Proposed development outcome
Site area	3,694 m^2
Height	Building height of 257.7 m (RL 269.10)
Ground floor area	Up to 84,233 m^2
Land use(s)	Commercial office and retail
Carparking	Up to 70 car parking spaces

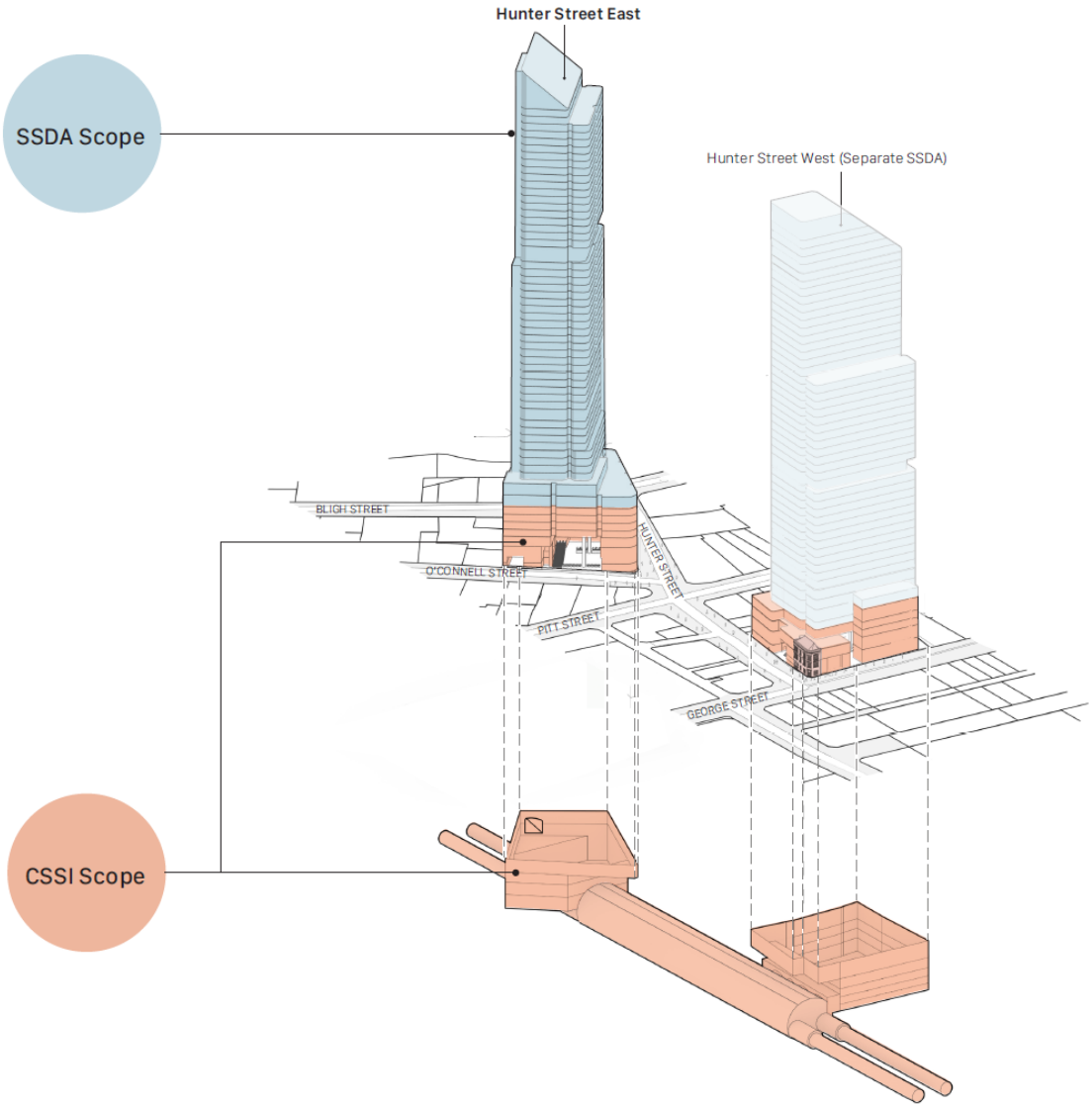

Figure 2-2 Proposed Concept SSDA development and CSSI scope

3 Scope of assessment

A noise and vibration impact assessment has been undertaken to determine the likely impacts on nearby sensitive receivers. The assessment includes:

- Reviewing the existing environment and identify noise and vibration sensitive receivers throughout the project area
- Determining the existing background noise levels based on previously undertaken ambient noise monitoring
- Establishing appropriate environmental noise criteria for operation and construction based on the noise logging results and local noise environments
- Establishing representative construction scenarios, locations, working times and duration of activities that would apply to construction of the proposal
- Establishing vibration levels within the proposed development due to impacts from existing underground rail operations
- Predicting noise levels at receivers within the assessment area due to the proposed construction activities using a noise prediction model.
- Assessing potential construction noise impacts with reference to the Interim Construction Noise Guideline and the Sydney Metro Construction Noise and Vibration Standard
- Assessing potential cumulative construction noise impact from Sydney Metro project construction and other nearby projects
- Assessing road noise impacts from construction activities in accordance with the NSW Road Noise Policy (RNP)
- Assessing potential construction vibration impacts from the project in accordance with the EPA Assessing vibration: a technical guideline
- Assessing potential operational noise impacts with reference to the NSW Noise Policy for Industry (NPfI) and the RNP, where applicable. The assessment considers cumulative noise impact from other developments
- Identifying suitable management and mitigation measures to minimise the predicted noise and vibration impacts generated by the project. A detailed noise and vibration assessment report will form part of the Detailed SSDA.

4 Existing environment

4.1 Existing noise environment

The existing noise environment in the Sydney CBD has the typical characteristic of an urban hum. While ambient noise is controlled by road traffic, the background noise cannot be attributed to a single dominant source. Background noise in the Sydney CBD generally comprises traffic noise at ground level, and cooling plant and other building services noise sources at higher levels above ground.

The site is generally surrounded by commercial receivers, however, there are also existing hotels located on Hunter Street. The nearest receiver to the site is the adjoining building on Bligh Street/O'Connell Street, however due to physical constraints the main noise sources would not be orientated towards this receiver.

The closest noise sensitive receivers surrounding the Hunter Street Station are listed in Table 4-1 and shown on Figure 4-1.

Table 4-1 Receiver types and addresses

Receiver	Address	Type
R-1	Office Building and Bar, 320 George Street	Commercial
R-2	Office Building, 309 George Street	Commercial
R-3	Wynyard Station, 287 George Street	Commercial, Transport
R-4	The Peapes Building, 285 George Street	Commercial
R-5	Office Building, 283 George Street	Commercial
R-6	Office Building, 275 George Street	Commercial
R-7	A by Adina Hotel, 2 Hunter Street	Hotel
R-8	Retail and Office Building, 10 Hunter Street	Commercial
R-9	Retail and Office Building, 20 Hunter Street	Commercial
R-10	The Grand Hotel, 30 Hunter Street	Hotel, Commercial
R-11	The Tank Stream Hotel, 97-99 Pitt Street	Hotel, Commercial
R-12	Radisson Blu Hotel, 27 O'Connell Street	Hotel
R-13	Office Building, 23-25 O'Connell Street	Commercial
R-14	The Public Trust Office, 19-21 O'Connell Street	Commercial
R-15	Office Building, 16-18 O'Connell Street	Commercial
R-16	EzyMart, 23 Bligh Street	Commercial
R-17	Office Building, 25 Bligh Street	Commercial
R-18	Lowy Institute, 31 Bligh Street	Commercial
R-19	Office Building, 4-6 Bligh Street	Commercial
R-20	Office Building, 1 Chifley Square	Commercial
R-21	City Mutual Building, 66 Hunter Street	Commercial
R-22	Martin Place Station, 4 Castlereagh Street	Transport
R-23	Office Building, 1 Castlereagh Street	Commercial

Receiver	Address	Type
R-24	Perpetual Trustee Building, 39 Hunter Street	Commercial
R-25	Office Building, 68 Pitt Street	Commercial
R-26	Currency House, 23 Hunter Street	Commercial
R-27	Office Building, 107 Pitt Street	Commercial
R-28	Office Building, 105 Pitt Street	Commercial
R-29	Retail and Office Building, 19-21 Hunter Street	Commercial
R-30	Apartments, Hotel and Retail, 15-17 Hunter Street	Hotel, Commercial
R-31	Office Building, 109 Pitt Street	Commercial

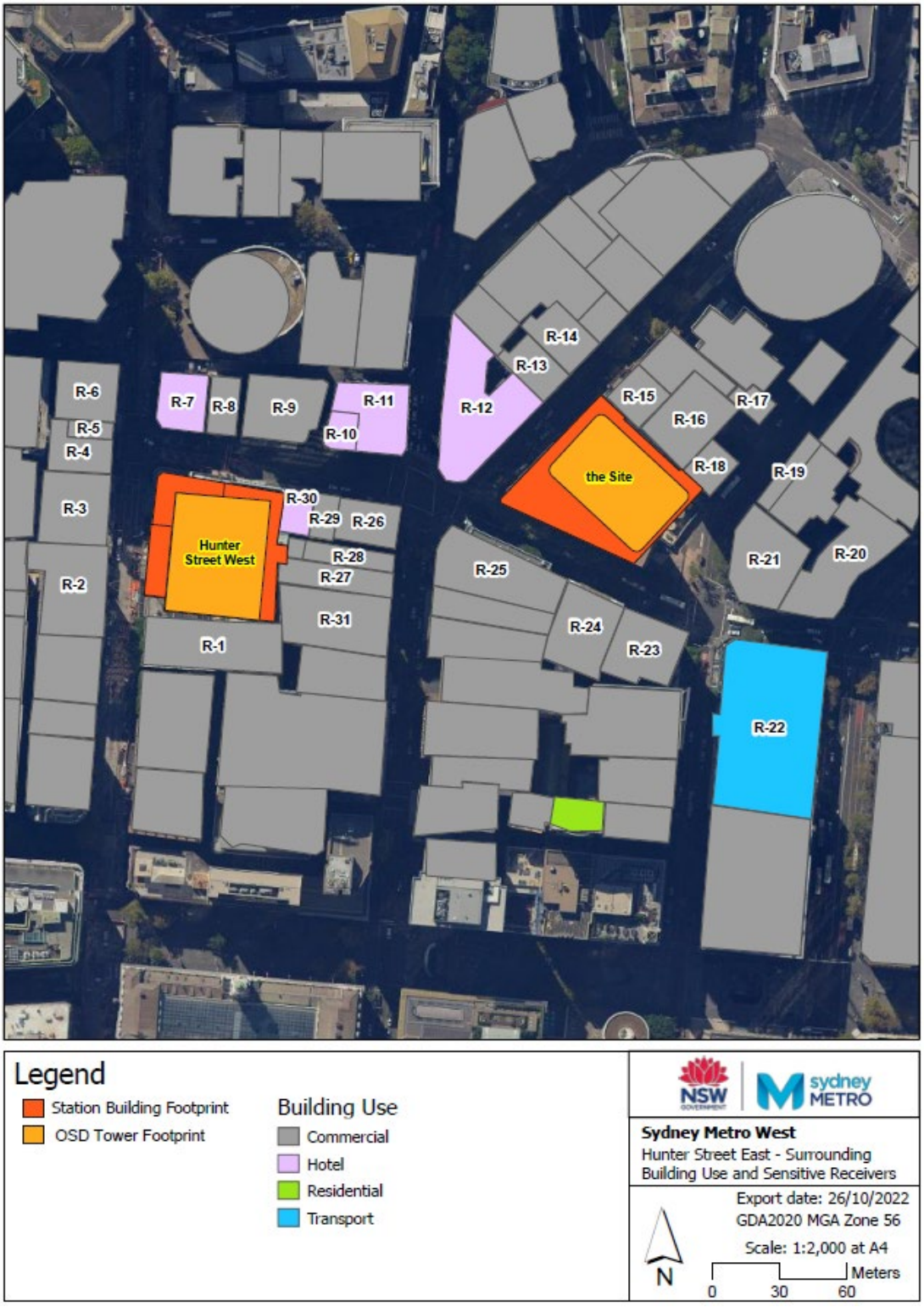

Figure 4-1 Site map identifying receiver locations around Hunter Street Station

4.2 Noise monitoring

Baseline noise monitoring was previously undertaken near the site as part of Sydney Metro Martin Place Stage 1 Amending Development Application works.

A noise logger measures the local noise environment and records noise statistics about the measurement period. For this project the noise logger was configured to measure 15-minute intervals and record:

- L_{AFmax} – the maximum noise level over the measurement period. This level is the maximum noise due to an individual noise event
- L_{Aeq} – the energy average noise level over the measurement period
- L_{A90} – the noise level which is exceeded for 90 per cent of the measurement period. This is the background noise level over the measurement period.

All measured noise levels are A-weighted, which is used across Australian and International Standards to account for the relative loudness perceived by the human ear.

Presented in Figure 4-2 is the noise monitoring location in relation to the project site. Table 4-2 presents the summary of the noise logging results from this location. The measured noise levels have been used to define the intrusiveness noise criteria in accordance with the NPfI requirements.

The NPfI defines three separate assessment time periods: daytime (7am to 6pm); evening (6pm to 10pm); and night-time (10pm to 7am). For each time-period the assessment background level (ABL) has been established by determining the lowest 10th percentile of the background noise (the L_{A90}) over the defined period for each day. The rating background level (RBL) is the median ABL over the entire monitoring period.

Figure 4-2 Unattended noise monitoring locations in relation to the site

Table 4-2 Unattended noise monitoring results

Address	Background noise (RBL), dB(A)			Ambient noise level (LAeq), dB(A)		
	Day	Evening	Night	Day	Evening	Night
50 Martin Place	64	61	58	66	64	62

Source: Sydney Metro Martin Place Stage 1 Amending DA – Acoustic Assessment Report (CSWSMP-MAC-SMA-NA-REP-999902, dated 4 July 2018)

5 Assessment criteria

5.1 Construction noise

Table 5-1 presents a summary of the different construction impacts and corresponding relevant guideline or document which has been used to establish the criteria.

Table 5-1 Construction noise categories to be assessed

Impact type	Sub-category	Relevant guideline or document
Construction noise	Airborne noise emissions	Interim Construction Noise Guideline, Department of Environmental and Climate Change NSW, July 2009 (ICNG) Sydney Metro Construction Noise and Vibration Standard, July 2022 (CNVS)
	Sleep disturbance	Interim Construction Noise Guideline, Department of Environmental and Climate Change NSW, July 2009 (ICNG) Noise Policy for Industry, NSW EPA, October 2017 (NPfI)
	Ground-borne noise	Interim Construction Noise Guidelines, Department of Environmental and Climate Change NSW, July 2009 (ICNG)
	Construction road traffic noise	Sydney Metro Construction Noise and Vibration Standard, July 2022 (CNVS) Road Noise Policy, Department of Environmental and Climate Change NSW, March 2011 (RNP)

Note: The NSW EPA have released Draft Construction Noise Guideline which will replace the ICNG when the draft guideline is finalised. The public consultation for the Draft Construction Noise Guideline closed in April 2021 with feedback currently under review. At the time of writing the ICNG is still applicable.

5.1.1 Airborne noise emissions

The Interim Construction Noise Guideline (ICNG) provides guidance on the appropriate construction noise goals, in addition to identifying appropriate noise management and mitigation strategies. The Sydney Metro Construction Noise and Vibration Standard (CNVS) provides further, more detailed information on management and mitigation structures.

The ICNG and CNVS also provide guidance on reasonable and feasible noise mitigation and management measures.

- feasible - a mitigation or management measure is feasible if it is practical to build or capable of being put into practice given project constraints
- reasonable - a mitigation or management measure is reasonable if the overall noise benefits outweigh the overall adverse social, economic, and environmental effects, including the cost of the measure.

The ICNG and CNVS both establish noise management levels (NMLs) based on existing background noise levels which trigger the requirement for certain management measures. The NMLs for residential and non-residential uses are outlined below.

Residential land uses

Table 5-2 presents a summary of the residential noise management levels.

Table 5-2 Construction noise management level criteria – residential receivers

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

Notes: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

The applicable noise criteria for this area have been defined based on the noise logger data captured at 50 Martin Place. Construction NMLs are assessed at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above the floor height. Table 5-3 provides a summary of the project resultant construction NMLs.

Table 5-3 Construction noise management levels – residential land uses

RBL (L_{A90}), dB(A)			Noise management level, $L_{Aeq,15min}$ dB(A)		
Daytime	Evening	Night-time	Daytime[1]	Evening[2]	Night-time[2]
64	61	58	74	66	63

Notes:

1. Daytime is assumed to fall within recommended standard construction hours and therefore RBL + 10 dB(A) has been applied.
2. Evening and night-time fall outside of standard construction hours therefore RBL + 5dB(A) has been applied.

Non-sensitive land uses

Construction NMLs for non-sensitive land uses are provided in Table 5-4.

Table 5-4 Construction noise management levels – non-sensitive land uses

Land use	Noise management level, $L_{Aeq,15min}$
Industrial premises	External noise level 75 dB(A)
Commercial premises (offices, retail outlets)	External noise level 70 dB(A)

Where the noise management level in Table 5-4 is lower than the 'noise affected' management level in Table 5-2 for residential receivers, the management level for residential receivers in Table 5-2 is applied, which accounts for the elevated background noise levels in the area.

5.1.2 Sleep disturbance

The ICNG requires a sleep disturbance noise assessment to be completed for construction works which are proposed for more than two consecutive nights.

The CNVS proposes an approach to assessing sleep disturbance events that shall be consistent with the NPfI. Where night-time noise levels at a residential location exceed:

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

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

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under 'fast' time response. The detailed assessment will consider all feasible and reasonable noise mitigation measures with the goal of achieving the above trigger levels for night-time activities. Table 5-5 summarises the sleep disturbance criteria for construction noise.

Table 5-5 Construction noise sleep disturbance criteria

Night-time RBL, L_{A90} dB(A)	Construction noise sleep disturbance criteria	
	$L_{Aeq,15min}$ dB(A)	L_{AFmax} dB(A)
58	63	73

5.1.3 Ground-borne noise

Ground-borne noise levels for residents are nominated in the ICNG and indicate where management actions would be implemented. These levels are only applicable when ground-borne noise levels are higher than airborne noise levels. Any levels exceeding objectives should be considered in the context of any existing exposure to ground-borne noise.

The ground-bore noise management levels (residential receivers only) are:

- evening (6pm to 10pm) internal $L_{Aeq,15min}$ 40dB(A)
- night-time (10pm to 7am) internal $L_{Aeq,15min}$ 35dB(A).

These levels are assessed at the centre of the most affected habitable room.

5.1.4 Construction road traffic noise

Road traffic noise impacts associated with road project construction is not explicitly provided in either the ICNG nor the RNP. However, the CNVS references the RNP for a suitable assessment approach to address construction road traffic noise impact.

An initial assessment has been completed to determine the increase in traffic noise due to the project construction. Where this increase is 2 dB(A) or less, no further assessment is required. Where the increase is greater than 2 dB(A) and exceeds the road category specific criterion, a more detailed assessment is completed.

Further detail about applying the RNP is included in section 5.3.4.

5.2 Construction vibration

Table 5-1 summarises the construction vibration impacts that shall be assessed and the relevant guideline or document for establishing the appropriate criteria.

Table 5-6 Construction vibration categories to be assessed

Impact type	Sub-category	Relevant guideline or document
Construction vibration	Human comfort	Department of Environment and Conservation, Assessing Vibration: A Technical Guideline, February 2006 (AVATG)
	Structural damage	British Standard BS 7385.2-1993 Evaluation and measurement for vibration in Buildings Part 2 (BS 7385.2) Australian Standard AS 2187.2-2006 Explosive-Storage and use Part 2:Use of explosives (AS 2187.2)

5.2.1 Human comfort

Perceptible vibration can be an annoyance to building occupants, particularly if the duration or frequency of events is significant. Vibration criteria are provided by Assessing vibration: A technical guideline (AVATG) and provides guidance in terms of continuous and impulsive vibration, and intermittent vibration. Vibration from construction activities associated with this project would be generally considered to be intermittent vibration.

Intermittent vibration

The intermittent vibration criteria provided by AVATG is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration are provided below in Table 5-7. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 5-7 Human comfort criteria – intermittent vibration

Land use	Vibration Dose Value (VDV) design goals (m/s1.75)			
	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas (Note 1)	0.10	0.20	0.10	0.20
Residences (Note 2)	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria.
2. Criteria for residences are lower than schools as people expect to be able to relax/sleep in their homes without annoyance and are generally more concerned about structural damage than would be the case within schools and offices.

Continuous and impulsive vibration

Acceptable levels of human exposure to continuous and impulsive vibration are dependent on the time of day and the activity taking place in the occupied space. AVATG provides the preferred values for continuous and impulsive vibration. These are presented in Table 5-8.

Where vibration values are below the preferred values in Table 5-8, there is a low probability of adverse comment or disturbance to building occupants. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short duration. Vibration values above the preferred values in Table 5-8 may be dealt with through negotiation with the regulator and affected community.

Table 5-8 Human comfort criteria – continuous and impulsive vibration

Location	Assessment period	Peak Particle Velocity (PPV), mm/s	
		Preferred (z-axis)	Maximum (z-axis)
Continuous vibration			
Critical areas (Note 1)	When in use	0.14	0.28
Residences (Note 2)	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices, schools, educational institutions, and places of worship	When in use	0.56	1.1
Workshops	When in use	1.1	2.2
Impulsive vibration			
Critical areas (Note 1)	When in use	0.14	0.28

Location	Assessment period	Peak Particle Velocity (PPV), mm/s	
		Preferred (z-axis)	Maximum (z-axis)
Residences (Note 2)	Daytime	8.6	17.0
	Night-time	2.8	5.6
Offices, schools, educational institutions, and places of worship	When in use	18.0	36.0
Workshops	When in use	18.0	36.0

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria.
2. Criteria for residences are lower than schools as people expect to be able to relax/sleep in their homes without annoyance and are generally more concerned about structural damage than would be the case within schools and offices.

5.2.2 Structural damage

Vibration transmitted through the ground may cause damage to structures and architectural elements or discomfort to their occupants. The vibration levels at which people become annoyed are well below vibration levels at which damage occurs. The likelihood of such damage or discomfort may be ascertained by measuring the vibration from a vibrational impact close to the location of concern such as a building or other structure.

Transient vibration

Table 5-9 provides frequency-dependent guide levels for transient vibration described in BS 7385.2 and the AS 2187.2. The levels specified are peak component particle velocities, and the methodologies used for assessing the frequencies, are similar in both documents. The frequency-dependent guide values provide PPV for the prevention of minor or cosmetic damage occurring in structures from ground vibration.

Table 5-9 Transient vibration criteria for cosmetic damage (AS 2187.2 / BS 7385.2)

	Peak component particle velocity in frequency range of predominant pulse	
Type of building	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structure. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note: Values referred to are at the base of the building.

Continuous vibration

For continuous vibration which has the potential to generate resonance within structures these values are typically reduced by 50 per cent. Common construction equipment such as rock-breaking and vibratory rollers are likely to generate resonances which would attract this penalty. Presented below are the vibration screening criteria which should be applied for all construction activities.

Table 5-10 Continuous vibration criteria for cosmetic damage (AS 2187.2 / BS 7385.2)

	Peak component particle velocity in frequency range of predominant pulse	
Type of building	**4 Hz to 15 Hz**	**15 Hz and above**
Reinforced or framed structures. Industrial and heavy commercial buildings	25 mm/s at 4 Hz and above	
Unreinforced or light framed structure. Residential or light commercial type buildings	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above

5.3 Operational noise and vibration

Table 5-11 summarises the potential operational noise and vibration impacts, and the relevant documents which provide appropriate design noise goals.

Table 5-11 Summary of operational impact categories to be assessed

Impact type	Sub-category	Relevant guideline or document
Environmental noise emission	Airborne environmental noise emissions	NSW Noise Policy for Industry, October 2017 (NPfI)
	Sleep disturbance	
	Emergency plant	
	Traffic generating development	Road Noise Policy, Department of Environmental and Climate Change NSW, March 2011 (RNP)
External noise intrusion	Airborne external noise intrusion	State Environment Planning Policy (Transport and Infrastructure) 2021 (Infrastructure SEPP) NSW Development Near Rail Corridors and Busy Roads – Interim Guideline Australian / New Zealand Standard 2017:2016 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors (AS/NZS 2017:2016)
	Ground-borne noise	NSW Development near Rail Corridors and Busy Roads – Interim Guideline
Development Control Plan requirements		Sydney Development Control Plan (DCP) 2012, City of Sydney

5.3.1 Airborne environmental noise emission

The NPfI provides guidance on appropriate noise levels for external noise emissions from fixed facilities on surrounding sensitive receivers. The NPfI considers noise goals in terms of intrusiveness and amenity noise levels. The intrusiveness noise level protects against significant changes in noise, while the amenity noise level seeks to protect against cumulative noise impacts from industry. Together, these levels are used to assess the potential impact of noise and assess reasonable and feasible noise mitigation measures. Project noise trigger levels are developed through this process. They are not used directly as regulatory limits.

The NPfI requires a project to take consideration of other industrial noise sources in setting amenity noise objectives. In cases of a new development where there are no existing industrial sources, the NPfI accepts a default of the amenity noise level minus 5 dB to take account of future industrial sources.

For the proposed development, the services noise will be assessed with the default amenity noise level minus 5 dB adjustment to account for cumulative noise sources. The cumulative operational noise impact associated with the metro station and this proposal has not been assessed together as they will each meet an amenity noise level objective that allows for other industrial noise sources in the area. If both projects use their entire amenity noise criteria, the combined noise impact would remain 2 dB below amenity noise levels discussed below.

Intrusiveness base noise criteria

The intrusiveness noise level protects against significant changes in noise levels and is applicable to residential receivers only. The criterion is defined by the formula below:

$$L_{Aeq,15min} = rating\ background\ noise\ level + 5\ dB$$

The RBL is the average background noise level over a measurement period of at least one week.

Table 5-12 summarises the measured RBL and corresponding intrusiveness level for each time period.

Table 5-12 Operational noise intrusiveness levels – residential land uses only

RBL, L_{A90} dB(A)			Intrusive noise level criteria, $L_{Aeq,15min}$ dB(A)		
Daytime	Evening	Night-time	Daytime	Evening	Night-time
64	61	58	69	66	63

Amenity base noise criteria

The amenity noise level seeks to protect against cumulative noise impacts from industry.

The NPfI uses project noise trigger levels measured over a 15-minute time period, assessed as an $L_{Aeq,15min}$. The night-time amenity noise criterion is the most stringent, hence the controlling time-period. To account for converting $L_{Aeq,period}$ to $L_{Aeq,15min}$, the NPfI accepts a default conversion factor of $L_{Aeq,15min} = L_{Aeq,period} + 3$ dB.

To ensure industrial noise levels do not gradually increase with new developments, a minus 5 dB(A) correction is applied to the amenity noise level. The amenity noise levels have been presented in Table 5-13.

Table 5-13 Operational noise amenity levels

Receiver	Noise amenity area	Time period	NPfI Amenity noise level, L_{Aeq} dB(A)	Adjusted amenity noise level[1], $L_{Aeq,15min}$ dB(A)
Residential	Rural	Day	50	48
		Evening	45	43
		Night	40	38
	Suburban	Day	55	53
		Evening	45	43

Receiver	Noise amenity area	Time period	NPfl Amenity noise level, L_{Aeq} dB(A)	Adjusted amenity noise level[1], $L_{Aeq,15min}$ dB(A)
		Night	40	38
	Urban	Day	60	58
		Evening	50	48
		Night	45	43
Hotels, motels, caretakes quarters, holiday accommodation, permanent resident caravan parks	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day			
School classroom – Internal	All	Noisiest 1-hour period when in use	35	33 (Note 2)
Hospital ward	Internal	Noisiest 1-hour period	35	33
	External	Noisiest 1-hour period	50	48
Place of worship	Internal	When in use	40	38 (Note 2)
Passive recreation area	All	When in use	50	48
Active recreation area	All	When in use	55	43
Commercial premises	All	When in use	65	63
Industrial premises	All	When in use	70	68
Industrial interface	All	All	Add 5 dB(A) to the recommended noise amenity area	

Notes:

1. Adjusted level calculated by applying 5 dB reduction to account for cumulative existing and future industrial noise sources and 3 dB addition to adjust the amenity noise level from L_{Aeq} to $L_{Aeq,15min}$.
2. For assessment, 10 dB can be added to the internal noise level criteria to assess the external noise level. This is generally accepted as the reduction provided by the façade with an open window.

Project noise trigger levels

The project noise trigger level is the lower (i.e., the more stringent) value of the project intrusiveness noise level and project amenity noise level determined in the above sections. Operational project noise trigger levels for residential land uses are presented in Table 5-14.

Table 5-14 Operational project noise trigger levels - residential land uses only

Time of Day	Intrusiveness Level, dB(A)	Adjusted Amenity Noise Level (Urban), dB(A)	Project Noise Trigger Level, dB(A)
Day	69	58	58
Evening	66	48	48
Night	63	43	43

Corrections for annoying noise characteristics

Table C1 of the NPfI provides corrections for tonality, intermittency, irregularity, or dominant low-frequency content. These corrections are to be added to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. NPfI also provides adjustments for duration that can increase the project noise criterion for unusual or one-off high-noise level events.

Low frequency noise correction

A difference of 15 dB or more between the C- and A-weighted noise measurements, identifies the potential for an unbalanced spectrum and an increased likelihood of low frequency noise annoyance.

The difference between C- and A-weighted noise levels is typically used as a screening tool to determine if further investigation is required to determine potential annoyance (i.e., where the difference is 15 dB or more). Where further investigation confirms significant low frequency content, a low frequency noise correction is applied to the predicted or measured noise levels.

The NPfI identifies that the corrections should “reflect external assessment locations”, or sensitive receiver locations so the existing noise environment should be considered.

At the monitoring location the existing ambient noise levels are 2 dB, 3 dB, and 4 dB greater than the background noise during the daytime, evening, and night-time period respectively. The design noise criteria will be below the existing ambient noise level so triggering of the low frequency noise criteria is unlikely.

5.3.2 Sleep disturbance

The NPfI contains guidance on sleep disturbance and the following screening levels are used to identify where further investigation of sleep disturbance should be undertaken for residential properties:

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

This assessment has considered both the night-time $L_{Aeq,15min}$ noise levels and L_{AFmax} noise levels, where they are relevant. The sleep disturbance screening levels are presented in Table 5-15.

Table 5-15 Operational noise – sleep disturbance screening levels

Night-time RBL, dB(A)	Sleep disturbance screening levels, dB(A)	
	$L_{Aeq,15min}$	L_{AFmax}
58	63	73

5.3.3 Emergency plant noise

In the absence of any relevant NSW guideline for emergency generators and equipment, it is recommended that the intrusiveness noise criteria in Table 5-12 be relaxed by 5 dB(A) for emergency plant equipment. Table 5-16 presents criteria for emergency operations noise criteria.

Table 5-16 Emergency plant operational noise criteria – residential land uses

Receiver	Noise Amenity Area	Time Period	NPfI Intrusiveness Criteria, $L_{Aeq,15min}$ dB(A)	Emergency Operations Noise Criteria, $L_{Aeq,15min}$ dB(A)
Residential	Urban	Day	69	74
		Evening	66	71
		Night	63	68

5.3.4 Traffic generating development

Guidance for the assessment of noise from traffic movements to and from site, including truck and car movements is provided by the RNP.

Table 5-17 presents the RNP road traffic noise assessment criteria for residential/commercial land use developments with potential to create additional traffic on existing roads. The external noise criterion is assessed at 1 metre from the affected residential building facades and at a height of 1.5 metres above the ground or floor level.

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

Table 5-17 Operational noise assessment criteria – traffic generating development

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

5.3.5 Airborne external noise intrusion

The State Environment Planning Policy (Transport and Infrastructure) 2021 provides guidance for residential development to ensure that occupants are adequately protected from noise associated with existing road and railway infrastructure.

For non-residential development such as this proposal, reference is made to the AS/NZS 2107:2016 “Acoustics – Recommended design sound levels and reverberation times for building interiors” (AS/NZS 2107:2016) which provides recommended design internal noise level for different building types and occupancies.

All internal areas of the development shall be designed to mitigate external noise intrusion to the recommended internal noise criteria contained within AS/NZS 2107:2016 based upon their use.

Combined internal noise levels due to external noise intrusion and internal mechanical services such as air conditioning and mechanical ventilation plant should not exceed the upper level of the range recommended in AS/NZS 2107:2016.

Internal noise levels due to road traffic noise intrusion should be controlled to meet AS/NZS 2107:2016 recommended design sound levels less 3 dB. This allows for an equal contribution from mechanical services noise sources within the development.

Table 5-18 External Noise Intrusion – Non-Residential Land Uses

Type of occupancy/activity	Design sound level range $L_{Aeq,T}$, dB(A)
Educational Buildings • Lecture rooms up to 50 seats • Teaching spaces/single classroom – open plan teaching space	 30 to 35 35 to 45
Health Buildings • Consulting rooms	 40 to 45
Office Buildings • General office areas	 40 to 45
Hotels and Motels in inner city areas or entertainment districts or near major roads • Sleeping areas (night-time)	 35 to 40
Small Retail Stores (General)	<50

5.3.6 Ground-borne noise

Where buildings are constructed over or adjacent to land over tunnels, ground-borne noise may be present where airborne noise does not provide a masking effect. The NSW Development near Rail Corridors and Busy Roads – Interim Guideline specifies a night-time residential noise criterion of $L_{Amax,slow}$ 35 dB(A) to which 95 percent of train passbys must comply.

5.3.7 Ground-borne vibration

The NSW Development near Rail Corridors and Busy Roads – Interim Guideline specifies vibration criteria listed in the AVATG for appropriate vibration goals for continuous, impulsive, and intermittent vibration. These criteria have been defined in Table 5-19.

Table 5-19 Operational vibration – human comfort criteria – intermittent vibration

Land use	Vibration Dose Value (VDV) design goals (m/s$^{1.75}$)			
	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas (1)	0.10	0.20	0.10	0.20
Residences (2)	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria.
2. Criteria for residences are lower than schools as people expect to be able to relax/sleep in their homes without annoyance and are generally more concerned about structural damage than would be the case within schools and offices.

5.3.8 Development Control Plan requirements

The City of Sydney noise and vibration requirements for any existing or new premises are contained in the Sydney Development Control Plan 2012 (DCP). It is noted that the DCP is not applicable to SSD, however does provide good guidance for assessing noise impacts at residential developments.

The key provisions in the DCP relating to acoustics are:

"4.2.3.11 Acoustic privacy

(1) A Noise Impact Assessment prepared by a suitably qualified acoustic consultant may be required when submitting a development application for commercial and retail uses which may affect the acoustic privacy of the adjacent residential use.

(2) Where necessary, a residential development is to include acoustic measures to reduce the impact of noise from existing or planned external sources (for example busy roads, adjoining industries, live music venues and public parks and plazas in which people may congregate or host live music or events).

(3) Development is to incorporate measures that reduce the entry of noise from external sources into dwellings.

(4) Where possible, the attenuation of noise at its source is preferred. Where this option is adopted, the applicant will need to demonstrate that the measures to be undertaken:

(a) have the consent of relevant parties associated with that noise source;

(b) last for the life of the development proposal.

(7) The repeatable maximum $L_{Aeq(1hour)}$ for residential buildings and serviced apartments must not exceed the following levels:

(a) for closed windows and doors:

(i) 35dB for bedrooms (10pm-7am); and

(ii) 45dB for main living areas (24 hours).

(b) for open windows and doors:

(i) 45dB for bedrooms (10pm-7am); and

(ii) 55dB for main living areas (24 hours).

(8) Where natural ventilation of a room cannot be achieved, the repeatable maximum $L_{Aeq(1hour)}$ level in a dwelling when doors and windows are closed and air conditioning is operating must not exceed:

(a) 38dB for bedrooms (10pm-7am); and

(b) 48dB for main living areas (24 hours).

(9) These levels are to include the combined measured level of noise from both external sources and the ventilation system operating normally.

(10) To limit the transmission of noise to and between dwellings, all floors are to have a weighted standardised impact sound level ($L'_{nT,w}$) less than or equal to 55 where the floor separates a habitable room and another habitable room, bathroom, toilet, laundry, kitchen, plant room, stairway, public corridor, hallway and the like.

(11) The overall design and layout of dwellings, where appropriate, is to include:

(a) a limit on window size and number where oriented towards an intrusive noise source;

(b) seals at entry doors to reduce noise transmission from common corridors or outside the building;

(c) minimisation of the number of shared walls with other dwelling units;

(d) storage, circulation areas, and non habitable rooms to buffer noise from external sources;

(e) double or acoustic glazing; and

(f) operable acoustic screens to balconies.

(12) Mixed-use development which includes two or more dwellings is to provide separate lift access and a separate entrance for use exclusively for the dwellings."

6 Impact assessment

6.1 Construction noise impacts

6.1.1 Construction staging

Construction planning is proceeding based on two possible staging scenarios:

- Scenario 1: Continuity of construction works from station to proposed development
- Scenario 2: Gap between completion of station (with full de-mobilisation) and commencement of proposed development works.

Both Scenario 1 and Scenario 2 will have the construction of the proposed development occurring after metro station construction works have ceased. Therefore, the construction impacts from the proposed development can be considered separately.

Detailed construction scenarios would be established in the Construction Noise and Vibration Management Plan (CNVMP) when more detail is available about the program of works including construction staging, likely construction scenarios, equipment types and locations, noise and vibration source levels, and hours of work.

6.1.2 Construction hours

It is anticipated that most construction works would be carried out during ICNG standard working hours. Any work undertaken outside of standard working hours would be undertaken in accordance with the ICNG. Internal fit-out works is expected to be undertaken outside of standard working hours once the building façade/glazing has been completed and will be carried out in accordance with the ICNG requirements.

While no specific out of hours work has been identified for this project, there are a range of activities which could occur on a major construction project such as:

- relocation of utilities
- the delivery of materials as required by the Police or other authorities for safety reasons
- where it is required to avoid the loss of lives, property and/or to prevent environmental harm in an emergency
- works which are determined to comply with the relevant Noise Management Level (NML) at the most affected sensitive receiver.

Any construction work outside ICNG standard hours (including one or two nights of work) would require prior approval. This would include a noise impact assessment to determine the potential for sleep disturbance impacts and the identification of reasonable and feasible noise management and mitigation measures.

6.1.3 Construction plant and equipment

Table 6-1 presents typical sound power levels of the construction equipment used in this assessment as well as the cumulative overall level of all the listed equipment.

The sound power levels are typical levels taken from the data provided in Australian Standard AS 2436-2010 - Guide to noise and vibration control on construction, demolition, and maintenance sites (AS 2436) and the UK Department for Environmental, Food and Rural Affairs (DEFRA) Update of noise database for prediction of noise on construction and open sites noise database. The assessment assumes all equipment is modern and in good working order.

Table 6-1 Typical sound power levels of modelled construction equipment

Scenario	Equipment/ activity	Quantity	Sound Power Level, dB(A)
Tower construction	Diesel tower cranes	2	99
	External man and material hoist	2	94
	Electric concrete placing boom	1	103
	Electric formwork hoist	2	82
	Diesel manitou at ground	1	92
	Forklift	1	101
	Delivery trucks of various sizes at ground	1	98
	Rubbish removal trucks at ground	1	98
	Diesel mobile cranes at ground	1	104
	Overall sound power level of all equipment		**110**

Source: AS 2436 and DEFRA.

For the noise assessment, the worst-case (highest noise level) construction scenario has been modelled. The modelled scenario includes all equipment in Table 6-1 operating continuously and simultaneously for the entire 15-minute assessment period, occurring at the closest point to the receiver. For equipment located on ground level, a 5 dB reduction has been applied to account for shielding effects from site hoarding.

6.1.4 Noise modelling methodology

To quantify noise emissions from the proposed construction works, environmental noise modelling software (SoundPLAN version 8.2) has been used to predict the $L_{Aeq(15min)}$ noise levels at nearby noise sensitive receivers.

The environmental noise model includes:

- ground terrain, sourced from Elvis Foundation Spatial Data
- building footprints, interpreted from SIX Maps aerial photography
- construction works area with the combined overall source noise levels of the anticipated equipment.

The predicted construction noise levels are likely to be conservative as they assume a potential worst-case scenario where all equipment operates simultaneously and continuously for the entire 15-minute period. As such, noise levels are likely to be lower than the worst-case noise levels presented for most time periods during the works.

6.1.5 Modelled noise impacts

Noise at sensitive receivers from construction activity at the proposed development site has been modelled based on the scenario outlined in section 6.1.3 and the methodology outlined in section 6.1.4. Noise contribution from a similar construction scenario (i.e., activity, equipment, and staging) at the Hunter Street Station West site has also been included in the modelling.

The predicted construction noise impacts are presented in Table 6-2, with a noise contour map provided in Appendix A.

Table 6-2 Predicted standard construction hours noise impacts

ID	Address	Receiver Type	Criteria, dB(A)	Predicted Noise Level, dB(A)	
				$L_{Aeq(15min)}$	Exceedance
R-1	Office Building and Bar, 320 George Street	Commercial	74	76	2
R-2	Office Building, 309 George Street	Commercial	74	76	2
R-3	Wynyard Station, 287 George Street	Commercial and Transport	74	74	-
R-4	The Peapes Building, 285 George Street	Commercial	74	72	-
R-5	Office Building, 283 George Street	Commercial	74	70	-
R-6	Office Building, 275 George Street	Commercial	74	66	-
R-7	A by Adina Hotel, 2 Hunter Street	Hotel	74	74	-
R-8	Retail and Office Building, 10 Hunter Street	Commercial	74	74	-
R-9	Retail and Office Building, 20 Hunter Street	Commercial	74	73	-
R-10	The Grand Hotel, 30 Hunter Street	Hotel and commercial	74	69	-
R-11	The Tank Stream Hotel, 97-99 Pitt Street	Hotel and commercial	74	65	-
R-12	Radisson Blu Hotel, 27 O'Connell Street	Hotel	74	77	3
R-13	Office Building, 23-25 O'Connell Street	Commercial	74	77	3

ID	Address	Receiver Type	Criteria, dB(A)	Predicted Noise Level, dB(A)	
				$L_{Aeq(15min)}$	Exceedance
R-14	The Public Trust Office, 19-21 O'Connell Street	Commercial	74	75	1
R-15	Office Building, 16-18 O'Connell Street	Commercial	74	93	19
R-16	EzyMart, 23 Bligh Street	Commercial	74	96	22
R-17	Office Building, 25 Bligh Street	Commercial	74	64	-
R-18	Lowy Institute, 31 Bligh Street	Commercial	74	90	16
R-19	Office Building, 4-6 Bligh Street	Commercial	74	67	-
R-20	Office Building, 1 Chifley Square	Commercial	74	60	-
R-21	City Mutual Building, 66 Hunter Street	Commercial	74	71	-
R-22	Martin Place Metro Station, 4 Castlereagh Street	Transport	74	45	-
R-23	Office Building, 1 Castlereagh Street	Commercial	74	70	-
R-24	Perpetual Trustee Building, 39 Hunter Street	Commercial	74	74	-
R-25	Office Building, 68 Pitt Street	Commercial	74	75	1
R-26	Currency House, 23 Hunter Street	Commercial	74	65	-
R-27	Office Building, 107 Pitt Street	Commercial	74	97	23
R-28	Office Building, 105 Pitt Street	Commercial	74	83	9
R-29	Retail and Office Building, 19-21 Hunter Street	Commercial	74	70	-
R-30	Apartments, Hotel and Retail, 15-17 Hunter Street	Hotel and commercial	74	79	5
R-31	Office Building, 109 Pitt Street	Commercial	74	93	19

The nearest residential receiver is around 100m south of the construction works, therefore construction noise impacts will be limited. An exceedance of up to 23 dB has been predicted at some commercial receivers located closest to the proposed development.

The predicted noise level exceedances above trigger a requirement to ensure that all feasible and reasonable noise management and mitigation measures are included in the contractors CNVMP, to be prepared as part of the subsequent Detailed SSDA.

6.1.6 Cumulative impacts

The predicted cumulative noise impact of both Hunter Street West and Hunter Street East OSDs being constructed simultaneously are presented in Table 6-2.

There are predicted exceedances at a few commercial receivers with the highest exceedance being no more than 23 dB. These impacts would be considered in more detail in the contractors CNVMP with the identification of appropriate noise management and mitigation measures to limit impacts on the surrounding community.

In addition to the cumulative Hunter Street Station West and East OSD impacts above, there is the potential for cumulative construction impacts with other future developments (not associated with the project) proposed near the project site. At this stage, detailed information of the activities during construction of the proposed development and other nearby potential future developments are not available and therefore an objective assessment cannot be conducted.

Nevertheless, if significant noise generating construction activities are anticipated to occur at other sites near the development, consultation should be undertaken with the contractors to manage cumulative impacts on sensitive receivers within common areas. It is anticipated that community consultation measures will be sufficient to manage any cumulative impacts that could arise.

6.2 Construction traffic noise impacts

The main access routes for construction vehicles would be determined at a later stage and the potential noise impacts at sensitive receivers and assessed in accordance with the RNP. Given the existing traffic volumes through the site and the ability of workers to use the existing public transport network, the traffic noise impacts from construction activities are likely to be negligible.

Further investigation of likely traffic noise impacts would be completed by the contractor in the CNVMP as part of the subsequent Detailed SSDA which would include the identification of appropriate management and mitigation measures, if required.

6.3 Construction vibration impacts

There is no high vibration producing equipment identified in the construction stages in section 6.1.3. If any high vibration activities are proposed in the later stages of the project (such as rock breaking, piling, excavation, vibratory rolling, etc.) impacts of these activities will need to be managed to determine any potential human comfort impacts to receivers or structural/cosmetic damage to nearby structures.

If the use of vibration intensive plant is proposed, management controls for the plant should be captured in the contractor's CNVMP as part of the subsequent Detailed SSDA.

The CNVMP should also identify other vibration sensitive structures such as tunnels, fibre-optic cable, gas pipelines and other underground infrastructure. Specific vibration goals should be determined for these items to mitigate potential structural damage.

6.4 Operational noise impacts

6.4.1 Airborne environmental noise emissions

Building services

The environmental noise emission from the proposed development services plant should be assessed against the environmental criteria presented in section 5. This should be assessed in detail during design development.

Noise generated by the proposed development is expected to be controlled by a few major items of plant, including the following:

- heat pumps
- cooling towers
- stair pressurisation fans
- generators.

The cooling towers are currently planned to be located on the roof of the building tower. Noise mitigation including acoustic louvres and attenuators on the exhaust fans are currently considered in the indicative reference design that accompanies the Concept SSD and should provide suitable noise attenuation to meet applicable noise criteria in section 5.3.

Noise mitigation including ducted exhausts with an attenuator in the plenum have been considered to meet the applicable noise criteria. Heat pumps on the tower may be located on the roof with suitable acoustic louvres and attenuators to meet the noise criteria. Acoustic louvres and absorption within the plant room have been incorporated in the design to control noise breakout.

Stair pressurisation fans would generally be located on the roof. Suitable attenuators have been included in the design to meet the applicable noise criteria.

Generators are required for the commercial towers. They would generally be located on the roof and require attenuators and acoustic louvres to attenuate noise associated with air flow paths.

As part of the Detailed SSDA, the cumulative impact of noise emissions from plant associated with the operation of the building would be assessed. Appropriate noise mitigation would be included in the detailed design of the proposed development to meet the noise criteria in section 5.3.1. A review of potential plant and mitigation strategies has been completed and these mitigation strategies are considered reasonable and achievable.

Further information would be provided throughout the Detailed SSDA noise and vibration assessment to confirm appropriate noise attenuation is included in the design to comply with the applicable noise criteria.

Emergency operations

Emergency operations for the proposed development should be assessed against the criteria presented in Table 5-16 as part of the Detailed SSDA. Acoustic treatments, such as attenuators, acoustic louvres, and mufflers, should be incorporated into the detailed design as required to meet the emergency operations noise emission criteria.

Sleep disturbance

Noise emissions from the proposal are controlled by the major mechanical plant discussed above. The plant generates continuous noise, with L_{Amax} maximum noise levels typically 1 to 2 dB greater than the ambient L_{Aeq} noise levels. Compliance with the NPfI ambient noise criteria will also result in compliance with the sleep disturbance noise criteria.

It is expected that the following mitigation measures would be sufficient to minimise sleep disturbance:

- testing of emergency equipment, such as generators, during day-time periods.
- implementation of mitigation measures for mechanical plant identified in section 7.2.

6.4.2 Airborne external noise intrusion

External noise intrusion will be controlled by the acoustic performance of the façade. The composite performance of the façade is expected to be controlled by the glazing. A preliminary traffic noise intrusion assessment has been undertaken using a representative traffic noise spectrum based on the CNOSSOS-EU light, medium-heavy and heavy traffic spectrums. Noise levels incident on the building façade were determined from the unattended noise measurements detailed in section 4.2. Noise levels at these measurement locations were used to adjust the traffic noise spectrum to assess the worst affected façade of the commercial land uses at the proposed development.

The following indicative glazing options for the façade glazing construction for office / commercial land uses:

- single laminated glass at least 10.38 mm thick
- IGU with 10mm / 12mm air gap / 4mm glazing.

Regulating noise intrusion through the glazed windows is only effective with windows completely closed. Note that the specified glazing thickness only considers acoustic requirements and does not consider other requirements such as thermal, wind/structural loading, or safety.

The glazing recommendation is indicative only and would need to be reviewed during Detailed SSDA.

6.4.3 Ground-borne / structure-borne noise and vibration

Vibration generated from the operation of the Sydney Metro West project can affect the proposed development through two transmission paths:

- structure-borne noise generated from the track and radiated up through the development above
- ground-borne noise generated by vibration radiating from the tunnel and through the soil into adjacent buildings.

These two transmission paths will be assessed and mitigated through track form design under Stage 3 CSSI Application, to ensure adequate vibration mitigation is achieved at the source and the criteria defined in section 5.3 is achieved. No further vibration isolation of the proposed development is required.

Notwithstanding, the future developer should ensure that the final design and construction of the proposed development is fit for purpose of the intended use, considering the expected residual vibration impact from Sydney Metro West

operations. Note that additional mitigation may be required if the use of the space within the building is more sensitive than allowed for by the track-form design.

6.4.4 Road traffic generating development

The traffic generated by the proposed development will be constrained by the number of parking spaces that will be available. The Concept SSDA allows for the provision of up to a maximum of 70 car parking spaces to be split across both the East and West Hunter Street Station sites during the Detailed SSDA. Therefore, during peak hour, the proposed development would at most generate 70 vehicles movements associated with the car park.

Car park noise emissions

Car parking at the proposed development will be in the basement and therefore the associated noise will generally be contained within the basement and on site. Given that the car parking at the proposed development will replace the 86 existing car parking spaces, it is very unlikely that the car movements at the proposed development would noticeably add to the local road network or noise generated by road traffic.

As such, no specific additional mitigation measures for road traffic noise are recommended as part of this approval. However, opportunities to minimise future potential impacts should be considered as the design develops.

Loading dock noise emissions

The proposed loading dock is on ground level but will be enclosed within the building with access via O'Connell Street. Given that the loading dock will be enclosed, negligible noise impacts are expected to be generated by use of the loading dock. However, opportunities to minimise future potential impacts should be considered as the design progresses, including incorporating noise reduction provisions in the loading dock management plan prepared during the Detailed SSDA.

6.5 Operational vibration impacts

It is anticipated that operational vibration impacts associated with the development can be managed with standard mitigation measures. These measures would typically include vibration isolation of any vibration generating plant. A summary of the noise and vibration mitigation measures relevant to the operation of the proposal is presented in Table 7-1. The list of measures will be reviewed and refined as part of the detailed design such that the operational noise and vibration requirements are met.

7 Management and mitigation measures

7.1 Construction noise and vibration measures

Construction noise and vibration impacts should be mitigated and managed in accordance with a CNVMP that has been prepared based on the CNVS.

7.1.1 Construction noise and vibration management plan

Prior to the commencement of major construction works the contractor should develop a detailed CNVMP. The CNVMP should:

- identify relevant construction noise and vibration criteria as detailed in this report
- identify neighbouring land uses that are sensitive to noise and vibration
- summarise key noise and vibration generating construction activities and the associated predicted levels at neighbouring land uses
- identify reasonable and feasible work practices to be implemented during the works
- summarise stakeholder consultation and complaints handling procedures for noise and vibration.

7.1.2 Managing predicted exceedances from modelled construction scenarios

Exceedances of the construction noise management levels have been predicted in section 6.1.5. Further investigation should be undertaken in detailed design to manage these exceedances, including the following:

- the criteria for non-residential sensitive receivers are only applicable when the receiver is in use. Therefore, further investigation into the operation of these nearby sensitive uses should be undertaken to manage these impacts.
- the noise levels for these scenarios represent a typical worst-case with all equipment operating concurrently. These levels are considered conservative and as more detail about the construction methods and equipment is developed this can be refined further.

7.2 Operational noise and vibration measures

A summary of the noise and vibration mitigation measures relevant to the operation of the proposal is presented in Table 7-1. The list of measures would be reviewed and refined as part of the detailed design such that the operational noise and vibration requirements are met.

Table 7-1 Operational recommendations summary

Operational item	Mitigation measures
Building services noise	Acoustic treatment has been recommended for the following mechanical plant: • cooling towers will incorporate acoustic louvres and attenuators on the exhaust fans • heat pumps will incorporate ducted exhausts with an attenuator in the exhaust plenum • stair pressurisation fans will include suitable attenuators • generators will incorporate attenuators and acoustic louvres. In general, standard acoustic treatments should be implemented for all major equipment installed as part of the proposed development to meet the established criteria. Standard acoustic treatments include the following: • acoustic barriers around roof top plant • robust construction of plant rooms • acoustic louvres to plant room openings • acoustic attenuators for mechanical ductwork • acoustic mufflers in generator exhaust systems • internal lining of ductwork • selection of low noise plant.
Building services vibration	All major equipment, installed as part of the proposed development, should be mounted on isolation mounts. The following measures should be adopted for mounting of mechanical plant: • Isolation mounts and connections should be provided for all reciprocating and rotating equipment, pipework, and ductwork. • Selection of suitable vibration isolation systems should be made based on the design minimum isolation efficiency, floor static deflection, and plant/equipment mass, rotational/reciprocating speeds, and power requirements etc. • The method of vibration isolation should be selected for each application. • A minimum clearance of 50 mm between vibrating and rotating equipment and nearby building structure and 25 mm between the underside of a concrete inertia block or machine base and the top of a concrete floor slab should be achieved. Contractors must ensure that any debris between items of plant and the building structure is removed. • Unless otherwise specified the manufacturers' recommendations for installation of vibration isolation mounts and flexible connections should be strictly observed. • Where metal (coil) springs are required, they should be provided with neoprene pads in series fixed to the base of the springs. • All rotary machinery should be accurately balanced both statically and dynamically.
Emergency operation	Acoustic treatments, such as attenuators, acoustic louvres, and mufflers, should be incorporated into the design as required to meet the emergency operations noise emission criteria.

Operational item	Mitigation measures
Sleep disturbance	Appropriate reasonable and feasible acoustic treatments should be incorporated into the design of the OSD buildings as required to minimise sleep disturbance. It is expected that the mitigation measures detailed above for building services noise will be sufficient for managing sleep disturbance. Where possible, testing of emergency equipment, such as generators, should be scheduled during day-time periods.
Traffic noise intrusion	The preliminary assessment recommends an indicative glazing thickness of 10.38mm thick laminated glass for office uses in the OSD buildings. The preliminary assessment indicates that mechanical ventilation is incorporated into sleeping areas so that residents can keep windows shut if desired. These recommendations will be reviewed during the Detailed SSDA and it is noted that non-acoustic requirements (e.g., structural, safety or mechanical plant emissions) may have additional façade requirements.
Sydney Metro ground-borne/structure-borne noise and vibration	It is expected that structure-borne noise and ground-borne noise relating to the operation of Sydney Metro will be mitigated through track form design. No further vibration isolation of the proposed development is anticipated. The OSD developer should ensure that design of the development is fit for purpose and aligns with the intended use considered during the track-form design, otherwise further mitigation may need to be considered for more sensitive uses.
Road traffic generated from development	The reduction in carparking spaces for the proposed development and the availability of Sydney Metro as an alternative transport option to driving are expected to lead to a reduction in traffic volumes related to the proposed development. Therefore, no net increase in the ambient acoustic environment on surrounding roads is expected. No specific additional mitigation measures are recommended at this stage.
Car park noise emissions	No net increase to the ambient acoustic environment is expected due to a decrease in car parking spaces and the fact that the carparking will be located underground. During detailed design, car park noise emission should be re-assessed to ensure the latest design complies with the environmental noise criteria. Further, opportunities to minimise potential impacts should be considered as the design develops.
Loading dock noise emissions	No net increase to the ambient acoustic environment is expected due to the loading dock being located with the enclosed building. During detailed design, loading dock noise emissions should be re-assessed to ensure the latest design complies with the environmental noise criteria. Further, opportunities to minimise potential impacts should be considered as the design develops, including incorporating noise reduction provisions in the loading dock management plan prepared during the Detailed SSDA.

8 Conclusion

This report presents the results of a noise and vibration assessment of the proposed development for Hunter Street East OSD. The report has been prepared to outline the noise and vibration impacts of the proposed development and to specifically respond to the SEARs issued for the Concept SSDA. Construction and operational noise and vibration criteria for the proposed development have been established based on the SEARs.

The site is located on the corner of Hunter Street, O'Connell Street and Bligh Street. The site is surrounded by both commercial receivers and hotels. The nearest sensitive hotel receiver is the Radisson Blu Hotel, which is situated directly opposite the site on the corner of O'Connell Street and Hunter Street. There are also hotels situated at 30 Hunter Street, 97-99 Pitt Street, 15-17 Hunter Street and on the corner of George Street and Hunter Street. The nearest sensitive residential receiver is Astra Apartments at 3 Hosking Place, Sydney, which is approximately 100m south of the site.

The key findings of the assessment of the proposed development are:

- Noise levels have been predicted for the worst-case (highest noise level) construction scenario. The nearest residential receiver is around 100m south of the construction works, so construction noise impacts would be limited. Exceedances of up to 23 dB have been predicted at a few commercial and hotel receivers closest to the site, which will be managed and mitigated through the implementation of a contractors CNVMP, to be prepared as part of the subsequent Detailed SSDA.
- The integrated nature of the delivery of the proposed development may lead to concurrent construction of some components of the station and proposed development. A detailed construction itinerary would be developed and provided in the CNVMP by the proposed development contractors for the proposed development which would include duration and timing of the construction. Construction noise impacts have been predicted for the worst-case scenario of the both Hunter Street East and West OSDs being constructed simultaneously.
- The main access routes for construction vehicles will be determined at a later stage and the potential noise impacts at sensitive receivers will be assessed in accordance with the RNP. However, given the existing traffic volumes through the site and the ability of workers to use the existing public transport network, the traffic noise impacts from construction activities are likely to be negligible.
- There is no high vibration producing equipment or processes anticipated during construction at this stage.
- Vibration generated for the operation of the Sydney Metro West project can affect the proposed development from ground-borne noise (generated by vibration from the operational railway). These potential impacts would be mitigated through track-form design to ensure adequate vibration mitigation is achieved at the source. Vibration isolation of the proposed development is not anticipated to be required, however the developer should ensure that the design of the development is fit for purpose and aligns with the intended use considered during the track-form design.

The following mitigation measures and recommendations are proposed for the Concept SSDA development and will be developed further as part of the future Detailed SSDA:

- Major noise and vibration emitting sources from the proposed development have been identified, such as traffic and plant, and should be treated to meet the established criteria with the use of standard acoustic treatments.
- Noise and vibration intrusion to the proposed development from the station and tunnel, from sources such as rail induced noise and vibration, public address systems, engine noise and emergency and ventilation equipment, is expected to be controlled at the source and within the station and tunnel envelopes, in accordance with the relevant requirements stipulated for the Stage 3 CSSI Application.
- External noise intrusion will be controlled by the acoustic performance of the façade. External glazing recommendations have been provided and are considered achievable.
- It is expected that the implementation of standard acoustic mitigation measures would be sufficient to meet all operational noise and vibration criteria established in this report in line with the SEARS.
- Indicative construction scenarios applicable to the proposed development have been modelled and construction noise levels at nearby sensitive receivers have been predicted to exceed the stipulated construction noise criteria at some commercial and hotel receivers due to their proximity to the site. A CNVMP should be developed as part of the Detailed SSDA to manage and minimise potential impacts on nearby receivers, including structural or cosmetic damage to surrounding building structures.
- Construction noise and vibration impacts should be mitigated in accordance with the CNVS.

Appendix A – Construction noise contour map

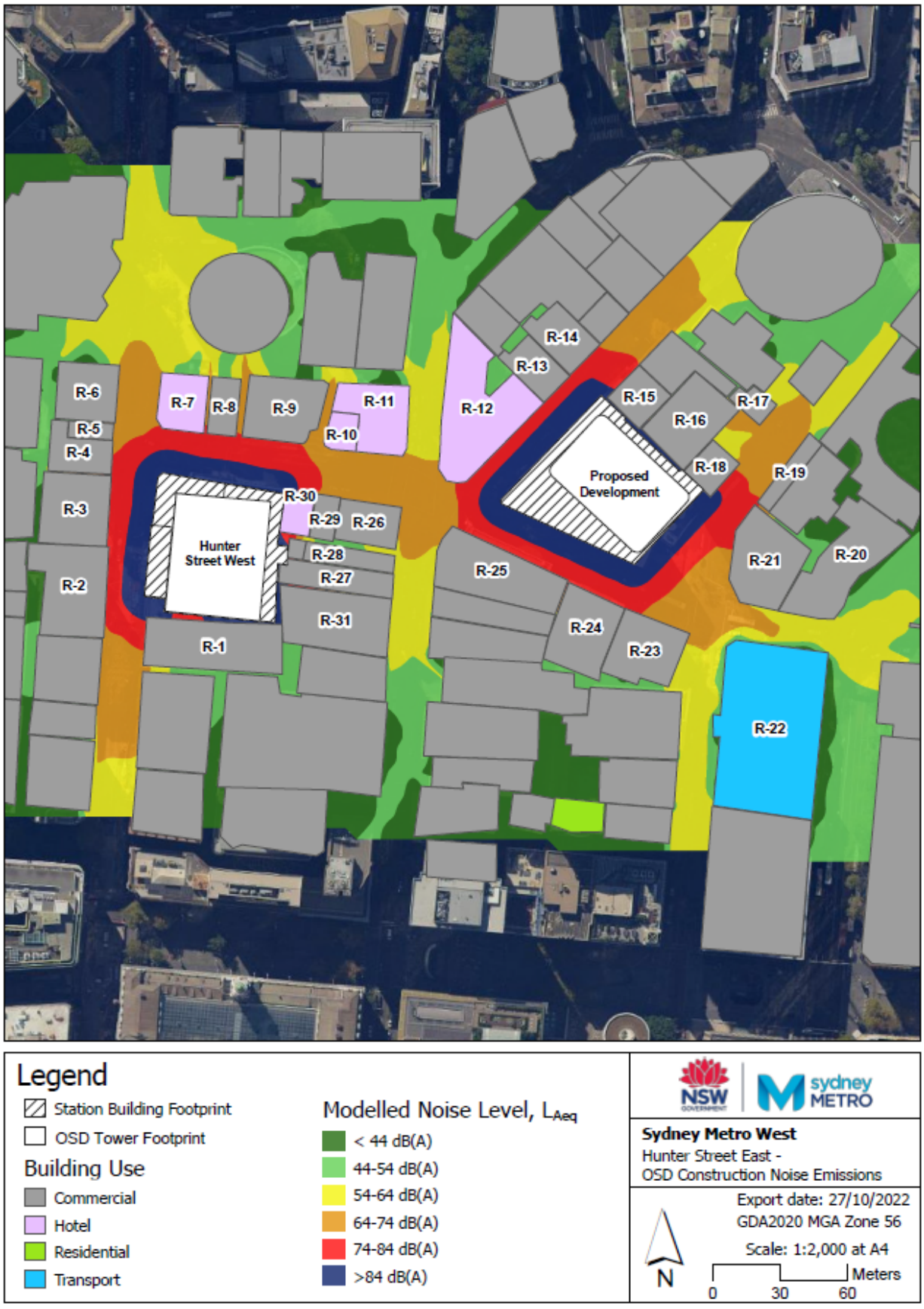

Figure A-1 Cumulative construction noise contour for concurrent construction activity of Hunter Street East and West OSDs