ACOUSTIC REPORT

APPENDIX O

Sydney Metro City & Southwest

Pitt Street South Over Station Development:

Acoustic Report

Applicable to:	Sydney Metro City & Southwest
Author:	GHD Pty Ltd
Owner	Sydney Metro
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Glossary

Term	Definition
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dBA	Decibel expressed with the frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at low and high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level that is exceeded for 90 per cent of the measurement period.
$L_{Aeq(15hr)}$	The L_{Aeq} noise level for the period 7:00 to 22:00 hours.
$L_{Aeq(9hr)}$	The L_{Aeq} noise level for the period 22:00 to 7:00 hours.
L_{Amax}	The maximum A-weighted sound pressure level occurring in a specified time period.
Noise sensitive receiver	A noise modelling term used to describe a map reference point where noise is predicted. They consist of areas or places potentially affected by noise or vibration including: • a residential dwelling • an educational institution, library, childcare centre or kindergarten • a hospital, surgery or other medical institution • an active (for example sports field, golf course) or passive (for example national park) recreational area • commercial or industrial premises • a place of worship.
Peak particle velocity	Peak particle velocity is the maximum vector sum of three orthogonal time-synchronized velocity components regardless of whether these component maxima occurred simultaneously.
Rating background level	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
Tonality	Noise containing a prominent frequency or frequencies characterised by definite pitch.
VDV	Vibration dose value - As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.

Term	Definition
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

1.0 Purpose of this report

1.1 Background

This report supports a concept State Significant Development Application (concept SSD Application) 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 SSD Application is made in accordance with Section 4.22 of the EP&A Act.

Sydney Metro is seeking to secure concept approval for a building envelope above the southern portal of Pitt Street Station, otherwise known as the over station development (OSD). The concept SSD Application seeks consent for a building envelope, maximum building height, land use options, pedestrian and vehicular access, circulation arrangements and associated car parking as well as the strategies and design parameters for the future detailed design of development.

Sydney Metro proposes to procure the construction of the OSD as part of an Integrated Station Development package, which would result in the combined delivery of the station, OSD and public domain improvements. The station and public domain elements form part of a separate planning approval for Critical State Significant Infrastructure (CSSI) approved by DPE on 9 January 2017.

As the development is associated with railway infrastructure and is for residential or commercial premises with a Capital Investment Value of more than $30 million, the project is State significant development (SSD) pursuant to Schedule 1, Clause 19(2)(a) of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). The full extent of the proposed development can also be considered to be SSD by virtue of Clause 8(2) of the SRD SEPP.

This report has been prepared to specifically respond to the Secretary's Environmental Assessment Requirements (SEARs) issued for the concept SSD Application for Pitt Street South on 30th November 2017 which state that the Environmental Impact Statement (EIS) is to address the following requirements:

Acoustic Impact Assessment

1.1. Overview of the Sydney Metro in its context

The New South Wales (NSW) Government is implementing *Sydney's Rail Future*, a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of customers in the future. Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*.

Sydney Metro is Australia's biggest public transport project, consisting of Sydney Metro Northwest, which is due for completion in 2019 and Sydney Metro City & Southwest, which is due for completion in 2024.

Sydney Metro West is expected to be operational in the late 2020s (refer to Error! Reference source not found.).

Figure 1: Sydney Metro alignment map

Sydney Metro City & Southwest includes the construction and operation of a new metro rail line from Chatswood, under Sydney Harbour through Sydney's Central Business District (CBD) to Sydenham and on to Bankstown through the conversion of the existing line to metro standards.

The project also involves the delivery of seven new metro stations, including at Pitt Street. Once completed, Sydney Metro will have capacity for 30 trains an hour (one every two minutes) through the CBD in each direction - a level of service never seen before in Sydney.

On 9 January 2017, the Minister for Planning approved the Sydney Metro City & Southwest - Chatswood to Sydenham application lodged as a Critical State Significant Infrastructure project (reference SSI 15_7400), hereafter referred to as the CSSI Approval.

The CSSI Approval includes all physical work required to construct the CSSI, including the demolition of existing buildings and structures on each site. Importantly, the CSSI Approval also includes provision for the construction of below and above-ground structures and other components of the future integrated station development (including building infrastructure and space for future lift cores, plant rooms, access, parking and building services, as relevant to each site). The rationale for this delivery approach, as identified within the CSSI

Application, is to enable the integrated station development to be more efficiently built and appropriately integrated into the metro station structure.

The EIS for the Chatswood to Sydenham component of the Sydney Metro City & Southwest project identified that the OSD would be subject to a separate assessment process.

Since the CSSI Approval was issued, Sydney Metro has lodged four modification applications to amend the CSSI Approval as outlined below:

- Modification 1- Victoria Cross and Artarmon Substation which involves relocation of the Victoria Cross northern services building from 194-196A Miller Street to 50 McLaren Street together with inclusion of a new station entrance at this location referred to as Victoria Cross North. 52 McLaren Street would also be used to support construction of these works. The modification also involves the relocation of the substation at Artarmon from Butchers Lane to 98 – 104 Reserve Road. This modification application was approved on 18 October 2017.
- Modification 2- Central Walk which involves additional works at Central Railway Station including construction of a new eastern concourse, a new eastern entry, and upgrades to suburban platforms. This modification application was approved on 21 December 2017.
- Modification 3 - Martin Place Station which involves changes to the Sydney Metro Martin Place Station to align with the Unsolicited Proposal by Macquarie Group Limited (Macquarie) for the development of the station precinct. The proposed modification involves a larger reconfigured station layout, provision of a new unpaid concourse link and retention of the existing MLC pedestrian link and works to connect into the Sydney Metro Martin Place Station. This modification application was approved on 22 March 2018.
- Modification 4 - Sydenham Station and Sydney Metro Trains Facility South which incorporated Sydenham Station and precinct works, the Sydney Metro Trains Facility South, works to Sydney Water's Sydenham Pit and Drainage Pumping Station and ancillary infrastructure and track and signalling works into the approved project. This modification application was approved on 13 December 2017.

Given the modifications, the CSSI Approval is now approved to operate to Sydenham Station and also includes the upgrade of Sydenham Station.

The remainder of the City & Southwest project (Sydenham to Bankstown) proposes the conversion of the existing heavy rail line and the upgrade of the existing railway stations along this alignment to metro standards. This portion of the project, referred to as the Sydenham to Bankstown Upgrade, is the subject of a separate CSSI Application (No. SSI 17_8256) for which an Environmental Impact Statement was exhibited between September and November 2017 and a Response to Submissions and Preferred Infrastructure Report was submitted to the NSW Department of Planning & Environment (DPE) in June 2018 for further exhibition and assessment.

1.2. Planning relationship between Pitt Street Station and the OSD

While the southern portal of Pitt Street Station and the OSD will form an integrated station development, the planning pathways under the *Environmental Planning and Assessment Act 1979* involve separate approval for each component of the development. In this regard, the approved station works (CSSI Approval) are subject to the provisions of Part 5.1 of the EP&A Act (now referred to as Division 5.2) and the OSD component is subject to the provisions of Part 4 of the EP&A Act.

For clarity, the approved station works under the CSSI Approval included the construction of below and above ground structures necessary for delivering the station and also enabling construction of the integrated OSD. This included but is not limited to:

- demolition of existing development
- excavation
- station structure including concourse and platforms
- lobbies
- retail spaces within the station building
- public domain improvements
- station portal link (between the northern and southern portals of Pitt Street Station)
- access arrangements including vertical transport such as escalators and lifts
- structural and service elements and the relevant space provisioning necessary for constructing OSD, such as columns and beams, space for lift cores, plant rooms, access, parking, retail and building services.

The vertical extent of the approved station works above ground level is defined by the 'transfer slab' level (which for Pitt Street South is defined by RL 58.25), above which would sit the OSD. This delineation is illustrated in Error! Reference source not found. below.

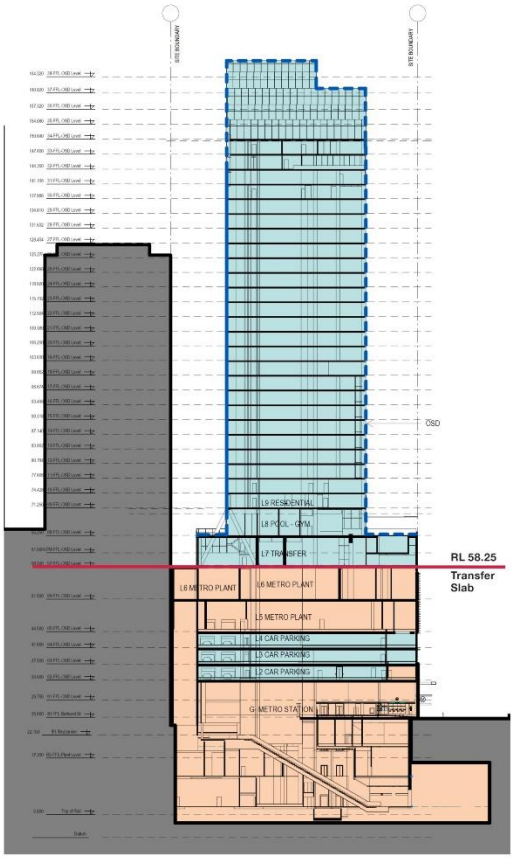

Figure 2: Delineation between station and OSD

The CSSI Approval also establishes the general concept for the ground plane of Pitt Street Station including access strategies for commuters and pedestrians. In this regard, pedestrian access to the station would be from Bathurst Street and the OSD lobby would be accessed from Pitt Street.

Since the issue of the CSSI Approval, Sydney Metro has undertaken sufficient design work to determine the space planning and general layout for the station and identification of those spaces within the station area that would be available for the OSD. In addition, design work has been undertaken to determine the technical requirements for the structural integration of the OSD with the station. This level of design work has informed the concept proposal for the OSD. It is noted that ongoing design development of the works to be delivered under the CSSI Approval would continue with a view to developing an Interchange Access Plan (IAP) and Station Design Precinct Plan (SDPP) for Pitt Street Station to satisfy Conditions E92 and E101 of the CSSI Approval.

The public domain improvement works around the site would be delivered as part of the CSSI Approval.

1.3. The Site

The Pitt Street South OSD site is located near the corner of Pitt Street and Bathurst Street, comprising four individual allotments but excluding the Edinburgh Castle Hotel, above the southern portal of the future Pitt Street Station. The context of the site is demonstrated at Error! Reference source not found. below.

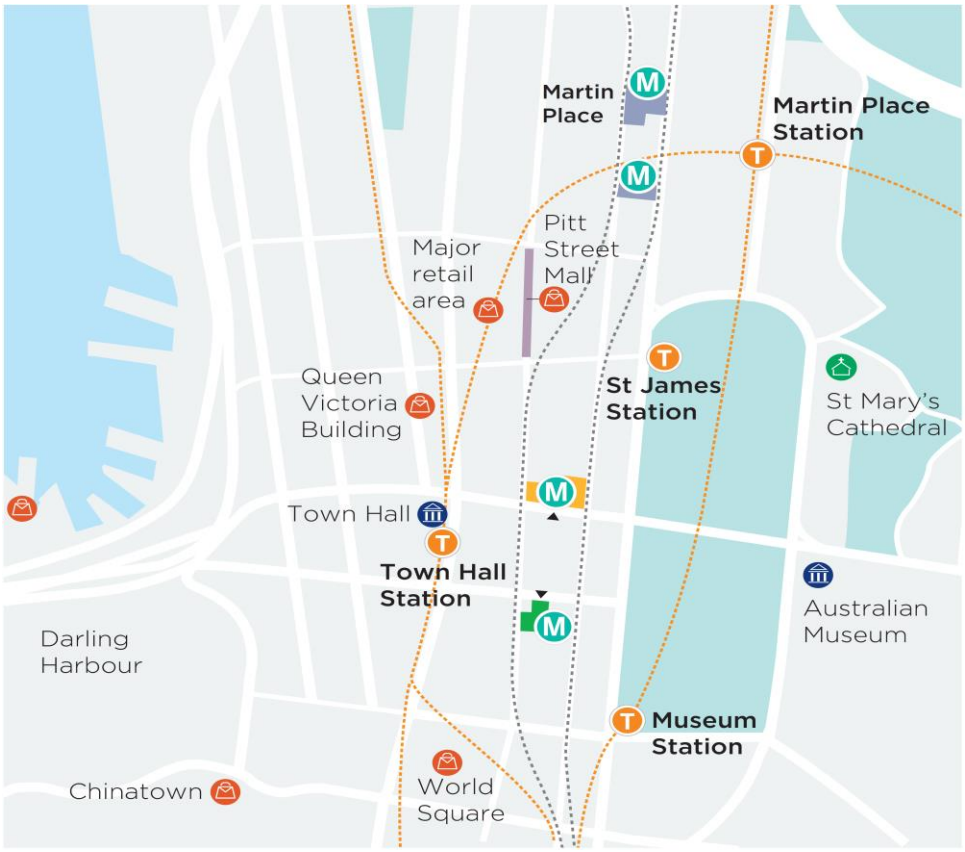

Figure 3: Pitt Street Station location plan

The site is located in the City of Sydney Local Government Area. The site (refer to **Figure 4** below) is irregular in shape, has a total area of approximately 1,708 square metres and has street frontages of approximately 32 metres to Pitt Street and 24 metres to Bathurst Street.

The Pitt Street South site comprises a number of individual properties which front Bathurst Street and Pitt Street. Specifically, the site comprises the following:

- 125-129 Bathurst Street, Sydney (Lot 1 in DP60293)
- 131-135 Bathurst Street, Sydney (Lot 1 in DP59101)
- 296-300 Pitt Street, Sydney (Lot 1 in DP436359)
- 302 Pitt Street, Sydney (Lot 1 in DP62668)

Figure 4: Aerial photo of Pitt Street South

1.4. Overview of the proposed development

This concept SSD Application comprises the first stage of the Pitt Street South OSD project. It will be followed by a detailed SSD Application for the design and construction of the OSD to be lodged by the successful contractor who is awarded the contract to deliver the integrated station development.

This concept SSD Application seeks approval for the planning and development framework and strategies to inform the future detailed design of the OSD. It specifically seeks approval for the following:

- a building envelope
- a maximum envelope height of Relative Level (RL 171.6) which equates to approximately 35 storeys, including the podium height of RL 71.0 which equates to approximately 8 storeys above ground
- use for the OSD component of the development for uses, subject to further detailed applications, which could include:
    - residential accommodation; or
    - commercial premises

- use of the conceptual OSD space provisioning within the footprint of the CSSI Approval (both above and below ground), including the OSD lobby areas, podium car parking, storage facilities, services and back-of-house facilities

- car parking for a maximum of 34 spaces located across three levels of the podium
- loading, vehicular and pedestrian access arrangements from Pitt Street
- strategies for utilities and service provision
- strategies for the management of stormwater and drainage
- a strategy for the achievement of ecologically sustainable development
- indicative future signage
- a strategy for public art
- a design excellence framework
- the future subdivision of parts of the OSD footprint (if required)

As this concept SSD Application is a staged development pursuant to section 4.22 of the EP&A Act, future approval would be sought for detailed design and construction of the OSD. Concept indicative designs showing potential residential and commercial building form outcomes at the site have been provided as part of this concept SSD Application at Appendix E and Appendix F, respectively.

Pitt Street Station is to be a key station on the future Sydney Metro network, providing access to the Sydney CBD. The proposal combines the metro station with an OSD component. The OSD would assist in strengthening the role of Central Sydney as the key centre of business in Australia and would contribute to the diversity, amenity and sustainability of the CBD.

It is noted that Pitt Street Station northern portal OSD is subject to a separate application, and does not form part of this concept SSD Application.

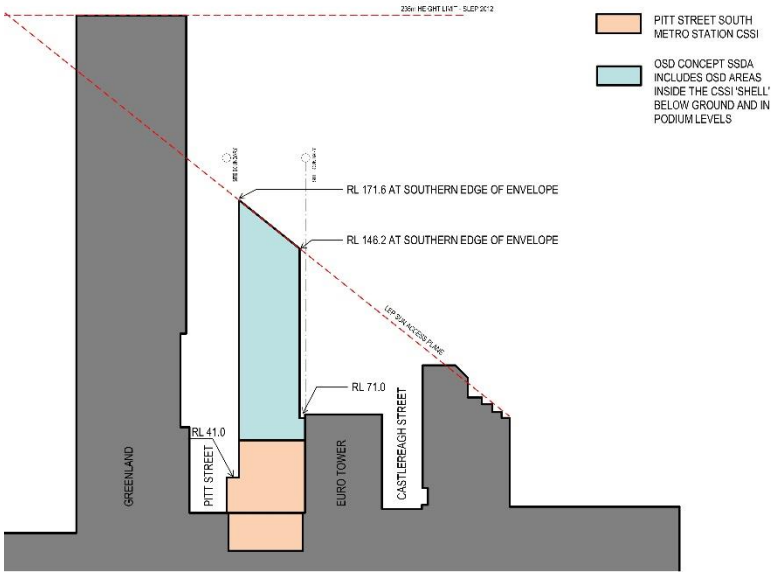

Figure 5: Pitt Street South OSD envelope, including OSD components (Blue) and station box (Orange)

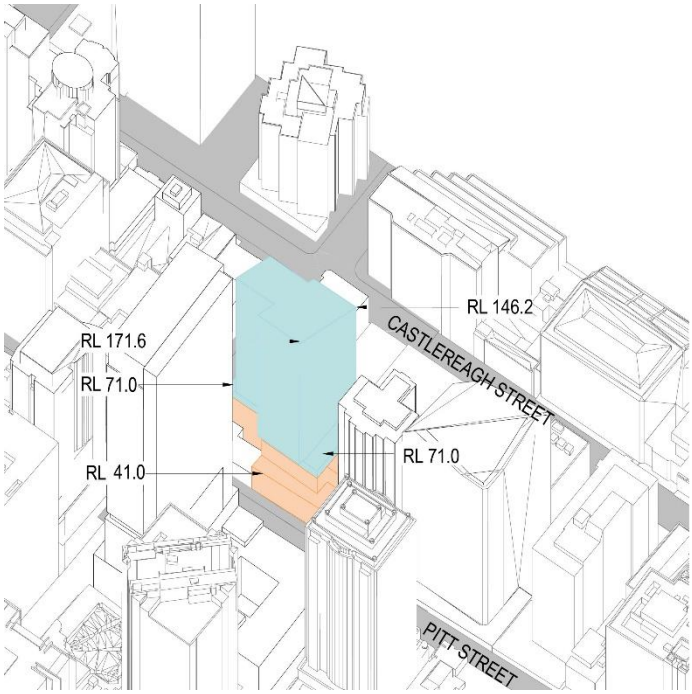

Figure 6: Pitt Street South OSD axonometric diagram, as seen from the south-west

1.5. Staging and framework for managing environmental impacts

Sydney Metro proposes to procure the delivery of the Pitt Street South integrated station development in one single package, which would entail the following works:

- station structure
- station fit-out, including mechanical and electrical
- OSD structure
- OSD fit-out, including mechanical and electrical.

Separate delivery packages are also proposed by Sydney Metro to deliver the excavation of the station boxes/shafts ahead of the integrated station development delivery package, and line-wide systems (e.g. track, power, ventilation) and operational readiness works prior to the Sydney Metro City & Southwest metro system being able to operate.

Three possible staging scenarios have been identified for delivery of the integrated station development:

1. Scenario 1 – the station and OSD are constructed concurrently by constructing the transfer slab first and then building in both directions. Both the station and OSD would be completed in 2024.
2. Scenario 2 – the station is constructed first and ready for operation in 2024. OSD construction may still be incomplete or soon ready to commence after station construction is completed. This means that some or all OSD construction is likely to still be underway upon opening of the station in 2024.
3. Scenario 3 – the station is constructed first and ready for operation in 2024. The OSD is built at a later stage, with timing yet to be determined. This creates two distinct construction periods for the station and OSD.

Scenario 1 represents Sydney Metro's preferred option as it would provide for completion of the full integrated station development and therefore the optimum public benefit at the site at the earliest date possible (i.e. on or near 2024 when the station is operational). However, given the delivery of the OSD could be influenced by property market forces, Scenarios 2 or 3 could also occur, where there is a lag between completion of the station component of the integrated station development (station open and operational), and a subsequent development.

The final staging for the delivery of the OSD would be resolved as part of the detailed SSD Application(s).

For the purposes of providing a high level assessment of the potential environmental impacts associated with construction, the following have been considered:

- Impacts directly associated with the OSD, the subject of this SSD Application
- Cumulative impacts of the construction of the OSD at the same time as the station works (subject of the CSSI Approval)

Given the integration of the delivery of the Sydney Metro City & Southwest metro station with an OSD development, Sydney Metro proposes the framework detailed in Error! Reference source not found. to manage the design and environmental impacts, consistent with the framework adopted for the CSSI Approval.

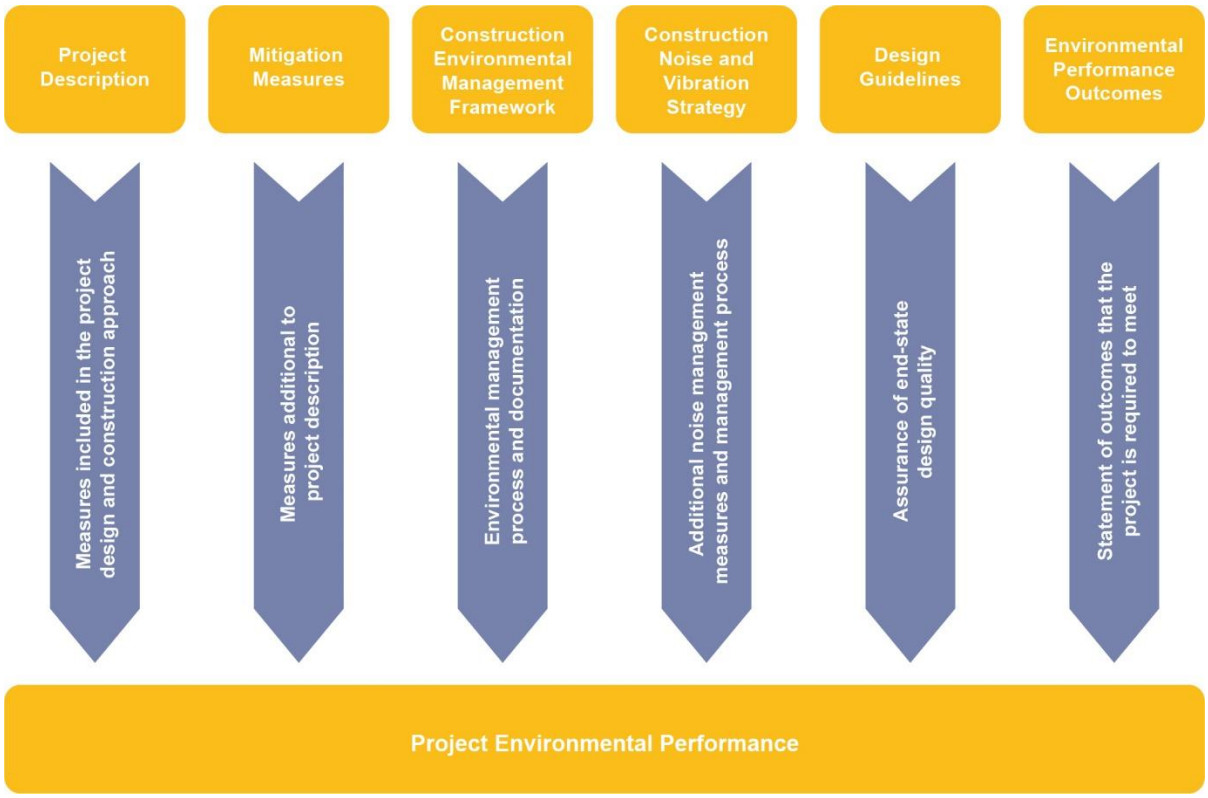

Figure 7: Project approach to environmental mitigation and management

Sydney Metro proposes to implement a similar environmental management framework where the integrated delivery of the CSSI station works and the OSD occur concurrently. This would ensure a consistent approach to management of design interface and construction-related issues.

Sydney Metro proposes this environmental management framework would apply to the OSD until completion of the station and public domain components of the integrated station development delivery contract (i.e. those works under the CSSI Approval). Should the OSD be constructed beyond the practical completion and opening of the station, standard practices for managing construction related environmental impacts would apply in accordance with the relevant guidelines and Conditions of Approval for the detailed SSD Application(s).

1.6. Scope of report

The assessment addresses the following:

- Noise emission from the proposed development, including noise associated with the use and operation of the development and the mechanical plant and equipment servicing the development
- Noise intrusion into sensitive areas of the development from the existing external noise sources
- Impact on the development from the vibration associated with the use of the SMCS corridor.
- Potential construction noise and vibration impacts associated with the construction of the development

1.7. Planning context

In preparing this document, the following publications were used:

- The City of Sydney Council's Development Control Plan (DCP) and Standard Conditions of Development Consent
- Interim Construction Noise Guideline (ICNG) (DECC, 2009)
- Environment Protection Authority's Industrial Noise Policy (INP) (2000)
- Environment Protection Authority's Noise Policy for Industry (NPfI) (2017)
- Environment Protection Authority's Noise Guide for Local Government (2013)
- NSW Department of Planning's Development Near Rail Corridors and Busy Roads – Interim Guideline (2008)
- Infrastructure SEPP (2007)
- Protection of the Environment Operations Act (POEO) 1997
- Sydney Metro Chatswood to Sydenham EIS – Technical Paper 2: Noise and Vibration (SLR, 2016)
- Sydney Metro City & Southwest Construction Noise and Vibration Strategy
- Assessing Vibration: A Technical Guideline
- Rail Infrastructure Noise Guideline

2.0 NSW Industrial Noise Policy / Noise Policy for Industry

The NSW Industrial Noise Policy (INP) was superseded by the Noise Policy for Industry (NPfI) on 27 October 2017. The main difference between the NPfI and the INP is that the project specific Amenity criterion is more stringent. The derivation of the Intrusiveness criterion remains the same.

The 'Implementation and Transitional Arrangement for the *Noise Policy for Industry (2017)' (EPA October 2017)* allows for the ongoing use of the INP under certain circumstances. They are replicated below:

1. The *NSW Noise Industrial Noise Policy* (2000) is withdrawn and is replaced by the *Noise Policy for Industry* (2017) except as described in points 2, 3 and 8 below.
2. The *Noise Policy for Industry* (2017) will take effect immediately upon its release and should be referenced in relevant Secretary's Environmental Assessment Requirements (SEARs) for new industrial development issued after the policy release date. Where SEARs were issued before the release of the new policy, and have not been modified, the assessment requirements referenced in the SEARs will apply for a period of two (2) years from the date of the issue of the SEARs consistent with the provisions in the *Environmental Planning and Assessment Regulation* 2000, Schedule 2, Part 2, 3 (7).
3. In situations where SEARs are not issued (that is, development consent that is not State Significant Development or Infrastructure), however a proponent can demonstrate that the environmental assessment substantially commenced before release of the new policy, planning and regulatory authorities may choose to determine the application based on the *NSW Industrial Noise Policy* (2000) for a period of up to one (1) year from the date of release on the *Noise Policy for Industry* (2017).

The Sydney Metro portion of the works has been approved prior to the publication of the NPfI, and the INP applies to that portion of the work. However the OSD is to be approved under a separate planning approval, after the publication of the NPfI. The design of the OSD portion is at concept phase and noise controls have not yet been designed.

Noise emission for the site applies to the cumulative noise levels from all aspects of the Indicative OSD Design and Sydney Metro Projects as follows:

- All operational aspects of the Indicative OSD Design including mechanical services plant, car parking, loading docks etc (OSD Design portion).
- The Pitt Street South mechanical and electrical plant for the continual operation of the station (Sydney Metro portion).
- The train tunnels require large fans for exhaust and ventilation. This includes the following sub-systems (Sydney Metro portion):
  - Tunnel Ventilation System (TVS)
  - Trackway Exhaust System (TES)

- Draft Relief (DR) shafts are also required for train passbys.

GHD understands that the Sydney Metro Project (station and tunnels) utilise the INP for the assessment of environmental noise emission with an adjustment applied to the criteria to allow for contribution from the indicative OSD design. The Sydney Metro Project was subject to a Critical State Significant Infrastructure (CSSI) process and has been conceptually approved. The SEARs for the Sydney Metro Project were issued prior to the release of the new NPfI and therefore, in accordance with the implementation arrangements, the INP is the relevant document to employ for the Sydney Metro portions of the project. It should also be considered that the assessment of the Sydney Metro Project (station and tunnels) has substantially commenced and has progressed significantly further than the Indicative OSD Design component.

This assessment has considered the differences between applying the INP and the NPfI to the OSD Design component. The aim for the total station system and OSD design is to ensure that noise emissions from Sydney Metro and OSD developments, when combined, will meet the applicable Conditions of Approval for the Sydney Metro CSSI portion of works. This has involved applying an allocation of allowable noise emissions for the three main aspects of the project described above, with each assigned noise emissions criteria set to 5dB below the applicable INP target.

Sydney Metro considers that the OSD Design is at a stage where it can accommodate the requirements of the NPfI, and that it is appropriate to acknowledge the current Policy in the assessment of the OSD Design. In addition, the cumulative noise emissions from Sydney Metro and OSD portions of the development need to meet the INP noise criteria in accordance with the CSSI approval.

The allocation of the allowable noise emissions from the OSD does not change, regardless of whether the INP or the NPfI is applied. This is because the NPfI approach for deriving the project-specific Amenity criterion results in a 5dB more stringent Amenity criterion than the now-superseded INP. A 5dB adjustment has already been applied for the noise allocation approach for the total development emissions, and therefore in terms of allowable noise emissions, the two approaches result in equal noise criteria for the OSD.

Therefore the noise emissions criteria for the OSD Design has taken a two-step approach:

1. Establish adjusted noise emissions criteria for the three main components of the Sydney Metro and OSD Design, such that the CSSI Approval conditions will be met by the whole development.

2. Compare the OSD Design adjusted criteria against the NPfI, to ensure that the adjusted criteria are no higher than the NPfI and therefore meet the intent of the new Policy.

The INP has been adopted for the assessment of environmental noise emission from the Indicative OSD Design with a similar adjustment to the criteria to allow for contribution from the Sydney Metro Project (station and tunnel). The adjusted criteria derived for the OSD

portion of the development have then been compared with the NPfI noise emissions criteria. This approach has been adopted to:

- Ensure that the CSSI noise emissions criteria (based on INP) are met by the whole development.
- Provide consistency across the assessment of noise emission from all sources located on the site (i.e. station, tunnels and indicative OSD design).
- Provide rational distribution of criteria between components (i.e. station, tunnel and indicative OSD design).
- Ensure that the intent of the updated NSW NPfI is met by the OSD portion of the design, particularly in relation to the approach for preserving acoustic amenity for noise-sensitive receivers.

3.0 Operational airborne noise assessment

3.1. Airborne noise criteria

3.1.1. Industrial Noise Policy

A summary of Rating Background Levels (RBLs) and relevant intrusive and amenity criteria specific to this project is given in **Table 3-1** (for residential receivers) and

Table 3-2 (for other sensitive land uses). The environmental noise criteria have been established in collaboration with Sydney Metro. The noise criteria have been adjusted to allow for an equal distribution of the INP noise criteria between the Indicative OSD Design and the Sydney Metro Projects as follows:

- All operational aspects of the Indicative OSD Design including mechanical services plant, car parking, loading docks etc. – OSD portion
- The Pitt Street South Station mechanical and electrical plant for the continual operation of the station. – Sydney Metro portion, approved
- The train tunnels require large fans for exhaust and ventilation. This includes the following sub-systems: – Sydney Metro portion, approved
    - Tunnel Ventilation System (TVS)
    - Trackway Exhaust System (TES)
    - Draft Relief (DR) shafts are also required for train passbys.

An equal distribution of the INP intrusiveness noise criteria between the Indicative OSD Design and Sydney Metro Projects results in each component (station, tunnel and indicative OSD design) being able to have an equal contribution to noise emission levels from the site but maintain compliance with the overall cumulative noise criteria.

The amenity criteria apply to environmental noise emissions from sources such as building services plant as these sources will run continuously and therefore will have the potential to contribute to background noise creep. The amenity criteria apply over the entire daytime, evening or night-time period, whereas intrusive criteria apply over any 15 minute period. All criteria must be applied at the most affected receiver boundaries.

The adjusted INP noise Amenity criteria allocated to the OSD Design have also been compared with the applicable NPfI Amenity noise criteria for the OSD. The Period Amenity criteria are identical taking the adjusted INP and the new NPfI approach. The adjusted INP Intrusiveness criteria for the OSD are 5dB below the NPfI approach for the OSD Design alone – that is, the “whole of development” approach which has been adopted for the OSD Design is 5dB more stringent than if the NPfI had been applied to the OSD Design on its own.

The adjusted INP criteria allocation ensures that the combined noise emissions from the OSD Design and the Sydney Metro station and tunnel-related portion of the project will meet the controlling overall CCSI criterion for the approved Sydney Metro project.

The noise data obtained for the EIS will be supplemented as the OSD design progresses, to ensure that noise emission criteria for residential receivers considers local variations in existing ambient noise due to shielding from road traffic noise by existing buildings, exposure to existing industrial-type noise sources such as rooftop plant, and so on. Additional noise monitoring cannot be obtained at this point due to large numbers of construction sites adjacent to the site.

Table 3-1 Summary of environmental noise emission criteria for residential receivers[1]

Period	Existing		Whole Integrated Station Development[2]		Each ISD component (OSD, Station, TVS)		OSD only
	RBL, $L_{A90\ period}$, dB(A)	Ambient $L_{Aeq\ period}$, dB(A)	Intrusiveness criteria, $L_{Aeq\ 15\ min}$, dB(A)	INP Amenity criteria, $L_{Aeq\ period}$, dB(A)	Adjusted Intrusiveness criteria, $L_{Aeq\ 15\ min}$, dB(A)	Adjusted INP Amenity criteria, $L_{Aeq\ period}$, dB(A)	NPfI Amenity criteria, $L_{Aeq\ period}$, [$L_{Aeq\ 15\ min}$], dB(A)
NCA 1 – residential receivers facing main road – based on B.27 260 Pitt Street							
Day	66	71	71	61	66	56	56 [59]
Evening	64	70	69	60	64	55	55 [58]
Night	61	68	66	58	61	53	53 [56]
NCA 1 – residential receivers off the main road (rear-facing[1]) – no data available at present							
Day	-	-	-	-	-	-	-
Evening	-	-	-	-	-	-	-
Night	-	-	-	-	-	-	-

Note 1: INP criteria are from the Resonate Acoustic Report for Pitt Street Station, and NPI Urban Amenity criteria (Period and 15-minute equivalent) have been derived by ACS in accordance with the NSW NPI. (Background and ambient noise levels source: Sydney Metro Chatswood to Sydenham Technical Paper 2: Noise and Vibration) (Criteria source: Resonate Acoustics and NSW Industrial Noise Policy).
Note 2: The whole integrated station development noise criteria applies to the combined noise emission from the Sydney Metro Project, including the tunnel ventilation, station and OSD
Note 3: The INP and NPfI define each period as follows:

- Daytime:
  - Monday to Saturday – 7:00 am to 6:00 pm
  - Sundays and public holidays – 8:00 am to 6:00 pm
- Evening:
  - Monday to Sunday and public holidays –6:00 pm to 10:00 pm
- Night-time:
  - Monday to Saturday – 10:00 pm to 7:00 am
  - Sundays and public holidays – 10:00 pm to 8:00 am

Table 3-2 INP amenity criteria for proposed site (commercial receivers)

Type of receiver	Noise amenity area	Time of day	Recommended LAeq(period) noise level, dBA	
			Acceptable	Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Commercial premises	All	When in use	65	70

3.1.2. Sleep disturbance

The Noise Guide for Local Government (EPA, 2013) provides the following information regarding sleep disturbance:

> *Currently there is no definitive guideline to indicate a noise level that causes sleep disturbance and more research is needed to better define this relationship. Where likely disturbance to sleep is being assessed, a screening test can be applied that indicates the potential for this to occur. For example, this could be where the subject noise exceeds the background noise level by more than 15 dB(A). The most appropriate descriptors for a source relating to sleep disturbance would be the LA1 (1 minute) (the level exceeded for 1% of the specified time period of 1 minutes) or LAmax (the maximum level during the specified time period) with measurement outside the bedroom window.*

The Industrial Noise Policy's – Application Notes and the Road Noise Policy recommend that where the $L_{A1(1min)}$ or $L_{A(max)}$ exceeds the $L_{A90(15min)}$ by more than 15 dBA outside the bedroom window, a more detailed analysis is required. The detailed analysis into sleep disturbance should assess the following factors that may be important in assessing the extent of impacts on sleep:

- the maximum noise level, or LA1(1 min), of the peak noise event
- the number of times and frequency of events where the maximum noise level exceeds the background level.

The Road Noise Policy provides further guidance, which indicates that:

- maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reactions which equates to 60 – 65 dBA outside considering a 10 dBA reduction for partially open windows
- one or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing which equates to 75 – 80 dBA

outside considering a 10 dBA reduction for partially open windows. 2017 at the corner of Pitt Street and Bathurst Street using a SVAN 977 sound level meter.

The NPI (EPA 2017) recommends a detailed maximum noise level event assessment be undertaken where night-time noise levels from a development exceed the following levels when assessed externally at the nearest residential location:

— $L_{Aeq(15min)}$ 40 dBA or the prevailing RBL + 5 dBA (whichever is greater); and/or

— L_{AFmax} 52 dBA or the prevailing RBL + 15 dBA (whichever is greater)

Applying the INP approach, there is an option to assess the $L_{A1,1minute}$ instead of the L_{Amax}. During design development, the OSD Design will examine in more detail whether the assessment approach using $L_{A1,1minute}$ or L_{Amax} from intermittent noise sources results in different outcomes. While the INP approach is applicable to the entire development, the NPfI approach will also be considered for the design controls required to manage sleep disturbance. **Table 3-3** below summarises the background noise level at the nearby residential receivers and the sleep disturbance criterion.

Table 3-3 **Sleep disturbance criteria (Source: NSW INP Application Notes and NSW Road Noise Policy)**

Receiver	Night RBL (L_{A90}), dB(A)	Sleep disturbance criteria, L_{Amax}, dB(A)	
		Screening level	Awakening reaction
Residential	61	76	65

3.1.3. City of Sydney requirements

The City of Sydney Standard Conditions of Development Consent provides the following requirements for noise emission for mechanical plant associated with the development

NOISE - GENERAL

a) The emission of noise associated with the use of the premises including the cumulative operation of any mechanical plant and equipment, and air conditioning shall comply with the following:

i) The $L_{Aeq(15\ minutes)}$ noise level emitted from the use must not exceed the project specific noise level for that receiver as determined in accordance with the NSW EPA Industrial Noise Policy. Noise must be measured in accordance with the Industrial Noise Policy and relevant requirements of Australian Standard AS 1055-1997 Acoustics Description and measurement of environmental noise.

ii) Project specific noise levels shall be determined by establishing the existing environmental noise levels, in complete accordance with the assessment $L_{A90(15\ minutes)}$ / rating $L_{A90(15\ minutes)}$ process to be in accordance with the requirements for noise monitoring listed in the NSW EPA Industrial Noise Policy and relevant

requirements of Australian Standard AS 1055-1997 Acoustics – Description and measurement of environmental noise.

iii) Modifying factors in Table 4.1 of the NSW EPA Industrial Noise Policy are applicable.

b) An $L_{A90(15\ minutes)}$ noise level emitted from the use must not exceed the $L_{A90(15\ minutes)}$ noise level by more than 3 dB in any Octave Band Centre Frequency (31.5 Hz – 8 kHz inclusive) when assessed inside any habitable room of any affected residence or noise sensitive commercial premises provided that;

i) Where the $L_{A90(15\ minutes)}$ noise level is below the threshold of hearing, Tf at any Octave Band Centre Frequency as defined in Table 1 of International Standard ISO 226 : 2006 – Normal Equal-Loudness-Level Contours then the value of Tf corresponding to that octave Band Centre Frequency shall be used instead.

ii) The $L_{Aeq(15\ minutes)}$ noise level and the $L_{A90(15\ minutes)}$ noise level shall both be measured with all external doors and windows of the affected residence closed;

iii) The relevant background noise level ($L_{A90(15\ minutes)}$) is taken to mean the day, evening or night rating background noise level determined in complete accordance with the methodology outlined in the NSW EPA Industrial Noise Policy and Australian Standard AS 1055-1997 Acoustics – Description and measurement of environmental noise.

iv) Background noise shall be established in the absence of all noise emitted from the use but with the ventilation equipment normally servicing the affected residence operating. Background noise measurements are to be representative of the environmental noise levels at the affected location.

v) Modifying factors in Table 4.1 of the NSW EPA Industrial Noise Policy are applicable. Internal Noise measurements are not to be corrected for duration.

The City of Sydney Council's Development Control Plan (DCP) 2012 provides the following requirements relating to acoustics.

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; and

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

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

(a) for closed windows and doors:

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

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

(b) for open windows and doors:

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

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

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

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

(b) 48 dB 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.

3.1.4. State Environmental Planning Policy (Infrastructure), 2007

Clause 87 and Clause 102 of the State Environmental Planning Policy (Infrastructure) 2007 states that consent must not be granted unless the noise criteria summarised in **Table 3-4** are not exceeded. The noise criteria within the SEPP (Infrastructure) 2007 are also consistent with those presented in

Table 4-1 of Development near Rail Corridors and Busy Roads Interim Guideline (Department of Planning, 2008).

Table 3-4 State Environmental Planning Policy (Infrastructure) 2007 internal noise criteria for residential buildings

Type of occupancy	Noise level	Period
Sleeping area (bedrooms)	35 dBA $L_{Aeq(9\ hr)}$	10 pm to 7 am
Other habitable rooms	40 dBA $L_{Aeq(15\ hr)}$	7 am to 10 pm

3.1.5. Australian Standard AS2107:2016 *Acoustics – Recommended design sound levels and reverberation times from building interiors*

Australian Standard AS2107:2016 *Acoustics – Recommended design sound levels and reverberation times from building interiors* provides recommended design sound levels for a variety of internal spaces. This guidance can be used to design external facades to reduce the impact of external noise sources, such as road traffic noise. **Table 3-5** below provides details for a range of possible internal spaces within the development. AS2107 provides a more comprehensive list if required.

Table 3-5 Recommended internal design sound levels – office / commercial spaces (Table 1 of AS2107:2016)

Type of occupancy	Recommended design sound level L_{Aeq}, dB(A)
	Design sound level ($L_{Aeq,\ t}$) range
Board and conference rooms	30 – 40
Executive office	35 – 40
General office areas	40 – 45
Meeting room (small)	40 – 45
Open plan office	40 – 45

3.1.6. Protection of the Environment Operations Act (POEO), 1997

The POEO Act defines 'offensive noise' as noise

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

Guidance from the EPA's Noise Guide for Local Government (EPA 2013) has been used to interpret offensive noise as noise which does not exceed background noise levels by more than 5 dBA when measured at the boundary of the nearest sensitive receiver.

In addition, EPA's Noise Policy for Industry provides guidance on the assessment of noise which consists of annoying characteristics, such as tonal noise, intermittent noise and low frequency noise. This document provides corrections to be applied to such noise.

3.2. Attended noise monitoring

Attended noise measurements were undertaken on 9 August 2017 between 4:30 and 5:30 pm.at the corner of Pitt Street and Bathurst Street using a SVAN 977 sound level meter to supplement and confirm the ambient noise levels provided in the EIS report.

The instrument was programmed to accumulate environmental noise data continuously over the measurement period of one hour. A calibration check on the noise monitoring equipment was performed before and after measurements using a sound level calibrator with a sound pressure level of 94 dBA at 1 kHz. The sound level meter was found to be within the acceptable tolerance of ± 0.5 dBA.

A summary of the equipment details is provided in **Table 3-6**.

Table 3-6 Attended noise monitoring equipment details

Location	Equipment details	Equipment settings
Corner of Pitt St and Bathurst St	SVAN 977 Type 1 SN: 36874	A-weighted Fast time response 15 minute intervals Pre – post calibration drift – 0.2 dB

The measured noise levels are summarised in **Table 3-7**. Note that the dominant source of noise was from road traffic.

Table 3-7 Measured noise levels, dBA

Location	L_{A90}	$L_{Aeq(1\ hr)}$	L_{Amin}	L_{Amax}
Corner of Pitt St and Bathurst St	66.2	73.5	61.1	101.0

3.3. Noise intrusion predictions

Based on the above 1 hour peak hour measurement, predicted maximum road traffic noise levels at the proposed development $L_{Aeq(1\ hr)}$ and the calculated $L_{Aeq(15\ hr)}$ and $L_{Aeq(9\ hr)}$ are presented in **Table 3-8**. The calculated $L_{Aeq(15\ hr)}$ and $L_{Aeq(9\ hr)}$ was used to predict internal noise levels in sensitive spaces within the proposed development. Note that the measured and calculated noise levels correlate well with the long term monitoring data within the EIS.

Note that a detailed assessment will be undertaken at the design stage of the development, when internal areas of the building have been designed. The general mitigation options are based on a worst case ground level noise level, however it is predicted that noise levels will decrease at the higher levels of the building. Modelling will be undertaken to determine the decrease in noise level at the design stage of the development.

Table 3-8 Predicted and calculated road traffic noise levels, dBA

Location	$L_{Aeq(1\ hr)}$	$L_{Aeq(15\ hr)}$	$L_{Aeq(9\ hr)}$
Corner of Pitt St and Bathurst St	73.5	70.9	68.0

Note:
1) Based on information provided within RMS' *NSW Road Noise Policy*, a correction factor of +2.5 has been applied to the $L_{Aeq(1\ hr)}$ to account for façade reflection not measured in the free field

2) Long term unattended noise monitoring will be undertaken at a later date to confirm the $L_{Aeq(15\ hr)}$ and $L_{Aeq(9\ hr)}$

3.4. Noise intrusion recommended acoustic treatments

Based on preliminary calculations, the following mitigation is likely to be required to reduce external noise levels to compliant levels in accordance with City of Sydney requirements. Calculations have been based on typical sizes for rooms (bedrooms and living areas / commercial spaces) and typical façade element sizes. This may differ from the final design.

3.4.1. Glazing treatments for windows and glazed doors

Heavy double glazing is likely to be required on the lower levels of the development, in particular habitable areas of the residential areas and offices/commercial spaces. It is also likely that double glazing will be required on higher levels of the development also, however final requirements will be determined on completion of the design of the internal areas of the development.

3.4.2. Ventilation

Based on the measured external noise levels, it is unlikely that internal noise levels will be achieved with windows open, in particular on the lower levels. Therefore, mechanical ventilation may be required to provide the required levels of ventilation.

3.5. Operational airborne noise intrusion from stations and ancillary facilities

The detailed design of these facilities and equipment to be used are not available at this stage, and the locations of shafts and service buildings may change during the detailed design stage. A detailed assessment of noise emission should be conducted once the details of all mechanical plant has been selected and designed.

4.0 Operational ground-borne noise and vibration

4.1. Ground-borne noise criteria

The Chatswood to Sydenham EIS provides the following ground-borne noise design objectives:

- Residential - Day (7:00 am to 10:00 pm) 40 dBA $L_{Amax(slow)}$ 95% percentile
- Residential - Night (10:00 pm to 7:00 am) 35 dBA LAmax(slow) 95% percentile
- Retail Areas - When in use 50 dBA LAmax(slow) 95% percentile
- General Office Areas - When in use 45 dBA LAmax(slow) 95% percentile
- Private Offices and Conference Rooms - When in use 40 dBA LAmax(slow) 95% percentile
- Retail areas -When in use 50 dBA $L_{Amax(slow)}$ 95% percentile

4.2. Human comfort vibration criteria

Vibration criteria for human comfort are detailed within the NSW EPA document Assessing Vibration: a technical guideline (DEC, 2006) (AVTG). British Standard BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) is recognised by the guideline as the preferred standard for assessing the 'human comfort criteria'.

The guideline provides details of the various types of vibration, and the corresponding assessment methodology and criteria.

4.2.1. Types of vibration

Vibration can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Examples of typical types of vibration and their sources are shown in

Table 4-1. Vibration from trains is categorised as intermittent vibration however the Chatswood to Sydenham EIS adopts the continuous vibration levels for residential receivers which is in line with the Sydney Metro Northwest project.

Table 4-1 Examples of types of vibration (Table 2.1 from AVTG)

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

4.2.2. Axis of vibration and acceleration weighting

The axis of vibration are shown in **Figure 8**. For each axis a different frequency dependent acceleration weighting is applied as the human body perceives vibration differently at different frequencies. AVTG adopts the BS 6472 – 1992 acceleration weighting of Wg for the Z-axis and Wd for the x and y axis. When the occupant is in the lying down position the acceleration weightings are switched when referenced to a geocentric co-ordinate system.

Note that AVTG refers to BS 6472 – 1992, however this standard has been updated to BS 6472 – 2008 which applies a geocentric co-ordinate systems (for standing and lying down) and a Wb acceleration weighting in the Z-axis. The EPA has not officially updated guidance to use the Wb acceleration weighting. As such the vibration values have been assessed using the Z-axis Wg weighted acceleration.

As the area is an industrial area it is assumes occupants are either siting or standing, therefore the Wg (z-axis) weighting has been applied to the vertical direction.

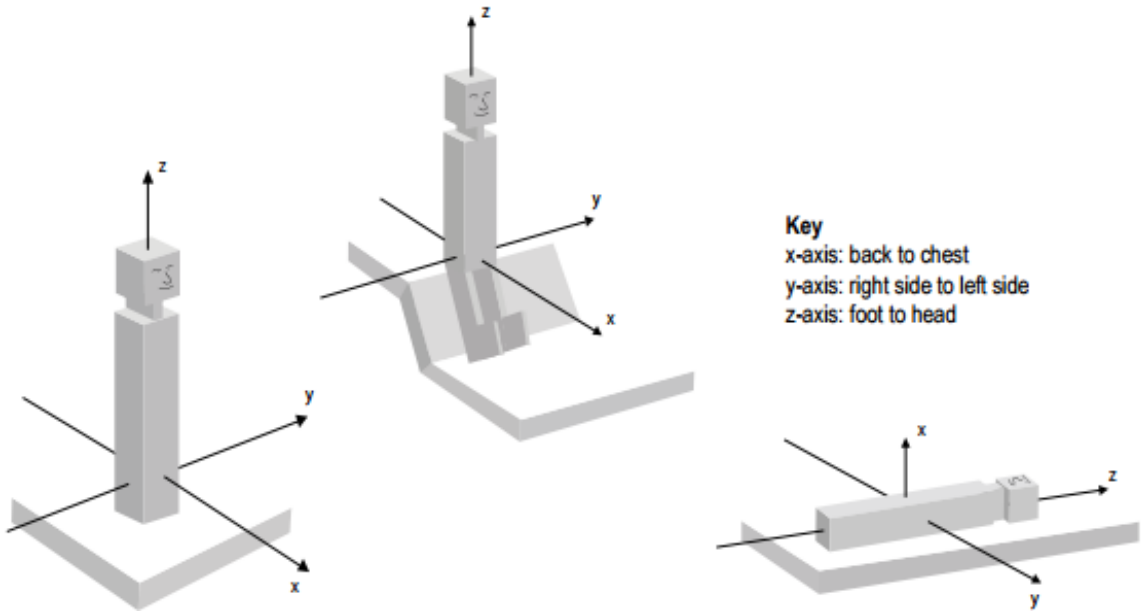

Figure 8: Orthogonal axes for assessment of human exposure to vibration (redrawn from BS 6472-1992) (Table 2.1 in AVTG)

4.2.3. Vibration criteria

The Chatswood to Sydenham EIS adopts the continuous vibration levels for residential receivers exposed to rail operations. This is considered the most stringent vibration criteria in AVTG. Acceptable values of frequency weighted acceleration are provided within AVTG and are reproduced below in

Table 4-2.

AVTG provides the following guidance on the application of the preferred values or the maximum values as follows:

‘There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community.’

Table 4-2 Preferred and maximum frequency weighted RMS values for continuous vibration acceleration (m/s^2) (1 Hz to 80 Hz)

Location	Assessment period	Preferred value		Maximum value	
		z-axis	x and y-axis	z-axis	x and y-axis
Offices	When in use	0.020	0.014	0.040	0.028
Residences	Daytime (7 am to 10 pm)	0.010	0.071	0.020	0.014
	Night-time (10 pm to 7 am)	0.007	0.005	0.014	0.010

4.3. Assessment of ground borne rail noise and vibration intrusion

4.3.1. Ground-borne noise

The development will be located above the proposed Sydney Metro rail line. As such, the vibration and ground-borne noise from the operation of the rail line has the potential to impact the proposed development. Although the Sydney Metro design is not completed, preliminary mitigation is proposed to reduce the vibration and ground-borne noise levels to compliant levels. The current OSD layout includes the following sensitive receiver types:

- Ground to Level 8: Store rooms, lobbies, loading docks, car parks, mail room, toilets, building managers office, plant rooms and a virtual office. Of these receiver types the most sensitive space would be the building managers office and the virtual office which conservatively would have a ground-borne noise criteria of 45 dBA.
- Level 9 onwards is residential which has a night- time criteria of 35 dBA

The Chatswood to Sydenham EIS recommends Standard Attenuation Track (Delkor Alt 1, or equivalent with assumed dynamic stiffness of 28 kN/mm) at the OSD site. Ground-borne predictions at adjacent sites are shown in the figures below and summarised as follows:

- 36 to 40 dBA Princeton apartments commercial levels (ground to level 2)
- 30 to 35 dBA Princeton apartments residential (Level 3 onwards)
- 30 to 35 dBA Edinburgh castle hotel commercial levels (ground to level 1)
- 30 to 35 dBA Edinburgh castle hotel (assessed against residential criteria) (Level 3)

The location of the Princeton Apartments and Edinburgh Castle Hotel are shown in the figures below.

An additional 1 dBA attenuation per floor is also expected. As such, based on the reported ground-borne noise levels in the Chatswood to Sydenham EIS at adjacent sites, the OSD should comply with the ground-borne noise criteria for the proposed usage.

If the design of the Sydney Metro or OSD changes mitigation may need to be considered to be incorporated to the design to reduce the impact of ground-borne noise on the development. This will be detailed at a later stage of the development process.

4.3.2. Ground-borne vibration

In the case of rail tunnels, the ground-borne noise trigger levels presented in Section 3.1 are generally more stringent than the vibration criteria below. Based on this track the EIS predicts ground-borne vibration levels are compliant with the criteria.

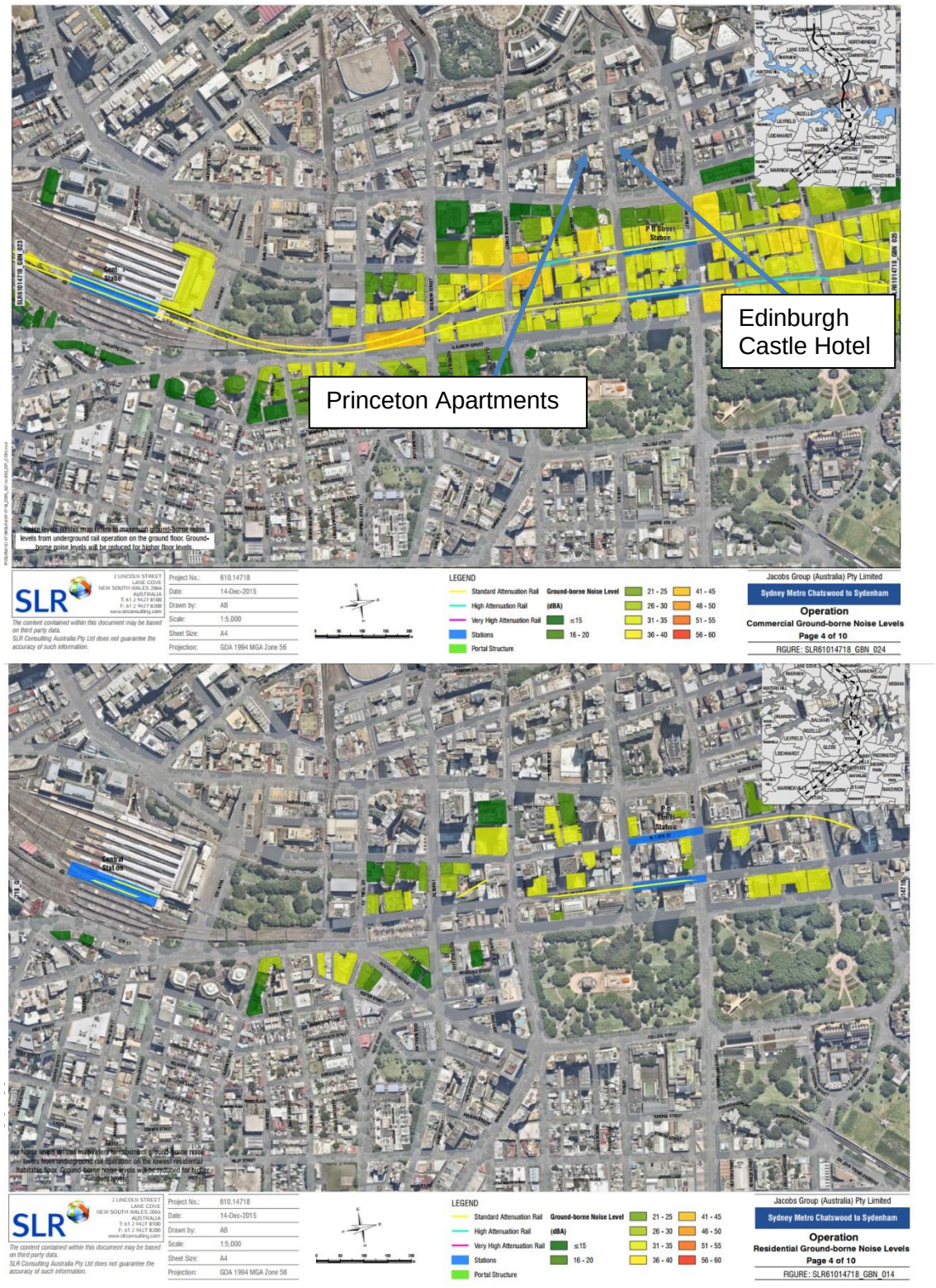

Figure 9: Chatswood to Sydenham EIS ground borne noise prediction

5.0 Construction noise and vibration assessment

5.1. Methodology

The methodology to identify potential construction noise and vibration issues associated with the proposal is as follows:

- Identify surrounding sensitive receivers potentially impacted by construction noise and vibration associated with the construction of the proposal
- Identify the appropriate construction noise and vibration criteria associated with the proposal
- Identify key issues to be addressed for the detailed design phase of the project

5.2. Study area

A preliminary review has been undertaken to identify sensitive receivers within the construction noise study area, which should be reviewed and refined during later stages of the project. The noise management levels relevant to this proposal are discussed in Section 4.4.3.

The area surrounding the site comprises a mix of commercial and residential high density buildings that will provide acoustic shielding from the proposed construction works. As such, a 300 m radius study area has been considered as appropriate and conservative to assess the potential construction noise impacts to nearby sensitive receivers.

Within the study area, the following noise sensitive receivers have been identified:

- Residential buildings (existing and future)
- Schools, child-care centres and other educational institutions
- Medical centres and operating theatres
- Places of worship
- Active recreation areas
- Passive recreation areas
- Commercial receivers, including offices and retail outlets
- Other noise-sensitive businesses

5.2.1. Residential receivers within the study area

The majority of residential receivers within the study area have been identified as hotels/serviced apartments and residential apartments within high-rise buildings.

The residential receivers identified within the construction noise study area are presented in **Table 5-1** and shown in Error! Reference source not found. below.

Table 5-1 Noise sensitive residential receivers within study area

Residential Receiver	Existing Building / Under Construction Development
Castlereagh Boutique Hotel	Existing building
Hotel Coronation	Existing building
Park Regis City Centre	Existing building
Victoria Tower Apartments	Existing building
Meriton Suites Pitt Street	Existing building
Castle Residences	Under Construction
Adina Apartments Town Hall	Existing building
Fraser Suites Kent Street	Existing building
Lumiere Apartments	Existing building
Greenland Centre	Under Construction
Primus Hotel Sydney	Existing building
Princeton Apartments	Existing building
Century Tower	Existing building
Merion Suite Kent Street	Existing building
Sydney Hotel CBD	Existing building
Regency Hyde Park	Existing building
Meriton Suites World Tower	Existing building
Hordern Towers	Existing building
Rydges World Square	Existing building

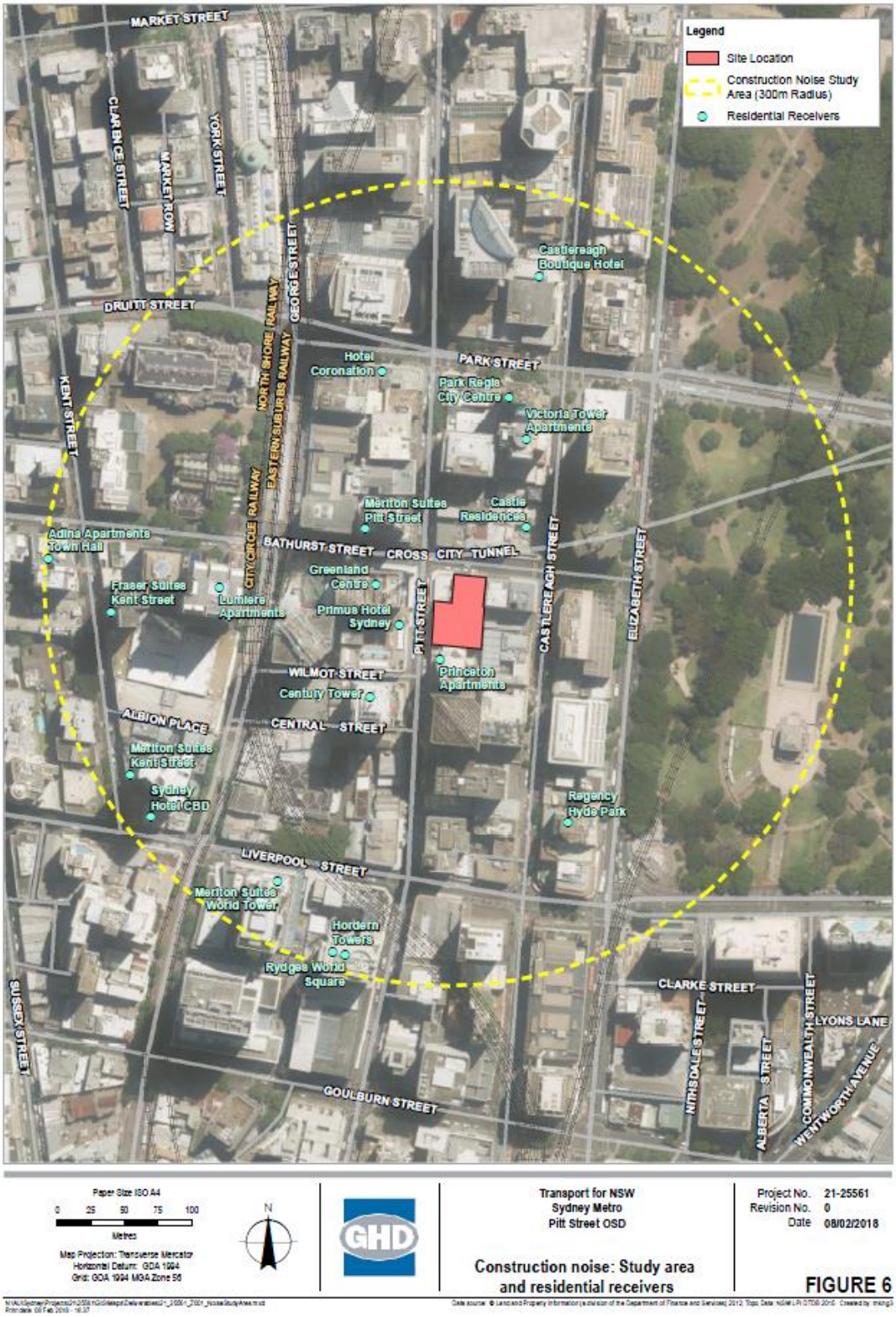

Figure 10: Construction noise study area and noise sensitive receivers

5.2.2. Other sensitive receivers within the study area

Other noise sensitive receivers identified within the study area include, but are not limited to, the following receivers:

Schools/Educational Facilities

- St Andrew's Cathedral School
- Kaplan Business School
- Australian College of Supplied Psychology
- Mercury Colleges
- Ivy College
- Supreme Business College
- Australian College of Management and Technology
- MIT Institute
- Jet English College

Child care centres

- Elizabeth Street Early Learning Centre
- George Street Early Learning Centre
- World Tower Child Care
- Active Kids World Square

Medical centres/surgery rooms

- Primary Psychology Sydney
- Sydney Medical Centre
- World Square CBD Medical Centre
- Sydney CBD Medical Centre and Skin Cancer Clinic
- City Doctors
- Sydney Cosmetic Clinic
- Myhealth Sydney CDB
- Dr. Lanzer Sydney Surgery

Places of worship

- St. Georges Presbyterian Church of Eastern Australia
- Church of Scientology Sydney
- Pitt Street Uniting Church
- St. Andrew's Cathedral
- The Uniting Church in Australia

Active recreation areas

- Hyde Park
- External areas of cafes/restaurants within the study area

5.2.3. Commercial receivers within the study area

The subject site is located within an area zoned “B8- Metropolitan Centre” within the City of Sydney Council local government area. As such, the majority of receivers within the study area can be classified as commercial receivers and include retail tenancies, offices and other business types. The various types of sensitive receivers classified as commercial is discussed within Section 4.4.1.

5.3. Construction works overview

The indicative design OSD Tower is a 58 storey concrete frame building to be constructed above a 6 level Metro station podium. It is anticipated that it will be built with a slip form core ahead of the floor structure. The initial floor levels include complex structural elements to transfer loads into the podium. It is clad with curtain wall glazing.

The construction period is anticipated to be approximately 2 years, potentially commencing 2022 and completing 2024. The structure is anticipated to take 70 weeks to complete, with the cladding being installed 7-8 storeys below the slabs, completing 10 weeks following the topping out of the structure. Fit-out and commissioning is likely to complete 25 weeks following final enclosure by the cladding.

5.3.1. Construction site compounds

A compound site would be required for the proposal. The construction compound would typically include a combination of demountable offices, meal rooms, toilets/showers, parking facilities, secure and bunded storage areas for site materials, including fuel and chemicals. The compound site would also typically allow for lay down areas, equipment storage, maintenance sheds, chemical/fuel stores and stockpile of earth and construction materials.

The location of the compound site will be determined at a later stage and the potential noise impacts of the compound site will be assessed in accordance with the ICNG.

5.3.2. Proposed construction hours

Construction of the proposal would take about 2 years to complete. It is anticipated that construction would be carried out during standard and out of standard construction working hours.

Any work undertaken outside of standard working hours would be in accordance with the Interim Construction Noise Guideline.

Prior advice would be given to the community if any work is planned to be undertaken outside standard construction hours.

5.3.3. Vehicle generation and construction access

The main access routes for construction vehicles will be determined at a later stage and the potential noise impacts at sensitive will be assessed in accordance with the Road Noise Policy.

5.4. Construction noise criteria

The ICNG provides guidance for assessment management of construction noise. The guideline recommends standard hours for construction activities as Monday to Friday: 7 am to 6 pm, Saturday: 8 am to 1 pm and no work on Sundays or Public Holidays.

Construction activities should aim to be undertaken during the recommended standard hours. However, the following activities have justification to be undertaken outside the recommended construction hours. This is assuming all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding community:

- The delivery of oversized plant or structure
- Emergency work
- Works for which it can be demonstrated that there is a need to operate outside the recommended standard hours
- Works which maintain noise levels at receivers to below the night-time noise affected construction noise management levels.

Table 5-2 and **Table 5-3** detail the noise management levels at sensitive residences and land uses respectively.

Table 5-2 Noise management levels at residences

Time of day	Management level $L_{Aeq(15min)}$	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 Rating background level + 10 dBA	The noise affected level represents the noise level which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15min)}$ 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 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 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 Rating background level + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Table 5-3 Noise management levels at sensitive land uses

Land use	Management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example,	External noise level 60 dBA

Land use	Management level, $L_{Aeq(15min)}$ (applies when properties are being used)
reading, meditation)	

5.4.1. Commercial receivers

Due to the broad range of sensitivities that commercial receivers may be potentially impacted by noise from construction, the process of defining management levels is separated into two categories. The external noise levels would be assessed at the most-affected occupied point of the premises:

- Offices, retail outlets (external): LAeq(15 minute) 70 dB
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below

Other noise-sensitive businesses within the study area require separate specific noise goals and it is recommended in the ICNG that the internal construction noise levels at these premises are to be referenced against the 'maximum' internal levels presented in AS 2107.

Recommended 'maximum' internal noise levels from AS 2107 are reproduced in **Table 5-4** for other sensitive receiver types. However, the ICNG and AS 2107 do not provide specific criteria for childcare centres. Childcare centres generally have internal play areas and sleep areas. The Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments provides criteria for these land uses. Based on this guideline, $L_{Aeq\ (1\ hour)}$ of 55 dBA for external play areas and $L_{Aeq\ (1\ hour)}$ of 40 dBA for indoor play areas and sleeping areas would be adopted to assess construction noise emission to child-care receivers.

Table 5-4 Noise management levels at sensitive land uses

Land use	Time period	AS 2107 Classification	Recommended Maximum Internal L_{Aeq}, dBA
Hotel	Daytime/Evening	Bars and Lounges	50
	Night	Sleep Areas – Hotels near major roads	40
Cafe	When in use	Coffee bar	50
Bar/Restaurant	When in use	Bars and Lounges/Restaurants	50
Library	When in use	Reading Areas	45
Recording Studio	When in use	Music Recording Studios	25
Theatre/Auditorium	When in use	Drama Theatres	30

5.4.2. Background noise monitoring and existing noise environment

To establish the construction noise management levels (NMLs), rating background levels (RBLs) have been sourced from the initial noise monitoring undertaken as part of the Sydney Metro Chatswood to Sydney EIS. A summary of the background noise monitoring data at Pitt Street (Location B.27) is presented below in **Table 5-5**. Note should be made that the background noise monitoring was undertaken in 2009.

Table 5-5 Background noise monitoring data - Pitt Street B.27

Site	EIS Monitor Location ID	Rating Background Levels (RBLs)		
		Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Pitt Street	B.27 (2009)	66	64	61

The exact location of the B.27 (2009) noise monitor is not shown on the map supplied in Chapter 10 of the EIS, however based on further information, this was located at the Criterion Hotel, located at 260 Pitt Street. This monitor has been assumed to be representative of the ambient noise environment surrounding the project site.

5.4.3. Sleep disturbance

In relation to sleep disturbance the NSW Road Noise Policy (NSW Department of Environment, Climate Change and Water, 2011) notes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

The Environmental Noise Management Manual (Roads and Traffic Authority, 2001) suggests that the assessment of sleep disturbance should include an examination of "maximum noise events". A "maximum noise event" is defined as any single event where the L_{Amax} external noise level exceeds 65 dBA and the L_{Amax} noise level exceeds the $L_{Aeq\ (1\ hour)}$ noise level by more than 15 dBA.

A summary of the night period external RBL at residences and the sleep disturbance criteria is presented below in **Table 5-6**.

Table 5-6 Sleep disturbance criterion

Location	Night RBL (L_{A90})	RBL + 15 dBA sleep disturbance level	L_{Amax} sleep disturbance level - internal
Residences (external)	61	76	**50 (preferred)** **55 (maximum)**

The adopted sleep disturbance criteria should be an internal L_{Amax} noise level of 55 dBA as it is the lower of the sleep disturbance noise levels.

It is noted that many facades within the CBD area will have fixed glazing. The L_{Amax} noise level detailed above refers to internal noise levels with windows open, assuming a 10 dB reduction through partially open windows. The building construction, in particular the type of glazing, should be determined for each resident that is predicted to be above L_{Amax} 65 dBA externally which conservatively assumes a 10 dB reduction for partially open windows.

5.4.4. Proposal specific construction noise management level

The noise management levels at all sensitive receivers within the study area are summarised in

Receiver area	Construction noise management level, LAeq(15min)					
	During standard recommended hours		Outside of standard recommended hours			
	7 am to 6 pm Monday to Friday, 8 am to 1 pm Saturday, no work on Sunday or public holidays		Day 7 am to 8 am and 1 pm to 6 pm Saturday, 8 am to 6 pm Sunday & public holidays	Evening 6 pm to 10 pm Monday to Sunday & public holidays	Night 10 pm to 7 am, Monday to Saturday; 10 pm to 8 am Sunday & public holidays	Sleep dist. criteria1 LAmax
	Noise affected	Highly noise affected				
Residences	76	75	71	69	66	65
School	45 (internal noise level)[1]					
Community centre	55 (external noise level)[1]					
Medical centre (non-surgery)	55 (external noise level)[1]					
Places of worship	55 (external noise level)[1]					
Active recreation areas	65 (external noise level)[1]					

Commercial premises	70 (external noise level)[1]
Industrial premises	75 (external noise level)[1]
Child Care Centre (assumed to be same as school)	45 (internal noise level)[1]
Hotel - Bars and Lounges	50 (internal noise level)[1]
Hotel - Sleep Areas – Hotels near major roads	40 (internal noise level)[1]
Cafe/ Coffee bar	50 (internal noise level)[1]
Bars/Lounges/Restaurants	50 (internal noise level)[1]
Library Reading Areas	45 (internal noise level)[1]
Music Recording Studios	25 (internal noise level)[1]
Theatres/ Auditoriums	30 (internal noise level)[1]
Note: 1) - Applies when properties are being used.	

Table 5-7. The rating background noise level for the day, evening and night time periods have been sourced from the EIS.

It is noted that the Daytime Noise Management Level is higher than the Highly Affected Noise Management Level due to the high levels of existing noise in the area.

Table 5-7 Proposal specific construction noise management level, dBA

Receiver area	Construction noise management level, $L_{Aeq(15min)}$					
	During standard recommended hours		Outside of standard recommended hours			
	7 am to 6 pm Monday to Friday, 8 am to 1 pm Saturday, no work on Sunday or public holidays		Day 7 am to 8 am and 1 pm to 6 pm Saturday, 8 am to 6 pm Sunday & public holidays	Evening 6 pm to 10 pm Monday to Sunday & public holidays	Night 10 pm to 7 am, Monday to Saturday; 10 pm to 8 am Sunday & public holidays	Sleep dist. criteria[1] L_{Amax}
	Noise affected	Highly noise affected				
Residences	76	75	71	69	66	65
School	45 (internal noise level)[1]					
Community centre	55 (external noise level)[1]					
Medical centre (non-surgery)	55 (external noise level)[1]					
Places of worship	55 (external noise level)[1]					
Active recreation areas	65 (external noise level)[1]					
Commercial premises	70 (external noise level)[1]					
Industrial premises	75 (external noise level)[1]					
Child Care Centre (assumed to be same as school)	45 (internal noise level)[1]					
Hotel - Bars and Lounges	50 (internal noise level)[1]					
Hotel - Sleep Areas – Hotels near major roads	40 (internal noise level)[1]					
Cafe/ Coffee bar	50 (internal noise level)[1]					
Bars/Lounges/Restaurants	50 (internal noise level)[1]					
Library Reading Areas	45 (internal noise level)[1]					
Music Recording Studios	25 (internal noise level)[1]					
Theatres/ Auditoriums	30 (internal noise level)[1]					
Note: 1) - Applies when properties are being used.						

5.4.5. Ground-borne (regenerated) noise

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling can be more noticeable than airborne noise. The following ground-borne noise levels indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise management levels are sourced from the Chatswood to Sydenham Construction Noise and Vibration Strategy and presented in **Table 5-8** below.

Table 5-8 Ground borne noise management levels

Receiver	Assessment location	Ground-borne noise management levels (internal) $L_{Aeq(15min)}$		
		Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Residential	Internal	45	40	35
Commercial	Internal	50	N/A	N/A

The daytime criteria are applicable to both residential and commercial receivers, whereas the evening and night-time criteria are only applicable to residential receivers. The internal noise levels are to be assessed at the centre of the most-affected habitable room. For a limited number of discrete, ongoing ground-borne noise events, such as drilling or rock-hammering, The L_{Amax} noise descriptor using a slow response on the sound level meter may be better than the $L_{Aeq(15\ min)}$ noise descriptor in describing the noise impacts. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction on the days when construction work is allowed would take into account whether the community:

- Has identified times of day when they are more sensitive to noise (for example Sundays or public holidays).
- Is prepared to accept a longer construction duration in exchange for days of respite.

5.5. Road traffic noise

Noise emission due to construction vehicles operating outside the boundaries of the project site are assessed against the Road Noise Policy (RNP) (DECCW 2011) to determine any potential adverse noise impacts on residential receivers. The RNP provides traffic noise criteria for sensitive receivers in the vicinity of existing roads **(Table 5-9**). The criteria are applied to traffic on public roads to identify potential road traffic impacts and the requirement for reasonable and feasible mitigation measures.

The Road Noise Policy (DECCW 2011) application notes state that *"for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the*

development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."

If road traffic noise increases during construction work is within 2 dBA of current levels then the objectives of the Road Noise Policy (DECCW 2011) are met and no specific mitigation measures are required.

Table 5-9 Road traffic noise criteria, dBA

Type of development	Day 7 am to 10 pm	Night 10 pm to 7 am
Existing residence affected by additional traffic on existing sub-arterial roads generated by land use developments	60 $L_{Aeq(15\ hr)}$	55 $L_{Aeq(9\ hr)}$
Existing residence affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq(1\ hr)}$	50 $L_{Aeq(1\ hr)}$

5.6. Construction vibration criteria

Vibration criteria have been set with consideration to Assessing Vibration: a technical guideline (DEC, 2006), as referenced in the CNVG. British Standard *BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by the guideline as the preferred standard for assessing the 'human comfort criteria'.

BS 6472-1992 provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose value is dependent upon the level and duration of the short term vibration event, as well as the number of events occurring during the daytime or night-time period. The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in **Table 5-10** below.

Table 5-10 Vibration does values ranges which might result in various possibilities of adverse comment within residential buildings

Place and time	Low Probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Note: For offices and workshops, multiplying factors of 2 and 4 respectively would be applied to the above vibration dose value ranges for a 16 hr day.			

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the

vibration level categories given in *BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration*, as shown below in **Table 5-11**.

Table 5-11 Guidance on effects of vibration levels for human comfort (BS 5228.2-2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

5.6.1. Cosmetic damage

BS 7385 is used to assess the effects of transient vibration on structures. The criteria provided in BS 7385 are presented in **Table 5-12** and graphically in **Figure 7**. The criteria provided in BS 7385 should be applied to all structures as BS 7385 states *'a building of historical value should not (unless it is structurally unsound) to be assumed to be more sensitive'*. Structures of significance should be assessed on a case-by-case basis if a dilapidation report indicates that they are structurally unsound.

Table 5-12 Transient vibration guide values - minimal risk of cosmetic damage (BS 7385-2)

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Line 1 - Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Line 2 - Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

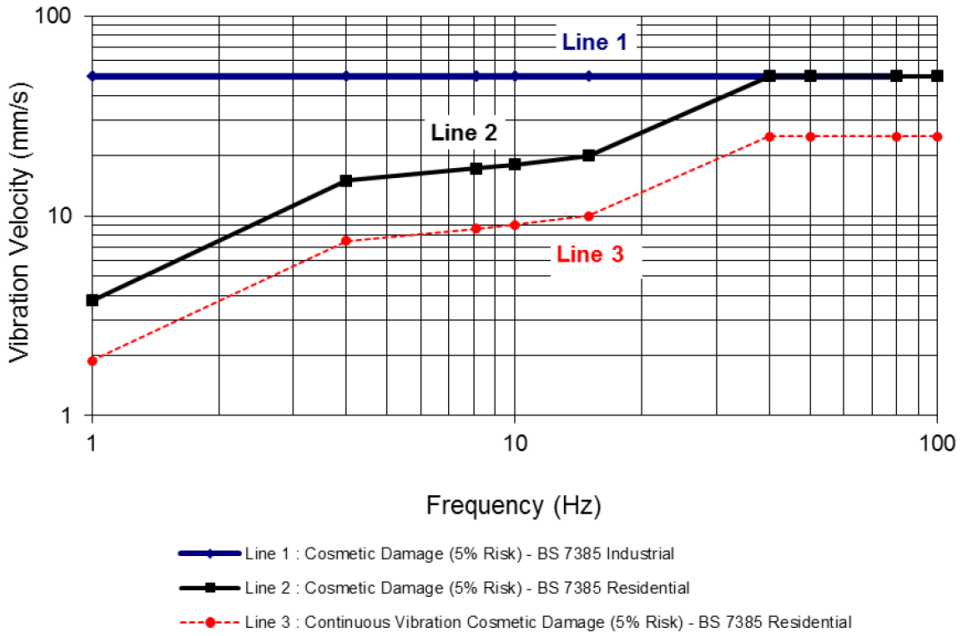

Figure 11 Graph of transient vibration guide values for cosmetic damage

5.6.2. General vibration screening criterion

The following general vibration screening criterion is an excerpt from the Chatswood to Sydenham Construction Noise and Vibration Strategy:

> *"The Standard states that the guide values in Table 6 (Table 4-10) relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 6 (Table 4-10) may need to be reduced by up to 50%. Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%. Therefore for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:*
>
> - Reinforced or framed structures: 25.0 mm/s
> - Unreinforced or light framed structures: 7.5 mm/s
>
> *At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level."*

5.6.3. Heritage structures

Heritage buildings and structures would be assessed as per the screening criteria in Section 4.6.3, as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage criteria of 2.5 mm/s peak component particle velocity (from DIN 4150) should be considered.

5.6.4. Sensitive scientific and medical equipment

Some scientific equipment can require more stringent vibration objectives than those applicable to human comfort. Any vibration sensitive receivers within 100 metres of the proposal site using vibration sensitive scientific or medical equipment should be identified and assessed against the criteria set in the *Chatswood to Sydney Construction Noise and Vibration Strategy*.

5.6.5. Other vibration sensitive structures and utilities

Other structures and utilities may be particularly sensitive to vibration which may need specific structural damage goal. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables

Specific vibration goals should be determined on a case-by-case basis for the detailed construction noise and vibration assessment.

5.6.6. Vibration and overpressure from blasting

The DECCW's ICNG recommends that vibration and overpressure from blasting be assessed against the levels presented in the Australian and New Zealand Environment Council's (ANZECC) Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).

The Chatswood to Sydney Construction Noise and Vibration Strategy provides the following vibration and overpressure upper limits:

- Vibration (PPV): 25 mm/s
- Overpressure: 125 dBL

These upper limits are deemed acceptable where the proponent has a written agreement with the relevant landowner to exceed the criteria and the Secretary has approved the terms of the written agreement. These upper limits to vibration and overpressure are intended to target the protection of building structures from cosmetic damage rather than human comfort criteria as construction works are considered short-term.

5.7. Issues to be addressed in the detailed Construction Noise and Vibration Management Plan (CNVMP)

Construction works timing

The timing of the construction works for the station and podium levels and the tower levels should be determined prior to the development of the detailed CNVMP. If construction works for the tower levels of the development are delayed and the tenancies within the podium levels commence operation, the sensitive receivers within the podium levels will likely be the most-affected receivers to the construction works occurring directly above. If this is the case, structure-borne construction noise may adversely impact the acoustic amenity of the sensitive receivers within the podium levels of the development.

Background noise monitoring

The background noise monitoring conducted for the EIS was undertaken in 2009. The acoustic environment surrounding the proposal site in 2009 is not likely to be representative of the current ambient acoustic environment and as such, the measured background noise levels may no longer be appropriate. Additional background noise monitoring is recommended at a minimum of two locations to update the construction noise management levels for nearby residential receivers.

Construction scenarios

Detailed construction scenarios are to be established in the detailed CNVMP. The construction scenarios are to include:

- An overview of the construction works
- A list of construction equipment associated with each scenario
- The location of construction equipment
- Confirm source noise and vibration levels for construction equipment
- The duration of works for each scenario
- Confirm the hours of works for each construction scenario (standard and out-of-hours works)

Heritage structures

All heritage structures within approximately 100 metres of the proposal site should be identified to assess potential structural or cosmetic damage due to vibration for the detailed CNVMP.

Other vibration sensitive structures

Other vibration sensitive structures within 100 metres of the proposal site of the proposal site should be identified for the detailed CNVMP and determine structure-specific vibration goals to assess potential structural damage.

These structures may include tunnels, fibre-optic cabling, gas pipelines and other underground infrastructure.

Predicted noise levels at receivers

A computer noise model will be developed in the detailed CNVMP to predict construction noise levels for each scenario at sensitive receivers.

Predicted vibration levels at receivers

Vibration levels will be predicted at sensitive receivers to determine any potential human comfort or structural/cosmetic damage to nearby structures.

Vibration and overpressure from blasting

Any blasting associated with the construction of the proposal should be assessed in the detailed CNVMP.

Determine standard and additional noise mitigation measures

The detailed CNVMP will include standard noise mitigation measures to be incorporated as well as additional noise mitigation measures depending on the results of the construction noise and vibration assessment.

Night works and sleep disturbance impacts

Any proposed construction works during the night-period should be identified prior to the detailed CNVMP to determine any potential sleep disturbance impacts.

Vibration sensitive scientific/medical equipment

Any vibration sensitive scientific/medical equipment located within 100 metres of the proposal site should be identified and assessed in the detailed CNVMP.

Dilapidation surveys

If construction activities have the potential to cause damage through vibration to nearby public utilities, structures, buildings and their contents, an Existing Condition Inspection of these items is required to be undertaken in accordance with AS 4349.1 “Inspection of Buildings”.

Construction compound site and site access

The location of the compound site and the construction site access points should be determined to inform the detailed CNVMP.

Construction vehicles

The number of light and heavy vehicles utilising public roads associated with the construction of the project should be determined to assess the potential impacts due to an increase in road traffic noise levels at sensitive receivers. The construction traffic routes are to be determined and the existing daily traffic counts for the associated roads are required to inform the road traffic noise section of the detailed CNVMP.

6.0 Conclusion

GHD has undertaken a preliminary air-borne noise, ground-borne noise and vibration assessment for the proposed Pitt Street South OSD located at 125 – 135 Bathurst Street and 300-302 Pitt Street.

Preliminary noise measurements and mitigation recommendations have been provided relating to noise intrusion from external noise sources. Internal noise levels with windows open is unlikely to achieve relevant noise goals.

The OSD should comply with the ground-borne noise criteria for the proposed usage. If the design of the Sydney Metro or OSD changes mitigation may need to be considered to be incorporated to the design to reduce the impact of ground-borne noise on the development. This will be detailed at a later stage of the development process.

The development is capable of complying with the criteria. A detailed assessment of noise emission and noise and vibration intrusion from the road, station, facilities and rail line should be undertaken at a later stage of the development process.

A preliminary construction noise and vibration assessment has been undertaken to identify the sensitive receivers within the study area, determine the applicable criteria and identify key issues to be addressed in the detailed construction noise and vibration management plan.

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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