JOHN HOLLAND

Waterloo Integrated Station Development

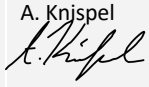
Construction Noise and Vibration Management Plan

SMCSWSWL-JHG-SWL-EM-PLN-000005

Document and Revision History

Document Details	
Title	Construction Noise and Vibration Management Plan
Client	Sydney Metro City & Southwest

Revisions

Rev #	Date	Description	Prepared by	Reviewed by	Approved by
0	31/07/2020	Approved by DPIE		S. Reynolds	A. Knispel
0.1	30/03/2021	Annual review – minor amendments		S. Reynolds	
0.2	03/05/2021	Updated to address SM/AA/ER comments		S. Reynolds	
1.0	20/05/2021	Final		S. Reynolds	A. Knispel
1.1	05/05/2022	Annual review – minor amendments including capping beam removal and update to construction hours		S. Reynolds	
2.0	19/05/2022	Updated to address SM/AA/ER comments		S. Reynolds	A. Knispel
03	15/08/2022	Amended to reflect Project Planning Approval Mod #9 change to Saturday working hours		S. Reynolds	A. Knispel 

Management reviews

Review date	Details	Reviewed by
August 2023		

APPROVAL
CITY & SOUTHWEST ACOUSTICS ADVISOR

Review of	**Waterloo Integrated Station Development Construction Noise and Vibration Management Plan**	**Document reference:**	**Waterloo Integrated Station Development Construction Noise and Vibration Management Plan Prepared by VMS Australia for John Holland Pty Ltd.** *Report Number 10-1808 Revision 03 dated 15 August 2022* *Document Number: SMCSWSWL-JHG-SWL-EM-PLN-000005*
Prepared by:	Carl Fokkema Alternate Acoustics Advisor		
Date of issue:	30 August 2022		

As approved Alternate Acoustics Advisor for the Sydney Metro City & Southwest project, I have reviewed and provided comment on the Construction Noise and Vibration Impact Statement (CNVIS) for the Waterloo Integrated Station Development, as required under A27 (d) of the project approval conditions (SSI 15-7400).

This revision 03 includes updated to construction hours following Approval of Mod 9 and were of a minor nature and are consistent with the terms of approval and the document approved by the Secretary.

I am satisfied that such amendments are necessary, approve revision 03 of the CNVMP (dated 15 August 2022), Document Number: SMCSWSWL-JHG-SWL-EM-PLN-000005 and consider that the document is appropriate for submission to the Secretary for information.

Carl Fokkema, City & Southwest Alternate Acoustics Advisor

Construction Noise and Vibration Management Plan and Monitoring Program Waterloo Integrated Station Development

Report Number 10-1808

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This Report by VMS Australia Pty Ltd is prepared for the Client listed above and is based on the objective, scope, conditions and limitations as agreed. The Report presents only the information that VMS Australia Pty Ltd believes, in its professional opinion, is relevant and necessary to describe the issues involved. The Report should not be used for anything other than the intended purpose. All surveys, forecasts, projections, and recommendations contained in or associated with this report are made in good faith and on the basis of information supplied to VMS Australia Pty Ltd at the date of this report, and upon which VMS Australia Pty Ltd relied.

VMS Australia Pty Ltd does not accept any liability or responsibility to any party with respect to the information and opinions contained in this report.

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Glossary

Term/Acronym	Definition
AA	The independent Acoustic Advisor appointed under the Project Planning Approval
Acceleration	Acceleration is defined as the rate of change of Velocity of a particle over a period of time and is typically measured in the units of m/sec^2.
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
AMMM	Additional Mitigation Measures Matrix
Annoying Activities	As defined by the Interim Construction Noise Guideline to include: • use of 'beeper' style reversing or movement alarms, particularly at night-time • use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work • grinding metal, concrete or masonry • rock drilling • line drilling • vibratory rolling • rail tamping and regulating • bitumen milling or profiling • jackhammering, rock hammering or rock breaking • impact piling
AS 1055	Standards Australia AS1055–1997™ – Description and Measurement of Environmental Noise
AS2187:2006	Australian Standard AS 2187.2-2006: Explosives - Storage and Use - Use of Explosives
AS2436	Standards Australia AS 2436–2010™ – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.
AS61672 or AS1259	Standards Australia AS IEC 61672.1–2004™ – Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS1259.2-1990™ – Acoustics – Sound Level Meters – Integrating/Averaging as appropriate to the device.
Attenuation	The reduction in the level of sound or vibration.
AVTG	Assessing Vibration – a technical guideline
A-weighting, dBA	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
BS 6472	British Standard (BS 6472–1992) – Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) dated 1992;
BS 7385	British Standard BS7385: Part 2-1993 - Evaluation and Measurement for Vibration in Buildings — Part 2 – Guide to Damage Levels from Ground-borne Vibration, dated 1993.
CEMF	Construction Environmental Management Framework (Appendix B) of the Submissions and Preferred Infrastructure Report)
CEMP	Construction Environmental Management Plan

Term/Acronym	Definition
CNS	Transport for New South Wales Construction Noise Strategy (Document Number ST-157/4.1, 23 April 2019)
CNVIS	Construction Noise and Vibration Impact Statement
CNVMP	Construction Environmental Management Sub-plan , Waterloo Integrated Station Development, Noise and Vibration Management Sub-Plan (this document)
CNVS	Sydney Metro City & Southwest Construction Noise and Vibration Strategy (Report Number 610.14213 R3, dated 29 November 2017)
CoA	Conditions of Approval for SSI 15_7400
Construction	Includes all physical work required to construct the Project, as defined in the CoA
CSSI	Critical State Significant Infrastructure
DEC	Department of Environment and Conservation (now OEH)
DECC	Department of Environment and Climate Change (now OEH)
DECCW	Department of Environment, Climate Change and Water (now OEH)
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa. Note that the above formula is only valid for sound propagation in the free-field (see below).
DIN4150:3	German Institute for Standardisation – DIN 4150 (1999-02) Part 3 – Structural Vibration - Effects of Vibration on Structures.
DP&I	NSW Department of Primary Industries, including DPI Agriculture, DPI Biosecurity and Food Safety, DPI Land and Natural Resources, DPI Crown Lands and Water and DPI Fisheries
DPE	NSW Department of Planning and Environment (Previously NSW Department of Planning, Industry and Environment)
EIS	Sydney Metro City & Southwest Chatswood to Sydenham Environmental Impact Statement, 3 May 2016
ENMM	Environmental Noise Management Manual (RTA 2001)
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2000 (NSW)
EPA	Environment Protection Licence under the POEO Act
EPL	Environment Protection Licence
ER	The independent Environmental Representative appointed under the Project Planning Approval
Fast/Slow Time Weighting	Averaging times used in sound level meters.

Term/Acronym	Definition
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. engineering considerations and what is practical to build. Reasonable Feasible relates to relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Heritage item	A place, building, work, relic, archaeological site, tree, movable object or precinct of heritage significance that is listed under one or more of the following registers: the State Heritage Register under the Heritage Act 1977 (NSW), a heritage item registered under a Local Environmental Plan under the EP&A Act, the World, National or Commonwealth Heritage lists under the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth), and an Aboriginal object or Aboriginal place as defined in section 5 of the National Parks and Wildlife Act 1974 (NSW).
Hertz, Hz	The unit of Frequency (or Pitch) of a sound or vibration. One hertz equals one cycle per second. 1 kHz = 1000 Hz, 2 kHz = 2000 Hz, etc.
HNML	Highly Noise Affected Management Level
ICNG	Interim Construction Noise Guideline (OEH, 2009)
Infrastructure Approval	CSSI project approval for SSI 15_7400 Sydney Metro granted by the Minister for Planning on 9 January 2017
ISD	Integrated Station Development
JHPL	John Holland Pty Ltd
L90,15minute	A noise level index. The noise level exceeded for 90% of the time over a 15-minute period. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
Leq,15minute	A noise level index called the equivalent continuous noise level over a 15-minutes period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
Lmax,T15minute	A noise level index defined as the maximum noise level during a 15-minute period. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
Metro Quarter Development	Metro Quarter Development (MQD) comprises the land bounded by Botany Road, Raglan Street, Cope Street and Wellington Street, but excluding the Congregational Church located at 103 Botany Road. It is situated approximately 3km from the Sydney CBD and is surrounded by established residential and commercial land uses.
Monitoring Program	Construction Noise and Vibration Monitoring Program
NCA	Noise Catchment Area
NML	Noise Management Level as derived from the Interim Construction Noise Guideline

Term/Acronym	Definition
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
NPfI	NSW Nosie Policy for Industry (2017)
NSW Vibration Guideline, the	NSW Department of Environment and Conservation – NSW Environmental Noise Management – Assessing Vibration: a Technical Guideline (the NSW Vibration Guideline), February 2006.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
OEH	Office of Environment and Heritage
OOHW	Out of Hours Works
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
PPV	The particles of a medium are displaced from their random motion in the presence of a vibration wave. The greatest instantaneous velocity of a particle during this displacement is called the Peak Particle Velocity (PPV) and is typically measured in the units of mm/s.
Project	Sydney Metro City & Southwest - Waterloo Integrated Station Development
Project Planning Approval	Critical State Significant Infrastructure Sydney Metro & Southwest Chatswood to Sydenham Infrastructure Approval dated 9 January 2017 (Application no. SSI 15_7400)
RBL	The Rating Background Level for each period is the medium value of the Assessment Background Level values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
REMM	Revised Environmental Mitigation Measures (Chapter 11 of the Submissions and Preferred Infrastructure Report).
Residential zones	As defined by the relevant Local Environment Plan including Zone R1 General Residential, Zone R2 Low Density Residential, Zone R3 Medium Density Residential, Zone R4 high Density Residential
RFT	Request for Tender
RMS	NSW Roads and Maritime Services
RNP	NSW Road Noise Policy (DECCW 2011)
Secretary	Secretary of the NSW Department of Planning and Environment or nominee
Sensitive periods	Period of time determined in consultation with affected sensitive receiver
Sensitive receiver	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres, passive recreation areas (including outdoor grounds used for teaching), active recreation areas (including parks and sports grounds). Receivers that may be considered to be sensitive include commercial premises (including film and television studios, research facilities, entertainment spaces, temporary accommodation such as caravan parks and camping grounds, restaurants, office premises, and retail spaces) and industrial premises, and others as identified by the Secretary

Term/Acronym	Definition
Sound Power	Sound Power is the rate at which sound energy is emitted, reflected, transmitted or received, per unit time. Unlike sound pressure, sound power is neither room-dependent nor distance-dependent.
Sound Power Level (SWL)	The Sound Power Level is the sound power relative to a standard reference pressure of 1pW ($20x10^{-12}$ Watts) on a decibel scale. The SWL of a simple point source may be used to calculate the SPL at a given distance (r) using the following formula: $SPL = SWL - 10 \times Log_{10}(4 \times \pi \times r^2)$ Note that the above formula is only valid for sound propagation in the free-field (see below).
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (SPL)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.
Spoil	All material generated by excavation into the ground
SSI	State Significant Infrastructure
Submissions and Preferred Infrastructure Report	Sydney Metro City & Southwest Chatswood to Sydenham Submissions and Preferred Infrastructure Report, October 2016
Sub-plans	Sub Plans to the CEMP requiring the approval the Secretary of the Department of Environment and Planning under Conditions C3 and C7 including construction noise and vibration, construction soil, water and groundwater, heritage, flora and fauna and air quality
SWMS	Safe Work Method Statement
Sydney CBD	Sydney Central Business District
Sydney Metro	Sydney Metro City & Southwest Project
TfNSW	Transport for New South Wales
Vibration Dose, VDV	When assessing intermittent vibration it is necessary to use the vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period. The VDV formulae uses the RMS Acceleration raised to the fourth power and is known as the Root-mean-quad method. This technique ensures the VDV is more sensitive to the peaks in the acceleration levels. VDVs are typically measured in the units of $m/s^{1.75}$.
VMS	VMS Australia Pty Ltd
Works	All physical activities to construct the Project
Waterloo ISD	Waterloo Integrated Station Development Project comprises of construction of the new Waterloo station infrastructure to support customer movement and experience.

1 Introduction

1.1 Purpose

VMS Australia Pty Ltd (VMS) has been engaged by John Holland Pty Ltd (JHPL) to prepare this Construction Noise and Vibration Management Plan (CNVMP) for the potential impacts from noise and vibration generated during the construction of the Waterloo Integrated Station Development (Waterloo ISD, the Project).

This CNVMP has been prepared to address the relevant requirements of the Sydney Metro Construction Environmental Management Framework (CEMF), the Revised Environmental Mitigation Measures (REMMs), the Project Planning Approval (SSI 15_7400) and applicable legislation. This CNVMP has been endorsed by the Acoustic Advisor (AA) and Environment Representative (ER) and submitted for approval by the Secretary of the Department of Planning and Environment (DPE) no later than one month before commencement of Construction. Construction will not commence until the Construction Environmental Management Plan (CEMP) and sub-plans (including this CNVMP) have been approved.

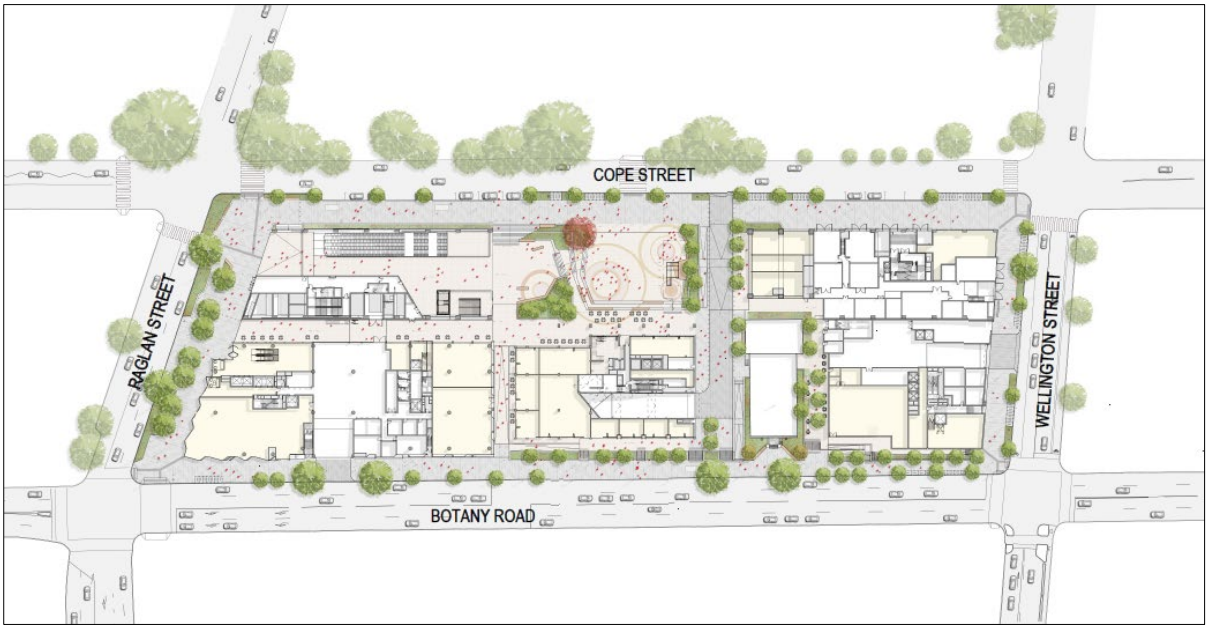
This CNVMP includes the construction monitoring program for noise and vibration to meet the requirements of Project Planning Approval C9 (a) to C17.

1.2 Background

The Waterloo ISD Project Works comprises the construction of the new station infrastructure to support customer movement and experience.

The Waterloo ISD is located within the South Sydney local area in the suburb of Waterloo, as shown in **Figure 1.** The Project Site is situated on once city block bounded by Botany Road, Raglan Street, Cope Street and Wellington Street, but excluding the Congregational Church located at 103 Botany Road. The Project Site is situated approximately 3km from the Sydney CBD and is surrounded by established residential dwellings.

Figure 1 Project Site Location Plan



2 Objectives

The key objectives of the CNVMP are to:

- Minimise unreasonable noise and vibration impacts on surrounding residents and businesses
- Undertake active community consultation
- Achieve noise management levels where feasible and reasonable
- Avoid structural damage to buildings or heritage items as a result of construction vibration
- Maintain positive cooperative relationships with schools, childcare centres, local residents, and building owners

These objectives conform to Sydney Metro's objectives as described in the CEMF.

The Compliance Matrix in **Appendix A** provides a comprehensive list of compliance requirements and environmental documents.

2.1 Review of CNVMP

This CNVMP will be reviewed annually to ensure that the management of noise and vibration emissions from the construction activities to surrounding sensitive receivers remains effective and in compliance with the requirements of the Project Planning Approval (refer to **Appendix A1** of this document) and Revised Environmental Mitigation Measures (REMMs) NV1, NV2, NV3, NV4, NV5 and NV7 (refer to **Appendix A2** of this document). A review of noise and vibration risks and management measures will be reviewed in accordance with Section 6.2 of the CEMP. This includes reviewing risks based on the construction activity and implementing appropriate management measures as outlined in Section in this plan as required by CoA C4(d).

The review would include:

- A review of the effectiveness of the management practices, noise and vibration monitoring and compliance with the Project noise and vibration criteria.
- Collation of incidents and complaints over the preceding 6 months, including response, actions and outcomes.
- Feedback from stakeholders, including the Environmental Representative for the CSSI (ER) and Acoustics Advisor (AA).

The CNVMP can be reviewed and revised on a more frequent basis due to:

- Poor performance against noise and vibration criteria and/or unacceptable impacts on the surrounding sensitive receivers.
- Significant changes to the proposed works program and activities.
- At the request of the ER or AA.

All changes to the CNVMP would be submitted to Sydney Metro. Minor amendments will be approved by the AA in accordance with CoA A27.

3 Construction Activities and Tasks

The project scope of works (Project Works) is detailed in the Construction and Site Management Plan (CSMP) and is summarised in **Table 1**. Generally work will be completed within the Station box excavation to enable the station construction and fit out. Works external to the station box which may have an impact on receivers includes utility relocation/installation and concrete delivery for station works. Out of hours work will generally be required for extended concrete pours to achieve quality specifications and the delivery of oversized concrete structures. Section 12 outlines the mitigation measures to manage noise and vibration.

Table 1 Project Scope of Works

Works	Description
Station Works	The works for the new underground metro station include: - Detailed excavation and drilling required for sumps, track slab-invert, onsite detention tanks, drainage, services and foundations to support the structural works and removal of capping beam structures; - Waterproofing of the station box; - All primary and secondary structural works including for the entire station box, entrances, all services, utilities, systems, fit out elements, concourses, station platforms, over-track exhaust plenums and vertical transport; - Track invert slab including underline crossings, earthing mats and drainage; - Plant and equipment rooms; - Public and staff toilets; - All back of house areas; - Architectural fit-out; - Low-voltage electrical, fire, hydraulics, lighting and mechanical systems; - Building management control system; - Provisions for works by Interface Contractors; - Provisions for advertising and vending machines; - Lifts and escalators; - Signage and wayfinding; - External façade to the MQD Transfer Level including over street awnings; - Landscaping, kerbs and precinct activation works; - Bicycle parking facilities; - Public art (within the Station Lot); - Security measures.
Local Area Works	Resurfacing or reconstruction of affected roads, footpaths, cycle ways or other public amenities, and signage, traffic control signals, street lighting, flood mitigation and traffic and transport management.
Utility Service Works	Identification, protection, diversion, reconstruction or repair of affected utility services, new utility service connections and other general provisions.

Works	Description
Property Works	Protection and adjustments to affected existing buildings and property, including demolition of built features.
Retail Works	The works for the base build of the retail spaces in Waterloo Station and the station precinct, but excludes the retail spaces in the MQD Lot, including: - Shell of the retail space tenancy units (including storage areas); - Base building services including LV power, cold water supply, chilled water loops (for air conditioning), fire systems, sewage facilities; - Grease traps and ventilation exhausts (where appropriate); - Waste collection facility for the retail areas; - Telephone and data systems; - Glazed shopfront finishes.
MQD Enabling Works	The works to be performed for the areas of the MQD which are located within the footprint of the station box and below the MQD Transfer Level which are required for the integration of the MQD Works with the Station Works and to enable further construction of the MQD Works without disruption to the operating station. The MQD Enabling Works include: - Foundations and structures to support the MQD; and - Egress and any other Building Code of Australia compliance required to support the MQD Works.

The construction sequence and program are detailed in the CSMP and summarised in **Table 2**.

Table 2 Indicative Schedule of Construction Phases for Waterloo ISD

Phase	Description	Indicative Timeframe[1]
Pre-Construction	CEMP preparation, review, endorsement and approval Site establishment and other activities that are not defined as Construction by the Project Planning Approval Design development	November 2019 – August 2020
Works by the Interface Contractors	Track installation and associated infrastructure Electronic ticketing equipment Other activities	August 2020 – mid 2024[2]
Construction of Waterloo ISD	Construction of the station including: Services External works Landscaping Property works Retail works	October 2020 – late 2022

Phase	Description	Indicative Timeframe[1]
	MQD Enabling Works Testing and commissioning	
Operational Readiness and handover		December 2022 – March 2024

Note 1: Timeframes are indicative only and may commence and/or end later and/or earlier than indicated.

Note 2: Not continuous access.

4 Legal and Other Requirements

The legislation and planning instruments considered during development of this CNVMP are outlined in **Table 3**.

Table 3 Legislation and Planning Instruments

Legislation	Description	Relevance to this Plan
Environmental Planning and Assessment Act 1979	This Act establishes a system of environmental planning and assessment of development proposals for the State.	The approval conditions and obligations are incorporated into this Plan
Protection of the Environment Operations Act 1997 (POEO Act)	The EPA is responsible for issuing Environment Protection Licences (EPLs) for 'scheduled activities' under this Act.	JHPL does not currently hold an EPL for the Project. This Plan will be revised in the event that an EPL is obtained for the Project.

The Plan addresses applicable requirements within the following documents:

- Critical State Significant Infrastructure Sydney Metro City & Southwest Chatswood to Sydenham Conditions of Approval (CSSI CoA) (Infrastructure Approval SSI 15_7400 determined 9 January 2017, as modified)
- Sydney Metro City & Southwest Construction Noise and Vibration Strategy (CNVS) (dated 29 November 2017)
- Section 9, Appendix B of the Construction Noise and Vibration Management of the Construction Environmental Management Framework (CEMF) (August 2016)
- Revised Environmental Mitigation Measures (REMMs) (dated October 2016)

4.1 Guidelines and Standards

Guidelines and standards relating to the management of noise and vibration include:

- Interim Construction Noise Guidelines (ICNG), Department of Environment and Climate Change, 2009 (ICNG).
- NSW Road Noise Policy, Department of Environment, Climate Change and Water 2011
- NSW Assessing Vibration – a technical guideline (AVTG), Department of Environment and Conservation 2006
- Construction Noise Strategy 7TP-ST-157/2.0 (CNS), Transport for NSW (2012)
- Australian Standard AS/NZs 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors
- Australian Standard AS 2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites
- British Standard BS 6472-2008 Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard 7385: Part 2-1993 Evaluation and measurement of vibration in buildings
- German Standard DIN4150-1999 Structural vibration Part 3: Effects of vibration on structures
- Environmental Noise Management Manual (ENMM), Roads and Traffic Authority 2001.

4.2 TfNSW and Sydney Metro Construction Noise and Vibration Strategies

TfNSW's Construction Noise Strategy (CNS) and the Sydney Metro City and Southwest Construction Noise and Vibration Strategy (CNVS) provide practical guidance on how to minimise the impacts of noise and vibration on the community. They outline all feasible and reasonable mitigation measures that should be considered by the Project to reduce airborne noise, groundborne noise and vibration during the construction of infrastructure projects.

The Sydney Metro City and Southwest Construction Noise and Vibration Strategy has been amended (Addendum A v2) to satisfy CoA E32 of the Project Conditions of Approval. The Addendum provides internal noise criteria for sensitive receivers, consistent with the requirements of CoA E38, E41 and E43. In accordance with this addendum, internal noise predictions in the Waterloo ISD CNVISs include façade transmission loss, mitigation, consultation and respite.

5 Roles and Responsibilities

The roles of responsibilities of key Waterloo ISD personnel with respect Noise and Vibration are described in **Table 4**.

Table 4 Roles and Responsibilities

Role	Responsibilities
Project Director	▪ Managing the delivery of the Waterloo ISD including overseeing implementation of noise and vibration management measures ▪ Act as Contractor's Representative
Environment & Sustainability Manager	▪ Oversee the implementation of all noise and vibration management initiatives including coordinating JHPL's response to noise and vibration complaints ▪ Responsible for managing ongoing compliance with the CoA and environmental document requirements
Commercial Manager	▪ Ensure sufficient resources are allocated to noise and vibration management
Construction Manager/Site Superintendent	▪ Manage the delivery of the construction process, in relation to noise and vibration management in conjunction with the Environment & Sustainability Manager
Stakeholder and Community Relations Manager	▪ Manage notifications and consultation for noise and vibration and liaise with the Environment and Sustainability Manager about noise and vibration complaints
Environment Coordinator	▪ Oversee noise and vibration training including inductions, toolbox talks and specific technical training on monitoring equipment ▪ Monitoring and reporting on compliance ▪ Manage review and continual improvement of this plan
Independent Environment Representative	▪ Receive and respond to communications from the Secretary in relation to the environmental performance of the Critical State Significant Infrastructure (CSSI); ▪ Consider and inform the Secretary on matters specified in the terms of the planning approval; ▪ Consider and recommend any improvements that may be made to work practices to avoid or minimise adverse impact to the environment and to the community; ▪ Review all documents required to be prepared under the terms of the planning approval, ensure they address any requirements in or under the planning approval and if so, endorse them before submission to the Secretary (if required to be submitted to the Secretary) or before implementation (if not required to be submitted to the Secretary); ▪ Regularly monitor the implementation of all documents required by the terms of the planning approval for implementation in accordance with what is stated in the document and the terms of the planning approval; ▪ Review the Proponent's notification of incidents in accordance with Condition A41 of this approval; ▪ As may be requested by the Secretary, help plan, attend or undertake Department audits of the CSSI, briefings, and site visits; ▪ Consider any minor amendments to be made to the CEMP, CEMP sub-plans and monitoring programs that comprise updating or are of an administrative nature, and are consistent with the terms of the planning approval and the CEMP, CEMP sub-plans and monitoring programs approved by the Secretary and, if satisfied such amendment is necessary, approve the amendment. This does not include any modifications to the terms of the planning approval;

Role	Responsibilities
	▪ If conflict arises between the Proponent and the community in relation to environmental performance of the CSSI, follow the procedure in the Community Communication Strategy approved under the Condition B3 of the approval to attempt to resolve the conflict, and if it cannot be resolved, notify the Secretary ▪ Must complete project induction covering John Holland environmental management system ▪ In conjunction with the AA, consider requests for out of hours construction activities an determine whether to endorse the propose activities in accordance with E47
Independent Acoustic Advisor	▪ Oversee construction noise and vibration planning, modelling, management and reporting ▪ Consider and recommend improvements that may be made to work practices to avoid or minimise adverse noise and vibration impacts ▪ Receive and respond to communication from the Secretary in relation to noise and vibration performance ▪ In conjunction with the ER, consider requests for out of hours construction activities and determine whether to endorse the proposed activities in accordance with Condition E47 ▪ Perform the roles under CoA A27 ▪ Attend or undertake audits of noise and vibration management of the works including briefings and site visits (as relevant) ▪ Approve minor amendments to the Noise and Vibration Construction Monitoring Program under CoA C15

5.1 Specialist Consultants

VMS Australia Pty Ltd (VMS) has been engaged to undertake comprehensive noise and vibration modelling of the Waterloo ISD proposed works and prepare the CNMVP. Throughout construction, VMS may provide specialist advice and services including:

- Preparing Construction Noise and Vibration Impact Statements
- Undertaking noise and vibration monitoring (including review of noise and vibration predictions)
- Assisting in community consultation
- Assisting in liaison with Sydney Metro and other government agencies on the appropriateness and accuracy of the noise and vibration assessments.

6 Sensitive Receivers

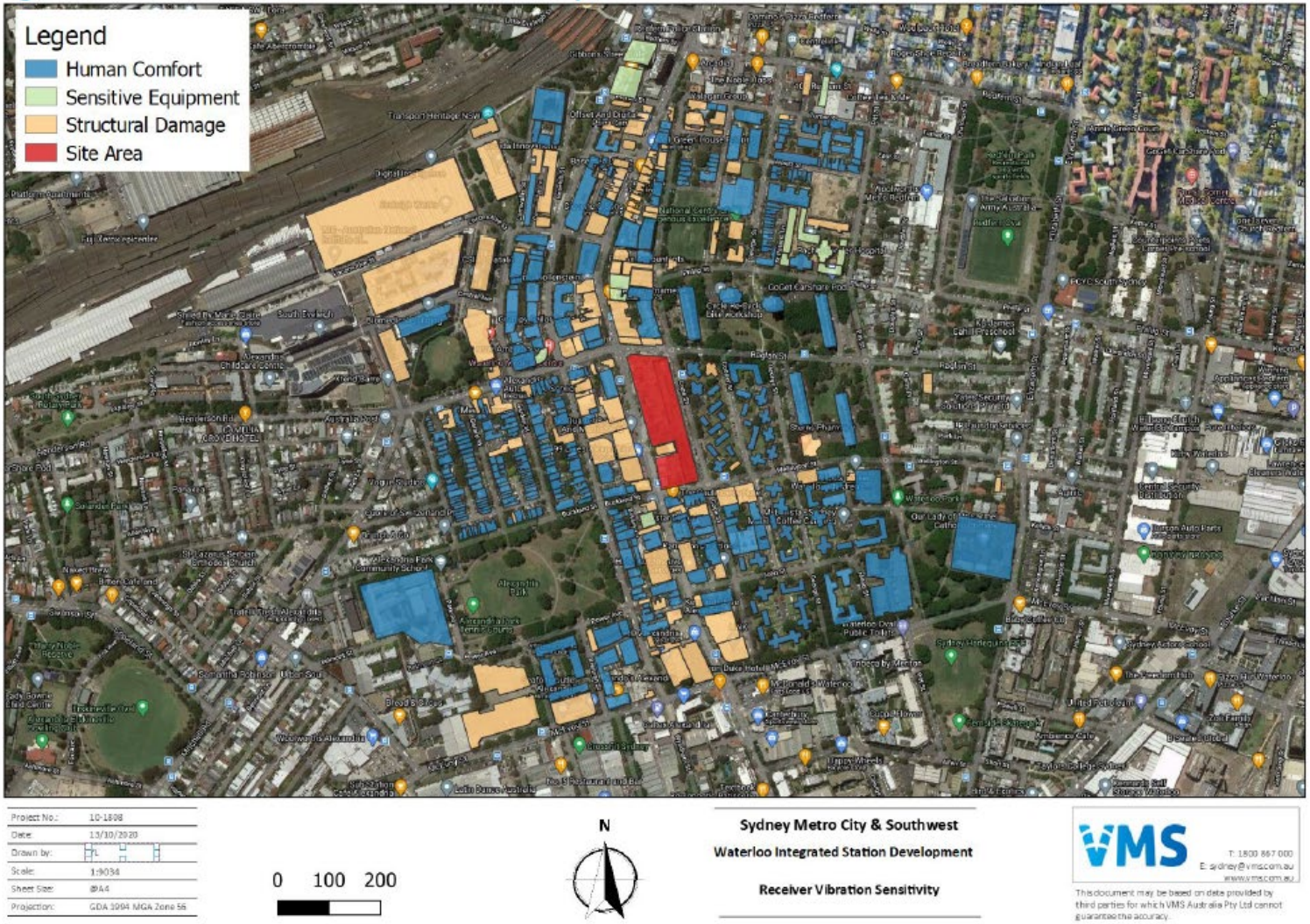
The Project has noise and vibration sensitive receivers within adjoining or adjacent buildings to the Project Site. The properties identified to be potentially most affected by the Project Works are detailed in **Appendix B**.

Figure 2 shows usage of the surrounding receivers. **Figure 3** shows the sensitivity to vibration for the surrounding receivers.

Figure 2 Site Plan – Receiver Usage

Note 1: The Receiver Type colour coding presented represents the building usage type. Refer to Appendix B for detailed building usage.

Figure 3 Site Plan – Receiver Vibration Sensitivity



Note 1: The Receiver Type colour coding presented represents the receiver vibration sensitivity throughout the entire building. Refer to Appendix B for detailed building usage.

7 Building Dilapidation Surveys

Condition surveys will be offered in accordance with CoA E59 to surrounding buildings that are identified as being at risk of vibration damage as a result of the Project Works. Surveys are to be prepared with the agreement of each property owner/occupier prior to commencement of Project Works and within three months of the completion of Project Works as required by Project Planning CoA E60.

The Construction Noise and Vibration Impact Statement (CNVIS) assesses the potential risk of vibration induced damage from the Waterloo ISD works and identifies any buildings which require dilapidation surveys.

The vibration monitoring procedure will be reviewed to determine if any buildings/structures require specific vibration monitoring following the completion of the pre-works dilapidation survey.

8 Construction Hours

8.1 Approved Construction Hours

The standard construction hours are defined in the CoA E36 and are as follows:

a) 7:00 am to 6:00 pm, Mondays to Fridays, inclusive;

b) 8:00 am to 6:00 pm on Saturdays; and

c) at no time on Sundays or public holidays.

8.2 Rock Breaking and Annoying Activities

Notwithstanding Conditions E44 and E48, rock breaking and other particularly annoying activities is not permitted outside of the standard construction hours, except:

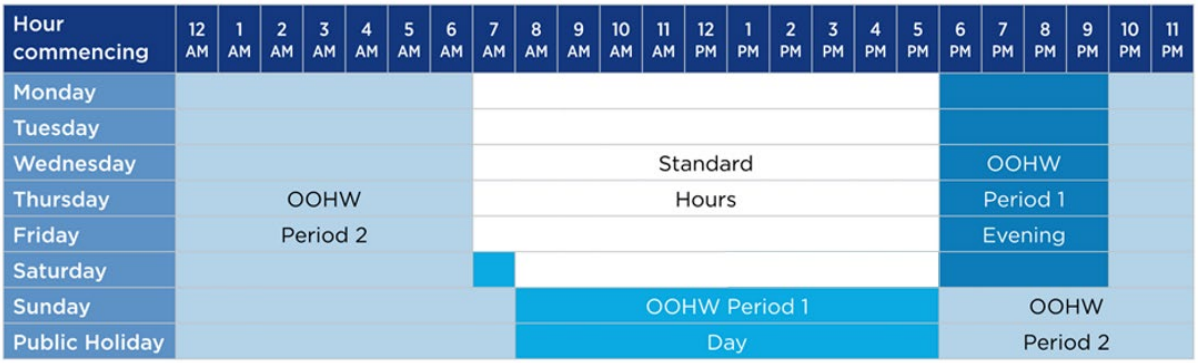
- where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or
- construction that causes LAeq(15 min) noise levels:
    - no more than 5 dB(A) above the rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and
    - no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses; and
    - continuous or impulsive vibration values, measures at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006); and
    - intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).

8.3 Out of Hours Work

Project Works may be carried out outside of standard hours under CoA E38, E41, E42 E44 and E47.

The out-of-hours work (OOHW) periods are further defined as OOHW Period 1 and 2, based on the TfNSW's Construction Noise Strategy (CNS) as presented in the **Figure 4**.

Figure 4 Out-of-Hours Work Periods



Under CoA E44, works may be undertaken outside the hours specified in CoA E36 under any of the following circumstances:

- For the delivery of material required by the NSW Police force or other authority for safety reasons
- Where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm. On becoming aware of the need for emergency construction, John Holland will notify Sydney Metro who must notify the AA, and the ER of the need for the activities or work to occur. John Holland will notify (using best endeavours) all affected sensitive receivers of the likely impact and duration of the work as required by CoA E45.
- Where different construction hours are permitted or required under an EPL in force in respect of the construction[1]
- Construction that causes $L_{Aeq(15\ minute)}$ noise levels:
    i. No more than 5 dB(A) above the rating background level at any residence
    ii. No more than the noise management levels (detailed in **Section 9**)
    iii. Continuous or impulsive vibration values, measured at the most affected residence are no more than those for human exposure to vibration (detailed in **Section 10.1**)
    iv. Intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration (detailed in **Section 10.2**)
- Where a Community Agreement has been negotiated for works which noise management levels and/or limits for ground-borne noise and vibration (human comfort) cannot be achieved
- Construction has been approved through the Sydney Metro Out of Hours Works Protocol.

All out of hours works (except in emergency situations) will be managed under CoA E47 (Sydney Metro Out of Hours Works Protocol). Subject to the protocol, the following activities included under CoA E48 may be undertaken 24 hours per day, 7 days per week:

- Station and tunnel fit out
- Excavation within an acoustic enclosure
- Haulage and delivery of spoil and materials.

Under the Sydney Metro Out of Hours Works Protocol, the following information must be provided to the ER for approval (following endorsement by the AA):

- Justification of the OOHW

[1] Note: An EPL is not required for Waterloo ISD

- Noise and Vibration Assessment
- Community notification
- Toolbox talk for the workforce on sensitive receivers and management requirements (prior to the commencement of works
- Noise and Vibration verification monitoring.

The Sydney Metro OOHW Approval Form will be used as a template for all OOHW applications. Should high noise works be planned for after 9pm, approval is required from DPIE following endorsement by the AA and ER.

The use of high noise impact equipment is to be avoided where possible outside of standard construction hours, unless the Noise Management Levels present in **Section 9** can be achieved at sensitive receivers. Where the NMLs cannot be achieved, the additional noise mitigation measures detailed in Section **12.2.2** would be implemented.

9 Construction Noise Management Levels

The three primary noise metrics used to describe construction noise emissions are:

- $L_{A1(1minute)}$ - The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the LAmax or maximum noise level.
- $L_{Aeq(15minute)}$ - The "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.
- L_{A90} - The "background noise level" or "Rating Background Level" (RBL) in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the RBLs.

The subscript "A" indicates that the noise levels are filtered to match normal hearing characteristics (A weighted).

The NSW EPA Interim Construction Noise Guideline (ICNG) requires Project specific Noise Management Levels (NMLs) to be established for noise affected receivers. A site-specific Construction Noise Impact Statement (CNVIS) is to be prepared in accordance with CoA E33 which will predict noise impacts to all nearby sensitive receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed as per **Section 12** of this CNVMP.

9.1 Residential Receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers and applying the measured RBLs, as described in **Table 5**. These NMLs will be applied to the Construction Hours and Out of Hours Works as defined in CoA E36 and E48.

Table 5 Determination of NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 6:00 pm No work on Sunday or public holidays	RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, JHPL should apply all feasible and reasonable work practises to meet the noise affected level. JHPL 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.

Time of Day	NML LAeq(15minute)	How to Apply
		Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. JHPL should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, JHPL should negotiate with the community (refer to the Additional Noise Mitigation Measures in Section 8.2.3).

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2: The RBL (Rating Background Level) is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy.

9.1.1 Details of Baseline Data Available

Site specific residential construction NMLs for Waterloo ISD have been nominated in the Sydney Metro Chatswood to Sydenham EIS Technical Paper 2: *Noise and Vibration* (EIS NIA, SLR Consulting Report 610.14718R8 dated 28 April 2016). These NMLs have been reproduced in **Table 6**.

Table 6 Residential Construction Noise Management Levels

Receiver Types	LAeq(15minute) Construction NMLs (dBA)			
	Daytime[1]	Daytime OOH[2]	Evening[3]	Night-time[4]
Residential[5]	64	59	52	44

Note 1: The Daytime period includes Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm, except for Public Holidays.

Note 2: The Daytime Out of Hours period includes Saturdays 7.00 am to 8.00 am, and Sundays and Public Holidays 7.00 am to 6.00 pm

Note 3: The Evening period includes 6.00 pm to 10.00 pm.

Note 4: The Night-time period includes 10.00 pm to 7.00 am.

Note 5: The EIS NIA determined the NML from noise logging conducted at Monitoring Location B.06 (122 Wellington Street, Waterloo) between 31 August and 14 September 2015 The EIS NIA adopted the NML from B.06 for both Waterloo Noise Catchment Areas (NCAs), NCA29 and NCA31.

9.2 Other Sensitive Land Uses

The Project specific $L_{Aeq(15minute)}$ NMLs for non-residential noise sensitive receivers from the ICNG are provided in **Table 7**.

Other noise-sensitive businesses (commercial premises) require separate Project specific noise goals and it is suggested in the ICNG that the internal construction noise levels at these premises are to be referenced to the upper internal design sound levels presented in AS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors. Recommended upper internal design sound levels from AS2107 are reproduced in **Table 7** for other sensitive receiver types identified surrounding the Project Site.

For Education classified business shown in **Table 7** which may be classified as a childcare, the ICNG and AS 2107 do not detail specific criteria relating to childcare centres. Accordingly, reference is made to the Association of Australian Acoustic Consultants recommendations of $L_{Aeq(1hour)}$ of 40 dBA for indoor play and sleep areas. Receivers which may require further investigation into level of sensitivity include educational, health and studio businesses and residential as noted in the CNVS.

Table 7 Summary of Noise Management Levels for Other Sensitive Land Uses

Land Use	Area	NML $L_{Aeq(15minute)}$ Noise Levels	
		External	Internal
Hotel[1]	Bars and Lounges	70 dBA	50[2,3] (Daytime & Evening)
	Sleeping Areas: - Hotels near major roads	As per Table 6 for residential[4]	40[4] (Night-time)
Café[1]	Coffee bar	70 dBA[3]	50[2,3] (when in use)
Bar/Restaurant[1]	Bars and Lounges / Restaurant	70 dBA[3]	50[2,3](when in use)
Library[1]	Reading Areas	70 dBA	45[5](when in use)
Recording Studio[1]	Music Recording Studios	70 dBA	25[6](when in use)
Theatre/ Auditorium[1]	Drama Theatres	70 dBA	30[6](when in use)
Childcare Centres	Internal Play Area	65 dBA	55 dBA
	Sleeping Area	50 dBA (when in use)	40 dBA (when in use)
Classrooms at schools and other education institutions		55 dBA	45 dBA[7] (when in use)
Hospital wards and operating theatres		70 dBA	45 dBA
Places of Worship		70 dBA	45 dBA
Active recreation areas[8]		65 dBA	-
Passive recreation areas[9]		60 dBA	-
Community centres		Depends on the intended use of the centre. Refer to the recommended upper internal design sound levels in AS 2107 for specific uses.	
Commercial premises[10]	offices, retail outlets and small commercial premises	70 dBA (when in use)	45 dBA (when in use)

Land Use	Area	NML $L_{Aeq(15minute)}$ Noise Levels	
		External	Internal
Industrial premises[10]		75 dBA (when in use)	-

Note 1: Design noise levels specified in AS 2107 internal noise levels.

Note 2: Where no external seating has been identified, fixed window glazing and air conditioning is assumed to mitigate high existing ambient noise levels and/or control internal noise break-out. A minimum outside-to-inside attenuation of 20 dB is assumed. The internal ICNG noise goal then corresponds to a façade level of 70 dBA.

Note 3: Where an open frontage or outdoor seating area has been identified, the external noise goal is taken as 60 dBA.

Note 4: Hotels (sleeping areas during the night-time) are assumed to have incorporated acoustic façade design in order to mitigate high existing ambient noise levels (refer to Section 3) to achieve the internal design noise level of 40 dBA specified in AS 2107. Notwithstanding, the more conservative external NML corresponding to residential receivers (refer to Table 6) has been applied to the sleeping areas of hotels.

Note 5: These receivers are typically well insulated from external noise break-in.

Note 6: These receivers are typically well insulated from external noise break-in, with significant acoustic mitigation included in the façade design.

Note 7: Assumed based on external noise levels being 10 dB higher than internal noise levels when windows are open.

Note 8: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.

Note 9: Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg reading and meditation).

Note 10: Assess at the most affected occupied point on the premises.

9.3 Sleep Disturbance

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights between 10pm and 7am, maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL should be considered.

Based on the information presented in the NSW Road Noise Policy (RNP) and Environmental Noise Management Manual (ENMM), the research on sleep disturbance to date has shown that:

- *Maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep;*
- *One or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.*

Accordingly, to assess the potential of sleep disturbance, an initial screening level of the higher of following will be adopted:

- $L_{Amax} \leq$ RBL + 15 dBA
- $L_{Amax} \leq$ 65 dBA (assuming windows open)

Where there are noise events found to exceed the initial screening level, further analysis will be made to identify:

- The likely number of events that might occur during the night assessment period; and
- Whether events exceed an 'awakening reaction' level of 55 dBA L_{Amax} (internal)

9.4 Ground-borne Noise

Ground-borne noise refers to noise produced by vibration of floor slabs and other building elements, which radiates noise into the interior of a building, sometimes referred to as regenerated noise. The ICNG provides ground-borne noise criteria for evening and night time periods only, as the objectives are to protect the amenity and sleep of inhabitants whilst they are at home.

Ground-borne noise levels higher than those nominated in **Table 8** indicate mitigation measures would be implemented. Note, these levels only apply when ground-borne noises levels are higher than airborne noise levels.

Table 8 Management Levels according to Building Category and Time of Day (ICNG)

Time	Building Category	Management Level – LAeq(15minute)
Day: 7:00 am – 6:00 pm	Internal residential	45 dB
	Internal commercial	50 dB
Evening: 6:00 pm – 10:00 pm	Internal residential	40 dB
Night: 10:00 pm – 7:00 am	Internal residential	35 dB

Where levels are higher than predicted or in response to complaints ground-borne noise monitoring may be required. Where attended ground-borne noise monitoring is not possible, indirect unattended remote monitoring may be considered.

9.4.1 Additional Mitigation for Residential Receivers

In accordance with CoA E41, where residential receivers are located in a non-residential zone and are likely to experience an internal noise level exceeding $L_{Aeq(15\ minute)}$ 60 dBA between 8.00 pm and 9.00 pm or 45 dBA between 9.00 pm and 7.00 am (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in groundborne noise or a perceptible level of vibration is planned), they must be offered additional mitigation in accordance with CNVS as detailed in **Section 12.2.2**.

In accordance with CoA E42, where residential receivers are likely to experience an internal noise level exceeding $L_{Aeq(15\ minute)}$ 45 dBA (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in groundborne noise or a perceptible level of vibration is planned) between 8.00 pm and 7.00 am, they must be offered additional mitigation in accordance with CNVS as detailed in **Section 12.2.2**.

9.5 Construction Traffic Noise

Assessing permissible noise increases for construction traffic aims to protect sensitive receivers against decreases in amenity as a result of the construction works. An increase of up to 2 dB on existing traffic noise levels represents a minor impact barely perceptible by most people. Where levels are expected to exceed an increase of 2 dB feasible and reasonable noise mitigation measures are to be applied. The extent and type of mitigation measures are to consider the existing traffic noise levels and Project related traffic noise levels in accordance with the RNP.

It is understood that the proposed site access routes are on arterial and sub-arterial roads with significant existing traffic flows whereby increased Waterloo ISD Construction traffic flows not likely to exceed existing traffic flows by 60%. It is therefore expected that increased traffic noise due to works is likely to be less than the 2 dB allowance at all locations.

9.6 Workplace Health and Safety

Noise induced hearing loss typically occurs when individuals are exposed to excessive noise levels for extended periods of time (normally over several months or perhaps years). Alternatively, hearing damage can occur when a person is exposed to very high (peak) noise levels.

Section 56 of the "Work Health and Safety Regulation 2011" provides acceptable noise limits for the workplace. The full section is reproduced below:

> *56 Meaning of "exposure standard for noise"*
>
> *(1) In this Regulation, "exposure standard for noise", in relation to a person, means:*
>
> *(a) LAeq(8hour) of 85 dB(A), or*
>
> *(b) LCpeak of 140 dB(C).*

The "noise level equivalent" is defined as the steady sound pressure level which in the course of an 8 hour period, delivers the same A-weighted sound energy as the actual noise on any particular representative working day. The peak noise level is the C-weighted peak sound pressure level.

For employees confined to one work location for a typical 8 hour shift, the LAeq noise level for that particular task will represent their daily noise exposure. Conversely, if an employee works on a variety of tasks during a typical 8 hour shift then the total noise exposure level would be composed of several partial noise exposures for the variety of tasks undertaken. The relationship between noise exposure level and duration is demonstrated in **Table 9**.

Table 9 Relationship between Noise Exposure Level and Noise Exposure Duration

Noise Exposure Level (LAeq)	Approximate Duration of Noise Exposure Equivalent to WHS Regulation Level of LAeq(8hour) 85 dBA
80 dBA	24 hours
82 dBA	16 hours
85 dBA	8 hours
88 dBA	4 hours
92 dBA	2 hours
95 dBA	1 hour
98 dBA	30 minutes
101 dBA	15 minutes
104 dBA	8 minutes
107 dBA	4 minutes
110 dBA	2 minutes
113 dBA	1 minute
116 dBA	30 seconds

A number of management and mitigation measures will be implemented as applicable in order to ensure compliance with the WHS criteria for workers within and surrounding the site. Such measures may include:

- The use of hoarding and/or temporary noise barriers around the site.
- Rotation of employees to avoid high noise exposure areas for extended periods of time.
- Ensuring employees are given appropriate shift lengths and provided respite between shifts.
- Providing hearing protection to employees where appropriate.

- Providing specific WHS noise training to employers in order to provide awareness and guidance on managing their employees during highly noisy periods.

In accordance with CoA E43, at no time can noise generated by construction exceed the National Standard for exposure to noise in the occupational environment of an eight-hour equivalent continuous A-weighted sound pressure level of $L_{Aeq(8\ hour)}$ of 85dBA for any employee working at a location near the site.

It is considered highly unlikely that any sensitive receiver, including pedestrians and staff of nearby businesses would be exposed to high noise levels (>85 dBA) for periods long enough to exceed the WHS criteria. Notwithstanding, signage should be posted around construction sites in order to inform the general public of high noise exposure areas.

10 Vibration Criteria

10.1 Human Comfort Continuous and Impulsive Vibration Criteria

Vibration and its associated effects on people are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration: machinery, steady road traffic, continuous construction activity such as underground drilling
- Impulsive vibration: infrequent activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading
- Intermittent vibration: trains, nearby intermittent demolition activity, rock breakers and jack hammers.

Structural vibration in buildings can be detected by the occupants possibly affecting them in various ways including reducing working efficiency and quality of life. Complaint levels from occupants of the buildings subject to vibration depend on the use of the building and the time of day.

Acceptable levels of continuous vibrations depend on the time of day and the activity being undertaken. The preferred values for continuous and impulsive vibration for office and residential buildings are presented in **Table 10** and **Table 11** below (as presented in the EPA's *Assessing Vibrations: a technical guideline, Table C1.1*). It is noted that Table 1 of the CoA defines a "perceptible level of vibration" as the "preferred" peak velocity levels presented in **Table 10** and **Table 11**.

Table 10 Criteria for exposure to Continuous Vibration

Space Occupancy	Time of Day	Peak velocity(mm/s)	
		Preferred[1]	Maximum
Residential	Day	0.28	0.56
	Night	0.20	0.4
Offices	Day/Night	0.56	1.1

Note 1: The Preferred Peak Velocity presented represent a "perceptible level of vibration".

Table 11 Criteria for exposure to Impulsive Vibration

Space Occupancy	Time of Day	Peak velocity(mm/s)	
		Preferred[1]	Maximum
Residential	Day	8.6	17.0
	Night	2.8	5.6
Offices	Day/Night	18.0	36.0

Note 1: The Preferred Peak Velocity presented represent a "perceptible level of vibration".

10.2 Human Comfort Intermittent Vibration Criteria

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV). The calculation of a VDV is used to evaluate the cumulative effects of bursts of intermittent vibration. Various studies have shown that VDV assessment methods far more accurately assess the level of disturbance than methods which assess the vibration magnitude only.

The acceptable VDV intermittent vibration for residential and office building uses are outlined in **Table 12** (as nominated in the *EPA's Assessing Vibrations: a technical guideline, Table 2.4*).

Table 12 Acceptable Vibration Dose Values

Space Occupancy	Time of Day	VDV ($m/s^{1.75}$)	
		Preferred	Maximum
Residential	Day	0.20	0.40
	Night	0.13	0.26
Offices, schools, educational institutions, places of worship	Day/Night	0.40	0.80

10.3 Cosmetic Damage Vibration Criteria

Structural vibration criteria are defined in terms of levels of vibration emission from the works that will minimise the risk of damage to buildings and other structures.

Structural vibration criteria are designed to minimise the risk of cosmetic surface cracks and are set well below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in British Standard (BS) 7385-Part 2:1993 *Evaluation and Measurement for Vibration in Buildings* which have also been referenced and reproduced in AS 2187:2006.

The recommended limits from BS 7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in **Table 13**. In accordance with CoA E29, owners of properties at risk of exceeding the screening criteria for cosmetic damage will be notified before construction that generates vibration commences in the vicinity of those properties. The CNVIS identifies the predicted vibration based on the construction scenario, based on this, the mitigation measures included in Section 12 will be implemented to avoid cosmetic damage to properties identified as at risk, this includes selecting appropriate plant and equipment that does not result in vibration levels nominated in Table 13 when working within the safe working distance of the appliable building type.

Table 13 Transient vibration guide values – minimal risk of cosmetic damage

Type Building	Peak Component particle velocity in frequency range of predominant pulse	
	4Hz to 15Hz[1]	15Hz and above[1]
Reinforced or framed structures, industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Dwellings and buildings of similar design and/or use	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Note 1: Vibration values may need to be reduced by up to 50% if the dynamic loading caused by continuous vibration gives rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply.

10.4 Structural Damage to Heritage Buildings

BS 7385 notes that a building of historical value should not, unless it is structurally unsound, be assumed to be more sensitive. In the case of heritage listed buildings which is considered to be "structurally unsound*", guidance for structural damage can be derived from the German Standard DIN 4150-3 (2016-12) *Vibrations in Buildings - Part 3: Effects on Structures*. The guideline values for vibration levels for heritage buildings are reproduced in **Table 14**.

** Structural soundness will be determined by a person with appropriate experience in assessing the structural stability of the subject building type or susceptibility to vibration induced damage. Buildings deemed NOT structurally sound will be assessed under DIN4150.*

Table 14 DIN 4150 Recommended PPV vibration levels for Heritage Listed Buildings

Group	Type of Structure	Peak Particle Velocity (mm/s)			
		At Foundation			Plane of Floor of Uppermost Storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 at 10 Hz increasing to 40 at 50 Hz	40 at 50 Hz increasing to 50 at 100 Hz	40
2	Dwellings and buildings of similar design and/or use	5	5 at 10 Hz increasing to 15 at 50 Hz	15 at 50 Hz increasing to 20 at 100 Hz	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order and structurally unsound heritage buildings)	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz	8

Note 1: For frequencies above 100 Hz the upper value in this column should be used.

The building condition surveys required by Planning Approval Condition E59 will be referenced to determine the likelihood or potential for a building or structure to be considered unsound or sensitive to vibration.

All works are to be undertaken to comply with the above recommended vibration criteria. The CNVIS will outline the predicted vibration levels based on the construction activity. Where vibration levels are predicted to exceed the criteria then actual vibration levels will be monitored by an appropriately qualified and experienced consultant at the commencement of the construction activity and assessed against the criteria.

If compliance with the above levels is not being met using approved construction methods, alternative construction methods are to be considered, whilst assessment of the recommended velocity levels are reviewed in consideration of whether there is scope for altering the vibration criteria from the DIN 4150 vibration levels.

10.5 Buried Utilities

Vibration limits for buried utilities are likely to be imposed by the asset owner. John Holland will liaise directly with the asset owner (eg Sydney Water) to confirm if there are any specific vibration limits nominated for the adjoining utilities. The following vibration criteria would also be adopted to control vibration emission to adjoining buried utilities.

In terms of the most recent relevant vibration damage criteria for evaluating the effects of transient vibration on buried pipework, German Standard DIN 4150 Part 3 -1999 "*Structural Vibration - Part 5.3: Effects on Buried Pipework*" provides the guideline values reproduced in **Table 15**.

Table 15 Vibration Guideline Values for Buried Pipework

Pipe Material	Guideline Values for Velocity Measured on the Pipe
Steel (including welded pipes)	100 mm/s
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s

It should be noted that the guideline values above refer to velocity measured on the pipe. Appendix D.1 of the Standard states that where it is difficult to measure vibration on the pipe itself, such as in this case, measurements can be made on the ground surface. Furthermore that *"vibration measured on the ground surface is usually greater than that measured directly on pipes."*

Additionally, the guideline values relate to transient vibration, which does not give rise to resonant responses in structures and/or is not likely to induce fatigue failure of the structure. Subclause 6.3 of the Standard states that where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, then the guide values may need to be reduced by up to 50%. Rock-breaking activities, for example, are considered to have the potential to cause dynamic loading and it may therefore be appropriate to reduce the above values by 50%.

Where vibration measurements cannot be undertaken directly on the pipe, the vibration measurements can be undertaken in the ground immediately adjacent to the pipeline or on the ground surface above the pipeline. The criterion nominated above would still apply to the measured level. It is noted that this approach is likely to be conservative since it does not take into account the likely lower (attenuated) vibration levels to be expected on the pipe structure.

If the above criterion proves overly restrictive, modification of the recommended criterion may be made following a detailed in-situ vibration response trial of the pipeline itself and the surrounding ground.

10.6 Site Vibration Control Criteria

Based on the information contained in the CNVS and EIS, site specific vibration control criteria haven been nominated and are reproduced in **Table 16**.

Table 16 Nominated Site Vibration Control Criteria

Building type	Included Buildings	Site Control Criteria[1]	
		Operator warning level	Operator halt level
Reinforced frame structure	All surrounding commercial	20 mm/s PPV	25 mm/s PPV
Unreinforced or light framed structures	All surrounding Residential	5 mm/s PPV	7.5 mm/s PPV
Heritage (structurally sound)	Congregational Church	5 mm/s PPV	7.5 mm/s PPV
Buried Utilities	All	20 mm/s PPV	25 mm/s PPV
Human Response[2]	All	0.2 $m/s^{1.75}$ VDV	0.4 $m/s^{1.75}$ VDV
Vibration Sensitive Equipment[3]	Medical Centre, Hospital	0.013 mm/s PPV	0.018 mm/s PPV

Note 1: An exceedance of the operator warning level does not require activities to cease, but will alert the Project Manager and Foreman to proceed with caution at a reduced force or load.

Note 2: Based on information presented in DECCW's Assessing Vibration: a technical guideline.

Note 3: Based on the Generic Vibration Criteria for Vibration-Sensitive Equipment (SPIE 1991).

11 Construction Methodology - Noise and Vibration Sources

11.1 Construction Activities

Construction activities will comprise site preparation works followed by the main station works to be delivered in seven stages (refer to **Section 3**).

The site preparation involves erection of hoardings, amenities and offices, dilapidation surveys, scaffolding and establishment of site access. In general, minimal noise will be generated during these activities, however mobile cranes and delivery trucks would be required periodically which would result in higher noise emissions for short periods.

Noise and vibration will be generated from a range of activities associated with the main works, particularly during piling and concrete and oversized material deliveries. In order to reduce noise and vibration emissions, where possible, construction activities would be undertaken behind perimeter hoarding and piling activities will be occurring within the station box at depth.

Out of hours work will generally be required for extended concrete pours to achieve quality specifications and the delivery of oversized concrete structures. Section 12 outlines the mitigation measures to manage noise and vibration.

11.2 Noise and Vibration Sources

11.2.1 Plant and Equipment at Source Noise Control

Plant and equipment likely to be used during construction are identified in **Table 17** along with maximum allowable sound levels in accordance with the CNVS. The CNVIS will include further details on specific plant and equipment for each activity.

Table 17 Indicative Maximum Plant and Equipment Sound Levels

Plant Item	Maximum Allowable Construction Plant Sound Levels – dBA	
	Sound Power Level	Sound Pressure Level at 7m
Excavator 3t	90	65
Excavator 8t	100	75
Excavator 20t	105	80
Excavator 40t	115	90
Excavator 40t with hammer	118	93
Excavator 20t (with bucket/shear)	105	80
Concrete Saw	118	93
Wire Saw	95	70
Generators	104	79
Compressor	105	80
Skidsteer Loader	110	85
Crane (mobile)	110	85
Crane (fixed)[1]	105	80

Plant Item	Maximum Allowable Construction Plant Sound Levels – dBA	
	Sound Power Level	Sound Pressure Level at 7m
Jackhammer	113	88
Powered Hand Tools	94	69
Core Drill	102	82
Concrete Truck	112	87
Concrete Pump	109	84
Bored Piling Rig	110	85
Dump trucks 15t	108	83
Elevated work platform	102	77
Sucker / vacuum truck (utilities works)	100	75
Day maker (night work)	80	55

Note 1: Maximum allowable sound level not nominated in CNVS.

11.2.2 Vibration Generating Plant and Activity

CoA E35 requires that alternatives to rock hammering are reviewed with a view to adopting methods that minimise impacts on sensitive receivers aim of minimising impacts on sensitive receivers. The bulk excavation of the site was completed as part of the TSE Works. Accordingly, the greatest potential for vibration generating activities would be associated with detailed excavation works, for which the intensity and duration of vibration is expected to be low. Notwithstanding, John Holland will consider equipment selection and alternative construction methods or mitigation methods, such as rock sawing, for each stage of the Waterloo ISD works.

11.3 Construction Noise and Vibration Impact Statement

In accordance with CoA E33, a Construction Noise and Vibration Impact Statement (CNVIS) will be prepared prior to the commencement of construction activities which would include predictive modelling of noise and vibration impacts. The noise modelling will be in accordance with the ICNG, including adjustments for annoying activities. Where noise and/or vibration levels are predicted to exceed their corresponding noise and vibration objective, the CNVIS will include specific mitigation measures identified through consultation with affected sensitive receivers.

John Holland proposes to use similar types of equipment as detailed in **Table 17**. Predicted noise levels are to be based on the above equipment noise levels, distance attenuation and shielding from existing building and structures where applicable.

11.4 Cumulative Works

Where it has been identified that other construction works (including utility works associated with the CSSI where undertaken by third parties) are scheduled to be undertaken in the vicinity of the site, John Holland will consult with proponents of the other construction works and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers in accordance with CoA E40.

Where cumulative works are to occur a CNVIS will be prepared in accordance with CoA E33 to consider the other construction works and the appropriate management measures identified to minimise cumulative impacts and maximise respite for sensitive receivers. The CNVIS will include any specific mitigation measures identified through consultation with affected receivers.

12 Mitigation Measures

The EIS NIA identified significant potential noise and vibration impacts at the surrounding sensitive receivers due to the construction works. Consequently, the CNVS was submitted together with the EIS to identify the noise and vibration mitigation and management practices that will be adopted for the Sydney Metro City and Southwest Chatswood to Sydenham Project and forms part of the CoA. Mitigation includes, controlling noise emissions, in order of priority, at the source, the transmission path and at the receiver.

During delivery of the Waterloo ISD component of the Sydney Metro City and Southwest Chatswood to Sydenham Project John Holland would utilise practical construction methods to reduce emissions while still achieving an acceptable project delivery. The environmental performance outcomes identified in the EIS as amended by the documents list in Project Planning Approval Condition A1 will be achieved through the implementation of path controls as detailed in Table 18. No receiver controls are anticipated to be required based on the scope of work. The implementation of these measures will achieve the requirements of Condition C4 (a) which requires:

- *Noise levels would be minimised with the aim of achieving the noise management levels where feasible and reasonable;*
- *The project would avoid any damage to buildings from vibration.*

Some noise and vibration disturbance may still occur, particularly during out of hours work. The following section provides details of the mitigation measures proposed to minimise noise and vibration impacts.

12.1 Standard Mitigation Measures

Standard mitigation measures to minimise noise and vibration related impacts during construction activities are applied where possible and feasible in order to ensure the noise and vibration performance outcomes identified in the EIS NIA would be achieved. These are included in **Table 18**.

Table 18 Noise and Vibration Management and Mitigation Measures

Management and Mitigation Measures	Responsibility	Timing
Pre-construction		
Dilapidation/Condition Surveys of the surrounding infrastructure (roads and footpaths) and required properties in accordance with CoA 58	Construction Manager	Pre-site possession
Register of Noise &/or Vibration Sensitive Receivers including name and category of receiver.	Noise and Vibration Consultant	Pre-pilling and base slab works
Hoardings and/or site sheds are to be erected on work site boundaries to function as noise barriers shielding noisy activities from receivers where feasible.	Construction Manager	Pre-pilling and base slab works
Location of site access and egress and load out areas are to consider noise sensitive receivers and where feasible and reasonable to minimise reversing movements within the site.	Construction Manager	Pre-pilling and base slab works

Management and Mitigation Measures	Responsibility	Timing
All fixed plant at the work site is to be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures and other noise attenuation measures in order to ensure that the total noise emission from the work site complies with conditions of approval requirements. Plant and equipment that generate vibration would be selected based on the safe working distances outlined in the CNVIS Table 19.	Construction Manager, Site Superintendent	Pre-subcontractor engagement
General Construction		
Site Induction of all site personnel. Site Induction, Toolbox Talks and Team Meetings are to include a noise and vibration awareness/education component identifying impacts and implementation of control measures for the project. Site inductions are to include: • Project specific and standard noise and vibration measures • Construction hours of work • Nearest sensitive receivers • Relevant licence and approval conditions • Loading and unloading areas.	Project Director (PD), Foreman	Ongoing
Ensure works are only performed during approved constructions hours as per Conditions of Approval.		Ongoing
Complaints management will be as per the protocol outlined in the Sydney Metro Construction Complaints Management System.	Community Mgr/ PD	As received
Noise and vibration monitoring to be carried out as per CNVS and this CNVMP.	PD, Environment & Sustainability Mgr	Ongoing/As required
Minimise structure-borne noise to neighbouring buildings such as separating connection prior to hammering by means of saw cutting.	Construction Manager	As required
Deliveries will be carried out within the approved construction hours, unless directed by police or other relevant authority (RMS, Council, etc.).	Construction Manager	Ongoing
Where noise monitoring indicates that the existing measures are not adequate to meet noise goals then additional controls will be implemented where practicable and feasible including: • Installation of localised noise barriers around noisy areas • Modifications or alterations to plant and equipment ie. consider use of alternative excavator attachments • Avoid the simultaneous operation of two or more noisy plant items • Provision of respite from noise intensive activities • Alternate construction method or other negotiated outcomes with the affected community.	Environment & Sustainability Mgr, Site Superintendent	As required

Management and Mitigation Measures	Responsibility	Timing
Where the CNVIS identifies vibration may result in damage to buildings the following will be implemented: • Validate the predictions in the CNVIS using the vibrating plant/equipment in a location outside the safe working distance; • ECM to identify safe working distance from structures to avoid damage when plant/equipment may result in vibration impacts to buidlings. • Where required, physically delineate the safe working distance if using vibrating equipment on site to avoid any damage to buildings from vibration. • Review the construction method if vibration levels are likely to result in structural damage of a building.	Construction Manager, Environment & Sustainability Mgr, Site Superintendent	As required
Plant and Equipment		
Plant and equipment is to be selected to minimise noise emissions, in-so-far-as possible whilst maintaining efficiency of function.	Construction Manager, Site Superintendent	Ongoing
Non-tonal warning alarms to be used for all permanent mobile plant operating on Sydney Metro construction sites. Note WHS requirements must also be satisfied.	Construction Manager, Site Superintendent	Ongoing
The offset distance between noisy operating plant and sensitive receivers is to be as great as possible.	Construction Manager, Site Superintendent	Ongoing
Where feasible and reasonable the layout and positioning of noise-producing plant and activities on the work site are organised to minimise noise emission levels. Also, avoidance of the use of noisy plant working simultaneously close together when close to sensitive receivers.	Construction Manager, Site Superintendent	Ongoing
Where feasible and reasonable noise intensive construction activities, including rock/concrete hammering, shall be undertaken during less sensitive daytime periods.	Construction Manager, Site Superintendent	Ongoing
Air brake silencers are to be correctly installed and fully operational for any heavy vehicle that uses Sydney Metro construction site.	Construction Manager, Site Superintendent	Ongoing
Regular maintenance on plant and equipment to include compliance checks on plant noise emissions in accordance with predicted noise levels. Service and performance records are reviewed as per Incoming Plant Inspection Checklist.	Environment & Sustainability Mgr, Site Superintendent	Pre- construction
All plant and equipment are to be maintained in good order and in accordance with manufacturer's recommendations. Plant or equipment causing excessive noise are to be modified or if required removed from site.	Site Superintendent	Ongoing
Appropriately sized plant and equipment to be selected to avoid damage to buildings from vibration, refer to the CNVIS.	Site Superintendent	As required

Management and Mitigation Measures	Responsibility	Timing
Post Construction		
A post-demolition Dilapidation/Condition survey will be carried out with the agreement of the property owner/occupier on the surrounding infrastructure (including footpath and roads) and required buildings. Reports are to be submitted to the Principal's Representative for review as per the contract.	Construction Manager, Site Superintendent	Post construction

12.2 Implementation of Further Mitigation Measures and Corrective Actions

A range of noise mitigation measures have been recommended to reduce and control potential construction noise impacts.

Mitigation measures will be considered during the construction planning and site establishment phases of the Project, and in the development of the CNVIS. This will include the investigation and the selection of alternative methods for construction activities that affect sensitive receivers. Equipment selection will be undertaken during the development of the CNVIS, based on the predicted noise levels additional plant equipment will be selected for use wherever practicable.

The construction noise mitigation measures are recommended to, where feasible and reasonable, minimise potential for disturbance at receivers, preserve the acoustic amenity of the surrounding environment and aim to control noise levels within the construction NMLs.

12.2.1 General Construction Noise Mitigation

On the basis of being feasible and reasonable, mitigation measures that will be implemented during the construction works are summarised as follows:

- Adherence to daytime construction hours is recommended for construction works, in particular hydraulic hammering activities
- Use dampened rock hammers
- Night works, where applicable, should be programmed to minimise the number of consecutive nights work impacting the same receivers
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers will result in reduced noise emissions
- Equipment which is used intermittently is to be shut down when not in use
- Where possible, the offset distance between noisy plant items and nearby noise sensitive receivers should be as great as possible
- Where possible, equipment with directional noise emissions should be oriented away from sensitive receivers
- Undertake compliance checks on the noise emissions of plant and machinery used for the Project to indicate whether noise emissions from plant items are higher than noise emissions from well-maintained plant
- Regular noise monitoring during construction at sensitive receivers during critical periods to identify and assist in managing high risk noise events
- Where possible heavy vehicle movements should be limited to daytime hours
- Non-tonal warning alarms should be fitted to all permanent mobile plant

- Reversing of equipment should be minimised so as to prevent nuisance caused by reversing alarms
- Loading and unloading should be carried out away from sensitive receivers, where practicable
- Installation of localised noise barriers around noisy areas
- Installation of solid hoarding or sound barrier screening to perimeter fencing where permitted noise levels are exceeded at neighbouring noise affected properties
- Provision of respite from noise intensive activities
- Alternate construction method or other negotiated outcomes with the affected community
- Modifications or alterations to plant and equipment
- Limiting times for certain construction activities

These corrective actions will each alter the noise being produced in a different way. For example, the installation of localised noise barriers will be suitable for smaller or stationary items such as generators, whereas an equivalent reduction in noise would not be produced from delivery trucks arriving and departing site. Similarly, respite periods may only be required for certain activities. This might mean that station works can continue OOHs, however other noisy activities may be scheduled for standard daytime hours only, plus possible respite period.

To ensure the rectification of exceedance of noise and vibration levels, if required a specific procedure is to be developed which may involve a reduction in the impacting activity until the activity complies with noise and vibration goals, or reappraisal of the CNVIS and introduction of additional control measures.

12.2.2 Additional Noise Mitigation Measures

Additional noise mitigation measures to be explored in the CNVIS in the event of predicted exceedances of the noise goals (particularly during OOHWs) are described in the CNVS. The CNVS includes definition of the level of noise impact which triggers consideration of each additional mitigation measure (reproduced in **Table 19**, **Table 20** and **Table 21**).

CoA E41 and E42 nominate additional mitigation for OOHWs for total internal construction noise (ground-borne noise and noise intrusion through building facade) at residential receivers, as follows:

E41 The Proponent must ensure that residential receivers, located in non-residential zones, likely to experience an internal noise level exceeding Leq(15 minute) 60 dB(A) between 8pm and 9pm or Leq(15 minute) 45 dB(A) between 9pm and 7am (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise, or a perceptible level of vibration is planned (including works associated with utility adjustments)) must be offered additional mitigation in accordance with the Sydney Metro City and South West Noise and Vibration Strategy referenced in Condition E32.

E42 The Proponent must ensure that residential receivers in residential zones likely to experience an internal noise level of Leq(15 minute) 45dB(A) or greater between 8pm and 7am (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise, or a perceptible level of vibration is planned (including works associated with utility adjustments)) must be offered additional mitigation in accordance with the Sydney Metro City and South West Noise and Vibration Strategy referenced in Condition E32.

The additional mitigation measures described in the CNVS are summarised below, with discussion of their potential applicability to these works. Upon finalization of the CNVIS and modelling of impacts of the residual noise, after noise reduction measures are determined, the following additional noise mitigation measures below will be considered. During the planning of the works the Community and Stakeholders Management Team will liaise with the Project team for the implementation of the selected measures. The objective of these additional noise mitigation measures is to engage, inform and provide Project-specific messages to the community, recognising that advanced warning of potential disruptions can assist in reducing the impact.

- **Periodic Notifications** - Periodic notifications include regular newsletters, letterbox drops or advertisements in local papers to provide an overview of current and upcoming works and other topics of interest.
- **Website** - The Project website would form a resource for members of the community to seek further information, including noise and vibration management plans and current and upcoming construction activities.
- **Project Info-line and Construction Response Line** - TfNSW operate a Construction Response Line and Project Info-line. These numbers provide a dedicated 24 hour contact point for any complaints regarding construction works and for any Project enquiries. All complaints require a verbal response within 2 hours. All enquiries require a verbal response within 24 hours during standard construction hours, or on the next working day during out of hours work (unless the enquirer agrees otherwise).
- **Email Distribution List** - An email distribution list would be used to disseminate Project information to interested stakeholders.
- **Signage** - Signage on construction sites would be provided to notify stakeholders of Project details and Project emergency or enquiry information.
- **Alternative Accommodation (AA)** - Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.
- **Specific Notifications (SN)** - Specific notifications would be letterbox dropped or hand distributed to the nearby residences and other sensitive receivers no later than seven days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
- **Phone Calls (PC)** - Phone calls may be made to identified/affected stakeholders within seven days of proposed work. For these works considering the large numbers of receivers, phone calls are not likely to be considered a reasonable mitigation measure in all cases, but could be used to inform specific receivers if requested (after notification of the works as above).
- **Individual Briefings (IB)** - Individual briefings may be used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. For these works considering the large numbers of potentially affected receivers, individual briefings may not be considered a reasonable mitigation measure in all cases, but could be used for specific receivers if requested (after notification of the works as above).
- **Monitoring (M)** - Regular noise monitoring during construction at sensitive receivers during critical periods would be used to identify and assist in managing high risk noise events. Monitoring of noise would also be undertaken in response to complaints. All noise monitoring would be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures.
- **Project Specific Respite Offer (RO)** - Residents subjected to lengthy periods of noise or vibration may be eligible for a Project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. An example of a respite offer might be pre-purchased movie tickets. The provision of this measure would be determined on a case-by-case basis.

Table 19 Additional Mitigation Measures Matrix (AMMM) - Airborne Construction Noise

Time Period		Mitigation Measures Predicted LAeq(15minute) Noise Level Above Background (RBL)			
		0 to 10 dB	10 to 20 dB	20 to 30 dB	> 30 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	-	-	M, LB	M, LB
	Sat (8.00 am - 6.00 pm)				
	Sun/Pub Hol (Nil)				
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (7:00am – 08:00 am) Sun/Pub Hol (8am – 6pm)	-	LB	M, LB	M, IB, LB, PC, RO, SN
OOHW	Mon-Sat (10.00 pm - 7.00 am) Sat (10:00pm – 8:00am)	-	M, LB	M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN
	Sun/Pub Hol (6.00 pm - 7.00 am)				

Table 20 AMMM - Ground-borne Construction Noise

Time Period		Mitigation Measures Predicted LAeq(15minute) Noise Level Exceedance		
		0 to 10 dB	10 to 20 dB	>20 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	LB	LB	M, LB, SN
	Sat (8.00 am - 6.00 pm)			
	Sun/Pub Hol (Nil)			
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (07:00am – 08:00 am) Sun/Pub Hol (8.00 am - 6.00 pm)	LB	M, LB, SN	M, IB, LB, PC, RO, SN
OOHW	Mon-Sat (10.00 pm - 7.00 am) Sat (10:00pm – 8:00 am)	M, LB, SN	AA, M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN
	Sun/Pub Hol (6.00 pm - 7.00 am)			

Table 21 AMMM - Ground-borne Vibration

Time Period		Mitigation Measures Predicted Vibration Levels Exceed Maximum Levels
Standard	Mon-Fri (7.00 am - 6.00 pm)	M, LB, RP
	Sat (8.00 am - 6.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (07:00am – 08:00 am)	M, IB, LB, PC, RO, SN

Time Period		Mitigation Measures Predicted Vibration Levels Exceed Maximum Levels
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW	Mon-Fri (10.00 pm - 7.00 am) Sat (10:00pm – 8:00 am)	AA, M, IB, LB, PC, RO, SN
	Sun/Pub Hol (6.00 pm - 7.00 am)	

13 Noise and Vibration Monitoring

13.1 Details of Baseline Data to be Obtained and When

The NMLs presented in **Table 6** were determined in the EIS NIA from noise logging conducted at Monitoring Location B.06 (122 Wellington Street, Waterloo) between 31 August and 14 September 2015. Location B.06 has significantly less exposure to road traffic noise than receivers adjacent to Botany Road and Raglan Street. Further, there has been a general increase in road traffic noise (and background noise) in the areas surrounding the Project. The Noise Consultant recommended that background noise monitoring should be conducted at the following locations to review the NMLs for the Project:

- Corner of Wellington Street and Cope Street
- Corner of Botany Road and Raglan Street / Henderson Road

However, due to ongoing construction activities on the site by the TSE Contractor, additional noise monitoring has not been undertaken prior to site possession. It is noted that background noise monitoring was conducted during August 2017 by Osterman Consulting for Delta Group for the preparation of the Construction Noise and Vibration Impact Statement, Waterloo (August 2017). Unattended monitoring was completed at 45, 123 and 100 Botany Road over a minimum period of one week to obtain background levels. The daytime RBLs were recorded to be 60 dBA to 63 dBA. The difference in RBLs is minor. The Waterloo ISD Noise Consultant advised the monitoring locations in the Osterman (2017) report are representative of the corner of Botany Road and Raglan Street/Henderson Road. Therefore, it is proposed to use the NMLs nominated in the Table 6 for the Waterloo ISD works.

13.2 Details of All Monitoring of the Project to be Undertaken

Management and control of noise and vibration impacts shall be monitored and assessed as described below. Noise and vibration monitoring will to be undertaken by suitably qualified persons in accordance with the CNVMP.

Attended measurements will be undertaken within a period of 14 days from the commencement of each stage of construction in order to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNVIS. Attended noise measurements would be repeated at a minimum interval of every month in order to ensure ongoing compliance.

Figure 5 presents the proposed noise and vibration representative receiver monitoring locations during Waterloo ISD works. The representative receiver monitoring locations would be used as reference locations to track the performance over the life of the Project.

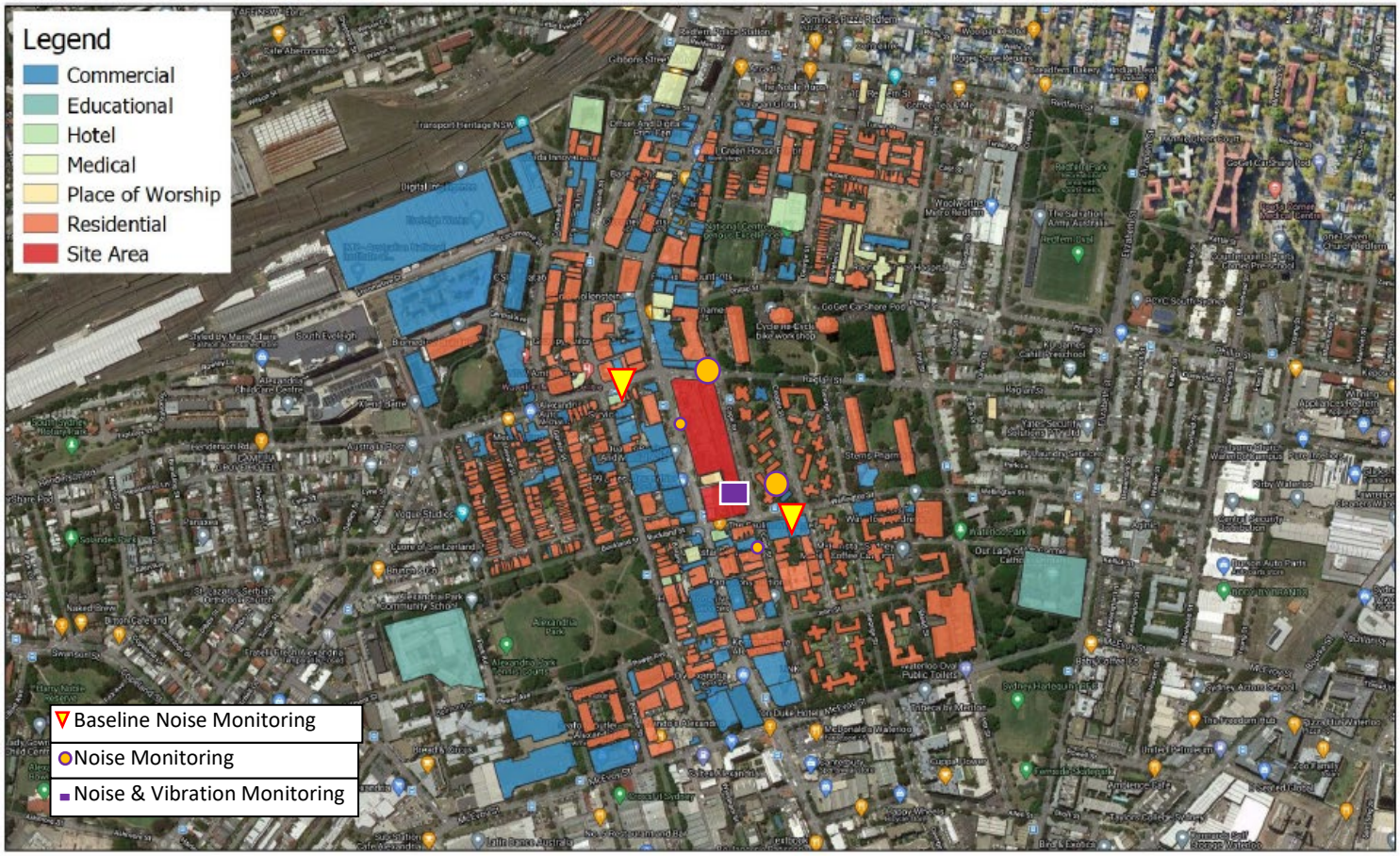
Real-time continuous noise and vibration monitoring would be implemented for highly intrusive construction works at the nominated representative receivers or at the most affected receiver, where high noise or vibration impacts have been predicted in the CNVIS, or in response to complaints. The real-time noise and vibration monitoring data will be available online to construction team, the Proponent, ER and AA, the Department and EPA in real time.

13.3 Location of Monitoring

The following key locations are to be included in this monitoring:

- Waterloo Congregational Church (noise and vibration)
- 104 Cope Street (noise)
- 219 Cope Street (noise)

Figure 5 Receivers and monitoring locations



13.4 Frequency of Monitoring to be Undertaken

Table 22 presents the noise and vibration monitoring program for the construction works.

Noise measurements will be undertaken consistent with the procedures documented in *AS 1055.1-1997 Acoustics - Description and Measurement of Environmental Noise - General Procedures*.

Vibration measurements will be undertaken in accordance with the procedures documented in the OEH's *Assessing Vibration - a technical guideline (2006), AS 2107.2 2006 Explosives – Storage and Use and DIN 4150:Part 3-1999 Structural Vibration - Effects of Vibration on Structures*.

Real time (unattended) noise or vibration monitoring will be undertaken to satisfy Project Planning Approval Condition C11. Real time monitoring will be deployed to manage impacts from 'high risk' activities, where the CNVIS predictions identify there is a high risk of annoyance from construction. The real-time noise monitors will be installed prior to commencement of the high risk activity. The monitor will be installed by an appropriately trained person in the measurement and assessment of construction noise and vibration, who is familiar with the requirements of the relevant standards and procedures.

The real-time monitoring data will be available to Waterloo ISD, Sydney Metro, ER, AA, DPIE and EPA via a web based portal.

Table 22 Noise and Vibration Monitoring Program

Type	Location	Timing/Frequency	Purpose
Vibration	105 Botany Road (Waterloo Congregational Church)	Continuous	Monitoring vibration emissions from all construction activities that result in vibration
Noise	104 Cope Street	Operator-attended	Monitoring noise emissions from all construction activities
	219 Cope Street		
	62-82 Botany Road		
	123 Botany Road (Cauliflower Hotel)		
	47 Botany Road (Abbotts Hotel)		
	122-136 Wellington Street		
	123 Wellington Street		
	132 Botany Road		

13.5 Plant and Equipment Noise Auditing

John Holland environmental & sustainability coordinator will undertake compliance auditing of plant and equipment noise emissions. This would be undertaken via attended measurements of a representative selection of plant and equipment used on-site. The representative items of equipment are to be regularly monitored to confirm that the operating noise levels of all noise intensive plant items comply with the nominated sound power level shown in **Table 17**.

13.6 Noise Monitoring

Noise monitoring undertaken by an VMS or John Holland environmental team as required as per the Noise and Vibration Monitoring Program presented in **Table 22**. This initial monitoring measures airborne and ground-borne noise to assess whether construction activities exceed predictions in the CNVIS. Determination is made if the existing noise controls on site are adequate or whether changes are required for proceeding works.

John Holland will seek the advice of a heritage specialist on methods and locations for installing attended or unattended equipment used for noise monitoring of heritage-listed structures.

Monitoring undertaken on private property is to be followed in strict accordance with the CNVS and notification to Sydney Metro if agreement from the property owner/occupier is not granted.

Noise monitoring is to occur within the noise sensitive areas identified in **Figure 5** or other identified monitoring location.

13.6.1 Parameters of the Project to be Monitored

All noise monitoring will be recorded over 15 minute sample intervals. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum noise metrics to be stored in memory and reported are the following A-weighted noise levels: L90, Leq and Lmax.

13.6.2 Reporting of Monitoring Results

All noise monitoring will record the following information as a minimum:

- The precise monitoring location.
- Name of the person undertaking monitoring (in the case of attended monitoring) and site manager.
- Details of the instrument used for the measurement including make, model, serial number and last calibration date.
- Date and time of test.
- Weather condition during test, including air temperature, wind speed, wind direction and details of rain/wet conditions if applicable.
- Plant and equipment operating at the time of measurement (in the case of attended monitoring).
- Measured 15 minute noise level(s) at the monitoring location, including LAeq, LAmax and LA90 statistical parameters.

13.6.3 Procedures to Identify and Implement Additional Mitigation Measures Where Results of Monitoring are Unsatisfactory

If noise monitoring measurements show that permitted levels are being exceeded, alternative methods and/or equipment will be reviewed as per the Standard Mitigation Measures. If construction noise levels continue to exceed NMLs the Additional Mitigation Measures Matrix (AMMM) may be applied to reduce the noise impacts.

Where attended noise monitoring results are higher than predicted in the CNVIS and the noise is demonstrated to be associated with the construction activities, the CNVIS predictions will be reviewed and additional mitigation measures implemented where feasible.

13.7 Vibration Monitoring

Vibration monitoring is to be undertaken in accordance with the Noise and Vibration Monitoring Program presented in **Table 22** to assess the vibration impacts on the adjacent buildings and occupants. This initial monitoring measures vibration to assess whether construction activities exceed predictions in the CNVIS. Determination is made if the existing vibration controls on site are adequate or whether changes are required for proceeding works.

John Holland will seek the advice of a heritage specialist on methods and locations for installing attended and unattended equipment used for vibration monitoring of heritage-listed structures.

If ongoing vibration monitoring is required peak vibration levels are recorded and trigger an audible/visual alarm and/or SMS Alert corresponding to both "Operator Warning Level" and "Operator Halt Level" set according to nominated site vibration criteria levels presented in **Table 16**.

Monitoring can also be undertaken at various stages of construction to determine the effect in alterations to the construction methodology, or as proximity of the works approaches adjacent receivers, or if deemed appropriate and after consultation with the various stakeholders. The CNVIS would be updated if required to reflect these changes.

In response to vibration complaints additional monitoring may be undertaken to investigate and assess the extent and source of vibration exceedances and to apply mitigation measures preventing the complaint from reoccurring.

13.7.1 Parameters of the Project to be Monitored

All vibration monitoring will be recorded over a minimum 15 minute sample interval. For every sample, the data is to be processed statistically and stored in memory. The minimum vibration metrics to be stored in memory and reported are the following vibration levels: Vibration Dose Value VDV, RMS, Peak Particle Velocity (PPV) and Frequency (Hz).

13.7.2 Reporting of Monitoring Results

All vibration monitoring will record the following information as a minimum:

- The precise monitoring location.
- Name of the person undertaking monitoring (in the case of attended monitoring) and site manager.
- Details of the instrument used for the measurement including make, model, serial number and last calibration date.
- Date and time of test.
- Plant and equipment operating at the time of measurement (in the case of attended monitoring).
- Measured vibration level(s) at the monitoring location, including the Peak Particle Velocity (PPV), the dominant frequency of vibration (in Hz).

13.7.3 Procedures to Identify and Implement Additional Mitigation Measures Where Results of Monitoring are Unsatisfactory

If vibration monitoring measurements show that permitted levels in the CNVIS may be exceeded (including at the Waterloo Congregational Church) during vibration testing outside the safe working distance, work will stop and alternative methods and/or equipment will be reviewed as per the Standard Mitigation Measures. Advice from the Vibration Consultant will be obtained where levels exceed and specific advice is required to prevent structural impacts to buildings. The CVNIS will be reviewed and amended to consider the impacts and identify appropriate mitigation measures. If construction vibration levels continue to exceed the vibration objectives the Additional Mitigation Measures Matrix (AMMM) may be applied to reduce the vibration impacts.

13.8 Reporting

The noise and vibration monitoring reports will be submitted to the Project Director and Environment & Sustainability Manager with noise and/or vibration monitoring results and details of affected sensitive receivers within one week of being undertaken or at weekly intervals for continuous monitoring. In the case of noise exceedances, details of the plant or operations causing the exceedances along with corrective action and the status of its implementation are to be supplied.

Details of noise and vibration monitoring will be reported to Sydney Metro on an annual basis. The consolidated noise and vibration monitoring report will be submitted to the Secretary and relevant regulatory agencies for information by Sydney Metro as required by Project Planning Approval C16.

13.9 Inspections

An activity log or site diary will be used by the Site Supervisor on site to keep an accurate record of construction activities on a daily basis. If required, the activity log will be used to correlate on-site activities with measured noise and vibration levels and/or complaints. The acoustic consultant may periodically review the proposed monitoring program with the aim to reduce or increase the monitoring depending on monitoring results and community feedback received.

The Site Supervisor, Environment & Sustainability Manager or nominated representative is to conduct regular site inspections, observing any instances of excessively noisy machinery or key activities that are associated with the works. Noise or vibration records are to be reviewed for potential issues arising from works. Results from the inspection are then to be recorded on an environmental checklist.

Copies of noise and vibration monitoring results will be made available to Sydney Metro as required.

14 Communication, Community Consultation and Reporting

JHG will ensure meaningful and effective consultation and communication processes are established and maintained throughout the life of the project in accordance with the CEMP and Project Planning Approval requirements. Community consultation and the fostering of positive cooperative relationships assists in managing impacts from noisier operations and alleviating community concerns thereby minimizing complaints. This includes the following in consultation with the Sydney Metro:

- Periodic notification of construction activities
- Specific works notification prior to disruptive or noisy activities
- Community consultation meetings
- Notification in accordance with CoA E29

Sydney Metro will take the lead on stakeholder and community liaison. JHG is to support the overall management and coordination of stakeholder community liaison and ensuring notifications and consultation are provided within adequate periods. This is to include participation in the Communications Management Control Group (CMCG) prior to commencement of construction.

JHG will display emergency contact numbers on site entry points.

All community consultation is to be in accordance with the Sydney Metro Overarching Stakeholder and Community Involvement Plan and the Community Communication Strategy. Community Communication strategy is to be developed by the Project Manager in accordance with contract requirements, where required refer to JHG *Community Communication Strategy (SMCSWSWL-JHG-SWL-CL-PLN-000001)*.

14.1 Communication and Reporting

Table 23 presents the reporting and communication summary requirements during the project.

Table 23 Reporting and Communication Summary Requirements

Reporting & Communication	Frequency	Responsibility	Report To
Daily Prestart Meetings	Daily	Site Supervisor	Place on Noticeboard
Toolbox Meeting	As required	Project Manager	HSEQ Manager
Monitoring Reports	As occurs	Site Supervisor	Project Manager / HSEQ Manager

14.2 Noise Complaints and Community Consultation

All complaints handling is to be in accordance with the Sydney Metro Construction Complaints Management System, the Waterloo ISD CEMP and the Community Consultation Strategy. Complaints will be investigated, reported, documented, actioned and closed out as per the details provided in the Waterloo ISD Community Consultation Strategy and CEMP.

14.3 Consultation with Government Agencies

The Project Planning Approval requires the CNVMP and the Noise and Vibration Monitoring Program to be prepared in consultation with government agencies. Table 24 outlines the requirement and the outcome of the consultation.

Table 24 Consultation requirements

Condition	Document	Agency	Comment	Response
C3	CNVMP	City of Sydney	the City has reviewed the Waterloo Noise and Vibration Management Plan and is satisfied that appropriate noise and vibration criteria have been identified, nearest affected receivers have been identified, mitigation measures have been proposed and that an appropriate monitoring strategy is detailed.	No action required
C9 (a)	Noise and Vibration Monitoring Program	City of Sydney	the City has reviewed the Waterloo Noise and Vibration Management Plan and is satisfied that appropriate noise and vibration criteria have been identified, nearest affected receivers have been identified, mitigation measures have been proposed and that an appropriate monitoring strategy is detailed.	No action required
		EPA	The EPA encourages the development of such plans to ensure that proponents have determined how they will meet their statutory obligations and designated environmental objectives. However, it is not EPA policy to approve or endorse these documents. The EPA's role is to set environmental objectives/requirements for environmental management, rather than being directly involved in the development of strategies to achieve those objectives/requirements	No action required

Appendix A

A1 Project Planning Conditions of Approval

The CoA relevant to this CNVMP are listed **Table A1** in accordance with the requirements of Section 3.3 of the CEMF. A cross reference is also included to indicate where the condition is addressed in this CNVMP or other Project documents.

Table A1 Compliance Matrix - Minister's Conditions of Approval

<table>
<tr><th>CoA Requirement</th><th>Reference</th></tr>
<tr><td colspan="2">CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN</td></tr>
<tr><td>C3. The following CEMP sub-plans must be prepared in consultation with the relevant government agencies identified for each CEMP sub-plan and be consistent with the CEMF and CEMP referred to in Condition C1.
<table>
<tr><th></th><th>Required CEMP sub- plan</th><th>Relevant government agencies to be consulted for each CEMP sub-plan</th></tr>
<tr><td>(a)</td><td>Noise and vibration</td><td>Relevant Council(s)</td></tr>
</table></td><td>This CNVMP

Section 14.3</td></tr>
<tr><td>C4. The CEMP sub-plans must state how:
a) the environmental performance outcomes identified in the EIS as amended by the documents listed in A1 will be achieved;
b) the mitigation measures identified in the EIS as amended by documents listed in A1 will be implemented;
c) the relevant terms of this approval will be complied with; and
d) issues requiring management during construction, as identified through ongoing environmental risk analysis, will be managed.</td><td>Section 2.1

Section 12

Section 2
Section 2.1</td></tr>
<tr><td>C5. The CEMP sub-plans must be developed in consultation with relevant government agencies. Where an agency(ies) request(s) is not included, the Proponent must provide the Secretary justification as to why. Details of all information requested by an agency to be included in a CEMP sub-plan as a result of consultation and copies of all correspondence from those agencies, must be provided with the relevant CEMP sub-plan.</td><td>This CEMP sub-plan</td></tr>
<tr><td>C6. Any of the CEMP sub-plans may be submitted to the Secretary along with, or subsequent to, the submission of the CEMP but in any event, no later than one (1) month before commencement of construction.</td><td>This CEMP sub-plan</td></tr>
<tr><td>C8. Construction must not commence until the CEMP and all CEMP sub-plans have been approved by the Secretary. The CEMP and CEMP sub-plans, as approved by the Secretary, including any minor amendments approved by the ER (or AA in regards to the Noise and Vibration sub-plan), must be implemented for the duration of construction. Where the CSSI is being staged, construction of that stage is not to commence until the relevant CEMP and sub-plans have been approved by the Secretary.</td><td>Section 1.1</td></tr>
<tr><td>C12. The Construction Monitoring Programs must be developed in consultation with relevant government agencies as identified in Condition C9 of this approval and must include, to the written satisfaction of the Secretary, information requested by an agency to be included in a Construction Monitoring Programs during such consultation. Details of all information requested by an agency including copies of all correspondence from those agencies, must be provided with the relevant Construction Monitoring Program.</td><td>Section 14.3
Table 22</td></tr>
</table>

CoA Requirement	Reference
C13. The Construction Monitoring Programs must be endorsed by the ER (or AA in regards to the Noise and Vibration Construction Monitoring Program) and then submitted to the Secretary for approval at least one (1) month before commencement of construction or within another timeframe agreed with the Secretary.	This CEMP sub-plan **Section 1.1**
C14. Construction must not commence until the Secretary has approved all of the required Construction Monitoring Programs, and all relevant baseline data for the specific construction activity has been collected.	This CEMP sub-plan **Section 1.1**
CONSTRUCTION MONITORING PROGRAMS	
C9. The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance.	**Section 13** **Section 14.3**
C10. Each Construction Monitoring Program must provide:	
a) details of baseline data available;	**Section 9.1.1**
b) details of baseline data to be obtained and when;	**Section 13.1**
c) details of all monitoring of the project to be undertaken;	**Section 13.2**
d) the parameters of the project to be monitored;	**Section 13.6** **Section 13.7**
e) the frequency of monitoring to be undertaken;	**Section 13.4**
f) the location of monitoring;	**Section 13.3**
g) the reporting of monitoring results;	**Section 13.6.2** **Section 13.7.2**
h) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and	**Section 13.6** **Section 13.7**
i) any consultation to be undertaken in relation to the monitoring programs.	**Section 14**
C11. The Noise and Vibration Construction Monitoring Program and Blast Construction Monitoring Program must include provision of real time noise and vibration monitoring data. The real time data must be available to the construction team, Proponent, ER and AA in real time. The Department and EPA must be provided with access to the real time monitoring data in real time.	**Section 13**
C15. The Construction Monitoring Programs, as approved by the Secretary including any minor amendments approved by the ER (or AA in regards to Noise and Vibration Construction Monitoring Program), must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Secretary, whichever is the greater.	**Section 13**
C16. The results of the Construction Monitoring Programs must be submitted to the Secretary for information, and relevant regulatory agencies, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program.	**Section 13**

	Required Construction Monitoring Programs	Relevant government agencies to be consulted for each Construction Monitoring Program
(a)	Noise and Vibration	EPA and Relevant Council(s)

CoA Requirement	Reference
C17. Where a relevant CEMP sub-plan exists, the relevant Construction Monitoring Program may be incorporated into that CEMP sub-plan.	**Section 13**
NOISE AND VIBRATION	
Vibration	
E28. The Proponent must ensure that vibration from construction activities does not exceed the vibration limits set out in the British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration	**Section 10.3**
E29. Owners of properties at risk of exceeding the screening criteria for cosmetic damage must be notified before construction that generates vibration commences in the vicinity of those properties. The management of construction works in the vicinity of properties at risk of exceeding the screening criteria for cosmetic damage must be considered in the Noise and Vibration management sub plan required by Condition C3.	**Section 14** **Section 10.3** CNVIS
E30. The Proponent must conduct vibration testing before and during vibration generating activities that have the potential to impact on heritage items to identify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent must review the construction methodology and, if necessary, implement additional mitigation measures.	**Section 13.7**
E31. The Proponent must seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring of heritage-listed structures.	**Section 13.6** **Section 13.7**
CONSTRUCTION NOISE AND VIBRATION STRATEGY	
E32. The Proponent must review the Sydney Metro City and Southwest Construction Noise and Vibration Strategy in the PIR during detailed construction planning to consider scale and duration of impacts, the requirements of this approval and all measures to limit construction noise impacts to sensitive receivers including: a) at property or architectural treatment; b) relocation; and c) other forms of mitigation where impacts are predicted to be long term and significant. The revised Sydney Metro City and Southwest Construction Noise and Vibration Strategy must be submitted to the Secretary for approval at least one (1) month before construction commences.	**Section 4.2** **Section 12**
E33. Construction Noise and Vibration Impact Statements must be prepared for each construction site before construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers.	**Section 11.2.2**
E34. Noise generating works in the vicinity of potentially-affected community, religious, educational, community institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) must not be timetabled within sensitive periods, unless other reasonable arrangements to the affected institutions are made at no cost to the affected institution or as otherwise approved by the Secretary.	**Section 9.2**

CoA Requirement		Reference
E35.	The Proponent must review alternative methods to rock hammering and blasting for excavation as part of the detailed construction planning with a view to adopting methods that minimise impacts on sensitive receivers. Construction Noise and Vibration Impact Statements must be updated for each location or activity to adopt the least impact alternative in any given location unless it can be demonstrated, to the satisfaction of the AA, why it should not be adopted.	**Section 11.2.2** CNVIS
STANDARD CONSTRUCTION HOURS		
E36.	Construction, except as allowed by Condition E48 (excluding cut and cover tunnelling), must only be undertaken during the following standard construction hours: a) 7:00am to 6:00pm Mondays to Fridays, inclusive; b) 8:00am to 6:00pm Saturdays; and c) at no time on Sundays or public holidays.	**Section 8**
RESPITE FOR RECEIVERS		
E39.	The Proponent must consult with proponents of other construction works in the vicinity of the CSSI and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers.	**Section 11.4**
E40.	The Proponent must ensure all works (including utility works associated with the CSSI where undertaken by third parties) are coordinated to provide the required respite periods identified in accordance with the terms of this approval.	**Section 11.4**
MITIGATION – NON RESIDENTIAL ZONES		
E41.	The Proponent must ensure that residential receivers, located in non-residential zones, likely to experience an internal noise level exceeding Leq(15 minute) 60 dB(A) between 8pm and 9pm or Leq(15 minute) 45 dB(A) between 9pm and 7am (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise, or a perceptible level of vibration is planned (including works associated with utility adjustments)) must be offered additional mitigation in accordance with the Sydney Metro City and South West Noise and Vibration Strategy referenced in Condition E32.	**Section 9.1** **Section 12.2.2** CNVIS
E42.	The Proponent must ensure that residential receivers in residential zones likely to experience an internal noise level of Leq(15 minute) 45dB(A) or greater between 8pm and 7am (inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in ground-borne noise, or a perceptible level of vibration is planned (including works associated with utility adjustments)) must be offered additional mitigation in accordance with the Sydney Metro City and South West Noise and Vibration Strategy referenced in Condition E32.	**Section 9.1** **Section 12.2.2** CNVIS
WORKPLACE HEALTH AND SAFETY FOR NEARBY WORKERS		
E43.	At no time can noise generated by construction exceed the National Standard for exposure to noise in the occupational environment of an eight-hour equivalent continuous A-weighted sound pressure level of LAeq,8h, of 85dB(A) for any employee working at a location near the CSSI.	**Section 9.6**
VARIATION TO STANDARD CONSTRUCTION HOURS		
E44.	Notwithstanding Condition E36 construction associated with the CSSI may be undertaken outside the hours specified under those conditions in the following circumstances:	**Section 8.2**

CoA Requirement	Reference
a) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or b) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or c) where different construction hours are permitted or required under an EPL in force in respect of the construction; or d) construction that causes Laeq(15 minute) noise levels: i. no more than 5 dB(A) above the rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009), and ii. no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses, and iii. continuous or impulsive vibration values, measured at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006), and iv. intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006); or e) where a negotiated agreement has been reached with a substantial majority of sensitive receivers who are within the vicinity of and may be potentially affected by the particular construction, and the noise management levels and/or limits for ground-borne noise and vibration (human comfort) cannot be achieved. All agreements must be in writing and a copy forwarded to the Secretary at least one (1) week before the works commencing; or f) construction approved through an Out of Hours Work Protocol referred to in Condition E47, provided the relevant council, local residents and other affected stakeholders and sensitive receivers are informed of the timing and duration at least five (5) days and no more than 14 days before the commencement of the works. Note: This condition does not apply where an EPL is in force in respect of the construction.	
E45. On becoming aware of the need for emergency construction in accordance with Condition E44(b), the Proponent must notify the AA, the ER and the EPA (if an EPL applies) of the need for those activities or work. The Proponent must also use best endeavours to notify all affected sensitive receivers of the likely impact and duration of those works.	**Section 8.2**
E46. Notwithstanding Conditions E44 and E48, rock breaking and other particularly annoying activities for station shaft or cut and cover stations is not permitted outside of standard construction hours, except at Central (excluding Central Walk works at 20-28 Chalmers Street, Surry Hills); or (a) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or (b) where different construction hours are permitted or required under an EPL in force in respect of the construction; or I construction that causes LAeq(15 min) noise levels:	**Section 8.2**

CoA Requirement		Reference
	i. no more than 5 dB(A) above the rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and ii. no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses; and iii. continuous or impulsive vibration values, measures at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006); and iv. intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).	
OUT OF HOURS WORK PROTOCOL FOR WORKS NOT SUBJECT TO AN EPL		
E47.	An Out of Hours Work Protocol for the assessment, management and approval of work outside of standard construction hours, as defined in Condition E36 of this approval, must be prepared in consultation with the EPA and submitted to the Secretary for approval before construction commences for works not subject to an EPL. The protocol must include: a) the identification of low and high risk construction activities; b) a risk assessment process in which the AA reviews all proposed out of hours activities and identifies their risk levels; c) a process for the endorsement of out of hours activities by the AA and approval by the ER for construction activities deemed to be of: i. low environmental risk; or ii. high risk where all construction works cease by 9pm. All other high risk out of hours construction must be submitted to the Secretary for approval unless otherwise approved through an EPL. The protocol must detail standard assessment, mitigation and notification requirements for high and low risk out of hours works; and detail a standard protocol for referring applications to the Secretary.	**Section 8.2**
24 HOUR CONSTRUCTION		
E48.	Notwithstanding Condition E36 of this approval and subject to Condition E47, the following activities may be undertaken 24 hours per day, seven (7) days per week: a) tunnelling and associated support activities (excluding cut and cover tunnelling, and excluding the installation and decommissioning of the Blues Point acoustic shed except where compliance with Condition E44 is achieved); b) excavation within an acoustic enclosure (excluding the Blues Point temporary site except where compliance with Condition E44 is achieved); c) excavation at Central (excluding Central Walk works at 20-28 Chalmers Street, Surry Hills) without an acoustic enclosure; d) station and tunnel fit out; and e) haulage and delivery of spoil and materials.	**Section 8**
Blast Management		

CoA Requirement		Reference
E50	A Blast Management Strategy must be prepared and include: (a) sequencing and review of trial blasting to inform blasting; (b) regularity of blasting; (c) intensity of blasting; (d) periods of relief; anI(e) blasting program.	No blasting required for the Project
Building Condition Survey		
E59	Before commencement of construction, all property owners of buildings identified as being at risk of damage must be offered a building condition survey. Where an offer is accepted a structural engineer must undertake the survey. The results of the surveys must be documented in a Building Condition Survey Report for each building surveyed. Copies of Building Condition Survey Reports must be provided to the owners of the buildings surveyed, and if agreed by the owner, the Relevant Council within three (3) weeks of completing the Survey Report and no later than one (1) month before the commencement of construction.	**Section 7**

A2 Revised Environmental Mitigation Measures

In addition to the CoAs presented above, the Chatswood to Sydenham Submissions and Preferred Infrastructure Report nominates Revised Environmental Mitigation Measures (REMM) that, where applicable, must be complied with during the development of the Waterloo ISD. The REMM requirements which are relevant to this CNVMP are presented in **Table A2**.

Table A2 Compliance Matrix - Revised Environmental Mitigation Measures Requirements

REMM Requirement	Reference
NV1. The Construction Noise and Vibration Strategy would be implemented with the aim of achieving the noise management levels where feasible and reasonable. *This would include the following example standard mitigation measures where feasible and reasonable:* • *Provision of noise barriers around each construction site* • *Provision of acoustic sheds at Chatswood dive site, Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, Waterloo and Marrickville dive site* • *The coincidence of noisy plant working simultaneously close together would be avoided* • *Offset distances between noisy plant and sensitive receivers would be increased* • *Residential grade mufflers would be fitted to all mobile plant* • *Dampened rock hammers would be used* • *Non-tonal reversing alarms would be fitted to all permanent mobile plant* • *High noise generating activities would be scheduled for less sensitive period considering the nearby receivers* • *The layout of construction sites would consider opportunities to shield receivers from noise.* *This would also include carrying out the requirements in relation to construction noise and vibration monitoring.*	**Section 12** **Section 13**
NV2. Unless compliance with the relevant traffic noise criteria can be achieved, night-time heavy vehicle movements at the Chatswood dive site, Crows Nest Station, Victoria Cross Station and Waterloo Station sites would be restricted to: • The Pacific Highway and Mowbray Road at the Chatswood dive site • The Pacific Highway, Hume Street and Oxley Street at the Crows Nest Station construction site • McLaren Street, Miller Street and Berry Street at the Vic Cross Station construction site • Botany Road and Raglan Street at the Waterloo Station construction site.	CNVIS
NV3. Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. *For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.*	CNVIS
NV4. Feasible and reasonable measures would be implemented to minimise ground borne noise where exceedances are predicted.	CNVIS

REMM Requirement	Reference
NV7. Alternative demolition techniques that minimise noise and vibration levels would be investigated and implemented where feasible and reasonable. This would include consideration of: • *The use of hydraulic concrete shears in lieu of hammers/rock breakers* • *Sequencing works to shield noise sensitive receivers by retaining building wall elements* • *Locating demolition load out areas away from the nearby noise sensitive receivers* • *Providing respite periods for noise intensive works* • *Methods to minimise structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw cutting and propping, using hand held splitters and pulverisers or hand demolition* • *Installing sound barrier screening to scaffolding facing noise sensitive neighbours* • *Modifying demolition works sequencing/hours to minimise impacts during peak pedestrian times and/or adjoining neighbour outdoor activity periods.*	**N/A – no demolition works**

A3 Construction Environmental Management Framework

The CEMF requirements which are relevant to this CNVMP are nominated in Section9.2.a of the CEMF and presented in **Table A3**.

Table A3 Compliance M–trix - Construction Environmental Management Framework Requirements

CEMF Requirement	Reference
9.1 Construction Noise and Vibration Management Objectives a. The following noise and vibration management objectives will apply to construction: i. Minimise unreasonable noise and vibration impacts on residents and businesses; ii. Avoid structural damage to buildings or heritage items as a result of construction vibration; iii. Undertake active community consultation; and iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners	Section 12 Section 7 Section 10 Section 14 Community Communications Strategy
9.2 (a) Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for their scope of works consistent with the Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009). The Construction Noise and Vibration Management Plan will include as a minimum: i. Identification of work areas, site compounds and access points; ii. Identification of sensitive receivers and relevant construction noise and vibration goals; iii. Be consistent with, and include the requirements of the noise and vibration mitigation measures as detailed in, the environmental approval documentation and the Sydney Metro Construction Noise and Vibration Strategy (C iv. Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios) that have the potential to generate noise or vibration impacts on surrounding sensitive receivers, in particular residential areas; v. Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program; vi. Community consultation requirements and Community notification provisions specifically in relation to blasting; vii. The requirements of any applicable EPL conditions; viii. Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week; ix. Pre-construction compliance requirements and hold points;	Detailed on the Environmental Control Map **Section 6** **Section 9** **Section 10** **Section 12** **Section 3** **Section 12** **Section 14** Note: no blasting required **Section 4** **Section 12** **Section 712** **Section 5**

CEMF Requirement	Reference
x. The responsibilities of key project personnel with respect to the implementation of the plan xi. Noise monitoring requirements; xii. Compliance record generation and management; and xiii. An Out of Hours Works Protocol applicable to all construction methods and sites.	**Section 13** **Section 0** Refer to CoA E47 (Sydney Metro Out of Hours Works Protocol)
9.2 (b) Detailed Construction Noise and Vibration Impact Statements will be prepared for noise intensive construction sites and or activities, to ensure the adequacy of the noise and vibration mitigation measures. Specifically, Construction Noise and Vibration Impact Statements will be prepared for EPL variation applications and works proposed to be undertaken outside of standard construction hours.	This CNVMP
9.2 (c) Noise and vibration monitoring would be undertaken for construction as specified in the CNVS and the EPL.	**Section 13**
9.2 (d) The following compliance records would be kept by Principal Contractors: i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria; and ii. Records of community enquiries and complaints, and the Contractor's response.	**Section 0** **Section 14**
9.3 Construction Noise and Vibration Mitigation a. All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. Examples of noise and vibration mitigation measures include: i. Construction hours will be in accordance with the working hours specified in Section 5.1; ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers.	**Section 8** **Section 12** **Section 13.3**

A4 Construction Environmental Management Plan

The CEMP requirements which are relevant to this CNVMP are nominated in Section 6 of the CEMP and presented in **Table A4**.

Table A4 Compliance Matrix - Construction Environmental Management Plan Requirements

CEMP Requirement	Reference
This CEMP is supported by sub plans relevant to the scope of the Waterloo ISD work and outlined in the Sydney Metro Staging Report. These are listed in Table 10. **Table 10: Sub plans/procedures for Waterloo ISD** **Document** / **Relevant Plan/Procedure** Noise and Vibration Management Sub Plan / Noise and Vibration Management Sub Plan	This **CNVMP**

A5 Revised environmental performance outcomes

The revised environmental performance outcomes which are relevant to this CNVMP are presented in **Table A5**.

Table A5 Revised Environmental Performance Outcomes

Relevant Secretary's environmental assessment requirements desired performance outcomes	Environmental performance outcome	Reference
Construction noise and vibration		
Noise and vibration – amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimize adverse impacts on acoustic amenity. **Noise and vibration – structural** Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimize adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage.	• Noise levels would be minimised with the aim of achieving the noise management levels where feasible and reasonable • The project would avoid any damage to buildings from vibration.	This CNVMP

Appendix B Sensitive Receivers

ID	Address	Usage
Residential Receivers		
0	104 Raglan St	RESIDENTIAL
1	87 Cooper St	RESIDENTIAL
2	209 Cope St	RESIDENTIAL
3	213 Cope St	RESIDENTIAL
4	215 Cope St	RESIDENTIAL
5	217 Cope St	RESIDENTIAL
6	219 Cope St	RESIDENTIAL
7	123 Wellington St	RESIDENTIAL
8	117 Wellington St	RESIDENTIAL
9	95 Cooper St	RESIDENTIAL
10	93 Cooper St	RESIDENTIAL
11	91 Cooper St	RESIDENTIAL
12	89 Cooper St	RESIDENTIAL
14	225 Cope St	RESIDENTIAL
15	229-231 Cope St	RESIDENTIAL
16	233-243 Cope St	RESIDENTIAL
17	241 Cope St	RESIDENTIAL
18	6 John St	RESIDENTIAL
19	113-131 Cooper St	RESIDENTIAL
20	111 Cooper St	RESIDENTIAL
21	97-109 Cooper St	RESIDENTIAL
23	149 Cope St	RESIDENTIAL
24	Phillip St High Rise Apartment Building	RESIDENTIAL
25	2 John St	RESIDENTIAL
26	161 Botany Rd	RESIDENTIAL
27	143-159 Botany Rd	RESIDENTIAL
28	133-149 Botany Rd	RESIDENTIAL
29	131 Botany Rd	RESIDENTIAL
30	127-129 Botany Rd	RESIDENTIAL
33	122-136 Wellington St	RESIDENTIAL
35	180-182 Cope St	RESIDENTIAL
36	184 Cope St	RESIDENTIAL
37	186 Cope St	RESIDENTIAL
38	190-204 Cope St	RESIDENTIAL
39	170 Botany Rd	RESIDENTIAL

ID	Address	Usage
40	176-178 Wyndham St	RESIDENTIAL
41	172-174 Wyndham St	RESIDENTIAL
42	162-168 Wyndham St	RESIDENTIAL
43	158-160 Wyndham St	RESIDENTIAL
44	146-156 Wyndham St	RESIDENTIAL
45	140-144 Wyndham St	RESIDENTIAL
46	136-138 Wyndham St	RESIDENTIAL
47	132-134 Wyndham St	RESIDENTIAL
48	128-130 Wyndham St	RESIDENTIAL
49	126 Wyndham St	RESIDENTIAL
50	124 Wyndham St	RESIDENTIAL
51	118-120 Wyndham St	RESIDENTIAL
52	8 Botany Lane	RESIDENTIAL
54	138-142 Botany Rd	RESIDENTIAL
55	144 Botany Rd	RESIDENTIAL
56	146-156 Botany Rd	RESIDENTIAL
57	158-168 Botany Rd	RESIDENTIAL
59	1-3 Buckland St	RESIDENTIAL
60	7-23 Buckland St	RESIDENTIAL
61	102-116 Wyndham St	RESIDENTIAL
62	86-100 Wyndham St	RESIDENTIAL
64	66-74 Wyndham St	RESIDENTIAL
65	64 Wyndham St	RESIDENTIAL
66	60-62 Wyndham St	RESIDENTIAL
67	56-58 Wyndham St	RESIDENTIAL
69	8 Henderson Rd	RESIDENTIAL
75	20-34 Wyndham St	RESIDENTIAL
76	36-54 Wyndham St	RESIDENTIAL
78	56-58 Botany Rd	RESIDENTIAL
79	3 Henderson Rd	RESIDENTIAL
81	9-11 Henderson Rd	RESIDENTIAL
82	24-26 Botany Rd	RESIDENTIAL
83	28-42 Botany Rd	RESIDENTIAL
84	92-110 Cope St (Block of Apartments)	RESIDENTIAL
85	125-131 Raglan St	RESIDENTIAL
88	3 Phillip St (High Rise)	RESIDENTIAL

ID	Address	Usage
89	180 Pitt St (High Rise)	RESIDENTIAL
90	249 George St (High Rise)	RESIDENTIAL
91	200 Pitt St (High Rise Apartments)	RESIDENTIAL
92	95 Wellington St	RESIDENTIAL
93	8 Boundary St	RESIDENTIAL
94	1-3 Botany Rd	RESIDENTIAL
95	5-11 Botany Rd	RESIDENTIAL
97	76-78 Cope St	RESIDENTIAL
98	80 Cope St	RESIDENTIAL
99	82-86 Cope St	RESIDENTIAL
100	219 George St	RESIDENTIAL
101	110 Wellington St	RESIDENTIAL
102	105 Wellington St	RESIDENTIAL
103	West St Apartment Block	RESIDENTIAL
104	333 George St	RESIDENTIAL
105	309 George St (Apartment Block)	RESIDENTIAL
106	331 George St (Apartment Block)	RESIDENTIAL
107	337 George St (Apartment Block)	RESIDENTIAL
108	Cnr John and Mead St Apartment Block	RESIDENTIAL
109	31 John St	RESIDENTIAL
110	341 John St (Apartment Block)	RESIDENTIAL
111	44 Cooper St (Apartment Block)	RESIDENTIAL
112	46 Cooper St (Apartment Block behind 240 George St)	RESIDENTIAL
113	48 Cooper St (Apartment Block behind 242 George St)	RESIDENTIAL
114	50A Cooper St (Behind 244 George St)	RESIDENTIAL
115	50 Cooper St (Behind 244 George St)	RESIDENTIAL
116	52 Cooper St (Behind 246 George St)	RESIDENTIAL
117	246 George St	RESIDENTIAL
118	244 George St	RESIDENTIAL
119	242 George St	RESIDENTIAL
120	240 George St	RESIDENTIAL
121	56 Cooper St	RESIDENTIAL
122	248 George St	RESIDENTIAL
123	250 George St (Cooper St)	RESIDENTIAL
124	252 George St (Cooper St)	RESIDENTIAL
125	254 George St (Cooper St)	RESIDENTIAL

ID	Address	Usage
126	29 John St	RESIDENTIAL
127	27 John St	RESIDENTIAL
128	247 Cope St	RESIDENTIAL
129	249 Cope St	RESIDENTIAL
130	251 Cope St	RESIDENTIAL
131	63 Mcevoy St	RESIDENTIAL
132	312-314 George St (Aparmetnt Block)	RESIDENTIAL
133	179 Botany Rd	RESIDENTIAL
134	171-173 Botany Rd	RESIDENTIAL
135	169 Botany Rd (Construction Site - On Time of Image)	RESIDENTIAL
136	1 John St	RESIDENTIAL
137	3-25 John St	RESIDENTIAL
138	202 Cope St	RESIDENTIAL
139	204-218 Botany Rd	RESIDENTIAL
140	216-220 Wyndham St	RESIDENTIAL
143	204 Wyndham St	RESIDENTIAL
144	196-202 Wyndham St	RESIDENTIAL
146	6 Moores Lane	RESIDENTIAL
147	184-192 Wyndham St	RESIDENTIAL
148	182 Wyndham St	RESIDENTIAL
149	180 Wyndham St	RESIDENTIAL
150	2 Moores Lane	RESIDENTIAL
151	6 Moores Lane	RESIDENTIAL
152	172-174 Botany Rd	RESIDENTIAL
154	105-109 Mcevyoy St (Mixed Use)	RESIDENTIAL
155	14-30 Brenan St (Aparment Block)	RESIDENTIAL
156	2-12 Brenan St (Apartment Block)	RESIDENTIAL
157	123 Wyndham St	RESIDENTIAL
158	117 Wyndham St	RESIDENTIAL
159	1-7A Power Ave	RESIDENTIAL
160	9 Power Ave	RESIDENTIAL
161	115 Wyndham St	RESIDENTIAL
162	25-37 Buckland St	RESIDENTIAL
163	114 Garden St	RESIDENTIAL
164	112 Garden St	RESIDENTIAL
165	108-110 Garden St	RESIDENTIAL

ID	Address	Usage
166	104-106 Garden St	RESIDENTIAL
167	100-102 Garden St	RESIDENTIAL
168	98 Garden St	RESIDENTIAL
169	96 Garden St	RESIDENTIAL
170	94 Garden St	RESIDENTIAL
171	92 Garden St	RESIDENTIAL
172	88-90 Garden St	RESIDENTIAL
173	86 Garden St	RESIDENTIAL
174	84 Garden St	RESIDENTIAL
175	76-82 Garden St	RESIDENTIAL
176	72-74 Garden St	RESIDENTIAL
177	64-70 Garden St	RESIDENTIAL
178	60-62 Garden St	RESIDENTIAL
179	30-32 Henderson Rd	RESIDENTIAL
180	28 Henderson Rd	RESIDENTIAL
181	24-26 Henderson Rd	RESIDENTIAL
182	22-22A Henderson Rd	RESIDENTIAL
183	20 Henderson Rd	RESIDENTIAL
184	18 Henderson Rd	RESIDENTIAL
185	14-16 Henderson Rd	RESIDENTIAL
186	57-59 Wyndham St	RESIDENTIAL
187	61 Wyndham St	RESIDENTIAL
188	63-65 Wyndham St	RESIDENTIAL
189	69 Wyndham St	RESIDENTIAL
190	71 Wyndham St	RESIDENTIAL
191	75-83 Wyndham St	RESIDENTIAL
192	85-87 Wyndham St	RESIDENTIAL
193	89-91 Wyndham St	RESIDENTIAL
194	93 Wyndham St	RESIDENTIAL
195	95-99 Wyndham St	RESIDENTIAL
196	100-101A Wyndham St	RESIDENTIAL
197	103-105 Wyndham St	RESIDENTIAL
198	107-109 Wyndham St	RESIDENTIAL
199	111 Wyndham St	RESIDENTIAL
200	113 Wyndham St	RESIDENTIAL
201	111-117 Mcevoy St	RESIDENTIAL

ID	Address	Usage
202	Atlas Apartments (Loveridge St)	RESIDENTIAL
203	Atlas Apartments Loveridge St (Loveridge Buildings)	RESIDENTIAL
204	11 Power Ave (Mixed Use Building)	RESIDENTIAL
205	Atlas Apartments Brennan St (Brennan Buildings)	RESIDENTIAL
208	39-41 Buckland St	RESIDENTIAL
209	43-45 Buckland St	RESIDENTIAL
210	47 Buckland St	RESIDENTIAL
211	49 Buckland St	RESIDENTIAL
212	51-55 Buckland St	RESIDENTIAL
213	55 Buckland St	RESIDENTIAL
214	57 Buckland St	RESIDENTIAL
215	84 Gerald St	RESIDENTIAL
216	80-82 Gerald St	RESIDENTIAL
217	78 Gerald St	RESIDENTIAL
218	76 Gerald St	RESIDENTIAL
219	72-74 Gerald St	RESIDENTIAL
220	70 Gerald St	RESIDENTIAL
221	66-68 Gerald St	RESIDENTIAL
222	60-64 Gerald St	RESIDENTIAL
223	58 Gerald St	RESIDENTIAL
224	56 Gerald St	RESIDENTIAL
225	48-52 Gerald St	RESIDENTIAL
226	Behind 48-52 Gerald St	RESIDENTIAL
228	36-46 Garden St	RESIDENTIAL
229	32 Garden St	RESIDENTIAL
230	28 Gerald St	RESIDENTIAL
231	54 Henderson Rd	RESIDENTIAL
232	52A Henderson Rd	RESIDENTIAL
233	52B Henderson Rd	RESIDENTIAL
234	50 Henderson Rd	RESIDENTIAL
235	48 Henderson Rd	RESIDENTIAL
236	40-46 Henderson Rd	RESIDENTIAL
237	61 Garden St	RESIDENTIAL
238	63-65 Garden St	RESIDENTIAL
239	67 Garden St	RESIDENTIAL
240	69 Garden St	RESIDENTIAL

ID	Address	Usage
241	71 Garden St	RESIDENTIAL
242	75-79 Garden St	RESIDENTIAL
243	81-85 Garden St	RESIDENTIAL
244	87-91 Garden St	RESIDENTIAL
245	93 Garden St	RESIDENTIAL
246	95-97 Garden St	RESIDENTIAL
247	99 Garden St	RESIDENTIAL
248	101 Garden St	RESIDENTIAL
249	103 Garden St	RESIDENTIAL
250	105 Garden St	RESIDENTIAL
251	107-109 Garden St	RESIDENTIAL
252	111-113 Garden St	RESIDENTIAL
253	115 Garden St	RESIDENTIAL
254	59-61 Buckland St	RESIDENTIAL
255	65-67 Buckland St	RESIDENTIAL
256	69 Buckland St	RESIDENTIAL
257	71 Buckland St	RESIDENTIAL
258	73 Buckland St	RESIDENTIAL
259	75 Buckland St	RESIDENTIAL
260	77A Buckland St	RESIDENTIAL
261	77 Buckland St	RESIDENTIAL
262	79 Buckland St	RESIDENTIAL
263	46 Phillips St	RESIDENTIAL
264	44 Phillips St	RESIDENTIAL
265	42 Phillips St	RESIDENTIAL
266	40 Phillips St	RESIDENTIAL
267	38 Phillips St	RESIDENTIAL
268	36 Phillips St	RESIDENTIAL
269	34 Phillips St	RESIDENTIAL
270	32 Phillips St	RESIDENTIAL
271	30B-30C Phillips St	RESIDENTIAL
272	30-30A Phillips St	RESIDENTIAL
273	26-28 Phillips St	RESIDENTIAL
274	24 Phillips St	RESIDENTIAL
275	22-22A Phillips St	RESIDENTIAL
276	18-20 Phillips St	RESIDENTIAL

ID	Address	Usage
277	14-16 Phillips St	RESIDENTIAL
278	12 Phillips St	RESIDENTIAL
279	8-10 Phillips St	RESIDENTIAL
280	6 Phillips St	RESIDENTIAL
281	2-4 Phillips St	RESIDENTIAL
282	2C Phillips St	RESIDENTIAL
283	2B Phillips St	RESIDENTIAL
284	2A Phillips St	RESIDENTIAL
285	66-74 Henderson Rd	RESIDENTIAL
286	31 Gerard St	RESIDENTIAL
287	33 Gerard St	RESIDENTIAL
288	35 Gerard St	RESIDENTIAL
289	35A Gerard St	RESIDENTIAL
290	37 Gerard St	RESIDENTIAL
291	39 Gerard St	RESIDENTIAL
292	41 Gerard St	RESIDENTIAL
293	43-43A Gerard St	RESIDENTIAL
294	45 Gerard St	RESIDENTIAL
295	47 Gerard St	RESIDENTIAL
296	49-51 Gerard St	RESIDENTIAL
297	53 Gerard St	RESIDENTIAL
298	55 Gerard St	RESIDENTIAL
299	57 Gerard St	RESIDENTIAL
300	61-63 Gerard St	RESIDENTIAL
301	67 Gerard St	RESIDENTIAL
302	69-73 Gerard St	RESIDENTIAL
303	75 Gerard St	RESIDENTIAL
304	77 Gerard St	RESIDENTIAL
305	79 Gerard St	RESIDENTIAL
306	81 Gerard St	RESIDENTIAL
307	83 Gerard St	RESIDENTIAL
311	Eveleigh Works	RESIDENTIAL
318	32 Cornwallis St	RESIDENTIAL
319	32 Rosehill St (Apartment Block)	RESIDENTIAL
320	18 Rosehill St	RESIDENTIAL
321	15-29 Cornwallis St	RESIDENTIAL

ID	Address	Usage
322	31 Cornwallis St	RESIDENTIAL
323	84-88 Rosehill St	RESIDENTIAL
324	80 Rosehill St	RESIDENTIAL
325	44-78 Rosehill St	RESIDENTIAL
326	1 Wyndham St	RESIDENTIAL
327	5 Wyndham St	RESIDENTIAL
328	7 Wyndham St	RESIDENTIAL
329	9 Wyndham St	RESIDENTIAL
330	11-17 Wyndham St	RESIDENTIAL
331	25 Wyndham St	RESIDENTIAL
332	27 Wyndham St	RESIDENTIAL
333	29 Wyndham St	RESIDENTIAL
334	45 Wyndham St (Mixed Use)	RESIDENTIAL
335	48 Wyndham St (Cnr Wyndham and Henderson) (Mixed Use)	RESIDENTIAL
336	31 Henderson Rd (Construction Site at the Time of Image)	RESIDENTIAL
337	48 Garden St	RESIDENTIAL
338	54 Garden St	RESIDENTIAL
339	30-44 Garden St	RESIDENTIAL
340	26-28 Garden St	RESIDENTIAL
341	22-24 Garden St	RESIDENTIAL
342	10-20 Garden St	RESIDENTIAL
343	6-8 Garden St	RESIDENTIAL
344	Cnr Marion and Gibbons St	RESIDENTIAL
345	21 Gibbons St	RESIDENTIAL
346	23 Gibbons St	RESIDENTIAL
347	39-61 Gibbons St	RESIDENTIAL
349	1 Margaret St	RESIDENTIAL
350	5 William Lane	RESIDENTIAL
351	154-158 Regent St	RESIDENTIAL
352	144 Regent St	RESIDENTIAL
353	136 Regent St	RESIDENTIAL
354	19 William Lane	RESIDENTIAL
355	130 Regent St	RESIDENTIAL
356	140 Regent St	RESIDENTIAL
357	126 Regent St	RESIDENTIAL
359	5 William Lane	RESIDENTIAL

ID	Address	Usage
362	92-96 Regent St	RESIDENTIAL
363	90 Regent St	RESIDENTIAL
364	131 Regent St	RESIDENTIAL
365	133 Regent St	RESIDENTIAL
366	135 Regent St	RESIDENTIAL
367	137-141 Regent St	RESIDENTIAL
368	143-145 Regent St	RESIDENTIAL
369	147-151 Regent St	RESIDENTIAL
370	153-159A Regent St	RESIDENTIAL
371	161-165 Regent St	RESIDENTIAL
373	175-179 Regent St	RESIDENTIAL
374	181 Regent St	RESIDENTIAL
376	185-187 Regent St	RESIDENTIAL
377	189 Regent St	RESIDENTIAL
378	193 Regent St	RESIDENTIAL
379	199 Regent St	RESIDENTIAL
380	62 Cope St	RESIDENTIAL
381	58 Cope St	RESIDENTIAL
382	54 Cope St	RESIDENTIAL
383	46-52 Cope St	RESIDENTIAL
384	36-44 Cope St	RESIDENTIAL
385	26-34 Cope St	RESIDENTIAL
386	24 Cope St	RESIDENTIAL
387	16-24 Cope St	RESIDENTIAL
388	14 Cope St	RESIDENTIAL
389	12-12A Cope St	RESIDENTIAL
390	19-25 Cope St	RESIDENTIAL
391	41-47 Turner St	RESIDENTIAL
392	39 Turner St	RESIDENTIAL
393	27 Cope St	RESIDENTIAL
394	35 Cope St	RESIDENTIAL
395	Renwick St Structure (Behind 35 Cope St)	RESIDENTIAL
396	80 Renwick St	RESIDENTIAL
397	55 Cope St	RESIDENTIAL
398	57-59 Cope St	RESIDENTIAL
399	61-63 Cope St	RESIDENTIAL

ID	Address	Usage
400	67 Cope St	RESIDENTIAL
401	69-71 Cope St	RESIDENTIAL
402	73-75 Cope St	RESIDENTIAL
403	124 Renwick St	RESIDENTIAL
404	120-122 Renwick St	RESIDENTIAL
405	116-118 Renwick St	RESIDENTIAL
406	112-114 Renwick St	RESIDENTIAL
407	108-110 Renwick St	RESIDENTIAL
408	Salvation Army Phillip St	RESIDENTIAL
409	128 George St	RESIDENTIAL
410	90 Renwick St	RESIDENTIAL
411	Opposite 120 Renwick St	RESIDENTIAL
412	186 George St	RESIDENTIAL
413	158 George St	RESIDENTIAL
414	154 Renwick St	RESIDENTIAL
415	AIME George St	RESIDENTIAL
416	166 George St	RESIDENTIAL
417	113 George St	RESIDENTIAL
418	115 George St	RESIDENTIAL
419	117 George St	RESIDENTIAL
420	119-123 George St	RESIDENTIAL
421	125 George St (Apartments)	RESIDENTIAL
422	127 George St	RESIDENTIAL
423	2-22 Albert St	RESIDENTIAL
424	20 Albert St	RESIDENTIAL
425	18 Albert St	RESIDENTIAL
426	14-16 Albert St	RESIDENTIAL
427	8-12 Albert St	RESIDENTIAL
428	2-6 Albert St	RESIDENTIAL
429	130-132 Albert St	RESIDENTIAL
430	126-128 Pitt St	RESIDENTIAL
431	114 Pitt St	RESIDENTIAL
432	110-112 Pitt St	RESIDENTIAL
433	21 Turner St	RESIDENTIAL
434	25 Turner St	RESIDENTIAL
435	122A Pitt St (Apartment Block)	RESIDENTIAL

ID	Address	Usage
436	122B Pitt St (Apartment Block)	RESIDENTIAL
437	122C Pitt St (Apartment Block)	RESIDENTIAL
438	35 Turner St	RESIDENTIAL
439	Jone Lane Apartment Block (Opposite 35 Turner St)	RESIDENTIAL
440	141-143 George St	RESIDENTIAL
441	147-151 George St	RESIDENTIAL
442	153-167 George St	RESIDENTIAL
443	169-171 George St	RESIDENTIAL
444	173 George St	RESIDENTIAL
445	175 George St	RESIDENTIAL
446	177 George St	RESIDENTIAL
447	179 George St	RESIDENTIAL
448	181 George St	RESIDENTIAL
449	183 George St	RESIDENTIAL
450	185 George St	RESIDENTIAL
451	187 George St	RESIDENTIAL
452	189 George St	RESIDENTIAL
453	191-193 George St	RESIDENTIAL
454	195 George St	RESIDENTIAL
455	199 George St	RESIDENTIAL
456	5 St Peters Lane (Terraces)	RESIDENTIAL
457	177 St Peters Lane	RESIDENTIAL
458	25 Albert St	RESIDENTIAL
459	27-29 Albert St	RESIDENTIAL
460	31-33 Albert St	RESIDENTIAL
461	33A-35 Albert St	RESIDENTIAL
462	37 Albert St	RESIDENTIAL
463	2 Phillip St (Apartments Opposite Hospital)	RESIDENTIAL
464	Cnr Phillip and Pitt St Apartment Block	RESIDENTIAL
465	Apartment Block Behind 146 Pitt St	RESIDENTIAL
466	146-152 Pitt St	RESIDENTIAL
467	146-152A Pitt St	RESIDENTIAL
468	Row of Dwellings Behind 5 St Peters Lane	RESIDENTIAL
469	Abondoned Bulding Opposite 165 Pitt St	RESIDENTIAL
470	104 Wellington St	RESIDENTIAL
471	232 Pitt St	RESIDENTIAL

ID	Address	Usage
472	74 Wellington St	RESIDENTIAL
501	10 Henderson St	RESIDENTIAL
502	72 Botany Rd	RESIDENTIAL
503	74 Wyndham St	RESIDENTIAL
504	72 Wyndham St	RESIDENTIAL
505	54 Botany Rd	RESIDENTIAL
506	56-58 Wyndham St	RESIDENTIAL
31	123 Botany Rd (Cauliflower Hotel)	HOTEL
32	123 Botany Rd (Cauliflower Hotel Beer Garden)	HOTEL
68	12 Henderson Rd (Lord Raglan Hotel)	HOTEL
86	47 Botany Rd (Abbotts Hotel)	HOTEL
Non-residential Receivers		
22	116 Wellington St	COMERCIAL
34	176-178 Cope St	COMERCIAL
53	134-136 Botany Rd	COMERCIAL
58	128-132 Botany Rd	COMERCIAL
63	76-84 Wyndham St	COMERCIAL
70	60 Henderson Rd	COMERCIAL
71	62 Botany Rd	COMERCIAL
72	100-108 Botany Rd	COMERCIAL
74	110-126 Botany Rd	COMERCIAL
77	44-54 Botany rd	COMERCIAL
80	5-7 Henderson Rd	COMERCIAL
87	23-45 Botany Rd	COMERCIAL
96	13-21 Botany Rd	COMERCIAL
141	212 Wyndham St (Substation)	COMERCIAL
142	214 Wyndham St (Behind Substation)	COMERCIAL
145	200 Botany Rd (Kennards)	COMERCIAL
153	131 Wyndham St (Able Concrete)	COMERCIAL
206	119 Mcevoy St (Commercial Complex)	COMERCIAL
207	17-27 Power Ave (Commercial Complex)	COMERCIAL
227	73 Garden St (Alexandria Town Hall)	COMERCIAL
308	3 Central Ave (Complex)	COMERCIAL
309	1 Central Ave (Mixed Use)	COMERCIAL
310	2 Central Ave (Complex)	COMERCIAL
312	35 Henderson Rd	COMERCIAL

ID	Address	Usage
313	27 Garden St (Complex)	COMERCIAL
314	10 Garden St (Complex)	COMERCIAL
315	Transport Heritage NSW	COMERCIAL
316	4 Cornwallis St Eveleigh (Complex)	COMERCIAL
317	1 Marian St (The Watertower)	COMERCIAL
348	1 William Lane (Electrical)	COMERCIAL
360	BP Petrol Station (Regent St)	COMERCIAL
361	100 Regent St (Complex)	COMERCIAL
372	167-171 Regent St	COMERCIAL
375	183 Regent St	COMERCIAL
473	Pitt, Mcevoy, Mead, John St Complex	COMERCIAL
13	223 Cope St	INDUSTRIAL
73	105 Botany Rd (Church)	PLACE OF WORKSHIP
358	118 Regent St (Uniting Church)	PLACE OF WORKSHIP
1001	Alexandria Park	ACTIVE RECREATION AREAS
1000	Redfern Park	PASSIVE RECREATION AREAS

References

- Critical State Significant Infrastructure Sydney Metro City & Southwest Chatswood to Sydenham Conditions of Approval (CSSI CoA) (Infrastructure Approval SSI 15_7400 determined 9 January 2017)
- Sydney Metro City & Southwest Construction Noise and Vibration Strategy (CNVS) (dated 29 November 2017, as modified)
- Section 9, Appendix B of the Construction Noise and Vibration Management of the Construction Environmental Management Framework (CEMF) (August 2016)
- Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009) (ICNG).