

Construction Noise and Vibration Management Plan

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Date	17 February 2021	17 February 2021	17 February 2021

A W EDWARDS PTY LIMITED

REVISION

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AW EDWARDS acknowledges the Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander people and culture, and to their Elders past and present.

“COMMUNITY”
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Construction Noise and Vibration Management Plan**ABBREVIATIONS**

TERM	DEFINITION
ABL	Assessment Background Level is the single figure background level representing each assessment period – day, evening and night – over each 24hour period of monitoring. The ABL is determined by the tenth percentile method as prescribed in EPA policies.
Adverse weather	Weather effects that enhance noise (wind and temperature inversions) that occur at a site for a significant period of time (wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter).
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.
ANZECC	Australian and New Zealand Environment Conservation Council
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated.
'A' Weighted	A spectrum adaption that is applied to measured noise levels to approximate human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Background noise	Background noise is the term used to describe the underlying noise level present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level metre and is measured statistically as the A-weighted noise level exceeded for 90% of a sample period. This is represented as the L90 noise level (see below).
CEMF	Construction Environmental Management Framework (Appendix B of the Submissions and Preferred Infrastructure Report)
CEMP	Construction Environmental Management Plan A document setting out the management, control and monitoring measures to be implemented during construction of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
CNVMP	Construction Noise and Vibration Management Plan
CNVIS	Construction Noise and Vibration Impact Statement
CNVS	Sydney Metro Construction Noise and Vibration Strategy (Inc. Addendum A v2)
DECC	Department of Environment and Climate Change (now EPA (see below))
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPL	Environment Protection Licence
EPandA Act	Environmental Planning and Assessment Act 1979
EPandA Regulation	Environmental Planning and Assessment Regulation 2000
Feasible	Feasible relates to engineering considerations and what is practical to build or implement.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low

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TERM	DEFINITION
	pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L10	The sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
Leq	The 'equivalent noise level' is the summation of noise events and integrated over a selected period of time.
NCA	Noise Catchment Area
OEH	Office of Environment and Heritage
OOHW	Out-of-hours work (construction works outside of standard construction hours)
POEO Act	Protection of the Environment Operations Act 1997
Project Planning Approval	Critical State Significant Infrastructure Sydney Metro and 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 median value of the average background values for the period over all of the days measured. There is an RBL value for each period (day, evening and night).
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
REMM	Revised Environmental Mitigation Measures (Chapter 11 of the Submissions and Preferred Infrastructure Report).
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of one second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period and used to predict noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
SSI	State Significant Infrastructure

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TERM	DEFINITION
SWTC	Scope of Works and Technical Criteria
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

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1 INTRODUCTION

1.1 BACKGROUND

The Sydney Metro City and Southwest is a 30 kilometre metro rail between Chatswood and Bankstown, including; 17 kilometres of new tunnel from Chatswood, under the harbour to Sydenham connecting seven new underground stations at Crows Nest, Victoria Cross (North Sydney), Barangaroo, Pitt Street, Martin Place, Central and Waterloo. Upgrading 13 kilometres of the Bankstown line, including 11 existing stations; Sydenham, Marrickville, Dulwich Hill, Hurlstone Park, Canterbury, Campsie, Belmore, Lakemba, Wiley Park, Punchbowl and Bankstown plus southern service facilities.

Several separate environmental impact assessments of the project were progressed by Transport for NSW (TfNSW). In May 2016, an environmental impact statement (EIS) for the Chatswood to Sydenham section of the project was placed on public exhibition. A preferred infrastructure report on the Chatswood to Sydenham component (the PIR) was then prepared and publicly released in October 2016. The project was approved on 9 January 2017 (SSI 15_7400) (project planning approval). Following approval, six modifications have been approved by NSW Department of Planning, Infrastructure and Environment (DPIE).

A W Edwards has been appointed by Sydney Metro to construct the Crows Nest Integrated Station Development (the project).

1.2 PURPOSE

This Construction Noise and Vibration Management Plan (CNVMP) describes how A W Edwards will avoid, minimise and manage noise and vibration impacts generated during construction of the project. The extent of the construction work is shown in Figure 1.1.

This CNVMP forms part of the Construction Environmental Management Plan (CEMP) for the project and was prepared in accordance with:

- The relevant planning approvals and conditions of approval (CoA) for the project (refer to Chapter 2);
- Applicable legislation and regulatory requirements;
- Sydney Metro Construction Environmental Management Framework – Chatswood to Sydenham (CEMF);
- Sydney Metro City and Southwest Construction Noise and Vibration Strategy (CNVS);
- Revised Environmental Mitigation Measures (REMMs); and
- Sydney Metro contractual requirements, including the Project Deed and Scope of Work and Technical Criteria.

This CEMP will be submitted for approval to the Secretary of DPIE no later than one month before commencement of construction of the project.

There is also a separate Construction Noise and Vibration Impact Statement (CNVIS) which assesses the construction noise and vibration impacts onto the nearby sensitive receivers.

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.

Construction Noise and Vibration Management Plan**1.3 PROJECT OVERVIEW**

Crows Nest Station will be located between the Pacific Highway and Clarke Lane (eastern side of the Pacific Highway) and between Oxley Street and south of Hume Street. It will be strategically located to the south of the existing station at St Leonards and close to the leisure and retail strip along Willoughby Road.

Crows Nest Station will support the St Leonards specialised centre as a southern gateway to commercial and mixed-use activities. The station will also improve access to the restaurants and specialist shops in the Crows Nest village. Crows Nest Station will:

- Create a new transport focus on the southern side of the St Leonards specialised centre.
- Maximise legibility and connectivity with the local urban structure.
- Integrate the station with local improvement plans and make a positive contribution to the sense of place.

Refer to Chapter 2 of the CEMP for detailed scope of work and construction methodology.

1.4 OBJECTIVES AND ENVIRONMENTAL PERFORMANCE OUTCOMES

The following noise and vibration management objectives, consistent with those described in Section 9.1 of the CEMF will be applied to the project:

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

The following construction noise and vibration environmental performance outcomes identified in the PIR have been considered in the preparation of the CNVMP:

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

1.5 CONSULTATION

In accordance with CoA C3 and C5 for the project, the CNVMP must be prepared in consultation with the relevant Council(s). North Sydney Council and Lane Cove Municipal Council have been consulted during the development of this CNVMP, the consultation period began on the 27/11/2020 and ended on the 18/12/2020. Lane Cove Municipal Council had no feedback to the CNVMP as of the 18/12/2020 but did respond on 22/12/2021. Lane Cove Council had no recommended changes to the plan but did highlight areas of concern: haulage of materials seven days a week with no respite; management of complaints. A W Edwards does not propose hauling materials seven days a week and has implemented complaint management system that is compliant with the Sydney Metro Community Consultation Strategy. North Sydney Council had no feedback to the CNVMP as of the 18/12/2020 but did respond on 19/01/2021 clarifying they had no recommended changes.

Additionally, in accordance with CoA C9 for the project, the construction noise monitoring program must be prepared in consultation with the NSW Environment Protection Authority

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(EPA), North Sydney Council and Lane Cove Municipal Council. The construction noise monitoring program was submitted to the NSW Environment Protection Authority (EPA), North Sydney Council and Lane Cove Municipal Council on the 27/11/2020. No responses were received when the consultation period ended on 18/12/2020. The EPA did respond on 22/12/2020 clarifying that they neither review nor endorse the monitoring program. Lane Cove Municipal Council responded on 22/12/2020 highlighting the reliance of noise data from 2015 but had no recommended changes. A W Edwards has prepared a CNVIS that is specific to this project and the construction methodology that will be implemented, therefore the concern regarding previous noise data is alleviated. North Sydney Council responded on 19/01/2021 clarifying they had no recommended changes.

1.6 ENVIRONMENTAL MANAGEMENT STRUCTURE

This CNVMP is part of A W Edward's environmental management framework for the project and is supported by other documents such as:

- Construction Environmental Management Plan (CEMP);
- Community and Stakeholder Engagement Plan; and
- Environmental Control Maps (ECMs), inclusive of relevant noise and vibration management measures.

1.7 APPROVAL

This CNVMP and monitoring program will be reviewed by Sydney Metro, endorsed by the Environmental Representative (ER) and Acoustics Advisor (AA), and submitted to the Secretary of DPIE for approval no later than one month prior to commencement of construction in accordance with CoA A27, C6, C8 and C13.

The CNVMP as approved by the secretary, including any minor amendments by the Independent ER or AA will be implemented for the duration of construction.

Figure 1.1: Overview of construction footprint



Construction Noise and Vibration Management Plan

2 LEGAL AND APPROVAL REQUIREMENTS

2.1 PLANNING APPROVALS

Sydney Metro City and Southwest has been declared as Critical State Significant Infrastructure (CSSI) under Division 5.2 of the NSW Environmental Planning and Assessment Act 1979 (EPandA Act) and State Environmental Planning Policy (State and Regional Development) 2011. There are two CSSI planning approvals for Sydney Metro City and Southwest:

- Construction and operation of the section between Chatswood and the Sydenham dive site known as “CSSI_7400”, which was granted on 9 January 2017. Several modifications to CSSI_7400 have since been approved. A W Edwards will be required to comply with CSSI_7400, including the modifications to this approval, to the extent required by Sydney Metro.
- The section of the rail corridor between Sydenham and Bankstown and is known as “CSSI_8256” and does not have any requirements that are relevant to the project.

Any future amendments to the CSSI approval (Chatswood to Sydenham) will be subject to Sydney Metro approval and will continue to be managed and lodged by Sydney Metro.

The environmental assessments relevant to the project, which have been referenced during the preparation of this CNVMP are:

- Sydney Metro City and Southwest – Chatswood to Sydenham – Environmental Impact Statement (TfNSW, 2016), hereafter referred to as the ‘EIS’.
- Sydney Metro City and Southwest – Crows Nest Over Station Development – Environmental Impact Statement (TfNSW, 2018).
- Minor Works Approval for Enabling Works (CN-PCMW-001 Site Establishment Works) – April 2020.

2.2 LEGISLATION AND REGULATORY REQUIREMENTS

Legislation relevant to noise and vibration management includes:

- NSW Environmental Planning and Assessment Act 1979 (EPandA Act);
- NSW Protection of the Environment Operations Act 1997 (POEO Act); and
- NSW Heritage Act 1977 (Heritage Act).

The project does not conform to a scheduled activity defined in Schedule 1 of the POEO Act and as such no environment protection licence (EPL) is required for the project.

2.3 STANDARDS AND GUIDELINES

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

- Interim Construction Noise Guidelines (ICNG). NSW Department of Environment and Climate Change, 2009.
- NSW Road Noise Policy. NSW Department of Environment, Climate Change and Water, 2011.
- Assessing Vibration – a technical guideline. NSW Department of Environment and Conservation, 2006.
- Australian Standard AS/NZs 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors.

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- AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.
- AS1055:2018 Description and Measurement of Environmental Noise.
- British Standard BS 6472-2008 Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings. Guide to Damage Levels from Ground borne Vibration (1 Hz to 80 Hz).
- German Standard DIN 4150: Part 3 – 1999 Structural Vibration in Buildings: Effects on Structures and British Standard BS 7385-2:1993 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz).

The following Sydney Metro and TfNSW guidelines relating to noise and vibration management also apply to the project:

- Sydney Metro City and Southwest Construction Noise and Vibration Strategy;
- Construction Noise Strategy 7TP-ST-157/2.0 (CNS), Transport for NSW (2012);
- TfNSW Environmental Incident/Non-Compliance Report (9TP-FT-101); and
- TfNSW Environmental Incident Classification and Reporting (9TP-PR-105).

2.4 PROJECT APPROVAL REQUIREMENTS

This CNVMP has been produced to demonstrate compliance with the relevant CoA stipulated in SSI_7400, as summarised in Table 2.1.

The CoA relevant to the project have been confirmed via the Sydney Metro Chatswood to Sydenham Staging Report (Sydney Metro, 2019).

Document references are made to Sections in this CNVMP, the CNVIS and the CEMP.

Table 2.1: CoA requirements

ITEM	REQUIREMENT	DOCUMENT REFERENCE
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. (a) Noise and vibration – relevant Council(s)	Section 1.5
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.	Section 1.4 Section 6.4 Section 6.4 Table 2.1 CNVIS document Appendix A Section 5.2 CEMP Section 10 CEMP Appendix D CEMP
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	Section 1.5

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ITEM	REQUIREMENT	DOCUMENT REFERENCE
	of all correspondence from those agencies, must be provided with the relevant CEMP sub-plan.	
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.	Section 1.7
C7	The CEMP must be endorsed by the ER and then submitted to the Secretary for approval no later than one (1) month before the commencement of construction or within another timeframe agreed with the Secretary.	The ER endorsed the CNVMP on 5 February 2021.
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.	Section 1.7
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. (a) Noise and vibration – EPA and relevant Council(s)	Section 1.5
C10	Each Construction Monitoring Program must provide:	Section 7.4 and Section 7.5 a,b) Section 3.1, Section 7.4.2 c,e,f,h) Section 7.4 d,e,g) Appendix C
	a) details of baseline data available;	Section 3.1;
	b) details of baseline data to be obtained and when;	Section 7.4.2
	c) details of all monitoring of the project to be undertaken;	Section 6.5.1; Section 7.4
	d) the parameters of the project to be monitored;	Appendix C
	e) the frequency of monitoring to be undertaken;	Section 5.1; Section 7.4; Appendix B
	f) the location of monitoring;	Section 7.4.4; Section 7.5
	g) the reporting of monitoring results;	Section 7.4
	h) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and	
	i) any consultation to be undertaken in relation to the monitoring programs.	
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	Section 7.4.5 Section 7.5.2 Appendix C

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ITEM	REQUIREMENT	DOCUMENT REFERENCE
	in real time. The Department and EPA must be provided with access to the real time monitoring data in real time.	
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.	Section 1.5 Section 7.5 Section 7.5.1 Section 7.5.2
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.	The ER endorsed the monitoring program on 5 February 2021.
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.	Section 1.2
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 7.4 Section 7.5
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 7.4
C17	Where a relevant CEMP sub-plan exists, the relevant Construction Monitoring Program may be incorporated into that CEMP sub-plan.	Section 7.4 Section 7.5
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 level from ground-borne vibration	Section 4.8 CNVIS document
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 4.2.2 CNVIS document Section 6.5 Section 6.6 Section 7.9
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 7.4 Section 7.5.1 Section 7.5.2 Section 7.7

Construction Noise and Vibration Management Plan

ITEM	REQUIREMENT	DOCUMENT REFERENCE
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 6.4 Section 7.7
E32	The Proponent must review the <i>Sydney Metro City and Southwest Construction Noise and Vibration Strategy</i> 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 <i>Sydney Metro City and Southwest Construction Noise and Vibration Strategy</i> must be submitted to the Secretary for approval at least one (1) month before construction commences.	The requirements of the Sydney Metro City and Southwest Construction Noise and Vibration Strategy were considered in the preparation of the CNVIS. Section 4.2
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 5.3 CNVIS document
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 6.5
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 6.5
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 1:00pm Saturdays; and c) at no time on Sundays or public holidays.	Section 6.1
E37	The Proponent must identify all receivers likely to experience internal noise levels greater than Leq(15 minute) 60 dB(A) inclusive of a 5 dB penalty, if rock breaking or any other annoying activity likely to result in regenerated (ground-borne) noise or a perceptible level of vibration is planned (including works associated with utility adjustments), between 7am – 8pm at: (a) Crows Nest, Victoria Cross, Blues Point, Barangaroo, Martin Place, Pitt Street, and Central	Section 5.3 CNVIS document
E38	The Proponent must consult with all receivers identified in accordance with Condition E37 with the objective of determining appropriate hours of respite so that construction noise (including ground-borne noise), does not exceed internal noise levels of:	Section 5.3 Section 6.5 Section 6.6 Section 7.4.5 CNVIS document

Construction Noise and Vibration Management Plan

ITEM	REQUIREMENT	DOCUMENT REFERENCE
	<p>(a) Leq(15 minute) 60 dB(A) 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 between 7am – 8pm for more than 50 percent of the time; and</p> <p>(b) Leq(15 minute) 55 dB(A) 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 between 7am – 8pm for more than 25 percent of the time, unless an agreement is reached with those receivers. This condition does not apply to noise associated with the cutting surface of a TBM as it passes under receivers.</p> <p>Note This condition requires that noise levels be less than Leq(15 minute) 60 dB(A) for at least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below Laeq(15 minute) 55 dB(A). Noise equal to or above Leq(15 minutes) 60 dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm.</p>	
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 5.5
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 5.5 Section 5.3 Section 6.4
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 6.6 Section 6.1.3
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 6.6 CNVIS Section 4.1.3
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 4.1.5
E44	Notwithstanding Condition E36 construction associated with the CSSI may be undertaken outside the hours specified under those conditions in the following circumstances: a) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or	Section 6.2

Construction Noise and Vibration Management Plan

ITEM	REQUIREMENT	DOCUMENT REFERENCE
	<p>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</p> <p>c) where different construction hours are permitted or required under an EPL in force in respect of the construction; or</p> <p>d) construction that causes LAeq(15 minute) noise levels:</p> <p>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</p> <p>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</p> <p>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</p> <p>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</p> <p>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</p> <p>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.</p> <p>Note: This condition does not apply where an EPL is in force in respect of the construction.</p>	
E45	<p>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.</p>	Section 6.2
E46	<p>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</p> <p>(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</p> <p>(b) where different construction hours are permitted or required under an EPL in force in respect of the construction or approved through an Out of Hours Work Protocol developed in accordance with Condition E47; or</p> <p>(c) construction that causes LAeq(15 min) noise levels:</p>	Section 6.1.3

Construction Noise and Vibration Management Plan

ITEM	REQUIREMENT	DOCUMENT REFERENCE
	<p>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</p> <p>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</p> <p>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</p> <p>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).</p>	
E47	<p>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:</p> <p>a) the identification of low and high risk construction activities;</p> <p>b) a risk assessment process in which the AA reviews all proposed out of hours activities and identifies their risk levels;</p> <p>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:</p> <p>i. low environmental risk; or</p> <p>ii. high risk where all construction works cease by 9pm.</p> <p>All other high risk out of hours construction must be submitted to the Secretary for approval unless otherwise approved through an EPL.</p> <p>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.</p>	Appendix A
E48	<p>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:</p> <p>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);</p> <p>b) excavation within an acoustic enclosure (excluding the Blues Point temporary site except where compliance with Condition E44 is achieved);</p> <p>c) excavation at Central (excluding Central Walk works at 20-28 Chalmers Street, Surry Hills) without an acoustic enclosure;</p> <p>d) station and tunnel fit out; and</p> <p>e) haulage and delivery of spoil and materials.</p>	Section 6.1

2.5 CONSTRUCTION ENVIRONMENTAL MANAGEMENT FRAMEWORK

Construction Noise and Vibration Management Plan

This CNVMP has been produced to demonstrate compliance with the Sydney Metro Construction Environmental Management Framework as summarised in Table 2.2.

Table 2.2: CEMF requirements

ITEM	REQUIREMENT	DOCUMENT REFERENCE
9.1 (a)	The following noise and vibration management objectives will apply to construction:	-
	i) Minimise unreasonable noise and vibration impacts on residents and businesses;	Section 6.4 Section 6.5 Section 6.6
	ii) Avoid structural damage to buildings or heritage items as a result of construction vibration;	Section 4.2.3 Section 6.4
	iii) Undertake active community consultation; and	Section 6.3
	iv) Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.	Section 6.3
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:	This CNVMP
	i) Identification of work areas, site compounds and access points;	Section 1.2 Figure 1.1
	ii) Identification of sensitive receivers and relevant construction noise and vibration goals;	Section 3.2 and Chapter 4
	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 (CNVS);	Section 6.4 Section 6.5 Section 6.6
	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;	Section 5.1 Appendix B
	v) Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program;	Section 6.5 Section 6.6
	vi) Community consultation requirements and Community notification provisions specifically in relation to blasting;	N/A
	vii) The requirements of any applicable EPL conditions;	N/A
	viii) Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week;	Section 6.2
	ix) Pre-construction compliance requirements and hold points;	Section 6.4 Section 6.8 CEMP Section 9.3.3
	x) The responsibilities of key project personnel with respect to the implementation of the plan;	Section 6.4 Section 7.1
	xi) Noise monitoring requirements;	Section 7.4
	xii) Compliance record generation and management; and	Section 7.13
	xiii) An Out of Hours Works Protocol applicable to all construction methods and sites.	Appendix A

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ITEM	REQUIREMENT	DOCUMENT REFERENCE
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.	Section 5.3 CNVIS document
9.2 (c)	Noise and vibration monitoring would be undertaken for construction as specified in the CNVS.	Section 7.4
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 7.11 Section 7.13
9.3	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;	Section 6.1
	ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and	Section 6.4 Section 6.5
	iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers.	Section 6.4 Section 6.5

3 ACOUSTIC ENVIRONMENT

3.1 EXISTING ENVIRONMENT

The site is in a well-established urban environment that contains a wide range of commercial, residential and industrial land uses of varying densities interspersed with recreational areas and community facilities (such as schools, childcare centres, places of worship and medical facilities).

The dominant noise sources that are likely to influence background noise levels include:

- Road traffic noise;
- Other construction activities (building redevelopments, road and housing construction); and
- Aircraft noise.

Unattended noise monitoring was conducted in 2015 at representative locations to inform the EIS and establish the ambient noise environment at the nearest sensitive receivers. Additional noise monitoring was also conducted prior to construction as part of the TSE works. The ambient noise levels are presented in Section 7.4.2.

3.2 SENSITIVE RECEIVERS

Sensitive receivers can be divided into several categories, including:

- Residential.
- Commercial.
- Educational.
- Industrial.
- Mixed commercial/residential.
- Place of worship.
- Childcare.
- Special sensitive (e.g. hospitals).

The EIS divided the project area into multiple Noise Catchment Areas (NCAs). These NCAs reflect the changing land uses and ambient noise environments adjacent to the project.

Table 3.1 identifies the NCAs, receiver type and distance to the project.

Construction Noise and Vibration Management Plan

Table 3.1: Nearest sensitive receivers

NCA	RECEIVER DESCRIPTION	DISTANCE FROM PROJECT (M)
A	Residential receivers to the west on Pacific Highway	33
	Commercial receivers to the west on Pacific Highway	28
B	Commercial receivers to the north of Oxley Street	29
	North Side Community Church to the north on Oxley Street	51
C	Residential receivers to the north east on Clarke Street	5
	Commercial receivers to the north east on Clarke Street	2
	Active recreation receiver to the north on Hume Street	60
D	Residential receivers to the north east on Clarke Street	69
	Commercial receivers to the north east on Clarke Street	5
E	Residential receivers to the south on Pacific Highway	4
	Commercial receivers to the south on Pacific Highway	42

Note: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Figure 3.1 identifies the sensitive receivers within proximity to the site.

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises (TfNSW, 2016).

Properties within approximately 100 m of the site would likely to be affected by construction noise, while receivers greater than this distance are unlikely to hear any audible construction noise. Commercial and industrial receivers are generally considered to be less sensitive to noise and vibration compared to residential receivers (TfNSW, 2016).

Other sensitive receivers near the project identified in the EIS are shown in Table 3.2:

Table 3.2: Other nearest sensitive receivers

NCA	RECEIVER DESCRIPTION	RECEIVER TYPE	DISTANCE FROM PROJECT (M)
B	Northside Community Church Sydney	Worship	55
C	Kelly's Place Children's Centre	Education	50
B	Goodstart Early Learning St Leonards Pacific Highway	Education	64

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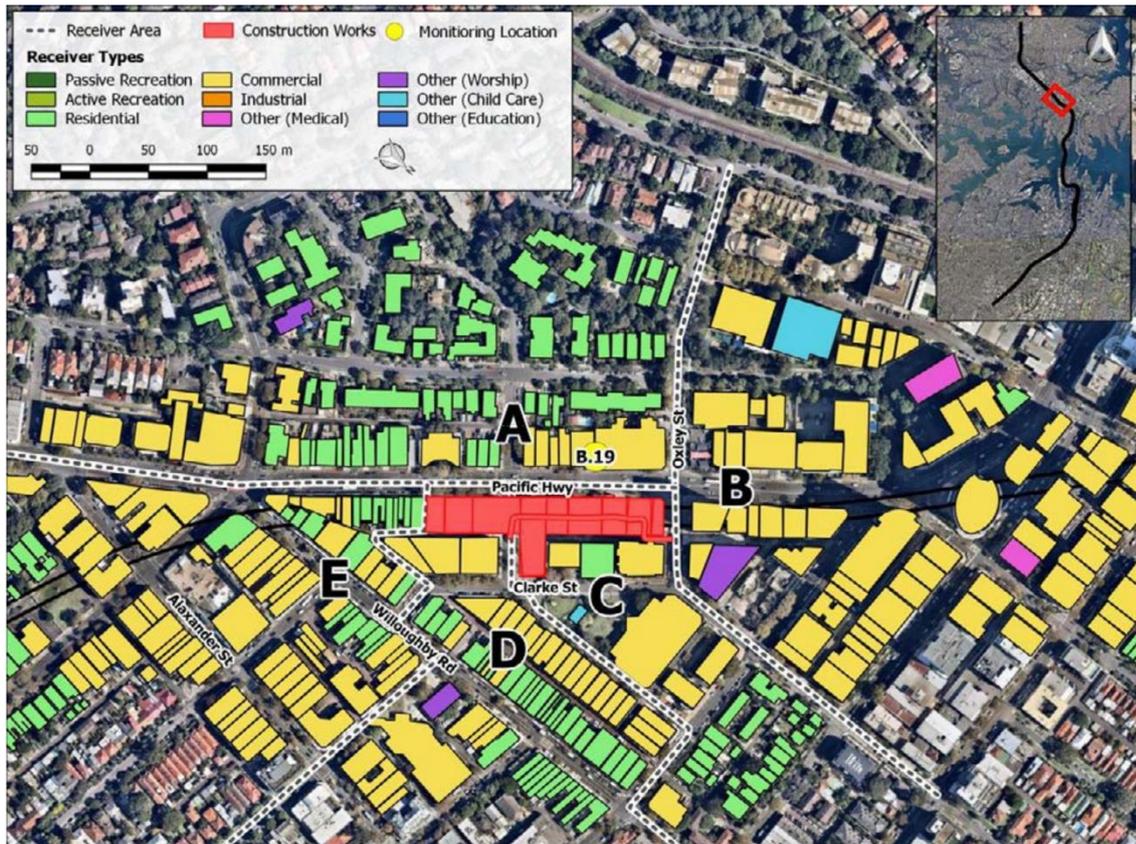


Figure 3.1: Sensitive receivers

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4 NOISE AND VIBRATION CRITERIA

4.1 NOISE CRITERIA

4.1.1 Airborne construction noise management levels

The Sydney Metro CNVS provides guidance on the required steps to establish the noise management levels (NML's) for different receiver types to address condition E37, E38, E41, E42 and E43. Table 4.1 below is an extract from the CNVS. This incorporates both airborne and ground-borne noise.

Table 4.1: Noise criteria applicable under the CoA for the Project

AREA	RECEIVER TYPE	APPROVAL	TIME PERIOD	CRITERIA
Identified Precincts ¹	All	E38	7am	$L_{Aeq(15minute)}$ 60 dB(A) internal, more than 50% of time (6.5 hours total)
			8pm	$L_{Aeq(15minute)}$ 55 dB(A) internal, more than 25% of time (3.25 hours total)
Non-residential Zones ²	Residential	E41	8pm	$L_{Aeq(15minute)}$ 60 dB(A) internal
			9pm	
		E41	9pm	$L_{Aeq(15minute)}$ 45 dB(A) internal
			7am	
Residential Zones ²	Residential	E42	8pm	$L_{Aeq(15minute)}$ 45 dB(A) internal
			7am	
All	All	E43	All	$L_{Aeq(8hour)}$ 85 dB(A) near the CSSI

The CNVIS applied the airborne and groundborne noise criteria cited in Table 4.1 to generate the project specific NML's which are summarised in Table 4.2. The NML's cited in Table 4.2 apply to airborne and groundborne noise.

Table 4.2: Construction noise management levels

RECEIVER AREA	RECEIVER TYPE	NML ($L_{Aeq(15min)}$)		SLEEP DIST (L_{Amax})	
		STD HOURS / DAY / E1 ^A	OOHW / E2 / N ^b	SCREENING	MAX
A	Residential	70-80	55-65	55	65
B	Residential	70-80	55-65	55	65
C	Residential	70-80	55-65	55	65
D	Residential	70-80	55-65	55	65
E	Residential	70-80	55-65	55	65
Other Sensitive Receivers (OSR) when in use					
OSR	Recording studio	60	-	-	-
OSR	Childcare centre	70-85	-	-	-
OSR	Educational facility	70-85	-	-	-
OSR	Places of worship	70-85	-	-	-
OSR	Café/restaurant/bar	60	-	-	-
OSR	Hotel (bar and lounge)	70-85	-	-	-
OSR	Hotel (Sleeping areas near Major roads)	70-85	-	-	65
OSR	Commercial premises	70-85	-	-	-
OSR	Industrial	70-85	-	-	-

E1 : evening from 6pm to 8pm per E37

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E2/N : evening and night, from 8pm to 7am

A : The standard hours external equivalent noise management level is based on Project Planning Approval Condition number E37 and depends on the assumed façade loss cited in the CNVIS

B : The OOHW external equivalent noise management level for residential receivers is based on Project Planning Approval Condition number E41/E42 and depends on the assumed façade loss

4.1.2 Groundborne construction noise management levels

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. The ground borne NMLs for the project are summarised in Table 4.2. It should be noted that these levels only apply when ground-borne noise levels are higher than airborne noise levels.

Where noise levels are higher than those nominated in Table 4.2 mitigation measures would be implemented.

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

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 LAeq(15 minute) 60 dBA between 8 pm and 9 pm, or 45 dBA between 9 pm and 7 am (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), they must be offered additional mitigation in accordance with the CNVS as per CoA E32.

In accordance with CoA E42, where residential receivers are likely to experience an internal noise level exceeding LAeq(15 minute) 45 dBA (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) between 8 pm and 7 am, they must be offered additional mitigation in accordance with the CNVS as per CoA E32.

4.1.3 Sleep disturbance and maximum noise events

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights between 10 pm and 7 am, 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) Practice Note 3, 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; and
- 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.

On the basis of the above guidance, an external sleep disturbance screening criterion of RBL + 15 dB and sleep disturbance NML of L_{Amax} 55 dBA (internal) have been adopted, the latter of which equates to an external NML of 65 dBA (assuming open windows).

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

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

Further guidance is shown in the Noise Policy for Industry Section 2.5 where the following factors are shown that may guide with assessing the extent of impacts on sleep:

- how often high noise events will occur
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development
- whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)
- current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.

4.1.4 Construction related road traffic noise

There is no specific guideline but guidance has been taken from the ICNG and RNP.

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, reasonable and feasible 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. As construction traffic associated with the project will not exceed existing traffic volumes by 60%, it is expected that increased traffic noise due to the Project is likely to be less than the 2 dB allowance at all locations along Pacific Highway. However, there is a potential exceedance of the 2 dB target on Clarke Lane. Therefore, a detailed assessment and possible measures to minimise the construction traffic noise impacts are shown in Section 8 in the separate CNVIS.

4.1.5 Occupational noise

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"

- In this Regulation, "exposure standard for noise", in relation to a person, means:
- LA_{eq}(8hour) of 85 dB(A), or
- LC_{peak} 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

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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.

A number of management and mitigation measures will be implemented, as applicable, in order to ensure compliance with the *Crows Nest Station Development Project Health and Safety Management Plan* (SMCSWSCN-AWE-SCN-HS-PLN-000068). 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 LAeq(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.

4.2 VIBRATION CRITERIA

The effects of vibration in buildings can be divided into three main categories, namely:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed (human comfort);
- Those where the building contents may be affected (cosmetic damage); and
- Those in which the integrity of the building or the structure itself may be compromised (structural damage).

4.2.1 Human comfort vibration

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

- Continuous vibration, such as road traffic or continuous construction activity such as operation of machinery;

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- Impulsive vibration, such as 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); and
- Intermittent vibration, such as trains, nearby intermittent demolition activity, rock breakers and jack hammers.

Acceptable levels of continuous vibration 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 sourced from Table C1.1 of the EPA's Assessing Vibration guideline (DEC, 2006) guideline and summarised in Table 4.3 and Table 4.4 below. It is noted that Table 1 of the CoA defines a "perceptible level of vibration" as the "preferred" peak velocity levels presented in Table 4.3 and Table 4.4.

Table 4.3: Criteria for exposure to continuous vibration

RECEIVER TYPE	TIME OF DAY	PEAK VELOCITY (MILLIMETRES PER SECOND (MM/S))	
		PREFERRED	MAXIMUM
Residential	Day	0.28	0.56
	Night	0.20	0.40
Offices	Day and night	0.56	1.1

Table 4.4: Criteria for exposure to impulsive vibration

RECEIVER TYPE	TIME OF DAY	PEAK VELOCITY (MILLIMETRES PER SECOND (MM/S))	
		PREFERRED	MAXIMUM
Residential	Day	8.6	17.0
	Night	2.8	5.6
Offices	Day and night	18.0	36.0

The DEC guideline states there is low probability of adverse comment where vibration levels comply with the "preferred" values but that vibration levels up to the "maximum" values are permissible if feasible and reasonable mitigation measures are applied.

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 nominated in Table 2.4 of the Assessing vibration guideline (DEC, 2006) and summarised in Table 4.5.

Construction Noise and Vibration Management Plan*Table 4.5: Acceptable vibration dose values*

RECEIVER TYPE	TIME OF DAY	VIBRATION DOES VALUE (M/S 1.75)	
		PREFERRED	MAXIMUM
Residential	Day	0.20	0.40
	Night	0.13	0.26
Offices	Day and night	0.40	0.80

4.2.2 Cosmetic damage vibration

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 4.6.

Table 4.6: Criteria for transient vibration resulting in cosmetic damage

BUILDING TYPE	PEAK COMPONENT PARTICLE VELOCITY IN FREQUENCY RANGE OF PREDOMINANT PULSE	
	4 – 15 HERTZ (HZ)	15 HZ AND ABOVE
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

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 levels based on the construction scenario, based on this, the mitigation measures included in Section 6.5 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 4.6 when working within the safe working distance of the applicable building type.

The standard states that the guide values in Table 4.6 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 4.6 may need to be reduced by up to 50%.

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Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

Therefore, for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure may be required to determine the applicable safe vibration level.

4.2.3 Structural damage vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of cosmetic damage such as surface cracks and are set well below the levels that have potential to cause structural damage. Cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

In terms of the most recent relevant vibration damage goals, AS 2187: Part 2-2006 'Explosives - Storage and Use - Part 2: Use of Explosives' recommends the frequency dependent guideline values and assessment methods given in British Standard BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2' as they "are applicable to Australian conditions".

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.

DIN 4150-3 classifies damage as anything that reduces the serviceability of a building including minor damage for residential and heritage-listed buildings such as cracks forming in plastered surfaces of walls, existing racks in the building becoming enlarged and/or partitions becoming detached from loadbearing walls or floors.

The DIN 4150-3 guideline values for peak particle velocity (mm/s) criteria at different building structures are summarised in Table 4.7.

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Table 4.7: Structural damage vibration criteria

TYPE OF STRUCTURE	PEAK COMPONENT PARTICLE VELOCITY (PPV) MM/S			
	VIBRATION AT THE FOUNDATION AT A FREQUENCY OF:			VIBRATION OF HORIZONTAL PLANE OF HIGHEST FLOOR AT ALL FREQUENCIES
	1 TO 10 HZ	10 TO 50 HZ	50 TO 100 HZ*	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

* For frequencies above 100 Hz, the maximum values specified in this column shall be applied. Values referred to are at the base of the building

The values outlined in Table 4.7 are based on the minimum levels at which observable damage has not previously been seen to occur. Therefore, DIN 4150-3 notes that an exceedance of the limits does not necessarily lead to damage but, should the limits be significantly exceeded, further investigations may be necessary.

4.2.4 Utility infrastructure

Vibration limits for buried utilities are likely to be imposed by the asset owner. A W Edwards will liaise directly with the asset owner (e.g. Sydney Water) to confirm if there are any specific vibration limits nominated for the adjoining 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, which are summarised in Table 4.8.

Table 4.8: Vibration criteria for buried pipelines

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.

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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 vibration levels to be expected on the pipe structure given positioning beneath the ground surface.

In the event that the above criteria proves restrictive for the project, modification of the recommended criteria may be made following a detailed in-situ vibration response trial of the pipeline itself and the surrounding ground.

4.2.5 Sensitive scientific and medical equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use inside the premises of an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument would be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon - 28 September 1999) may be adopted as vibration goals. These generic VC curves are presented below in Table 4.9 and Figure 4.1.

Table 4.9: Application and interpretation of the Generic Vibration Criterion (VC) curves (as shown in Figure 4.1)

CRITERION CURVE	RMS)1	DETAIL SIZE (MICRONS)2	DESCRIPTION OF USE
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.

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Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation requirements of many items depend upon the detail size of the process.

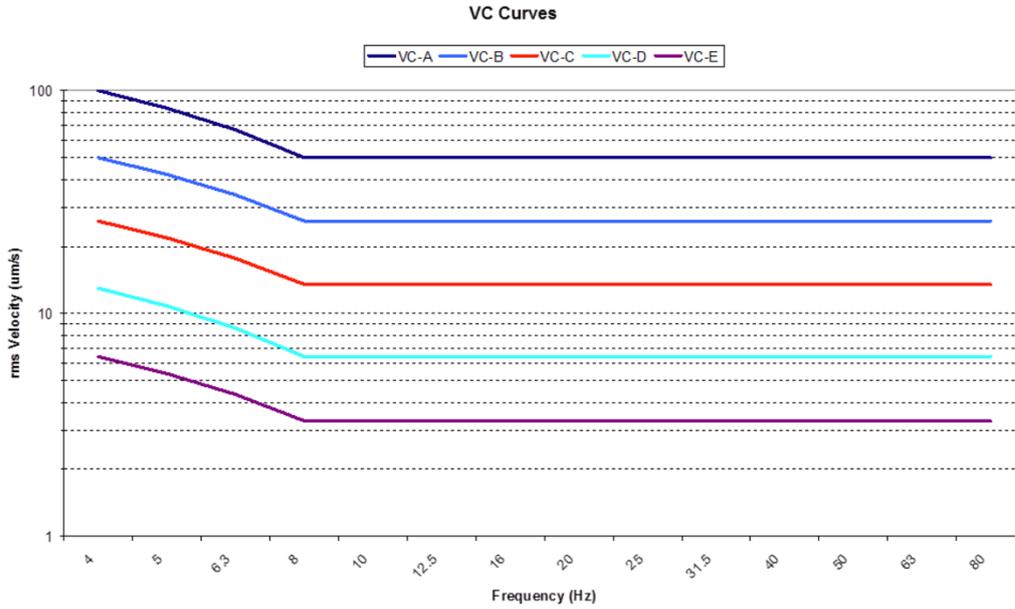


Figure 4.1: Vibration Criterion (VC) curves (source CNVS)

Construction Noise and Vibration Management Plan**5 POTENTIAL IMPACTS**

A risk management approach has been used to determine the severity and likelihood of an activity's impact on the environment and to prioritise its significance. This process considers potential regulatory and legal risks as well as taking into consideration the concerns of the community and other key stakeholders. Activities will be continually re-assessed during construction when undertaking inspections and implementing the compliance tracking program. The risk assessment included in Appendix D of the CEMP will therefore be updated to account for any changes during construction, and any changes in the risk assessment may necessitate additional mitigation measures to minimise noise and vibration impacts.

5.1 CONSTRUCTION ACTIVITIES

Construction activities will comprise site preparation works followed by the main station works to be delivered in nine stages (refer to Table 5.1 and Table 5.2).

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 6.4 and 6.5 outline the mitigation measures to manage noise and vibration.

A summary of the indicative construction schedule that was considered is provided in Table 5.1. Details of these construction works and scenarios are presented in Appendix B.

Table 5.1: Indicative construction schedule - Construction scenarios

ASSESSMENT SCENARIO ID	ACTIVITY	AREA OF WORKS	SCHEDULE	POTENTIAL IMPACTS
CN001	Pre Construction Minor Works	A,B,C	Dec 2020 - Feb 2021	Airborne noise
CN002	Site Establishment	A,B,C	Dec 2020 - Feb 2021	Airborne noise
CN003	Piling	C	Jan 2022 - Feb 2022	Airborne noise / Ground-borne Noise and Vibration
CN004	Excavation works	C	Sep 2021	Airborne noise / Ground-borne Noise and Vibration
CN005	Excavation works	A,B	Feb 2021 - April 2021	Airborne noise / Ground-borne Noise and Vibration

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ASSESSMENT SCENARIO ID	ACTIVITY	AREA OF WORKS	SCHEDULE	POTENTIAL IMPACTS
CN006	In ground services and under platform ground slab	A,B,C	Feb 2021 - April 2021	Airborne noise / Vibration
CN007	Below ground structure	A,B,C	Mar 2021 - Dec 2021	Airborne noise / Vibration
CN008	Partially demolish ground retention walls	C	Dec 2021 - Jan 2022	Airborne noise / Ground-borne Noise and Vibration
CN009	Above ground structure	A,B,C	Nov 2021 - April 2022	Airborne noise
CN010	OOHW - Box Girder delivery	A,B	May 2021 - April 2022	Airborne noise
CN011	Façade	A,B,C	May 2022 - June 2022	Airborne noise
CN012	Fit out 1	A,B	July 2021 - Feb 2023	Airborne noise
CN013	Fit out 2	A,B	Feb 2022 - Feb 2023	Airborne noise
CN014	Fit out 3	C	Mar 2022 - Feb 2023	Airborne noise

In addition, the following road works are planned in the local area shown in Table 5.2.

Table 5.2: Indicative construction schedule for road works in local area

ASSESSMENT SCENARIO ID	ACTIVITY	AREA OF WORKS	SCHEDULE	POTENTIAL IMPACTS
CN015	Road works	Hume Street	May 22 - Nov 22	Airborne noise / Vibration
CN016		Hume Street (west of Pacific Highway)	Nov 22 - Dec 22	
CN017		Oxley Street	Mar 22 - April 22	
CN018		Clarke Lane North	Nov 21 - June 22	
CN019		Clarke Lane South	June 22 - Oct 22	
CN020		Clarke Street North	June 22 - Feb 23	
CN021		Clarke Street South	Feb 23 - May 23	
CN022		Pacific Highway South	April 22 - Nov 22	
CN023		Pacific Highway North	Jul 22 - May 23	

5.2 NOISE AND VIBRATION SOURCES

The proposed equipment used at the station sites would be a subset of that presented in Table 5.3 with the station noise models using sound power levels (SWLs) per activity and plant operating loads and cycles, based on the maximum noise levels presented in Table 5.3. Additional plant items that were not presented in the CNVS are included in the list and referenced in the notes below the table.

Construction Noise and Vibration Management Plan*Table 5.3: Maximum allowable Sound Power Levels for construction equipment*

EQUIPMENT	MAXIMUM ALLOWABLE SOUND POWER LEVEL (DB) LAMAX	MAXIMUM ALLOWABLE SOUND PRESSURE LEVEL (DB) LAMAX AT 7 M
Excavator Hammer	118	93
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (tracking) - equiv. CAT D8	118	93
Dozer (tracking) - equiv. CAT D9	120	95
Dozer (tracking) - equiv. CAT D10	121	96
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83
Concrete Truck	112	87
Concrete Pump	109	84
Concrete Vibrator	105	80
Bored Piling Rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory Pile Driver	121	96
Impact Piling Rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete Saw	118	93
Jackhammer	113	88
Elevated work platform – scissor lift ¹	98	73
Circular saw, bench mounted (Cutting timber) ²	106	81
Diesel driven engine (power supply for tower crane) ²	110	85
Caged material hoist (electric) ²	96	71
Hand tools (electric) ³	102	77
Hydraulic vibratory compactor ²	106	81

Notes: - In accordance with the Interim Construction Noise Guideline for activities identified as particularly annoying (such as jack hammering, rock breaking and power saw operation), a 5dB “penalty” is added to the source sound power level when predicting noise using the quantitative method.

- The sound power levels presented are based on the Sydney Metro CNVS

(1) CNVS 2018

(2) BS 5228-1:2009

(3) AS 2436

Construction Noise and Vibration Management Plan*Table 5.4: Generic equipment or system Sound Power Level limit¹*

EQUIPMENT	MAXIMUM ALLOWABLE SOUND POWER LEVEL (DB) LAMAX	MAXIMUM ALLOWABLE SOUND PRESSURE LEVEL (DB) LAMAX AT 7 M
Motorised (<25kW)	90	65
Motorised (<50kW)	95	70
Motorised (<100kW)	100	75
Motorised (<200kW)	105	80
Motorised (>200kW)	110	85
All other Auxiliary Equipment or Systems	90	65

*(1) Sound Power Levels in dBA relative to 10 pW***5.3 CONSTRUCTION NOISE AND VIBRATION IMPACT STATEMENT**

In accordance with CoA E33, a Construction Noise and Vibration Impact Statement (CNVIS) separate to this CNVMP will be prepared prior to the commencement of construction activities and 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.

The CNVIS will address:

- Scope of work covered by the CNVIS
- Justification for OOHV (where required)
- Nearest noise and vibration sensitive receivers, based on land use survey
- Construction noise and vibration objectives
- Construction noise and vibration assessment
- Mitigation options and preferred management measures
- Noise and vibration monitoring requirements for each construction worksite/activity.
- The CNVIS will address the requirements of Conditions E33, E37, E38, E41, E42 and E43 where appropriate.

The CNVIS will outline physical mitigation measures such as noise barriers. In addition, there will also be a summary of staging of works, respite periods and community notification. The CNVIS will show how A W Edwards is required to notify the community of works pending to ensure the community is informed of the likely noise and vibration impacts during the assessed work, the duration of impact and any additional mitigation (e.g. respite periods) that may be required to manage noise and vibration impacts.

The ambient noise levels that will be used for the CNVIS are shown in Section 7.4.2.

A W Edwards proposes to use similar types of equipment as detailed in Table 5.3. Predicted noise levels are to be based on the above equipment noise levels, distance attenuation and shielding from existing building and structures where applicable.

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 Chapter 6 of this CNVMP.

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Similarly, all works are to be undertaken to comply with the vibration criteria recommended in Section 4.2. 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.

5.3.1 Management procedures and hold points for OOHW

The Project Planning Approval provides two approval pathways for works outside of the standard construction hours specified in CoA E36 and set out in Section 6.2:

- Sydney Metro Condition E47 OOHW Protocol, which applies to out of hours work.
- EPA Out of Hours Works Procedure (Refer to CEMP) which will be updated to address relevant conditions once the EPL is granted.

Both the Protocol and the Procedure address internal approval and hold points relating to:

- The justification of OOHW
- Noise and vibration assessment
- External approvals, including high noise/vibration risk works, either
 - No EPL:
 - ER approval following endorsement by AA
 - DPE approval following endorsement by AA and Independent ER for high noise works after 9 pm
- Community notification
- Tool boxing of the workforce on sensitive receivers and management requirements prior to the commencement of works
- Noise and vibration verification monitoring.

All out of hours works (except in emergency situations) will be documented on the relevant Out of Hours Works Form.

To further reduce potential noise impacts on the surrounding community, noise monitoring trials will be undertaken in the preceding time-period to confirm noise from the worksite is within the predicted noise levels. This proactive approach involves monitoring in the hour preceding the relevant OOHW period, where feasible, for example for:

- Evening (6pm to 10pm) OOHW, noise monitoring would be completed between 5pm and 6 pm to ensure that construction noise complies with evening predicted noise levels
- Night (10pm to 7am) OOHW, noise monitoring between 9pm and 10 pm to ensure construction noise complies with night-time predicted noise levels.

Verification monitoring would provide to the construction team such that methodologies may need to be reviewed or additional mitigation measures applied (if required).

5.3.2 Overview of evaluation and assessment process

A W Edwards recognise construction noise and vibration management is a key community issue. The CNVIS will assess the noise and vibration impact from each work activity and will be updated with changing work scenarios. Experience from previous construction works

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projects will be used to predict the construction noise impact as accurate as possible or appropriate.

- Use of SoundPLAN noise modelling software to develop detailed models of the construction worksites. The models allow different stages of construction to be modelled and noise emissions predicted, giving greater ability to find noise mitigation solutions that suit each construction stage of the worksite. Verification monitoring on previous infrastructure projects has found that measured noise levels are within the predicted noise levels, giving greater confidence in the modelled outcomes. The noise models consider:
 - Location of noise sources at each worksite, sources and their elevation (above ground, on surface or below ground)
 - Sensitive receiver locations, including land use details obtained from the GIS database, to ensure appropriate NMLs are applied
 - Height of sources and receivers referenced to digital ground contours within the construction site area and 1 to 2 metre digital ground contours outside the construction site area
 - Noise source levels of individual construction plant, based on the CNVS, standards, guidelines and an in-house database of construction plant and equipment noise data
 - Hard reflecting surfaces between sources and receivers
 - Attenuation from barriers (natural and purpose built) and other structures such as buildings surrounding the construction site
 - The assumed façade transmission loss calculated from information made available by previous contractors working on the Crows Nest site. Where information was not available, a conservative assumption was made based on a desktop and external visual assessment. The assumed façade transmission loss may be updated if further information becomes available.
- Training engineers on noise modelling and required inputs to ensure accurate information for the modelling process. Key details regarding the construction site layout, the likely plant and equipment (including truck movements), and hours of operation will be provided by the Design and Construction Teams
- Sensitivity analysis to determine the best combination of management measures including scheduling (avoiding impacts at night where possible), using quieter plant and equipment where practicable, using barriers and enclosures, and training staff in quiet noise practices
- Peer review of noise and vibration modelling to provide the community, Sydney Metro, the EPA and other government agencies with reassurance on the appropriateness and accuracy of the noise and vibration assessment work undertaken for the works. Under the Project Planning Approval an independent Acoustic Advisor will be engaged by Sydney Metro to oversee noise and vibration management.
- Comprehensive community notification and complaints management which has been informed and developed on the experience of previous contractors working on the Crows Nest site. We will engage with residents, utility owners, businesses and stakeholders to help them understand what to expect. This approach will ensure we offer a range of tailored options to respond to their concerns.

Construction Noise and Vibration Management Plan**5.4 INDICATIVE NOISE AND VIBRATION IMPACTS**

A separate and detailed site specific CNVIS has been developed which specifies all potentially affected sensitive receivers, predicted noise and vibration levels and specific mitigation requirements. A general summary is provided in Section 5.4.1, Section 5.4.2 and Section 5.4.3.

5.4.1 Airborne noise

The construction works to occur at or above ground level (including the diesel-powered tower cranes) would typically control the airborne noise levels at adjacent sensitive receivers. The works occurring within the station box would be partially mitigated by the station box acting as a barrier to the majority of ground level receivers.

The CNVIS has modelled the noise source and receiver locations to predict a typical worst-case scenario where construction activities are undertaken at the closest possible location to nearby receivers (refer Table 5.5). They represent the typical maximum airborne noise levels that receivers may experience for a limited amount of time without the application of mitigation measures. These levels would reduce as equipment moves further away from the sensitive receiver and as mitigation measures are applied.

Table 5.5: Receivers predicted to exceed the airborne criterion without mitigation

PHASE	NCA	ADDRESS	RECEIVER TYPE
Phase 1 - Excavation (A,B)	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	E	8/473 PACIFIC HWY, CROWS NEST NSW 2065	RES
Phase 2 - Excavation (C)	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	SE 102 35 HUME ST, CROWS NEST NSW 2065	COM
Phase 3 - In Ground Services and Under Platform (A,B)	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
Phase 4 - Below Ground Structure (A,B)	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio

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PHASE	NCA	ADDRESS	RECEIVER TYPE
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
Phase 5 - Below Ground Structure (C)	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
Phase 6 - Hume Street bridge removal	A	SE 101 LEVEL 382 PACIFIC HWY, CROWS NEST NSW 2065	COM
	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	SE 102 35 HUME ST, CROWS NEST NSW 2065	COM
	D	35 CLARKE ST, CROWS NEST NSW 2065	EDU
Phase 7 - Clarke Lane bridge removal	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	SE 102 35 HUME ST, CROWS NEST NSW 2065	COM
Phase 8 - Partially demolish Ground Retention Wall (C)	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	35 CLARKE ST, CROWS NEST NSW 2065	EDU
Phase 9 - Above Ground Structure (A,B,C)	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	E	8/473 PACIFIC HWY, CROWS NEST NSW 2065	RES
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
Phase 10 - Piling (C)	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	20 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	SE 102 35 HUME ST, CROWS NEST NSW 2065	COM

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PHASE	NCA	ADDRESS	RECEIVER TYPE
Phase 11 - Fitout 1 (A,B)	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	35 CLARKE ST, CROWS NEST NSW 2065	EDU
Phase 12 - Fitout 2 (A,B,C)	D	306/10-12 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	C	22-26 CLARKE ST, CROWS NEST NSW 2065	MED and Recording Studio
	D	107/6-8 CLARKE ST, CROWS NEST NSW 2065	Recording Studio
	D	35 CLARKE ST, CROWS NEST NSW 2065	EDU

These exceedances are predominantly predicted to occur at residential and commercial receiver locations facing onto Pacific Highway and located behind the station area on Clarke Lane, Oxley Street and Hume Street.

Receivers located directly adjacent to the works would act as 'noise barrier' for receivers located behind them. Therefore, sensitive receivers further offset from the construction works and located beyond the first block of buildings surround the construction site, would typically experience noise levels approximately 15 dB to 20 dB less than the receivers in closer proximity.

It is important to note that noise levels will vary with time depending on the location and type of plant in operation. Implementation of the standard mitigation and additional mitigation measures will be required for the duration of construction. Typically, additional mitigation measures during normal construction hours would include:

- Monitoring and verification of predictions
- Community consultation and notification

Specific noise mitigation measures would be detailed within the detailed CNVIS for normal and OOH works.

If verification measurements show exceedance of the predictions, the construction methodology shall be reviewed and amended if reasonable and feasible or additional mitigation measures will be investigated to reduce the noise impact.

5.4.2 Ground-borne noise and vibration

While the majority of the excavation works have been completed as part of the excavation of the station box, a small amount of demolition and excavation would be required for certain aspects of the station design, i.e. construction the lift well and minor road works. Vibration intensive plant, such as excavator with hammer, jackhammer and vibratory rollers as presented in Table 5.3, may be required.

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The CNVIS has modelled the noise source, excavation location and receiver locations to predict a typical worst-case scenario where construction activities are undertaken at the closest possible location to nearby receivers. They represent the typical maximum groundborne noise levels that receivers may experience for a limited amount of time without the application of mitigation measures. These levels would reduce as equipment moves further away from the sensitive receiver. Table 5.6 shows the prediction results for the light rock hammer.

Table 5.6: Receivers predicted to exceed the groundborne criterion for standard working hours without mitigation

RECEIVER	MINIMUM DISTANCE BETWEEN SOURCE AND RECEIVER, m	PREDICTED GBN LEVEL, dB(A)	STANDARD HOURS CRITERION INTERNAL, dB $L_{Aeq(15minute)}$	PREDICTED GNML EXCEEDANCE (dB)
20 Clarke Street	25	> 60	60	< 10
22-26 Clarke Street	25	> 60	60	< 10
18-34 Clarke Street	25	> 60	60	< 10
10-12 Clarke Street	25	> 60	60	< 10
6-8 Clarke Street	25	> 60	60	< 10
473 Pacific Hwy	25	> 60	60	< 10

5.4.3 Construction traffic

When trucks and other vehicles are operating within the boundary of a construction site, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction-related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as 'additional road traffic' rather than as part of the construction site.

On roads located immediately adjacent to construction sites, the community may associate heavy vehicle movements with the Sydney Metro City and South West project works. However, once the heavy vehicles move further from construction sites onto major collector or arterial roads, the noise may be perceived as being part of the general road traffic.

Noise from construction traffic on public roads is not assessed under the ICNG, although the guideline does reference the Environmental Criteria for Road Traffic Noise (EPA 1999), which has been superseded by the RNP. The RNP states that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments (in this case the construction area), any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'without construction' scenario.

Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration would also be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the following road traffic noise criteria in the RNP:

Construction Noise and Vibration Management Plan

- 60 dB LAeq(15hour) day and 55 dB LAeq(9hour) night for existing freeway/ arterial/ subarterial roads.
- 55 dB LAeq(1hour) day and 50 dB LAeq(1hour) night for existing local roads.

This approach is consistent with the Sydney Metro Construction Noise and Vibration Strategy

Considering the high existing volume of traffic on the adjacent roads, the noise impact generated by construction vehicles arriving and leaving the site would result in an increase in road traffic noise levels of less than 2 dB which is compliance with the established criteria. Notwithstanding the predicted compliance on main project access roads, potential construction traffic noise impacts will be assessed further as part of the CNVIS.

5.5 CUMULATIVE IMPACTS

A W Edwards, through our community, stakeholder engagement activities and general site awareness, continually attempt to identify other potential construction works (including utility works associated with the project where undertaken by third parties) that may be undertaken in the vicinity of our works. A W Edwards will attempt to consult with proponents of the other construction works and take reasonable steps to co-ordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers in accordance with CoA E39 and E40.

If significant cumulative works are to occur the CNVIS will be updated 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.

6 NOISE AND VIBRATION MANAGEMENT

6.1 APPROVED WORKING HOURS

6.1.1 Standard construction hours

The approved standard construction hours (defined in CoA E36) are as follows:

- 7:00 am to 6:00 pm, Mondays to Fridays;
- 8:00 am to 1:00 pm on Saturdays; and
- At no time on Sundays or public holidays.

In addition to the above standard construction hours, in accordance with CoA E48, the following activities may be undertaken 24 hours per day, seven days per week:

- Station and tunnel fit out; and
- Haulage and delivery of spoil and materials.

6.1.2 COVID-19 standard construction hours

In response to the COVID-19 pandemic, the standard construction hours have been extended in accordance with the Environmental Planning and Assessment (COVID-19 Development – Infrastructure Construction Work Days) Order 2020 (the 'Order') for the limited period as nominated by the Minister of Planning and Public Spaces. The Order expires on 25 March 2021.

The Order provides for the following:

- The carrying out of any building work or work, or the demolition of a building or work on a Saturday, Sunday or public holiday is development specified for the Order.
- The conditions specified for the development are that the development must:
 - Be the subject of a development consent;
 - Comply with all conditions of the consent other than any condition that restricts the hours of work or operation on a Saturday, Sunday or public holiday; and
 - For work or operation on a Saturday, Sunday or public holiday:
 - Comply with the conditions of the consent that restrict the hours of work or operation on any other day as if the conditions applied to work or operation on a Saturday, Sunday or public holiday;
 - Not involve the carrying out of rock breaking, rock hammering, sheet piling, pile driving or similar activities during the hours of work or operation that would not be permitted but for this Order; and
 - Take all feasible and reasonable measures to minimise noise.

In consideration of the Order, the standard construction hours for the COVID-19 special period are:

- 7:00 am to 6:00 pm, Mondays to Fridays; and
- 7:00 am to 6:00 pm on Saturdays and Sundays, or public holidays (with limited construction activities permitted i.e. no rock breaking, rock hammering, sheet piling, pile driving or similar activities).

Construction Noise and Vibration Management Plan**6.1.3 Rock breaking and high noise emitting activities**

Per E37, Table 5.5 identifies all receivers which may experience an internal noise level above 60 dB(A) $L_{Aeq(15\text{ min})}$, inclusive of a 5 dB penalty if rock breaking or any other annoying activity likely to result in regenerated (ground-borne) noise or a perceptible level of vibration is planned. The predicted noise levels in Table 5.5 is a worst-case scenario and does not take into consideration the effects of standard or additional mitigation measures.

Per E38, A W Edwards will consult with the receivers in Table 5.5 about the project's intended respite periods when undertaking high noise generating works. In addition, operator attended monitoring will be undertaken to verify the effects of all mitigation measures being implemented.

Table 6.1 presents noise criteria as shown in Addendum A of the Sydney Metro CNVS.

Table 6.1: Summary of the noise criteria applicable under the CoA (source Sydney Metro CNVS)

AREA	RECEIVER TYPE	APPROVAL CONDITION	TIME PERIOD	CRITERIA(3)
Identified Precincts (1)	All	E38	7am to 8pm	L _{Aeq} (15minute) 60 dB(A) internal, more than 50% of time (6.5 hours total)
				L _{Aeq} (15minute) 55 dB(A) internal, more than 25% of time (3.25 hours total)
Non-residential Zones (2)	Residential	E41	8pm to 9pm	L _{Aeq} (15minute) 60 dB(A) internal
		E41	9pm to 7am	L _{Aeq} (15minute) 45 dB(A) internal
Residential Zones(2)	Residential	E42	8pm to 7am	L _{Aeq} (15minute) 45 dB(A) internal
All	All	E43	All	L _{Aeq} (8hour) 85 dB(A) near the CSSI

Note 1: Identified precincts are provided in Condition E37 and include Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street, and Central.

Note 2: These are identified by the applicable Local Environmental Plan land zoning of the receiver.

Note 3: 5 dB penalty to be applied, if rock breaking or any other annoying activity likely to result in regenerated (ground-borne) noise or a perceptible level of vibration is planned.

Despite the application of CoA E44 and E48, rock breaking and other particularly annoying activities are 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 L_{Aeq}(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,

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- 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).
- Under CoA E46 MOD 7 which states that these works can be conducted if approved through an Out of Hours Work Protocol developed in accordance with CoA E47.

6.2 OUT OF HOUR WORKS

Out of hours work (OOHW) is defined as any work that is undertaken outside of standard construction hours (refer to Section 6.1.1 and 6.1.2).

In accordance with 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, A W Edwards will notify Sydney Metro who must notify the AA, and the Independent ER of the need for the activities or work to occur. A W Edwards will notify (using best endeavours) all affected sensitive receivers of the likely impact and duration of the work as required by CoA E45.
- Construction that causes LAeq(15 minute) noise levels:
 - No more than 5 dB(A) above the rating background level at any residence;
 - No more than the noise management levels (refer to Section 4.1);
 - Continuous or impulsive vibration values, measured at the most affected residence are no more than those for human exposure to vibration (detailed in Section 4.2.1);
 - Intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration (detailed in Section 4.2.1).
- 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; and/or
- Construction has been approved through the Sydney Metro Out of Hours Works Protocol subject to conditions.

In order to satisfy the requirements of CoA 47 and provide a management procedure to adequately assess and approve all OOHW, Sydney Metro has prepared the Sydney Metro Out of Hour Works Strategy/Protocol (Appendix A). All out of hours works (apart from emergency situations) will be managed under CoA E47 and the Sydney Metro Out of Hour Works Strategy/Protocol.

The Sydney Metro Out of Hour Work Approval Form will be completed for all OOHW applications and provided to Sydney Metro for approval. Should high noise works be planned for after 9 pm, approval is required from DPIE following endorsement by the AA and ER.

6.3 COMMUNITY NOTIFICATION

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A W Edwards 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
- Additional notification requirements identified by the CNVIS and triggered by Additional Mitigation Measures detailed in the Sydney Metro Construction Noise and Vibration Strategy.

Sydney Metro will take the lead on stakeholder and community liaison. A W Edwards is to support the overall management and coordination of stakeholder community liaison and ensuring notifications and consultation are provided within adequate periods.

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.

6.4 REMMS

Table 6.2 outlines the REMMs to be implemented for the project to minimise the potential for noise and vibration impacts.

Construction Noise and Vibration Management Plan*Table 6.2: Noise and vibration REMMs*

REFERENC E	MITIGATION MEASURE	TIMING	RESPONSIBILIT Y
NV1	<p>The Construction Noise and Vibration Strategy would be implemented with the aim of achieving the noise management levels where feasible and reasonable.</p> <p>This would include the following example standard mitigation measures where feasible and reasonable:</p> <ol style="list-style-type: none"> provision of noise barriers around each construction site; provision of acoustic sheds at the 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; and the layout of construction sites would consider opportunities to shield receivers from noise. <p>This would also include carrying out the requirements in relation to construction noise and vibration monitoring</p>	Pre-construction and Construction	<p>Construction Manager</p> <p>Site Manager</p> <p>Foreman</p> <p>Sydney Metro</p>
NV2	Unless compliance with the relevant traffic noise criteria can be achieved, night time heavy vehicle movements would be restricted to the Pacific Highway, Hume Street and Oxley Street.	Construction	<p>Construction Manager</p> <p>Site Manager</p> <p>Foreman</p>
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	Construction	<p>Construction Manager</p> <p>Site Manager</p> <p>Foreman</p> <p>Planning and Environment Manager</p>

Construction Noise and Vibration Management Plan

REFERENC E	MITIGATION MEASURE	TIMING	RESPONSIBILIT Y
	specialist to ensure sensitive heritage fabric is adequately monitored and managed.		
NV4	Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedances are predicted.	Construction	Construction Manager Site Manager Foreman Planning and Environment Manager
NV6	Transport for NSW would engage an Independent Acoustic Advisor to act independently of the design and construction teams and provide oversight of construction methods, construction noise and vibration planning, management and mitigation, and construction noise and vibration monitoring and reporting. The key responsibilities of the Independent Acoustic Advisor would include: <ul style="list-style-type: none"> a) Assurance of contractor noise and vibration planning, modelling, management and monitoring practices b) Verification of compliance with relevant guidelines and approval requirements c) Audit noise and vibration management practices. 	Pre-construction Construction	Sydney Metro
NV7	Alternative demolition techniques that minimise noise and vibration levels would be investigated and implemented where feasible and reasonable. This would include consideration of: <ul style="list-style-type: none"> a) The use of hydraulic concrete shears in lieu of hammers/rock breakers b) Sequencing works to shield noise sensitive receivers by retaining building wall elements c) Locating demolition load out areas away from the nearby noise sensitive receivers d) Providing respite periods for noise intensive works e) Methods to minimise structural-borne noise to adjacent buildings including separating the structural connection prior to demolition 	Construction	Construction Manager Site Manager Foreman Planning and Environment Manager

Construction Noise and Vibration Management Plan

REFERENC E	MITIGATION MEASURE	TIMING	RESPONSIBILIT Y
	through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition f) Installing sound barrier screening to scaffolding facing noise sensitive neighbours g) Modifying demolition works sequencing / hours to minimise impacts during peak pedestrian times and / or adjoining neighbour outdoor activity periods.		

6.5 STANDARD NOISE AND VIBRATION MITIGATION MEASURES

The standard mitigation and management measures to be implemented for the duration of construction by A W Edwards to minimise the potential for impacts associated with the generation of noise and vibration is outlined in Section 6.5.1 and Section 6.5.2.

Community, religious, and educational institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) that are potentially affected by noisy works will be consulted prior to construction commencing to determine their sensitive periods. Works are to be scheduled outside of these sensitive periods unless alternate arrangements are made (which may include respite).

A W Edwards will investigate alternative methods to rock hammering for excavation, with the objective being to minimise potential impacts on sensitive receivers. The CNVIS will be updated to adopt the least impact alternative unless it can be demonstrated, to the satisfaction of the AA, why it should not be adopted.

6.5.1 Minimum requirements

The CNVS sets out minimum standard construction noise and vibration mitigation measures to be implemented on all Sydney Metro projects as follows.

Management strategies during construction

- Construction hours would be in accordance with the ICNG and project approvals, except where otherwise specified in an approved noise management plan.
- When working adjacent to schools, medical facilities and childcare centres, particularly noisy activities would be scheduled outside sensitive periods, where feasible and reasonable.
- When working adjacent to community, religious, educational, community institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres), particularly noisy activities must be scheduled outside 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.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers will result in reduced noise emissions.

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- Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible.
- Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.
- Ongoing noise monitoring during construction at sensitive receivers during critical periods (i.e. times when noise emissions are expected to be at their highest - e.g. piling and hammering) to identify and assist in managing high risk noise events.
- Where feasible and reasonable heavy vehicle movements would be limited to daytime hours.
- The implementation of procedures to maximise the night-time onsite spoil storage capacity where spoil is produced between the hours of 10.00 pm and 7.00 am.

Site induction for all employees, contractors and subcontractors

The site induction would include the following as a minimum:

- All relevant project specific and standard noise and vibration mitigation measures
- Relevant licence and approval conditions
- Permissible hours of work
- Any limitations on high noise generating activities
- Location of nearest sensitive receivers
- Construction employee parking areas
- Designated loading/unloading areas and procedures
- Site opening/closing times (including deliveries)
- Environmental incident reporting and management procedures

Source noise control strategies

- Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, heavy vehicles, etc. In order to minimise noise emissions, residential grade mufflers would be fitted on all mobile plant utilised on Sydney Metro construction projects.
- The use of damped hammers is recommended such as the 'City' model Rammer hammers. These reduce the 'ringing' of the rock pick, cylinder and excavator arm that is commonly associated with rock breaking works. Approximately 10 dB attenuation can be achieved compared to undamped hammers of the same size.
- Regular maintenance of all plant and machinery used for the project will assist in minimising noise emissions, including the reporting of the results.
- Acoustic enclosure of plant items, if required, as identified during compliance monitoring.
- Air brake silencers would be correctly installed and fully operational for any heavy vehicle that approaches and uses any Sydney Metro construction site.
- Non-tonal reversing alarms would be used for all permanent mobile plant operating on Sydney Metro construction projects.

Noise barrier control strategies

Temporary noise barriers are recommended between the noise sources and nearby potentially affected noise sensitive receivers, wherever feasible. Typically, 5 dB to 15 dB attenuation can be achieved with a well-constructed barrier.

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Acoustic enclosures

Where significant noise impacts are predicted and/or long periods of construction works are planned, acoustic enclosures can be used as an effective mitigation method. Acoustic enclosures act to contain the sources of noise, whilst also providing the benefit of screening the construction site from view. An enclosure with no openings would be expected to provide attenuation the order of 20 dB.

Construction Noise and Vibration Management Plan**Vibration control strategies**

Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances.

If monitoring results indicate an exceedance of the relevant criteria, the following would occur:

- Work would stop.
- Less vibration intensive plant items or engineering technical would be trialled.
- Work could be scheduled to a time of day when the receiver is less sensitive if it relates to human comfort.
- If a less intensive plant item cannot be used, a detailed structural assessment of the sensitive receiver may be required.

Community consultation

Active community consultation and the maintenance of positive, cooperative relationships with schools, local residents and building owners and occupiers assists in managing impacts from noisier operations and in alleviating concerns and thereby minimising disturbance and complaint.

6.5.2 Summary of the standard mitigation measures

The Standard mitigation measures are reproduced from the CNVS in Table 6.3.

Table 6.3: Standard mitigation measures to reduce construction noise and vibration

ACTION REQUIRED	APPLIES TO	DETAILS
Management Measures		
Condition E38 requires consultation with all receivers identified with Condition E37 with the objective of determining appropriate hours of respite.	Airborne noise Ground-borne noise and vibration	All receivers included that exceed the criterion Leq(15 minute) 60 dB(A) inclusive of a 5 dB penalty, if rock breaking or any other annoying activity likely to result in regenerated (ground-borne) noise or a perceptible level of vibration is planned (including works associated with utility adjustments), between 7am – 8pm
Timing of works	Airborne noise Ground-borne noise and vibration	Saw cutting and breaking for OOH local area and utility works to be preferentially scheduled for daytime, minimised evenings and all efforts made to avoid night-time post-midnight.
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise and vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the environmental assessment documentation (e.g. EA, REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures	Airborne noise Ground-borne noise and vibration	Periodic Notification (monthly letterbox drop) Website Project information and construction response telephone line

Construction Noise and Vibration Management Plan

ACTION REQUIRED	APPLIES TO	DETAILS
		Email distribution list Place Managers
Register of Noise Sensitive Receivers	Airborne noise Ground-borne noise and vibration	A register of all noise and vibration sensitive receivers (NSRs) would be kept on site. The register would include the following details for each NSR: <ul style="list-style-type: none"> - Address of receiver - Category of receiver (e.g. Residential, Commercial etc.) - Contact name and phone number
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. This induction must at least include: <ul style="list-style-type: none"> - All relevant project specific and standard noise and vibration mitigation measures - Relevant licence and approval conditions - Permissible hours of work - Any limitations on noise generating activities with special audible characteristics - Location of nearest sensitive receivers - Construction employee parking areas - Designated loading/unloading areas and procedures - Site opening/closing times (including deliverables) - Environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/ radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air. Plant and equipment to be operated in a proper and efficient manner. Activities to be carried out in a competent manner (e.g. no skylarking, no deliberate noise generation.)
Monitoring	Airborne noise Ground-borne noise and vibration	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the

Construction Noise and Vibration Management Plan

ACTION REQUIRED	APPLIES TO	DETAILS
		nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise and vibration Airborne noise	High noise and vibration generating activities ² may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block ³ .
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne noise	The noise levels of plant and equipment must have operating Sound Power Levels compliant with the criteria in Table 5.3.
Rental plant and equipment	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 5.3.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant used on site or for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from NSRs Select site access points and roads as far as possible away from NSRs Dedicated loading/unloading areas to be shielded if close to NSRs Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable
Location of OOH works	Airborne noise Ground-borne noise and vibration	As much as practicable organise OOH works to move further from sensitive receivers so that the distance is maximised at night-time.
Path Controls		

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ACTION REQUIRED	APPLIES TO	DETAILS
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources would be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when siting plant. Use of temporary barriers or noise blankets.

(1) Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

(2) Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

(3) "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

6.5.3 Auditing and monitoring

All applicable items of plant would have noise audits conducted in accordance with the procedures outlined in Section 7.4.1 of this strategy upon arrival at a Sydney Metro construction site and at 6 month intervals thereafter.

Where it has been identified that noise and/or vibration monitoring is required at the nearest sensitive receiver; however, if the nearest sensitive receiver has refused monitoring at their property, monitoring would be undertaken at the near point to that receiver within the site boundary or at another suitable location determined by an acoustic consultant.

Construction Noise and Vibration Management Plan**6.6 ADDITIONAL NOISE AND VIBRATION MITIGATION MEASURES****6.6.1 Overview**

The implementation of the standard management measures for the duration of construction, should significantly reduce the noise and vibration impacts on nearby sensitive receivers. Nevertheless, due to the highly variable nature of construction activities and the likelihood of work outside the standard construction hours on Sydney Metro projects, exceedances of the construction noise and vibration management levels are likely to occur.

A separate and detailed site specific CNVIS has been developed which specifies all potentially affected sensitive receivers, predicted noise and vibration levels and specific mitigation requirements. The CNVIS identifies where there is a potential or actual exceedance of the construction noise and vibration management levels and recommends a number of additional measures to mitigate such exceedances. The additional mitigation measures are primarily aimed at pro-active engagement with affected sensitive and are outlined in Table 6.4.

Table 6.4: Additional management measures

MEASURE	DESCRIPTION	ABBREVIATION
Alternative accommodation	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.	AA
Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver have been identified). Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented.	M
Individual briefings	Individual briefings are 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. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.	IB
Letter box drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced	LB

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MEASURE	DESCRIPTION	ABBREVIATION
	warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.	
Project specific respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.	RO
Phone calls and emails	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.	PC
Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 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.	SN

6.6.2 Applying additional mitigation measures

In circumstances where, after application of the standard mitigation measures, the LAeq(15minute) construction noise and vibration levels are still predicted to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (see Table 6.5 to Table 6.7 for the additional measures to be implemented). This requirement is supplemental to the basic requirements in the ICNG.

Using the relevant AMMM, the following steps will be carried out to determine the additional mitigation measures to be implemented:

- Determine the duration (time period) when the work is to be undertaken.
- Determine the level of exceedance.
- From the relevant AMMM table, identify the additional mitigation measures to be implemented (using the abbreviation codes - expanded in Table 6.4).

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Table 6.5: Additional Mitigation Measures Matrix (AMMM) - Airborne construction noise

TIME PERIOD		MITIGATION MEASURES			
		PREDICTED LAEQ(15MINUTE) NOISE LEVEL EXCEED THE ANML BY			
		0 TO 10 DB	10 TO 20 DB	> 20 DB	HIGHLY NOISE AFFECTED
Standard	Mon-Fri (7.00 am - 6.00 pm) Sat (8.00 am - 1.00 pm) Sun/Pub Hol (Nil)	-	M, LB,	M, LB	LB, SN, IB, RO, M
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (1.00 pm - 10.00 pm) Sun/Pub Hol (8.00 am - 6.00 pm)	LB	M, LB	M, IB, LB, PC, RO,SN	M, IB, LB, PC, RO,SN
OOHW	Mon-Fri (10.00 pm - 7.00 am) Sat (10.00 pm - 8.00 am) Sun/Pub Hol (6.00 pm - 7.00 am)	M, LB,	M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN

Table 6.6: 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) Sat (8.00 am - 1.00 pm) Sun/Pub Hol (Nil)	LB	LB	M, LB, SN,
OOHW	Mon-Fri (6.00 pm - 10.00 pm) Sat (1.00 pm - 10.00 pm) Sun/Pub Hol (8.00 am - 6.00 pm)	LB	M, LB, SN,	M, IB, LB, PC, RO, SN
OOHW	Mon-Fri (10.00 pm - 7.00 am) Sat (10.00 pm - 8.00 am) Sun/Pub Hol (6.00 pm - 7.00 am)	M, LB, SN,	AA, M, IB, LB, PC, RO, SN	AA, M, IB, LB, PC, RO, SN

Construction Noise and Vibration Management Plan*Table 6.7: 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 - 1.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW	Mon-Fri (6.00 pm - 10.00 pm)	M, IB, LB, PC, RO, SN
	Sat (1.00 pm - 10.00 pm)	
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW	Mon-Fri (10.00 pm - 7.00 am)	AA, M, IB, LB, PC, RO, SN
	Sat (10.00 pm - 8.00 am)	
	Sun/Pub Hol (6.00 pm - 7.00 am)	

6.7 ADDITIONAL VIBRATION ASSESSMENT

All works are to be undertaken to comply with the vibration criteria recommended in Section 4.2. 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 criteria in Section 4.2 is not being met using approved construction methods, alternative construction methods are to be considered, assessment of the recommended velocity levels are to be reviewed and consideration of whether there is scope for altering the vibration criteria from the DIN 4150 vibration levels.

6.8 PROPERTY CONDITION 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. Surveys are to be prepared by a structural engineer with the agreement of each property owner/occupier prior to commencement of the project and within three months of the completion of the project as required by CoA E60.

The CNVIS will assesses the potential risk of vibration induced damage from the project and identify 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.

7 COMPLIANCE MANAGEMENT

7.1 ROLES AND RESPONSIBILITIES

The overall roles and responsibilities for A W Edwards personnel are outlined in Chapter 4 of the CEMP which includes the implementation of the CNVMP for the duration of construction. Furthermore, specific responsibilities for the implementation of the REMMs for the duration of construction are detailed in Section 6.4 of this CNVMP.

7.2 TRAINING

All employees, contractors and staff working on site will undergo site induction training relating to noise and vibration management issues, including:

- Requirements of this CNVMP;
- Relevant legislation;
- Approved working hours;
- location of sensitive receivers;
- The location of known heritage constraints within proximity to the works at risk of vibration damage, including establishment of safe working distances and vibration monitoring requirements;
- Roles and responsibilities for noise and vibration management;
- Procedure to follow in the event that out of hour works are required;
- Complaints handling process;
- Disciplinary action around non-compliance with this CNVMP.

Further details regarding staff induction and training are outlined in Chapter 8 of the CEMP.

7.3 INSPECTIONS

General requirements and responsibilities in relation to inspections and compliance monitoring are documented in Section 10.1 of the CEMP. Routine environmental inspections will include determination of compliance with this CNVMP.

7.4 CONSTRUCTION NOISE AND VIBRATION MONITORING PROGRAM

Condition C9 requires a noise and vibration monitoring program to be prepared for Crows Nest Station.

The Construction Monitoring Programs, as approved by the Secretary including any minor amendments approved by the Independent ER (or AA in regards to Noise and Vibration Construction Monitoring Program), will 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.

Noise verification monitoring locations are cited in Table 7.2 and attended vibration and ground-borne noise monitoring locations are cited in Table 7.3.

In accordance with Appendix A of the Sydney Metro City & Southwest CNVS (Version 4), operator-attended noise measurements will be undertaken at the commencement of any new construction activities or location. Structural vibration monitoring will be carried out where the CNVIS identifies potential structural vibration impacts.

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If exceedances of the goals are observed, the construction methodology must be reviewed and if necessary, additional mitigation measures applied.

The results of noise and vibration monitoring shall be documented in a 6 monthly construction noise and vibration monitoring report and submitted to the Secretary for information after AA endorsement. The 6 monthly reports shall contain:

- Details of the type of monitoring completed and a brief statement of the measurement method;
- Relevant noise and vibration planning approval conditions and management objectives;
- Monitoring equipment specifications and locations;
- Description of works, construction equipment, meteorological conditions and nearest affected sensitive receivers;
- Any unattended monitoring results;
- Any attended monitoring results;
- Statements of compliances and non-compliances against noise and vibration planning approval conditions and management objectives, including reasons for any identified noncompliances and strategies for minimising further occurrence of identified non-compliances.

7.4.1 Plant Noise Auditing

In order to compare the noise levels of plant and equipment with the values in Section 5.2, the following guidelines are recommended:

- Measurements of Sound Pressure Level (SPL) at 7 m (with plant or equipment stationary) shall be undertaken using procedures that are consistent with the requirements of Australian Standard AS2012–1990 Acoustics – Measurement of Airborne Noise Emitted by Earthmoving Machinery and Agricultural Tractors – Stationary Test Condition Part 1: Determination of Compliance with Limits for Exterior Noise.
- Measurements of Sound Power Level (SWL) shall be determined using procedures that are consistent with the requirements of International Standard ISO9614-2 1996 Acoustics – Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning.
- If measuring the SPL at 7 m of moving plant, compliance measurements would be guided by the requirements of Australian Standard AS2012–1977 Method for Measurement of Airborne Noise From Agricultural Tractors and Earthmoving Machinery.

For all measurements, the plant or equipment under test would be measured while operating under typical operating conditions. If this is not practical, it may be appropriate to conduct a stationary test at high idle.

The intention is for the SWL of plant and equipment to be spot checked under the following circumstances:

- When a new high noise intensive plant item is introduced to the site.
- Where the total measured noise level for an activity exceeds the predicted noise levels.
- In response to a community complaint.
- As directed by the project Environmental Manager.

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In the case of an exceedance in sound power levels, the item of plant would either be replaced, or the advice of an acoustic consultant would be sought to provide suitable mitigation measures, which may include:

- Ensuring all bolts are tightened and no parts are loose
- Cleaning and/or lubricating moving parts
- Replacing old or worn parts
- Implementing additional or upgrading existing muffling devices
- Building enclosures around items of stationary plant (e.g. pumps or generators).

A register of measured sound power levels for each item of plant would be kept for reference where future noise audits are conducted. The register would be reviewed annually in conjunction with this strategy and corresponding revisions made to the Sound Power Levels presented in Section 5.2 to represent contemporary plant noise emission levels.

Refer to the Project Health and Safety Plan for exposure controls relevant to occupational noise impacts.

7.4.2 Baseline noise monitoring data

Baseline noise monitoring data was reported in the EIS. Additional monitoring was conducted by the TSE contractor. Both sets of monitoring data are summarised in the table below.

Table 7.1: Baseline noise monitoring results

DESCRIPTION OF NCA RECEIVER TYPE	LOGGER ID	RBL DAY	RBL EVENING	RBL NIGHT
Residential south near Pacific Highway, north of site (close to highway) ¹	EIS B.19 for D/E, RTA TG360 for N	59	55	40
Residential northeast of work site (less exposed to traffic)	RTA TG360	48	44	40
Residential and commercial southeast of work site on Pacific	EIS B.19 for D&E and RTA TH703 for N	59	55	40
Highway and Falcon Street	EIS B.19 for D,E and RTA TH703 for N	59	55	40

Note 1: A night-time RBL of 50 dB(A) was measured as part of the EIS at this location

No additional baseline data is proposed because construction work is ongoing and the pre-construction noise levels at the nearest sensitive receiver are not representative of the pre-construction acoustic environment because buildings at each site have been demolished.

7.4.3 Parameters to be monitored

Refer to noise monitoring specifications in Appendix C.

7.4.4 Attended airborne noise monitoring in the community

Attended monitoring of construction noise levels will be undertaken as follows:

- As described in Appendix C in this CNVMP to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNVIS.

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- Where appropriate in response to a noise related complaint(s) (determined on a case by case basis).
- As otherwise required by the CNVIS.

Attended noise monitoring will be undertaken during works at one of the representative receivers identified in Table 7.1 in the NCAs most impacted by the works. Nominated attended measurement locations have been selected with the best opportunity to validate the predicted noise levels.

Table 7.2: Nominated noise verification monitoring locations

NCA	NOMINATED RECEIVER ADDRESS	MONITORING LOCATION AT 1M FROM
A	400 Pacific Highway	North-eastern façade
C	22 Clarke Street	South-western façade facing Clarke Lane
D	29 Hume Street	Western façade
E	473 Pacific Highway	North-eastern façade

If verification monitoring shows that the external noise levels from long-term construction works are consistently above the equivalent external NML, more detailed analysis should be conducted to quantify the building façade loss and the potential for noise to be above the internal NML of 45 dB(A) $L_{Aeq,15min}$ specified in CoA E41/E42. If internal noise levels are found to be above 45 dB(A) $L_{Aeq,15min}$, consideration will be given to the provision of at-property treatments, additional on-site measures or other management measures.

Monitoring may also be undertaken in response to a complaint. Where any investigation identifies works or activities being undertaken on the project's premises as the likely source of the complaint, AW Edwards must offer to undertake attended noise or vibration monitoring at the complainant's premises. The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise, who is familiar with the requirements of the relevant standards and procedures (refer Appendix C – Monitoring Procedure).

Where noise monitoring indicates that the activity, work or combination of simultaneous activities or works has caused or is causing noise or vibration levels higher than the predicted levels at any noise sensitive receiver A W Edwards must:

- Review the AMMs considered and apply and revise them if appropriate.
- Review and where possible, modify the work or activity to prevent any recurrence.

7.4.5 Attended groundborne noise monitoring in the community

Attended groundborne noise monitoring is to be undertaken to validate the predictions in the CNVIS and to verify that groundborne noise resulting from high vibration generating works is in accordance with the levels predicted in this CNVIS, subject to obtaining the property owner/occupier's consent to access the property.

Attended groundborne noise monitoring will be conducted at representative receivers most affected by the works. Noise measurements will be undertaken internally, ideally in rooms that are the most shielded from existing ambient noise to allow a higher signal to noise ratio to be obtained. The proposed indicative measurement locations are presented in Table 7.3.

7.4.6 Real-time (unattended) noise monitoring

Real time (unattended) noise monitoring will be undertaken to satisfy Project Planning Approval Condition C11. Real time noise monitoring will be deployed to manage noise

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impacts from ‘high risk’ sites/construction activities, where the CNVIS noise predictions identify there is a high risk of annoyance from construction noise.

For Crows Nest there could be up to two monitoring locations required to satisfy CoA E38. The real-time noise monitors will need to be installed prior to highly intrusive construction activities. A secure website is required for the measured noise data.

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 (refer to Appendix C – Monitoring Procedure).

The real-time monitoring data will be available to A W Edwards, Sydney Metro, ER, AA and DPIE via a web-based portal.

7.5 VIBRATION MONITORING

Where it is anticipated that an item of plant will exceed the cosmetic damage criteria given in Section 4.2.2, vibration monitoring would be required at the nearest affected receiver. Where it is anticipated that an item of plant will exceed the human response / ground borne noise criteria and concerns have been raised regarding vibration, vibration monitoring would also be required at the receiver(s) under question.

All vibration monitoring results would be assessed against the nominated vibration goals and compiled into a report. In accordance with Condition C16 the outputs of the monitoring program will be provided to the Secretary and relevant regulatory agencies, for information in the form of a monitoring report.

If exceedances of the vibration goals are observed, the construction methodology must be reviewed and if necessary, additional mitigation measures are to be applied,

7.5.1 Attended vibration monitoring

Attended vibration monitoring is to be undertaken as follows:

- At the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, where the vibration screening criteria is likely to be exceeded (see Section 4.2.2), as determined by the CNVIS
- Where deemed to be relevant to construction works in response to a vibration related complaint
- To measure vibration from excavation works for the purpose of determining ground-borne noise levels inside the premises, and
- As otherwise required by the CNVIS.

Representative locations for vibration and ground-borne noise monitoring is stated in Table 7.3.

Table 7.3: Attended vibration and GBN monitoring - nominated representative locations

PLANT	WORK AREAS	ADDRESS ²	VIBRATION MONITORING	GBN MONITORING
Vibration generating equipment	A,B,C	Crows Nest Day Surgery (dental and eye) L1, 22 Clarke Street	✓	✓
	A	28-34 Clarke Street ¹	✓	✓

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PLANT	WORK AREAS	ADDRESS ²	VIBRATION MONITORING	GBN MONITORING
	B	Crows Nest Cosmetic and Vein Clinic, Sydney Vasectomy 10 – 12 Clarke Street	✓	✓
	B	473 Pacific Highway	✓	✓
	B	6 – 8 Clarke Street	✓	✓

Where attended vibration monitoring is not feasible, due to extended periods of vibration intensive works, a permanent vibration monitoring system is to be installed to warn plant operators (via SMS, email) that there is potential cosmetic damage to buildings and structures.

Plant and equipment vibration measurement procedures, including real-time monitoring, are further detailed in Appendix C – Monitoring Procedure.

Condition E30 requires short-term monitoring at the commencement of construction to confirm vibration levels are within the required limits.

Where monitoring shows that the preferred values for vibration are likely to be exceeded, a review of the construction methodology will be undertaken and, if necessary, implement additional mitigation measures. Input from a heritage specialist and vibration consultant may also be required. The location of monitoring equipment will be documented on the ECM.

7.5.2 Real-time (unattended) vibration monitoring

Real time (unattended) vibration monitoring will be undertaken to satisfy Project Planning Approval Condition C11. Real time vibration monitoring will be deployed to manage noise impacts from 'high risk' construction activities, where the CNVIS vibration predictions identify there is a high risk of annoyance (or potential building damage) from construction vibration. Real-time vibration monitoring may also be used to measure vibration from excavation activity for the purpose of determining ground-borne noise levels inside noise-sensitive buildings.

For Crows Nest there could be up to two monitoring locations required to satisfy CoA E38.

The real-time vibration monitors will need to be installed prior to commencement of vibration intensive activities at these worksites. A secure website is required for data storage for the duration of the vibration intensive construction activities.

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 (refer to Appendix C – Monitoring Procedure). The real-time monitoring data will be available to A W Edwards, Sydney Metro, ER, AA, DPIE and EPA via a web based portal.

St Leonards Centre at 28-34 Clarke Street has been identified as a potentially vibration sensitive heritage object. To ensure the St Leonards Centre is sufficiently protected during the project, vibration monitoring will be conducted in accordance with the requirements of the Construction Noise and Vibration Management Plan as vibration from construction work has the potential to impact on the fabric of the heritage item. Condition E30 requires short-term

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monitoring at the commencement of construction to confirm vibration levels are within the required limits.

Where activities may result in impacts to heritage buildings, a review of the construction activities will be undertaken by the Planning and Environment Manager to determine the appropriate monitoring. Input from a heritage specialist and vibration consultant may also be required. The location of monitoring equipment will be documented on the ECM.

7.6 BLAST MONITORING

Not applicable as there is no blasting is proposed.

7.7 HERITAGE-LISTED STRUCTURES

In accordance with E30, vibration monitoring will be conducted 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, A W Edwards will review the construction methodology and, if necessary, implement additional mitigation measures.

A W Edwards will 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.

7.8 CONSULTATION AND DOCUMENTATION

A W Edwards will actively engage with North Sydney Council, Lane Cove Municipal Council and the Environment Protection Authority in developing and finalising this Plan including this monitoring program.

7.9 DILAPIDATION SURVEYS

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

Prior to conducting the Existing Condition Inspections, the property owners will be advised of the inspection scope and methodology and the process for making a property damage claim. At the same time, maintain a register of all properties inspected and of any properties where owners refused the inspection offer.

The findings of all dilapidation surveys conducted for each Sydney Metro construction site would be compiled into a report to be forwarded to the construction contractor and project manager. Follow-up Condition Inspections would be required at the completion of certain major works (e.g. completion of shaft bulk excavation works).

7.10 NON-CONFORMANCES

Non-conformances and issues requiring management during construction will be identified, managed and documented in accordance with Section 10 of the CEMP.

Construction Noise and Vibration Management Plan**7.11 COMPLAINTS**

Complaints will be recorded and addressed in accordance with Section 9.4.2 of the CEMP and the Community and Stakeholder Engagement Plan.

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

Noise and vibration complaints will be recorded and addressed in accordance with Section 6.3 of the CEMP and the Community Liaison Plan (CLP). The key steps in this process include:

- The Project team will respond to and manage complaints made by stakeholders in accordance with AS 4269 Complaints Handling.
- A record of any contact, complaint, enquiry or representation will be entered into Consultation Manager.
- All calls or enquiries will be responded to immediately or within 2 working hours. Calls will be answered by the Community Manager or a delegated on site supervisor during out of hours works.
- When a complaint or enquiry cannot be responded to immediately a follow up verbal response on what action is proposed will be provided to the complainant/enquirer within 24 hours of a complaint or enquiry being received.
- A written response to the complainant/enquirer will be made within 10 business days if the complaint or enquiry cannot be resolved by the initial or follow up verbal response. Draft response will be provided to Sydney Metro (if required) before responding to the contact.
- If a situation, issue or complaint concerning the environmental performance of the Project is unable to be resolved within a reasonable time period by the Community Relations team, the Environmental Representative will be consulted.
- If deemed necessary by the Community Manager, Environmental Manager and/or Environmental Representative, an appropriately qualified and experienced independent mediator will be engaged to attempt to resolve points of conflict.

7.12 AUDITS

Audits (both internal and external) will be undertaken to assess the effectiveness of management and mitigation measures, compliance with this CNVMP, planning approval conditions and relevant guidelines. Audit requirements are detailed in Section 6.2 of the CEMP.

7.13 RECORD MANAGEMENT

Compliance records would be maintained as detailed in Section 11.2 (Environmental Records) of the CEMP and may include the following aspects in regard to noise and vibration management:

- Inspections undertaken in relation to noise and vibration complaints;
- Noise monitoring data;
- Vibration monitoring data.

The above records will be made available to Sydney Metro.

8 REVIEW AND IMPROVEMENT

The CNVMP will be reviewed annually to ensure compliance with project approval requirements, legislative requirements and suitability and effectiveness for the management of construction noise and vibration impacts arising from the project.

The review may be in the form of:

- A formal management review;
- A second party audit; and/or
- Inclusion as a separate item at a site meeting.

The Planning and Environmental Manager may review and update the CNVMP more regularly where:

- Significant changes in design or construction activities occur;
- Where targets are not being achieved; or
- In response to lessons learned, audits and non-conformity reports.
- Construction activities result in poor performance against noise and vibration criteria and/or unacceptable impacts on surrounding sensitive receivers.
- In response to excessive community complaints.
- At the request of the Independent ER or AA.

Updates to the CNVMP (which includes the monitoring program) may be approved by the independent ER where the amendments are deemed to be minor, significant changes will be consulted on and approved by the Secretary.

The noise and vibration monitoring program included in the CNVMP, as approved by the Secretary including any minor amendments approved by the ER, 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.

APPENDIX A SYDNEY METRO OUT OF HOUR WORKS STRATEGY/PROTOCOL

The City and Southwest Out of Hours Work Strategy/Protocol explains the procedure as detailed in below extract. The full document (doc reference SM-17-00005396) is available for download.

A. OOH Work

Out of Hours (OOH) work is defined as any work that is undertaken outside of standard construction hours.

In accordance with C2S CoA E44(f) and S2B CoA E20(d), any type of OOH work is permitted to be undertaken on the City and Southwest project provided that it is subject to this document (excluding activities subject to C2S CoA E46 - update for MOD 7).

A list of work activities that may typically be undertaken OOH is provided in S2B CoA E22. All works that are proposed to be undertaken OOH and are subject to this document must be supported by a clear statement justifying the reason(s) why the work is being proposed to be undertaken OOH. Furthermore, this statement must demonstrate how the works are being scheduled in accordance with the following OOH work period prioritisation list:

- Standard Hours.
- Daytime OOH.
- Evening OOH.
- Night Time OOH.

Further guidance on the provision of justification is provided in SM-17-00000115 Out of Hours Work Application Form (refer to Section 4.2.2). Program acceleration is generally not a justifiable reason to undertake works OOH.

A.1. OOH Work Endorsement and Approval

In accordance with C2S CoA E47, all OOH work subject to the C2S planning approval requires endorsement by the AA and approval by either the ER, or in the case of 'high risk' works undertaken after 9pm, endorsement by the AA and approval by the Secretary. This includes all work subject to C2S CoA E37, E38 and E48. The requirements of these conditions are to be specifically addressed in each OOH application as relevant (refer to Section 4.2.2).

In accordance with S2B CoA E25(d), OOH work that is subject to the S2B planning approval and not subject to an EPL only require approval from the ER, or in the case of 'high risk' works undertaken after 9pm, approval by the Secretary. However, to ensure a consistent approach across the entire City and Southwest project, this document requires the Independent ER to apply the same responsibilities as the AA under this document to all OOH work subject to the S2B planning approval unless subject to an EPL.

A.2. OOH Work Approval Process

Figure 1 provides the OOH work approval process for the City and Southwest project. This includes a requirement to prepare an application that covers the assessment of noise and vibration impacts, mitigation measures (including community notification requirements) and review and approval for all proposed OOH work.

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All OOH work applications that are not subject to an EPL will be submitted to the Place Manager, Sydney Metro Environment Manager, AA (if subject to the C2S planning approval) and Independent ER for review and comment. These reviews will take into consideration a range of aspects, including reviewer experience and expert understanding, local knowledge of the area, current understanding of sensitive receiver requirements and other relevant documents (for example, the applicable Business Management Plan detailing predicted impacts to affected businesses, key issues and appropriate mitigation measures for implementation). This review process is further explained in Section 4.2.2.

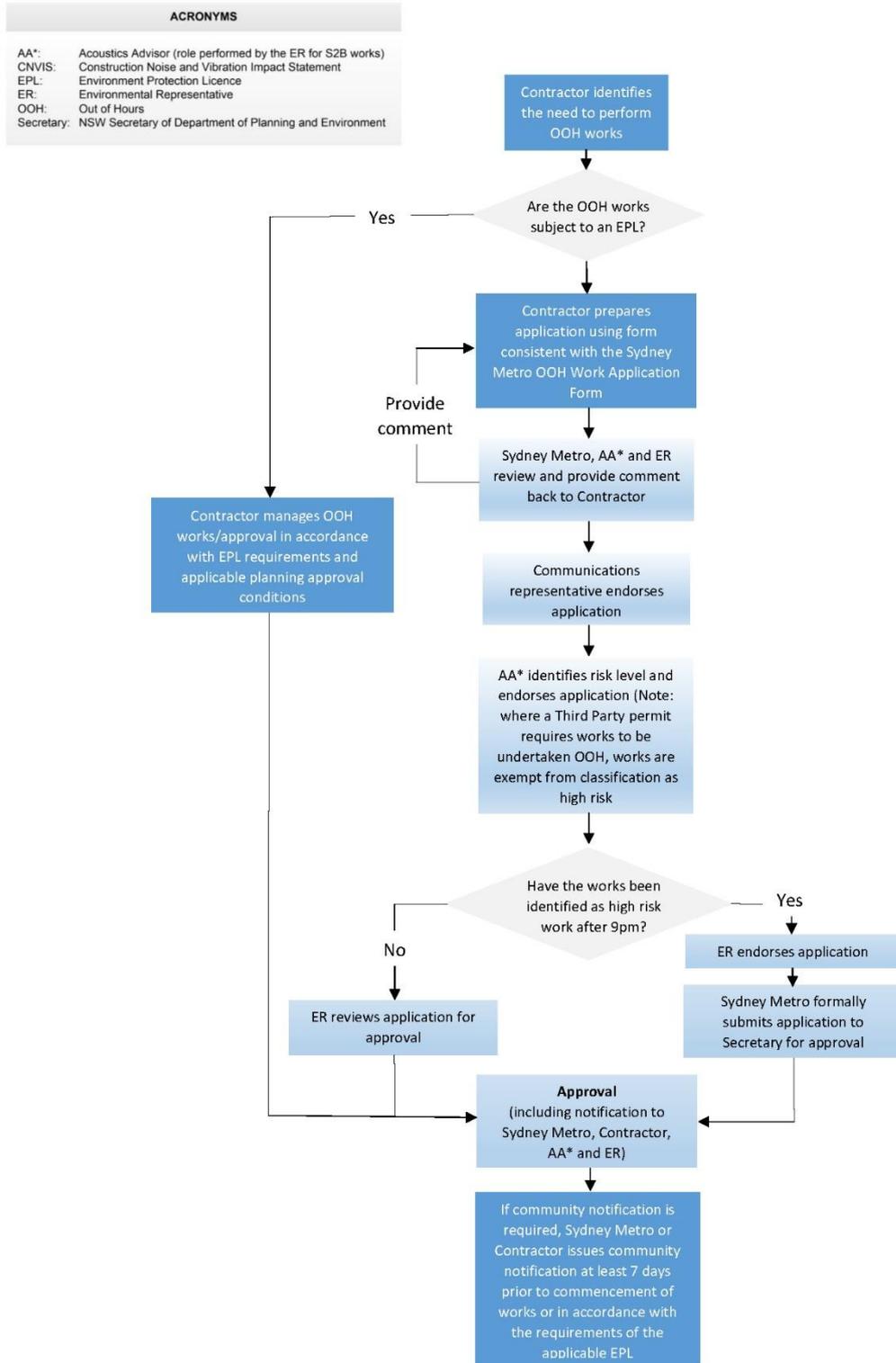


Figure 1: OOH Work Approval Process

Construction Noise and Vibration Management Plan**A.2.1. OOH Work subject to an EPL**

For OOH work that is subject to an EPL, the EPL conditions will dictate the approval process. As a minimum however, for proposed OOH work that is not approved in the EPL and a variation is required, the contractor is expected to:

- Prepare an application to the EPA in accordance with the CNVS and EPL requirements;
- Submit the revised application to the EPA for approval and submit the application to the Place Manager, Sydney Metro Environment Manager, AA (if subject to the C2S planning approval) and Independent ER for information;
- Notify Sydney Metro, the AA (if subject to the C2S planning approval) and Independent ER upon receiving EPA approval; and
- Ensure any required community notifications have been issued (by either Sydney Metro or the contractor directly) within the timeframe(s) specified and in accordance with any relevant conditions of the EPL.

For individual OOH work applications that are subject to an EPL (including Sydney Trains' EPL), endorsement/approval from the AA/ER is not required. However, Sydney Metro may request the AA/ER's endorsement prior to approval and commencement of the proposed OOH works (at Sydney Metro's discretion).

A.2.2 OOH Work not subject to an EPL

For OOH work that is not subject to an EPL, the approval process is dictated by either C2S CoA E47 or S2B CoA E25.

Contractors are required to prepare an OOH application using a form consistent with SM-17 <https://icentral.tdocs.transport.nsw.gov.au/otcs/cs.exe/app/nodes/380252400000115> Out of Hours Work Application Form. This form requires a noise and vibration impact assessment to be undertaken and contains a consolidated and conservative version of Table 14 from the CNVS. This facilitates simpler consideration of applicable additional mitigation measures to implement. The form also requires demonstration of how a range of additional noise and vibration mitigation measures have been considered for implementation, including community notifications and respite offers. The applicant is also required to indicate its risk level for the proposed OOH work within the application.

Where Third Party permits (e.g. Road Occupancy Licences and/or rail possessions) require works to be undertaken OOH, these works will be exempt from classification as 'high risk' (described under section 4.2.2.3) and will be subject to endorsement by the AA and approval by Independent ER as required under C2S CoA E47 or approval by the Independent ER under S2B CoA E25 in accordance with the 'Low Risk' approval pathway. Evidence of Third Party approval applicable to the works, specifying the time that the works must be undertaken must be included as part of application.

A.2.2.1. Respite

Respite offers for impacted receivers will be considered in accordance with the CNVS. Respite may be offered in the form of a reduction or absence of noise emissions for a period of time, or by removing the affected receiver from the noise emission point source (e.g. dinner/movie tickets and/or alternative accommodation offers).

The CNVS requires respite offers to be considered for all OOH works that are predicted to generate impacts higher than the applicable exceedance criteria for the applicable OOH period. Proposed OOH works must be coordinated to avoid the same receiver being affected

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over consecutive nights as much as is reasonable. OOH works must be staggered as much as is reasonable in order to maximise the respite period between OOH works.

If consideration of respite offers is required, a decision to implement respite offers will be determined on a case-by-case basis and considering, but not limited to, the following factors:

- The predicted maximum exceedance level;
- The predicted exceedance levels and associated duration and timings of those exceedance levels;
- The overall duration of the predicted exceedance levels;
- Surrounding land uses;
- Community feedback provided by Place Managers; and
- Any other OOH works (Sydney Metro or otherwise) that have affected or will affect the same receivers concurrently or within three days of either the start or end of the proposed OOH works.

In the event that respite is determined to be implemented for works that are subject to the S2B planning approval, respite will be implemented to meet the intent of S2B CoA E24 as applicable and so far is reasonable and practicable.

APPENDIX B CROWS NEST CONSTRUCTION SCENARIOS FOR USE IN THE CNVIS

SCHEDULE	AREA OF WORKS	ACTIVITY	POTENTIAL (AB / VIB) IMPACTS	EQUIPMENT	OPERATING LOCATION SURFACE OR BELOW GROUND	LW. ITEMS	QUANTITY	PENALTY	DUTY FACTOR (DF)	LW, MODIFIED (W/P/DF)
Jan 2022 - Feb 2022	C	Piling	AB, Vib	Bored Piling Rig	Above Ground	110	1	0	100%	108
				Concrete Pump	Above Ground	109	1	0	50%	109
				Concrete agitator	Above Ground	109	1	0	50%	107
				Concrete Vibrator	Above Ground	105	1	0	100%	103
				Total emission (Lw, 15minute in dBA)						115
Feb 2021 - April 2021	A,B	Excavation	AB, Vib	Concrete Saw	Below Ground	118	1	5	15%	115
				Excavator Hammer	Below Ground	118	1	5	15%	115
				Excavator (approx. 10 tonne)	Below Ground	100	1	0	25%	94
				Excavator (approx. 20 tonne)	Below Ground	105	1	0	25%	99
				Total emission (Lw, 15minute in dBA)						121
Sep 2021	C	Excavation	AB, Vib	Concrete saw	Below Ground	118	1	5	15%	115
				Excavator Hammer	Below Ground	118	1	5	15%	115
				Excavator (approx. 10 tonne)	Below Ground	100	1	0	50%	97
				Total emission (Lw, 15minute in dBA)						121
Feb 2021 - April 2021	A,B,C	In ground services and under platform ground slab	AB, Vib	Water cart	Below Ground	107	1	0	50%	104
				Concrete Pump	Below Ground	109	1	0	25%	103
				Elevated work platform – scissor lift	Below Ground	98	1	0	100%	98
				Concrete Vibrator	Below Ground	105	1	0	50%	102
				Hand tools (electric)	Below Ground	102	2	0	50%	102
				Circular saw, bench mounted (Cutting timber)	Below Ground	106	2	0	50%	106
				Diesel driven engine (power supply for tower crane)	Above Ground	110	1	0	25%	104
				Concrete agitator	Surface	109	1	0	25%	103
				Caged material hoist (electric)	Surface	96	1	0	100%	96
				Total emission (Lw, 15minute in dBA)						116
Mar 2021 - Dec 2021	A,B,C	Below ground structure	AB, Vib	Hand tools (electric)	Below Ground	102	4	0	50%	105
				Wheeled mobile crane	Below Ground	98	1	0	100%	98
				Concrete Pump	Below Ground	109	1	0	25%	103
				Elevated work platform – scissor lift	Below Ground	98	1	0	100%	98
				Diesel driven engine (power supply for tower crane)	Above Ground	110	1	0	50%	107
				Concrete agitator	Surface	109	1	0	25%	103
				Concrete Pump	Surface	109	1	0	50%	106
				Total emission (Lw, 15minute in dBA)						116
Dec 2021 - Jan 2022	C	Partially demolish ground retention walls	AB, Vib	Concrete saw	Below Ground	118	1	5	15%	115
				Excavator Hammer	Below Ground	118	1	5	15%	115
				Excavator (approx. 10 tonne)	Below Ground	100	1	0	50%	97
				Total emission (Lw, 15minute in dBA)						121

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SCHEDULE	AREA OF WORKS	ACTIVITY	POTENTIAL (AB / VIB) IMPACTS	EQUIPMENT	OPERATING LOCATION SURFACE OR BELOW GROUND	LW. ITEMS	QUANTITY	PENALTY	DUTY FACTOR (DF)	LW, MODIFIED (W/P/DF)
Nov 2021 - April 2022	A,B,C	Above ground structure	AB	Diesel driven engine (power supply for tower crane)	Above Ground	110	1	0	50%	107
				Concrete Pump	Surface	109	1	0	50%	106
				Concrete agitator	Surface	109	1	0	50%	106
				Hand tools (electric)	Above Ground	102	1	0	50%	99
						114				111
May 2021 - April 2022	A,B	OOHW - Box Girder delivery	AB	Diesel driven engine (power supply for tower crane)	Above Ground / Surface	110	1	0	50%	107
				Dump Truck (approx. 15 tonne)	Above Ground / Surface	108	2	0	50%	108
						112	0	0		111
May 2022 - June 2022	A,B,C	Façade	AB	Hand tools (electric)	Above Ground	102	3	0	50%	104
				Diesel driven engine (power supply for tower crane)	Above Ground	110	1	0	85%	109
						111				110
July 2021 - Feb 2023	A,B,C	Fit out 1	AB	Elevated work platform – scissor lift	Above Ground Levels	98	4	0	50%	101
Mar 2022 - Feb 2023	C			Hand tools (electric)	Above Ground Levels	102	1	0	85%	99
				Wheeled mobile crane	Above Ground Levels	98	1	0	67%	98
				Hand tools (electric)	Above Ground Levels	102	1	0	100%	99
						106	0	0	0	105
Feb 2022 - Feb 2023	A,B	Fit out 2	AB	Elevated work platform – scissor lift	Above Ground Levels	98	4	0	50%	101
				Hand tools (electric)	Above Ground Levels	102	1	0	50%	99
						103				103
Various dates	Various sites	Local Area / Public Domain Works	AB, Vib	Excavator (approx. 6 tonne)	Above Ground	95	4	0	25%	95
				Concrete Saw	Above Ground	118	1	5	15%	110
				Hydraulic vibratory compactor (tracked excavator)	Above Ground	106	1	0	50%	103
				Roller (vibratory)	Above Ground	109	1	0	50%	106
				Concrete agitator	Above Ground	109	1	0	50%	106
				Plate compactor/wacker packer	Above Ground	106	1	0	50%	103
				Hand tools (electric)	Above Ground	102	1	0	50%	99
						119				114

APPENDIX C MONITORING PROCEDURE

C.1 Specification for Determining the Sound Power of Construction Plant and Equipment

For consistency of outcomes, the monitoring procedures generally align with the procedure for the preceding Tunnel and Station Excavation works

C.1.1 Scope

This document specifies methods for determination of sound power levels for construction plant including earthmoving equipment and other ancillary plant and equipment used during construction.

C.1.2 Referenced Standards

- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;
- AS 2012.1 Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise
- ISO 3744 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane
- ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions
- ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions

C.1.3 Testing Procedures – Earthmoving Machinery

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

Each acoustically significant plant item identified in the CNVIS shall be tested in terms of both the 'stationary' and the 'dynamic' testing procedures detailed below.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 2004 "Electroacoustic - Sound Level Meters" and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the meters shall be checked in the field before and after the noise measurement period.

C.1.4 Stationary Testing

Stationary measurements shall be performed on all earthmoving plant according to the method of AS 2012.1 and/or ISO 6393.

In addition to measuring overall A-weighted noise levels, octave band frequency LAeq,T noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency

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range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band LAeq,T noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the LAeq,T and LA1,(1min) noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

All measured noise level data and determined sound power levels shall be included in the test reports.

C.1.5 Dynamic Testing

Details of equipment operation during testing will vary depending on the equipment type. Dynamic measurements shall be performed on all earthmoving plant according to the method in International Standard ISO 6395.

In addition to measuring overall A-weighted noise levels, octave band frequency LAeq,T noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in International Standard ISO 6395.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band LAeq,T noise levels shall also be processed to establish octave-band sound power levels.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

The overall A-weighted sound power levels to be determined shall be in terms of the LAeq,T and LA1,(1min) noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

All measured noise level data and determined sound power levels shall be included in the test reports.

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The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 'Electroacoustic - Sound Level Meters'. The calibration of the meters shall be checked in the field before and after the noise measurement period.

Noise measurements shall be performed on all acoustically significant non-earthmoving construction plant identified in the CNVIS according to the methods of either ISO 3744 or ISO 3746, whichever is applicable to the items of plant being tested.

Machinery shall be operated at high idle speed. In the case of drilling, boring and rockbreaking machines, the testing location shall allow for these machines to be operated in rock of characteristics that are typical for the project site.

In addition to measuring overall A-weighted noise levels, octave band frequency LAeq,T noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band LAeq,T noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the LAeq,T and LA1,(1min) noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures. All measured noise level data and determined sound power levels shall be included in the test reports.

C.2 Specification for Construction Noise Monitoring**C.2.1 Scope**

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

C.2.2 Referenced Standards and Guidelines

- AS 2659.1 – 1998 Guide to the use of sound measuring equipment – portable sound level meters
- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;

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- AS 1055 Acoustics - Description and Measurement of Environmental Noise;
- DECCW NSW Interim Construction Noise Guideline 2009; and EPA NSW Industrial Noise Policy 2000.

C.2.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in AS IEC 61672.1 2004 'Electroacoustic - Sound Level Meters - Specifications' and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters and computers housed in weather resistant enclosures. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option.

All environmental noise measurements shall be taken with the following meter settings:

- Time Constant - FAST (i.e. 125 milliseconds)
- Frequency Weightings - A-weighting
- Sample Period - 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise may be disregarded if rain or wind adversely affects the measurements. A wind speed greater than 5 m/s (18 km/h) measured at the microphone may adversely affect the measurement.

C.2.4 Long-term (unattended) Monitoring

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, whilst shielded as much as possible from non-construction site noise (e.g. road traffic, rail noise and other surrounding noise).

Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels: Lmin, L90, Leq, L10, L1 and Lmax.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

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Meteorological conditions such as wind velocity, wind direction and rainfall shall also be either monitored on site or recorded from the nearest weather station to the project site, over the entire noise monitoring period.

C.2.5 Real time (unattended) Monitoring

Real time (unattended noise monitoring should follow the same process as described in Section C.2.4 above.

In addition to the above, the vibration monitoring device must be fitted out with a modem to allow the data processor to monitoring data to a remote server. This allows the monitoring data to be downloaded stored to a networked PC or webserver. A secure website is required for data storage.

The statistical data can be processed in real time and displayed for review. A trigger could be set to warn of the potential for non-compliance by transmitting an email or SMS alert. This allows A W Edwards to respond to potential vibration issues before non-compliance occurs.

Upon receipt of an alert email/ SMS the source of potential non-compliance should be identified. This allows A W Edwards to respond to potential noise issues before non-compliance occurs. A reasonable and feasible approach to allow the worksite to comply with the noise obligations would be as follows:

- Review the AMMs considered and apply and revise them if appropriate.
- Review and where possible, modify the work or activity to prevent any recurrence.

C.2.6 Short-term (attended) Monitoring

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported are the following A-weighted noise levels: Lmin, L90, Leq, L10, L1 and Lmax.

In addition to measuring and reporting overall A-weighted noise levels, statistical L90, Leq, L10 noise levels shall also be measured and reported in third-octave band frequencies from 31.5Hz to 8kHz.

Outdoor noise monitoring is to be undertaken at least 3.5m from any reflecting structure other than the ground. The preferred measurement height is 1.2-1.5m above the ground. Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and about 1.5m from windows.

Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover shall also be recorded during short-term noise monitoring.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed

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above. The following information shall be recorded and included in a noise monitoring report:

- The type of monitoring conducted (for example, a particular project stage or following complaints) and a brief statement of the measurement method.
- The noise conditions on the consent / licence, or the relevant noise management objectives.
- Descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint.
- Date and time of measurements
- Name of person undertaking the measurements
- Type and model number of instrumentation
- Results of field calibration checks before and after measurements
- The results of monitoring at each monitoring location, including a comparison with the consent conditions or relevant noise management objectives
- Sketch map of area and monitoring location
- Details of the various construction equipment in use during the measurement period.
- Indicative noise levels at the measurement location from the operation of the various plant items, together with the observed duration of individual items.
- Details as to the likely dominant noise sources.
- Meteorological conditions (i.e. temperature, humidity, cloud cover, and wind speed and direction)
- A clear statement outlining the project's compliance or non-compliance with the conditions or objectives where the monitored level is higher than the conditions or objectives,
- The reasons for non-compliance should be stated, strategies for minimising noise identified and stated, and the appropriate actions to implement the mitigation and or management strategies.

C.3 Specification for construction vibration monitoring**C.3.1 Scope**

This document specifies methods for undertaking vibration monitoring during the construction phase of the project.

C.3.2 Referenced Standards and Guidelines

- AS 2775 Mechanical Mounting of Accelerometers
- AS 2670.2 Evaluation of human exposure to whole body vibration
- DECC NSW Assessing Vibration: A Technical Guideline
- DIN 4150.3 Structural Vibration in Buildings – Effects on Structures
- BS 7385:1 Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
- BS 7385:2 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground-borne Vibration
- ISO 4866 Mechanical Vibration and Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings

Construction Noise and Vibration Management Plan**C.3.3 Testing Procedures**

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be calibrated at least once every two years to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The monitoring system should also have a measurement frequency range down to 1Hz.

C.3.4 Short-Term (Attended) Monitoring

Vibration monitoring shall be undertaken at the following locations:

- At the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so to refine the indicative minimum working distances and provide a site-specific table of minimum working distances
- At the first opportunity following the commencement of tunnelling, cross passage and shaft excavation to verify and, if necessary, update the vibration model
- Vibration sensitive locations determined to fall within the 'buffer distances' established for each item of plant. Areas likely to require vibration monitoring are identified in this report; and
- Where vibration complaints or requests from relevant authorities, at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities;
- Where required to determine ground-borne noise levels from tunnelling or excavation works.
- Vibration monitoring shall be undertaken over the following period(s):
- For plant operating within the 'buffer distances', during the commencement of use of each plant on site until site-specific minimum working distances are established; and
- For complaints or requests from relevant authorities, during the of use of requested plant until site-specific minimum working distances are established.

All attended short-term vibration monitoring shall be recorded over 15 minute sample intervals. The following minimum range of vibration metrics should be stored in memory and reported:

- Vibration Dose Values (VDVs)
- Root-mean-square (rms) – maximums and statistical levels
- Peak-particle velocity (ppv) – maximums and statistical levels.

In addition to measuring and reporting overall vibration, statistical vibration shall also be measured and reported in third-octave band frequencies from 1Hz to 250Hz.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- The surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation;
- The vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;

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- The vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest; and
- Where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.
- Where vibration monitoring is undertaken to measure tactile vibration levels, vibration monitoring results shall be assessed and reported against the acceptable values of human exposure to vibration set out in Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline.

The following information shall be recorded and reported:

- Type of monitoring conducted (for example, at a particular project stage or following complaints) and a brief statement of the measurement method.
- The vibration conditions on the consent, or the relevant management objectives.
- Descriptions of the nearest affected residences and other sensitive land uses or, in the case of complaints, description of the complainant location and complaint.
- Date and time of measurements;
- Name of person undertaking the measurements
- Type and model number of instrumentation;
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day);
- Sketch map of area and measurement location;
- Measurement location details and number of measurements at each location;
- Operation and load conditions of the vibrating plant under investigation; and
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic, etc.).
- Details of corrective action applicable to vibration criteria exceedances and confirmation of its successful implementation. Where corrective action has not yet been implemented, it may be shown as pending and the status of its implementation will be carried forward to following reports.

C.3.5 Long-Term (Unattended) Monitoring

Vibration monitoring shall be undertaken at vibration sensitive locations determined to fall within the 'minimum working distances' established for each item of plant during the commencement of use of each plant on site.

Vibration monitoring shall be undertaken over the following period(s):

- Continuously whilst the vibrating plant is operational within the pre-determined 'minimum working distance' from the potentially affected building.

Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.

The data is to be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- Peak-particle velocity (ppv) – maximums and statistical metrics.

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Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- The outside-to-inside vibration transfer function shall be measured, whenever practicable, to assess the potential for humane annoyance inside buildings;
- The surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation;
- The vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- The vibration sensor or transducer shall be directly mounted to the vibrating surface using bees wax or a magnetic mounting plate onto a steel plate or bracket either fastened or glued to the surface of interest;
- Where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.; and
- A flashing light alarm should be attached in a visible position from the construction work area. When vibration exceeds the set threshold, the light will flash notifying the operator that works in that area should cease immediately.

C.3.6 Real time (unattended) Monitoring

Real time (unattended) vibration monitoring should follow the same process as described in Section C.3.5 above.

In addition to the above, the vibration monitoring device must be fitted out with a modem to allow the data processor to monitoring data to a remote server. This allows the monitoring data to be downloaded stored to a networked PC or webserver. A secure website is required for data storage.

The statistical data can be processed in real time and displayed for review. A trigger could be set to warn of the potential for non-compliance by transmitting an email or SMS alert. This allows A W Edwards to respond to potential vibration issues before non-compliance occurs. Works should cease immediately until the source of non-compliance is identified and a compliant construction methodology is determined.