Detailed Noise and Vibration Impact Statement - Claremont Meadows Ventilation Facility

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

Project number	WSA-200-SBT
Document number	SMWSASBT-CPG-OHE-SF150-EN-RPT-293012
Revision date	September 2023
Revision	**D**

Document approval

Rev	Date	Prepared by	Reviewed by	Approved by
D	Sep 2023	[redacted]	[redacted]	[redacted]
Signature:		[redacted]		

Details of Revision Amendments

Document Control

The Project Director is responsible for ensuring that this Report is reviewed and approved. The Environment Manager is responsible for updating this Report to reflect construction, legal and other requirements changes.

Amendments

Any revisions or amendments must be prepared by the Specialist Acoustic Consultant in consultation with the Construction Team and the Environment Team before being distributed/implemented.

Revision Details

Revision	Details
A	Initial Development
B	Respond to ER comments
C	Respond to ER comments
D	Minor edits

RENZO TONIN & ASSOCIATES
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Acoustics
Vibration
Structural Dynamics

SYDNEY METRO - WESTERN SYDNEY AIRPORT - STATION BOXES AND TUNNELLING WORKS

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5 September 2023

CPB Contractors Ghella JV

TM008-02-02F01 SMWSA-SBT_DNVIS-CMF (r5)

40 YEARS 1982-2022 ACOUSTIC ENGINEERING EXCELLENCE

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Document details

Detail	Reference
Doc reference:	TM008-02-02F01 SMWSA-SBT_DNVIS-CMF (r5)
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Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
6/07/2022	Initial issue	0	1	[redacted]	[redacted]	[redacted]
3/08/2022	Respond to CPBG comments	-	2	[redacted]	-	[redacted]
4/03/2023	Respond to ER comments	-	3	[redacted]	-	[redacted]
9/08/2023	Respond to ER comments	-	4	[redacted]	-	[redacted]
5/09/2023	Minor edits	-	5	[redacted]	-	[redacted]

File Path: R:\AssocSydProjects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\1 Docs\02 CLAREMONT M\TM008-02-02F01 SMWSA-SBT_DNVIS-CMF (r5).docx

Compliance

No.	Requirement	Reference
SSI 10051 Planning Approval		
E37	A detailed land use survey must be undertaken to confirm sensitive land use(s) (including critical working areas such as operating theatres and precision laboratories) potentially exposed to construction noise and vibration and construction ground-borne noise. The survey may be undertaken on a progressive basis but must be undertaken in any one area before the commencement of work which generate construction noise, vibration or ground-borne noise in that area. The results of the survey must be included in the Detailed Noise and Vibration Impact Statements required under Condition E47.	Section 3.1 and APPENDIX B
E38	Work must only be undertaken during the following 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 2.2
E39	Except as permitted by an EPL or approved in accordance with the Out of Hours Works Protocol required by Condition E42, highly noise intensive work that result in an exceedance of the applicable NML at the same receiver must only be undertaken: (a) between the hours of 8:00 am to 6:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) if continuously, then not exceeding three (3) hours, with a minimum cessation of work of not less than one (1) hour. For the purposes of this condition, 'continuously' includes any period during which there is less than one (1) hour between ceasing and recommencing any of the work.	Section 2.2
E40	This approval does not permit blasting.	Noted, blasting not proposed.
E41	Notwithstanding Conditions E38 and E39 work may be undertaken outside the hours specified in the following circumstances:	Section 2.2
	(a) Safety and Emergencies, including: (i) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or (ii) 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	Table 2.2
	(b) Low impact, including: (i) construction that causes LAeq(15 minute) noise levels: • no more than 5 dB(A) above the rating background level at any residence in accordance with the ICNG, and • no more than the 'Noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s); and (ii) construction that causes: • continuous or impulsive vibration values, measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006), or • intermittent vibration values measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).	Table 2.2
	(c) By Approval, including: (i) where different construction hours are permitted or required under an EPL in force in respect of the CSSI; or (ii) works which are not subject to an EPL that are approved under an Out-of-Hours Work Protocol as required by Condition E42; or (iii) negotiated agreements with directly affected residents and sensitive land user(s).	Table 2.2

No.	Requirement	Reference
	(d) By Prescribed Activity, including: (i) tunnelling and ancillary support activities (excluding cut and cover tunnelling and surface works not directly supporting tunneling) are permitted 24 hours a day, seven days a week; or (ii) grout batching at the Orchard Hills ancillary facility is permitted 24 hours a day, seven days a week; or (iii) delivery of material that is required to be delivered outside of standard construction hours in Condition E38 to directly support tunnelling activities, except between the hours 10:00 pm and 7:00 am to / from the Orchard Hills ancillary facility; or (iv) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from Orchard Hills ancillary facility; or (v) work within an acoustic enclosure are permitted 24 hours a day, seven days a week where there is no exceedance of noise levels or intermittent vibration levels under Low impact circumstances identified in Condition E41(b), unless otherwise agreed with the Planning Secretary; or (vi) tunnel and underground station box fit out works are permitted 24 hours per day, seven days per week.	Table 2.2
	On becoming aware of the need for emergency work in accordance with (a)(ii) above, the ER, the Planning Secretary and the EPA must be notified of the reasons for such work. The Proponent must use best endeavours to notify as soon as practicable all noise and/or vibration affected sensitive land user(s) of the likely impact and duration of those work. Notes: 1. Tunnelling does not include station box excavation. 2. Tunnelling ancillary support activities includes logistics support and material handling and delivery	Table 2.2
E42	An Out-of-Hours Work Protocol must be prepared…	N/A to this DNVIS
E43	Mitigation measures must be implemented with the aim of achieving the following construction noise management levels and vibration criteria: (a) construction 'Noise affected' noise management levels established using the Interim Construction Noise Guideline (DECC, 2009); (b) preferred vibration criteria established using the Assessing vibration: a technical guideline (DEC, 2006) (for human exposure); (c) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives" (for human exposure); (d) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions"; and (e) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration-effects of vibration on structures (for structural damage). Any work identified as exceeding the noise management levels and / or vibration criteria must be managed in accordance with the Noise and Vibration CEMP Sub-plan. Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5 dB(A) to the predicted level before comparing to the construction Noise Management Level.	Section 4
E44	All reasonable and feasible mitigation measures must be applied when the following residential ground-borne noise levels are exceeded: (a) evening (6:00 pm to 10:00 pm) — internal LAeq(15 minute): 40 dB(A); and (b) night (10:00 pm to 7:00 am) — internal LAeq(15 minute): 35 dB(A). The mitigation measures must be outlined in the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol, required by Condition E42.	Table 4.1
E45	Noise generating work in the vicinity of potentially-affected community, religious, educational institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) resulting in noise levels above the NMLs must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected institutions are made at no cost to the affected institution.	Section 5.3.2

No.	Requirement	Reference
E47	Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed the NMLs, vibration criteria and / or ground-borne noise levels specified in Conditions E43 and E44 at any residence outside construction hours identified in Condition E38, or where receivers will be highly noise affected or subject to vibration levels above those otherwise determined as appropriate by a suitably qualified structural engineer under Condition E87. The DNVIS must include specific mitigation measures identified through consultation with affected sensitive land user(s) and the mitigation measures must be implemented for the duration of the works. A copy of the DNVIS must be provided to the ER before the commencement of the associated works. The Planning Secretary and the EPA may request a copy (ies) of the DNVIS.	This document Section 5.3, Section 6.3 and Section 7.3
E48	Owners and occupiers of properties at risk of exceeding the screening criteria for cosmetic damage must be notified before works that generate vibration commences in the vicinity of those properties. If the potential exceedance is to occur more than once or extend over a period of 24 hours, owners and occupiers are to be provided a schedule of potential exceedances on a monthly basis for the duration of the potential exceedances, unless otherwise agreed by the owner and occupier. These properties must be identified and considered in the Noise and Vibration CEMP Sub-plan.	Section 0
E49	Where sensitive land use(s) are identified in Appendix B as exceeding the highly noise affected criteria during typical case construction, mitigation measures must be implemented with the objective of reducing typical case construction noise below the highly noise affected criteria at each relevant sensitive landuse(s). Activities that would exceed highly noise affected criteria during typical case construction must not commerce until the measures identified in this condition have been implemented, unless otherwise agreed with the Planning Secretary. Note: Mitigation measures may include path barrier controls such as acoustic sheds and/or noise walls, at-property treatment, or a combination of path and at-property treatment.	Section 5.2.1 and Section 5.3.1
E50	For all construction sites where acoustic sheds are installed, the sheds must be designed, constructed and operated to minimise noise emissions. This would include the following considerations: (a) all significant noise producing equipment that would be used during the night-time would be inside the sheds, where feasible and reasonable; (b) noise generating ventilation systems such as compressors, scrubbers, etc, would be located inside the sheds and external air intake/discharge ports would be appropriately acoustically treated; and (c) the doors of acoustic sheds would be kept closed during the night-time period. Where night-time vehicle access is required at sites with nearby residences, the shed entrances would be designed and constructed to minimise noise breakout.	Table C.2 in APPENDIX C
E51	Where Condition E49 determines that at-property treatment (temporary or permanent) is the appropriate measure to reduce noise impacts, this at-property treatment must be offered to landowners of residential properties for habitable living spaces, unless other mitigation or management measures are agreed to by the landowner. Landowners must be advised of the range of options that can be installed at or in their property and given a choice as to which of these they agree to have installed. A copy of all guidelines and procedures that will be used to determine at-property treatment at their residence must be provided to the landowner.	Section 5.3.1
E52	Any offer for at-property treatment or the application of other noise mitigation measures in accordance with Condition E51 does not expire until the noise impacts specified in Condition E49 affecting that property are completed, even if the landowner initially refuses the offer. Note: If an offer has been made but is not accepted, this does not preclude the commencement of construction under Condition E49.	CNVMP
E53	The implementation of at-property treatment does not preclude the application of other noise and vibration mitigation and management measures including temporary and long term accommodation.	CNVMP

No.	Requirement	Reference
E54	Vibration testing must be conducted during vibration generating activities that have the potential to impact on Heritage items to verify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and attended 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. Such measures must include, but not be limited to, review or modification of excavation techniques.	Section 6.3
E55	The Proponent must seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring at Heritage items.	CNVMP
E56	All work undertaken for the delivery of the CSSI, including those undertaken by third parties (such as utility relocations), must be coordinated to ensure respite periods are provided. The Proponent must: (a) reschedule any work to provide respite to impacted noise sensitive land use(s) so that the respite is achieved in accordance with Condition E57; or (b) consider the provision of alternative respite or mitigation to impacted noise sensitive land use(s); and (c) provide documentary evidence to the ER in support of any decision made by the Proponent in relation to respite or mitigation. The consideration of respite must also include all other approved Critical SSI, SSI and SSD projects which may cause cumulative and / or consecutive impacts at receivers affected by the delivery of the CSSI.	Section 5.3.5
E57	In order to undertake out-of-hours work outside the work hours specified under Condition E38, appropriate respite periods for the out-of-hours work must be identified in consultation with the community at each affected location on a regular basis. This consultation must include (but not be limited to) providing the community with: (a) a progressive schedule for periods no less than three (3) months, of likely out-of-hours work; (b) a description of the potential work, location and duration of the out-of-hours work; (c) the noise characteristics and likely noise levels of the work; and (d) likely mitigation and management measures which aim to achieve the relevant NMLs under Condition E43 (including the circumstances of when respite or relocation offers will be available and details about how the affected community can access these offers). The outcomes of the community consultation, the identified respite periods and the scheduling of the likely out-of-hour work must be provided to the ER, EPA and the Planning Secretary prior to the out-of-hours work commencing. Note: Respite periods can be any combination of days or hours where out-of-hours work would not be more than 5 dB(A) above the RBL at any residence.	Section 5.3.2 and the Community Communication Strategy (CCS)
Revised Environmental Performance Outcomes		
1	Construction noise and vibration impacts on local communities (including airborne noise and ground-borne noise and vibration) are managed in accordance with the Construction Noise and Vibration Standard, the Interim Construction Noise Guideline, and the Airports (Environment Protection) Regulations 1997	Section 4
2	Structural damage to buildings, heritage items and public utilities and infrastructure, including the Warragamba to Prospect Water Supply Pipelines, from construction vibration to be avoided	Table 4.1
Revised Environmental Mitigation Measures		
NV1	Where acoustic sheds are installed, the internal lining and type of material used in the construction of the sheds would be considered during design development and construction planning to ensure appropriate attenuation is provided	Table C.2 in APPENDIX C
Construction Environmental Management Framework		
5.1 (a)	Working Hours Standard working hours are between 7am – 6pm on weekdays and 8am – 1pm on Saturdays	Section 2.2

No.	Requirement	Reference
5.1 (b)	Works which can be undertaken outside of standard construction hours without any further approval include: i. Those which have been described and assessed in the environmental assessments. For example, tunnelling and underground excavations and supporting activities or works within Western Sydney International ii. Works which are determined to comply with the relevant Noise Management Level at sensitive receivers; iii. The delivery of materials outside of approved hours as required by the Police or other authorities(including Transport for NSW) for safety reasons; iv. Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency; and v. Where written agreement is reached with all affected receivers	Table 2.2
5.1 (c)	Where off-airport works are being undertaken under an Environmental Protection Licence, Principal Contractors may apply for EPA approval to undertake works outside of normal working hours	Section 2
8.1 a	Construction Noise and Vibration Management Objectives The following noise and vibration management objectives will apply to construction: i. Minimise unreasonable noise and vibration impacts on residents and businesses; ii. Avoid structural damage to buildings or heritage items as a result of construction vibration; iii. Undertake active community consultation; iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners; and	Section 4
8.2 a	Construction Noise and Vibration Management Implementation On-airport management of noise and vibration will be achieved through the implementation of the SMWSA Noise and Vibration CEMP and Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for all off-airport works consistent with the Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009). Both plans will include as a minimum: i. Identification of work areas, site compounds and access points; ii. Identification of sensitive receivers and relevant construction noise and vibration goals; iii. Be consistent with, and include the requirements of the noise and vibration mitigation measures as detailed in the planning approval documentation and the Sydney Metro Construction Noise and Vibration Standard (CNVS), including the provision of respite; iv. Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios) that have the potential to generate noise or vibration impacts on surrounding sensitive receivers, in particular residential areas; v. Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program; vi. The requirements of any applicable licence or approval (for example EPL); vii. Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week; viii. Pre-construction compliance requirements and hold points; ix. The responsibilities of key project personnel with respect to the implementation of the plan; x. Noise monitoring requirements; xi. Compliance record generation and management; and xii. An Out of Hours Works Protocol applicable to all construction methods and sites.	CNVMP

No.	Requirement	Reference
8.2 (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 works proposed to be undertaken outside of standard construction hours and to support applications to undertake out of hours works (this includes variations of EPLs and applications to relevant agencies).	This report
8.2 (c)	Noise and vibration monitoring would be undertaken for construction as specified in the CNVS.	Section 5.3.6 and Section 6.3.2
8.2 (d)	The following compliance records would be kept by Principal Contractors: i. Records of noise and vibration monitoring results against appropriate NMLs ii. Records of community enquiries and complaints, and the Contractor's response	CEMP
8.3 (a)	Construction Noise and Vibration Mitigation All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. The on-airport Noise and Vibration CEMP and the off-airport Noise and Vibration Management Plan will include the following noise and vibration mitigation measures as well as relevant Conditions:	Section 5.3
	i. Construction hours will be in accordance with the working hours specified in Section 5.1;	Section 2.2
	ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and	Section 5.3 and Table C.2 in APPENDIX C
	iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers	Section 5.3 and Figure C.1 in APPENDIX C
	iv. Provision of respite periods	Section 5.3.1

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1 Introduction

1.1 Purpose

This Detailed Noise and Vibration Impact Statement (DNVIS) has been prepared on behalf of CPB Ghella Joint Venture (CPBG) in accordance with the Sydney Metro Construction Noise and Vibration Standard (CNVS)[1] for the construction of the Sydney Metro: Western Sydney Airport Project – Station Boxes and Tunnelling (SBT) Works.

1.2 Relevant requirements and application of this DNVIS

SSI 10051 Infrastructure Condition of Approval (CoA) E47 requires that:

Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed the NMLs, vibration criteria and / or ground-borne noise levels specified in Conditions E43 and E44 at any residence outside construction hours identified in Condition E38, or where receivers will be highly noise affected or subject to vibration levels above those otherwise determined as appropriate by a suitably qualified structural engineer under Condition E87. The DNVIS must include specific mitigation measures identified through consultation with affected sensitive land user(s) and the mitigation measures must be implemented for the duration of the works. A copy of the DNVIS must be provided to the ER before the commencement of the associated works. The Planning Secretary and the EPA may request a copy (ies) of the DNVIS.

SBT Works will be delivered through the following sub-stages for NSW (off-airport) worksites:

- Preparatory Works: including demolition, site access and other local area works, site levelling/grading, utility and temporary services work, erection of demountable buildings and noise barriers, tunnelling preparatory works and use of ancillary facilities including onsite parking which has already been addressed in the Preparatory Construction Environmental Management Plan (CEMP) and in the DNVISs (ref: TM008-02-10F01 SMWSA-SBT_DNVIS-SE) and local area and utility works (ref: TM008-02-11F01 SMWSA-LAUW DNVIS; TM008-02-11F02 SMWSA-LAUW STH DNVIS).
- Bulk Excavation and Tunnelling Works: including the Preparatory Works scope (not completed prior to Final CEMP approval) including bulk excavation, acoustic shed/enclosure installation, tunnelling and cross passage installation (this DNVIS).

This DNVIS provides a noise and vibration assessment of works being undertaken at the Claremont Meadows ventilation facility as part of the bulk excavation and tunnelling works for the Project.

The aim of this assessment is to minimise the impact of construction noise and vibration on sensitive receivers and demonstrate compliance with relevant SSI-10051 Conditions of Approval (CoA) and Environment Protection Licence (EPL) No. 21672.

1.3 Quality assurance

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Description of construction works and hours

2.1 Summary of works addressed in this DNVIS

The Claremont Meadows services facility (CMF) worksite is located to the east of Gipps Street and south of the Great Western Highway at Claremont Meadows, as shown on Figure 2-1 and Figure B1 in APPENDIX B.

Figure 2-1 Claremont Meadows ventilation facility worksite location

Most of the works are proposed to be undertaken during standard construction hours. The water treatment facility will operate 24 hours once shaft excavation commences. The tunnelling ventilation fans providing fresh air into the tunnels during the TBM tunnel excavation will be relocated to the CMF worksite once the TBM passes through the Claremont Meadows shaft. The ventilation fans will be required to operate 24 hours per day when tunnelling works are underway. Tunnel invert concrete pours, which form part of tunnelling activities, are scheduled to be completed during and outside of standard construction hours.

The out of hours works (OOHW) are justified (see Section 2.2.1). The works are summarised in Table 2.1. A detailed summary of the construction activities assessed in this report is presented in Section 5.1 and in Table C.1 of APPENDIX C.

Table 2.1: Summary of construction works under this DNVIS

Activity	Aspect	Construction hours	Timing of activity
Compound	General worksite and car park	Standard hours + OOHW (D/E/N)	Jun-22 to May-24
Ventilation Facility	Piling activities	Standard hours (D)	Aug-22 to Dec-23
	Shaft Excavation & Construction	Standard hours (D)*	Nov-22 to Apr-24
Tunnelling and tunnel Support	Ventilation fans	Standard hours + OOHW (D/E/N)	Jan-24 to Aug-24
	Tunnel Invert concrete pours	Standard hours + OOHW (D/E/N)	Dec-23 to Mar-24

Notes: 'OOHW' means Out of Hours works, or work outside the standard construction hours (see Section 2.2)

'OOHW(D)' is the OOH 'Day' period, 1pm to 6pm Saturday; 8am to 6pm Sunday

'OOHW(E)' is the 'Evening' period, 6pm to 10pm Monday to Sunday

'OOHW(N) is the OOH 'Night' period, 10pm to 7am Sunday/Monday to Thursday/ Friday; 10pm to 8am Friday/Saturday and Saturday/Sunday

* Water treatment facility will operate 24 hours once shaft excavation commences

2.2 Construction Hours

Construction hours for the Project are defined by SSI 10051 CoA E38, E39 and E41. Table 2.2 below consolidates the information provided in these Conditions regarding construction working hours for the Project.

Table 2.2: Working hours for construction worksites

CoA	Construction Activity	Monday to Friday	Saturday	Sunday / public holiday
E38	Standard construction	7:00am to 6:00pm	8:00am to 1:00pm	No work[1]
E39	Highly noise intensive works[2]	8:00am to 6:00pm (plus respite[2])	8:00am to 1:00pm (plus respite[2])	No work[1]
E41(a)	Safety and emergency work[2]	6:00pm to 7:00am	6:00pm to 8:00am	8:00 am to 7:00am
E41(b)	Low impact work[3]	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
E41(c)	Works approved under and EPL or Out-of-Hours Work Protocol	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
E41(d)	Prescribed activity: • Tunnelling and ancillary support activities • Grout batching at Orchard Hills ancillary facility • Delivery of material to directly support tunnelling activities[4] • Haulage of spoil[4] • Work within an acoustic shed • Tunnel and underground station box fit out works	24 hours	24 hours	24 hours

Notes:

1. No work unless permitted and approved.
2. Minimum respite from highly noise intensive works of not less than one (1) hour between each continuous block of works not exceeding three (3) hours.
3. Construction that causes $L_{Aeq(15\ minute)}$ noise levels no more than 5dB(A) above the Rating Background Level (RBL) at any residence; and/or no more than the 'noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s). Construction that causes continuous/impulsive/intermittent vibration values at the most affected residence, no more than the preferred values for human exposure to vibration, specified in Table 2.2 and Table 2.4 of the AVTG.
4. Except between the hours 10:00pm and 7:00amto/from the Orchard Hills ancillary facility.

2.2.1 Justification for OOHW

The water treatment plant is a required to operate 24 hours a day to treat groundwater associated with the shaft excavation. The plant will need to be mitigated to satisfy the low impact requirements under CoA E41(b). All reasonable and feasible mitigation and management measures will be implemented to reduce noise from the water treatment plant to within NMLs.

The operation of tunnel ventilation fans and the tunnel invert concrete pours are prescribed activities under Condition of Approval E41(d) and are permitted to operate 24 hours to support and as part of tunnelling works. All reasonable and feasible mitigation measures will be implemented to reduce noise emission from the fans and the invert pours to below the NMLs.

2.2.2 Assessment periods

The standard hours and out of hours work (OOHW) periods are depicted in Table 2.3. The OOHW periods are further defined as OOHW Period 1 and 2, based on the CNVS[1].

Table 2.3: Assessment periods

Day/ Time	12am – 1am	1am – 2am	2am – 3am	3am – 4am	4am – 5am	5am – 6am	6am – 7am	7am – 8am	8am – 9am	9am – 10am	10am – 11am	11am – 12pm	12pm – 1pm	1pm – 2pm	2pm – 3pm	3pm – 4pm	4pm – 5pm	5pm – 6pm	6pm – 7pm	7pm – 8pm	8pm – 9pm	9pm – 10pm	10pm – 11pm	11pm – 12am
Monday to Friday										Standard construction Hours									OOHW Period 1					
Saturday																								
Sunday or Public Holiday	OOHW Period 2											OOHW Period 1							OOHW Period 2					

2.3 Construction traffic

When construction related traffic moves on the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as additional road traffic on public roads rather than as part of the construction site's activities.

Construction traffic associated with CMF worksite will access and exit the site via Gipps Street and the Great Western Highway. Gipps is a sub-arterial road, providing the connection between the Great Western Highway and local roads, with moderate traffic volume. The Great Western Highway is an arterial road with typically moderate to high traffic volume, including heavy vehicles. As noted in Table C1 in APPENDIX C, the worksite will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by:

- Delivery vehicles bringing raw materials, plant, and equipment to the site (typically standard hours, except for oversized deliveries)
- Concrete trucks bringing concrete to the site (typically standard hours)
- Spoil trucks removing spoil from the site (typically standard hours)

Construction traffic noise, related to the public road network, is addressed in Section 7.

2.4 Ground-borne noise

During the bulk excavation and tunnelling works at the CMF worksite, airborne noise is expected to be much higher than any ground-borne noise levels at the nearest sensitive receivers. On this basis, the potential impact of ground-borne noise is expected to be negligible and has not been addressed further in this DNVIS.

Ground-borne noise and vibration impacts from TBM tunnelling excavation is addressed in a separate DNVIS (TM008-02-07F01).

3 Nearest sensitive receivers

3.1 Land use survey

To assess and manage construction noise and vibration impact, a Land Use Survey has been undertaken to satisfy SSI 10051 CoA E37 and included in the Noise and Vibration CEMP Sub-plan (CNVMP). The Land Use Survey identifies existing land use and development within and around the CMF worksites, including a mix of residential, commercial, industrial and open space uses.

The Land Use Survey relevant to the CMF worksite are identified on an aerial photograph in APPENDIX B and was used in the preparation of this DNVIS. The land use revision date is shown in the top left corner of the drawing.

3.2 Residential receivers

Further to the Land Use Survey, residential areas have been divided into Noise Catchment Areas (NCAs) based on those established in the Environmental Impact Statement (EIS) [[3]] for the project [3]. All relevant residential sensitive receivers near the project are identified in APPENDIX B.

3.3 Other sensitive receivers

Additional to residential receivers, there are 'other' noise and vibration sensitive receivers (e.g. educational institutions, places of worship, recreational areas, etc.) surrounding the work sites that have been identified as part of the Land Use Survey. The nearest 'other' sensitive properties are identified in in APPENDIX B.

3.4 Commercial and industrial premises

All nearby commercial and industrial premises have been considered in this assessment and are identified in APPENDIX B.

3.5 Heritage receivers

Heritage receivers have been identified in EIS [3] and in the land use survey (Section 3.1) and have been considered in this assessment. There are no heritage receivers identified within 200 metres of the worksite (refer to Land Use Survey in APPENDIX B.

4 Construction noise and vibration objectives

Construction noise and vibration objectives are detailed in the CNVMP Section 6. A summary of the objectives as applicable to the worksite is provided in Table 4.1.

Table 4.1: Construction noise and vibration objectives

Impact	Relevant guideline	Construction noise/ vibration objective
Airborne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Construction noise management levels (NMLs) for residential receivers are based on long-term noise logging conducted on behalf of Sydney Metro to quantify ambient noise levels for the EIS [4]. During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) applies at all residential receivers. The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 2.2 of the CNVS. Receivers are considered 'noise affected' where construction noise levels are greater than the noise management levels identified in Table B.1 of APPENDIX B. A summary of these noise objectives and how they have been applied within this DNVIS is provided in Table 5.2. Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, a +5dB(A) correction must be added to the activity noise. Construction related activities that could exceed the NMLs shall be identified and managed in accordance with the Construction Noise and Vibration Management Sub-plan and with the noise and mitigation and management measures set out in Section 5.3.
Sleep disturbance	Noise Policy for Industry (EPA 2017) [7] CNVS [1]	Initial screening level: • $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or the • L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater, Where noise events are found to exceed the initial screening level, further analysis will be made to identify: • the likely number of events that might occur during the night assessment period, and • Whether events exceed an 'awakening reaction' level of 55 dB(A) L_{AFmax} (internal) that equates to NML of 65 dB(A) externally (assuming open windows).
Ground-borne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Receivers are considered 'ground-borne noise affected' where construction noise levels are greater than the noise management levels identified in Table B.2 of APPENDIX B.
Construction traffic	ICNG refers to the NSW Road Noise Policy (RNP) [7] CNVS [1]	Construction traffic impact initial screening test: • Traffic noise levels increase ≤ 2 dB(A) because of construction traffic Where traffic noise levels increase by more than 2 dB(A): • Freeway/arterial/sub-arterial road - 60 dB $L_{Aeq(15hour)}$ day/ 55 dB $L_{Aeq(9hour)}$ night • Existing local road - 5 dB $L_{Aeq(1hour)}$ day/ 50 dB $L_{Aeq(1hour)}$ night

Impact	Relevant guideline	Construction noise/ vibration objective
Vibration – disturbance to building occupants	NSW 'Environmental Noise Management Assessing Vibration: A Technical Guideline' (AVTG) [9] CNVS [1]	To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The initial screening test values are: • Critical areas - 0.28 mm/s (day or night) • Residential buildings - 0.56 mm/s (16h day); 0.40 mm/s (8h night) • Offices, schools, educational institutions and places of worship - 1.10 mm/s (day or night) • Workshops - 2.20 mm/s (day or night). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance as detailed in Section 6.4.6.1 of the CNVMP and Section 2.4 of the AVTG.
Vibration – structural damage to buildings	British Standard BS 7385-2:1993 'Evaluation and measurement for vibration in buildings'[12] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures [13] CNVS [1]	A conservative vibration damage screening level (peak component particle velocity) per receiver type is detailed in Section 2.4 of the CNVS and outlined below: • Reinforced or framed structures: 25.0 mm/s • Unreinforced or light framed structures: 7.5 mm/s. Heritage buildings and structures found to be structurally unsound (following inspection) would adopt a more conservative vibration damage screening level (peak component particle velocity): • Heritage structures (structurally unsound): 2.5 mm/s. Where the predicted and/or measured vibration is greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure will be completed to determine the applicable vibration limit.

5 Construction noise assessment

5.1 Noise prediction methodology

5.1.1 General modelling assumptions

Assessment of airborne noise impacts from activities associated with the construction works were determined by modelling the noise sources, receiver locations, topographical features, and possible noise mitigation measures using a Cadna-A computer noise model developed for this project. The model calculates the contribution of each noise source at identified sensitive receiver locations and allows for the prediction of the total noise from a site for the various stages of the construction works.

The noise prediction models consider:

- Location of noise sources varying from 0.5m to 2m above the ground depending on the equipment or plant in use;
- Receiver points at 1.5m above each floor level along all building facades. Predicted noise levels presented in APPENDIX D are the maximum noise levels for each building.
- Height of sources and receivers referenced to one metre digital ground contours for the site area and surrounding area;
- Sound Power Levels (L_w) of plant and equipment likely to be used during the various construction activities are included in Table C1 in APPENDIX C. L_{Aeq} sound power levels are identified for assessment against the construction NMLs. L_{A1} (or L_{Amax}) sound power levels are identified for sleep disturbance assessment.
- Activity timing, number of plant and hours of operation are included in Table C1 in APPENDIX C
- Separation distances between sources and receivers;
- Ground factors between sources and receivers varying from 1 for absorptive surfaces (e.g. park land) to 0 for reflective surfaces (e.g. water, concrete, paving);
- Attenuation from barriers (natural and purpose built), including temporary noise barriers/ construction hoarding identified in APPENDIX C.2.

Key details regarding the construction work locations, the likely plant and equipment, and hours of operation were informed by the Design and Construction Teams. This information is presented in APPENDIX C and formed the basis for all modelling assumptions used in this assessment. Noise levels were determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented in APPENDIX C.

Noise impacts during construction works have been predicted and compared to the noise management levels (NMLs) presented in APPENDIX B Table B1. The following sections present a summary of the

predicted noise impacts at each work area in terms of compliance with the NMLs. The colours in the table indicate whether receivers in the NCA comply with the NML and, where exceedance of the NML occurs, the perceived impact of the exceedance.

The construction activities included in this DNVIS are summarised in Table 5.1.

Table 5.1: Summary of construction activities

Activity (Table 2.1)	Aspect (APPENDIX C)[1]	Work area (APPENDIX B)	Scenario reference code (APPENDIX D)[1]
Ventilation Facility (including compound)	Piling + Shaft Excavation & construction – T[2]	Shaft (at surface)	PE - T[1]
	Piling + Shaft Excavation & construction – H[2]	Shaft (at surface)	PE - H[1]
Tunnelling and tunnel Support (including compound)	Ventilation fans	On the surface at the nozzle end	TS-V
	Tunnel Invert concrete pours	Top and bottom of shaft (at surface) and inside tunnel	TI

Notes:

1. All construction activity aspects listed below include 'General worksite and car park', as per Table C1 in APPENDIX C

2. 'T' refers to typical works, i.e. not including high noise impact plants, denoted by 'HN' in Table C1 in APPENDIX C. 'H' refers to high impact works, i.e. including high noise impact plants.

The noise predictions in this report represent a realistic worst-case scenario when construction occurs at a works location close to residences and other sensitive receivers. It is highly unlikely that the activities above will occur concurrently at each worksite. In the instance that this occurs, the maximum increase in the predicted noise levels is 2-3 dB(A). At each receiver, noise levels will vary during the construction period based on:

- the position of equipment within the worksite;
- the distance to the receiver;
- the construction activities being undertaken;
- the noise levels of plant items and equipment
- temporary noise barriers/ construction hoarding/ acoustic enclosures identified in APPENDIX C.2.

Actual noise levels will often be less than the predicted levels presented in this report.

5.2 Predicted noise levels

Noise impacts during construction works have been predicted and compared to the noise management levels (NMLs). A receiver is considered construction noise affected when the predicted construction noise level is above the NML. Table 5.3 and Table 5.4 present a summary of the number of residential receivers and 'other sensitive receivers (respectively) likely to be noise affected by the proposed

activities. The tables are colour coded to indicate how much the predicted noise level is above the NML and the corresponding perceived noise impact, based on the CNVS, as noted in Table 5.2.

Table 5.2: Key to the predicted construction noise results tables

Assessment	Time of day	Key			
$L_{Aeq(15min)}$	Standard hours[1] or Outside standard hours	0-10 dB(A) above NML (green)	11-20 dB(A) above NML (yellow)	21-30 dB(A) above NML (orange)	>30 dB(A) above NML (purple)
Sleep disturbance	Night only	$L_{Aeq,15min}$ above 40 dB(A) or RBL plus 5 dB, whichever is the greater (yellow)		L_{Amax} above 52 dB(A) or RBL plus 15 dB, whichever is the greater (purple)	

Notes: 1. Highly noise affected (HNA) which is greater than 75dB(A) during standard construction hours is shown with **Bold** text and applies to residential receiver buildings only.

Table 5.3 summarises the number of construction noise affected residential receivers (i.e. receivers where predicted L_{Aeq} noise levels construction works are above the NML) and the likely perceived noise impact. Table 5.4 presents the number of construction noise affected other sensitive receivers. Detailed predicted L_{Aeq} noise levels for all receivers in each NCA are presented in Table D.1 of APPENDIX D.

The prediction results presented are representative of noise levels during the works with the temporary noise barriers/ construction hoarding identified in APPENDIX C.2.

5.2.1 Standard construction hours

The results summarised in Table 5.3 and Table 5.4 show that nearby residential receivers are likely to be construction noise affected by bulk excavation and tunnelling works during standard construction hours. The highest impacts are likely to occur during shaft excavation works at the surface level of the shaft, where receivers are closest to the works. A noise barrier is proposed on the western site boundary, as shown in Figure C1 in APPENDIX C. The barrier provides shielding to the nearest residential receivers to the west of the Gipps Street, reducing noise levels below the 'highly noise affected' level of 75 d(A) for all activities. Note that predictions are based on the worst-case scenario during the peak construction period and at surface level. Actual noise levels are likely to be lower than the predicted noise levels.

All works associated with the bulk excavation and tunnelling works are predicted to be below the highly noise affected level of $L_{Aeq(15min)}$ 75 dB(A) at all residential receivers. The predicted noise levels are below the noise level predictions in the EIS because more detail regarding the site layout, site hoardings and noise walls and construction methodologies are known at this stage of the design.

Table 5.3: Number of receiver buildings over the noise management level (all NCAs) – residential receivers

Work area	Construction activity	Assessment reference	Highly noise affected[3]	Day (standard hours)				Day (outside standard hours)				Evening				Night				Sleep disturbance	
			L_{Aeq}	L_{Aeq}				L_{Aeq}				L_{Aeq}				L_{Aeq}				L_{Aeq}	L_{Amax}
			> 75 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	> 40 or RBL+5 dB(A)	> 52 or RBL+15 dB(A)
Claremont Meadows Ventilation Facility (CMF)	Piling + Shaft Excavation (Typical)	PE-T	0	278	25	0	0	-[1]	-[1]	-[1]	-[1]	1	0	0	0	1	0	0	0	-[1]	-[1]
	Piling + Shaft Excavation (High Impact)	PE-H	0	808	115	1	0	-[1]	-[1]	-[1]	-[1]	1	0	0	0	1	0	0	0	-[1]	-[1]
	Shaft Excavation + Tunnel Invert (Typical)	EI-T	0	188	10	0	0	1	0	0	0	2	0	0	0	2	0	0	0	1	0
	Shaft Excavation + Tunnel Invert (High Impact)	EI-H	0	766	110	1	0	1	0	0	0	2	0	0	0	2	0	0	0	1	0
	Tunnel Invert	TI	0	0	0	0	0	1	0	0	0	2	0	0	0	2	0	0	0	1	0

Note:
1. No work is proposed outside standard construction hours for this work activity, with the exception of the water treatment plant which operates 24/7.
2. Construction noise level cells are shaded based upon the predicted worst case NML exceedance in accordance with the key presented in Table 5.2.
3. Highly noise affected applies to residential receivers, as per the ICNG.

Table 5.4: Number of other sensitive receivers over the noise management levels (all NCAs)

Stage	Construction activity	Assessment reference	Commercial				Childcare				Educational				Recreational				Places of worship				Hotel/Motel/ Hostel				Industrial			
			1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)
Claremont Meadows Ventilation Facility (CMF)	Piling + Shaft Excavation (Typical)	PE-T	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Piling + Shaft Excavation (High Impact)	PE-H	3	0	0	0	2	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Shaft Excavation + Tunnel Invert (Typical)	EI-T	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Shaft Excavation + Tunnel Invert (High Impact)	EI-H	3	0	0	0	2	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tunnel Invert	TI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note:
1. Commercial, industrial, recreational and other sensitive receivers have been assessed against the respective NMLs, and exceedances have been presented in the count table.
2. Impacts only applicable when facility is in use.
3. Highly noise affected does not apply to OSRs, as per the ICNG.

5.2.2 Out of hours work

Bulk excavation works (including piling works and shaft excavation) assessed in this DNVIS are not scheduled to occur outside standard construction hours.

The water treatment plant will require 24 hour operation prior to and during SBT works. The water treatment plant will be acoustically treated as noted in Table C2 in APPENDIX C to ensure noise levels during its operation are below the NMLs.

Concrete pours for the tunnel invert would occur outside standard construction hours, provided all reasonable and feasible mitigation measures have been implemented to reduce noise levels with the aim of achieving the NML. Noise mitigation and management measures to manage the concrete pours are outlined in Section 5.3 and in APPENDIX C. The results summarised in Table 5.3 show that up to two (2) residential receivers are likely to be construction noise affected by out-of-hours tunnelling works. The main contributors to noise above the NML are concrete trucks required as part of the ground support work for the tunnelling. The predicted noise levels for the OOHW exceedances are within 2-4 dB of the NML during the night period and will require verification noise monitoring as described in Table 5.6. Measures for managing construction noise impacts are described in Section 5.3 and in APPENDIX C.

5.2.3 Sleep disturbance

Bulk excavation works and tunnelling works assessed in this DNVIS are not scheduled to occur outside standard construction hours, with the exception of the 24 hour operation of the water treatment facility and concrete pours for the tunnel invert. As noted above, the water treatment plant will be acoustically treated to ensure noise emission from its operation at night would be below the NMLs for sleep disturbance.

The main contributors to noise above the $L_{Aeq(15min)}$ sleep disturbance NML are the concrete trucks delivering concrete to the concrete drop shed adjacent to the shaft. Predicted noise levels indicate there is one receiver where $L_{Aeq(15min)}$ noise levels are within 2 dB(A) of the sleep disturbance NML. Predicted L_{AMax} noise levels are below the L_{AMax} screening level. The likelihood of concrete trucks on site at night causing sleep disturbance is considered low to negligible. Nonetheless, truck entry and exit from the worksite will be managed to reduce the likelihood of generating short-term, high impact noise that may cause awakening. Measurements on previous worksites with managed exits for heavy vehicles found that there are minimal high noise events as the truck departs site. Actual maximum noise levels generated on site are therefore likely to be much lower than the predicted noise impacts.

5.3 Noise mitigation and management

5.3.1 High noise impact activities

Bulk excavation and tunnelling works at the Claremont Meadows ventilation facility worksite have been assessed in this DNVIS. Works during standard construction hours will be managed to reduce noise

impacts to nearby receivers. Potential impact from high noise impact activities has been minimised through the implementation of noise mitigation measures, including construction hoarding and noise barriers. The predicted noise levels presented in Table 5.3 indicate that there are no highly noise affected residential receivers for all works. It would not be reasonable to implement at-property treatment, as required by CoA E49.

Respite from short term exposure to activities resulting in high noise impact will be provided by limiting highly noise intensive activities as follows to satisfy CoA E39:

- Between the hours of 8:00am to 6:00pm Monday to Friday
- Between the hours of 8:00am to 1:00pm Saturday, and
- In continuous blocks not exceeding three hours each with a minimum respite from those activities or works of not less than one hour.

For the purposes of this requirement 'continuous' includes any period during which there is less than one-hour respite between ceasing and recommencing any of the work that is subject to this requirement.

5.3.2 Consultation with affected receivers

CPBG has commenced works and will continue to consult with potentially affected stakeholders including business and residential receivers regarding specific mitigation and management measures applicable to the bulk excavation and tunnelling works at Claremont Meadows. A summary of the consultation program is provided below:

- Community information sessions have been held by Sydney Metro and CPBG JV to discuss site establishment, utility and tunnelling works. These sessions will continue for the project duration.
- A full page advertisement was published in the Western Weekender on 2 December 2022, notifying of upcoming tunnelling works.
- Consultation with noise affected receivers identified in APPENDIX D (Table D.3) to ensure additional mitigation measures are provided (if required, refer to Section 5.3.4).
- Residents and businesses within the 50m of the tunnel alignment have received a Property Condition Survey fact sheet and survey offer. Where survey offers have been accepted, Property Condition Surveys have been carried out and copies provided to property owners. Residents and businesses who have accepted a Pre-construction Property Survey will be offered a Post-construction Property Survey.
- Engagement with residents within 60 metres of tunnel alignment to keep them informed of tunnelling progress.
- Meetings with stakeholders upon request.
- Proactive noise monitoring and in response to complaints.

Community will be regularly updated on the progress of the project as described in the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002). Prior to the commencement of site establishment activities, receivers identified in APPENDIX D.3 will be notified to advise that noise from the works may at times be audible. A community construction update will be sent every three months thereafter, to notify all potentially impacted receivers of the nature of the upcoming works to be carried out, the expected noise levels and duration, as well as be given appropriate enquiries and complaints contact details (see Section 5.3.7). The community construction update will also include a schedule of likely OOHW for a period of no less than three (3) months..

In addition to the above, no out-of-hours work will be permitted where sensitive land user(s) may be noise affected unless an OOHW notification has been issued to potentially affected receivers at least seven (7) days prior. This notification will detail the following to satisfy the requirements of Conditions E47 and E57:

- A description of the potential work, location and duration of the OOHW;
- The noise characteristics and likely noise levels of the work; and
- Likely mitigation and management measures which aim to achieve the relevant NMLs under condition E43
- Contact details for the relevant CPBG representative to be contacted to provide feedback on appropriate respite periods or mitigation measures they may require for their specific circumstances.

Respite periods would be any combination of days or hours where out-of-hours work would not be more than 5 dB(A) above the RBL at any residence.

The outcomes of any community consultation undertaken in accordance with Condition E57 (i.e., regarding respite periods), the identified respite periods and the scheduling of the likely OOHW will be documented in a register and provided to Sydney Metro prior to commencing any relevant OOHW. Sydney Metro will be responsible for submitting this information to the ER, EPA and Planning Secretary.

Any specific mitigations measures identified during consultation will be documented within this DNVIS where required.

5.3.3 Noise control and management measures

Noise mitigation and management measures to reduce potential noise impacts will be implemented during the bulk excavation and tunnelling works and will be in place for the duration of construction, where reasonable and feasible. In accordance with the ICNG and consistent with the CNVS, feasible noise mitigation measures are those work practices or measures to reduce noise that are capable of being put into practice or of being engineered and are practical to build given project constraints such as safety and maintenance requirements.

Reasonable noise mitigation measures are those feasible noise mitigation measures that are considered reasonable in the circumstances, based on a judgement that the overall noise benefits outweigh the overall adverse social economic and environmental effects, including the cost of measure. To make such a judgement, consideration is to be given to noise level impacts, noise mitigation benefits, cost effectiveness of noise mitigation and community views.

Table 5.5 outlines site noise control measures that would be implemented on site during the bulk excavation and tunnelling works, where feasible and reasonable.

Table 5.5 Site noise control measures

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At source control measures							
Site planning and layout	Locate noise-generating activities away from sensitive receivers. Plan traffic flow, parking, loading/unloading, and other vehicle movements to keep vehicles away from sensitive receivers where possible and to minimise reversing movements.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	The laydown area has been selected to be as far away from sensitive receivers while still servicing the works. Works will be undertaken in the shaft, which will limit noise impacts.
Noise control kits	Plant that is brought to site for works should meet the sound power limits identified in this assessment. Where plant are above limits then the plant may require installation of 'noise control kits' to comply with the noise limits in this assessment. Such 'noise control kits' comprise: • high performance 'residential-grade' exhaust mufflers, • additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and • air intake and discharge silencers / louvres.	This measure could be feasibly implemented. Subject to availability for each equipment item.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Equipment will be assessed on a case-by-case basis	Yes	Yes	The need to fit 'noise control kits' onto the identified plant, will be confirmed once each plant item is tested prior to its regular use on site.
Limit equipment in use	Only the equipment necessary during each stage of the works will be used.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Outweighs the identified social, economic and environmental effects. Cost effectiveness to be determined on a case-by-case basis.	Yes	Yes	Excess equipment will be avoided where it is not needed for the works and where it is reasonable to do without it.
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited as outlined in this assessment	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. Verification monitoring to confirm OOH impacts	Yes	Yes	OOHW will be managed to ensure construction noise levels are within NMLs, where feasible and reasonable
Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Equipment that is not directly needed for works at a given time will be switched off.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Equipment selection	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.	This measure could be feasibly implemented. To be determined on a case-by-case basis.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Routine task for project team.	Yes	Yes	Project team shall review plant and equipment on a case-by-case basis and find opportunities to use items with lower noise/vibration impacts.
Truck movements	Where practicable, avoid the use of park air brakes at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site and avoid vigorous slamming of truck doors.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Drivers will be reminded to drive responsibly on-site.
Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all vehicles & mobile plant regularly used on site and on all vehicles & mobile plant required for OOHW.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Project team will prioritise use of non-tonal reversing alarms on equipment.
Path mitigation measures							
Noise barriers or temporary noise screens	Erection of noise barriers in strategic locations to shield sensitive receivers from noisy activities. Barriers may be permanent or temporary, depending on the duration and location of noisy works.	This measure could be feasibly implemented.	Yes	- Potential benefit of 5-10 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Noise barriers and construction hoarding to be installed along the construction boundary as detailed in Table C3 and Figure C1 in APPENDIX C of the DNVIS.
Enclosures	Construction of an enclosure to contain key noise-generating activities and/or items. Sound insulation and absorption performance shall be specified by a suitably qualified person (acoustic engineer).	This measure could be feasibly implemented.	Yes	- Potential benefit of 10-20 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. Acoustic enclosures required to allow OOHW to meet NMLs	Yes	Yes	Acoustic enclosures as detailed in Table C4 and Figure C1 in APPENDIX C of the DNVIS.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At receiver							
At-property treatments	Design and installation of architectural treatments to sensitive receiver buildings to reduce internal noise levels to key rooms.	This measure could be feasibly implemented. At property treatments to be confirmed subject to verification monitoring	Yes	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Eligibility considered for OOHW residual impacts, subject to verification monitoring.	Yes	TBC	Based on predicted standard hours noise levels at-property treatments have not been nominated for highly noise affected receivers (CoA E49) and will be subject to verification monitoring with regard to OOHW for the tunnel invert works.
Property acquisition	Purchase of sensitive receiver buildings by the project.	Not relevant to this project.	No	- Insufficient noise reduction achieved at an acceptable number of receivers. - Not cost effective. - Does not outweigh potential adverse effects - excessive cost to the project, unnecessary adverse impact associated with permanently relocating residents	No	No	Property acquisition is not a feasible or reasonable mitigation measure for these works.
Noise management measures							
Site inductions & Toolbox Talks	All employees, contractors and subcontractors will receive a Project induction. The environmental component may be covered in toolboxes and should include (but is not limited to): • location of nearest sensitive receivers • relevant project specific and standard noise and vibration mitigation measures; • permitted hours of work; • OOHW Procedure and Form • construction employee parking areas.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Routine task for project team.	Yes	Yes	Inductions and toolbox talks will continue to be conducted for the project.
Community consultation - disseminating information	Provide information to community of construction activity and potential impacts.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Routine task for project team.	Yes	Yes	Updates will be distributed regularly for the duration of the project.
Community consultation - active communication with nearby sensitive receivers	Seek feedback from community to identify more sensitive times of the day, or particularly sensitive days. An example is identifying when student exams (such as Higher School Certificate exams, end of semester exams) will take place.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Routine task for project team.	Yes	Yes	Project team shall proactively contact nearby sensitive receivers, particularly those which may have special requirements (e.g. recording studios).

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Behavioural practices	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.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Routine task for project team.	Yes	Yes	Project team shall monitor site behaviour and advise supervisors if issues arise or additional behavioural practices are needed.
Noise monitoring	Noise monitoring to be conducted at key locations to quantify noise impacts at sensitive receivers.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers.	Yes	Yes	Noise monitoring shall be carried out as detailed in this assessment, in accordance with the CNVMP.
Update Construction Environmental Management Plans	Regular updates of the CEMP to account for changes in noise and vibration management strategies.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Can be reasonably undertaken by project team where required.	Yes	Yes	Updates to the CEMP, including the CNVMP, will be carried out where required, with the ER's approval, and will be reviewed regularly.
Respite coordination	Consult with proponents of other construction works in the vicinity of the worksite and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers (e.g. aligning respite evenings).	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Respite coordination shall be conducted with neighbouring projects.
Implement additional mitigation measures	Identify and implement additional mitigation measures outlined in this assessment.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. Consistency with CNVS and CNVMP	Yes	Yes	Additional mitigation measures to be identified on a case-by-case basis and with consideration of the standard mitigation and management measures outlined in this report.

5.3.4 Additional noise mitigation measures

Section 5 of the CNVS directs that in instances where, after the application of all reasonable and feasible mitigation and management measures (refer to Section 5.3.2), the $L_{Aeq(15minute)}$ airborne construction noise levels are still predicted to exceed the NMLs, additional airborne noise management measures can be applied to further limit the risk of annoyance from construction noise. The CNVS suggests the Project should consider implementing additional mitigation measures such as:

- **Alternative accommodation** (**AA**) options may be provided for residents living close to construction works that are likely to incur unreasonably high impacts over an extended period of time (more than 2 consecutive days). Alternative accommodation will be determined on a case-by-case basis.
- **Monitoring** (**M**) of noise or vibration may be conducted at the affected receiver(s) or a nominated representative location where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration objectives. 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.
- **Individual briefings** (**IB**) 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.
- **Letter box drops** (**LB**) in the form of a newsletter produced and distributed to the local community via letterbox drop or email via the project mailing list. The newsletter will provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community.
- **Project specific respite offers** (**RO**) provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
- **Phone calls and emails** (**PC**) detailing relevant information about construction works would be made to identified noise or vibration affected stakeholders within 7 days of proposed work to provide tailored advice and the opportunity for stakeholders to provide comments on the proposed work and specific needs etc.
- **Specific notifications** (**SN**) 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.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 5-1.

Figure 5-1: Additional airborne noise mitigation measures

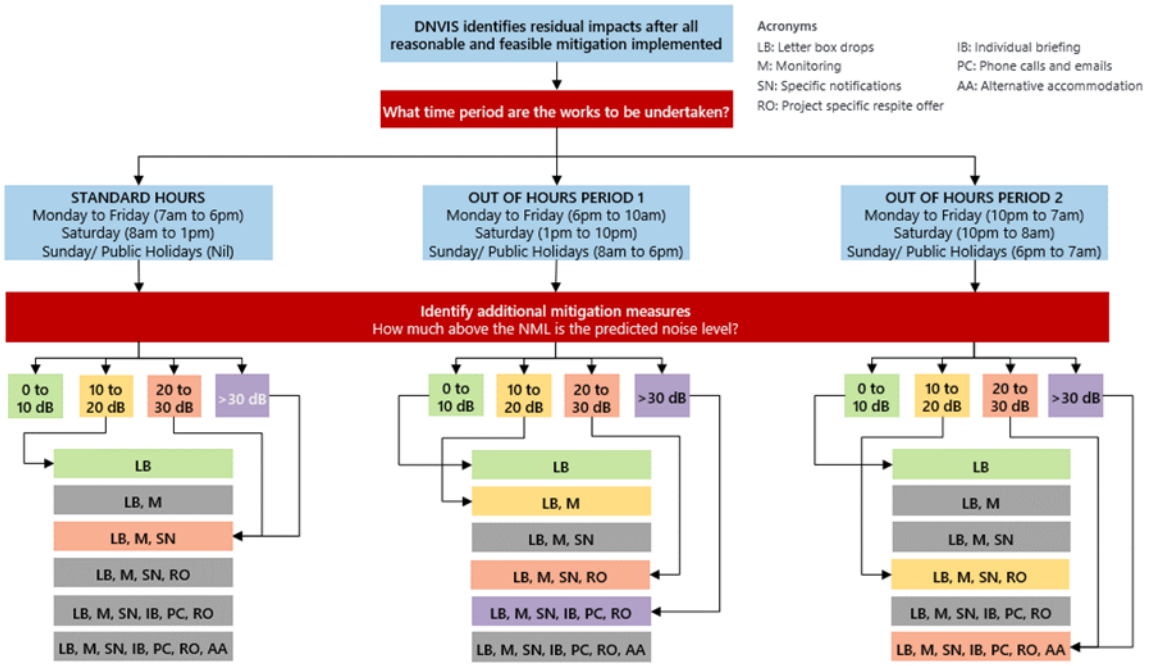


Figure 5-1 presents a summary of the additional noise mitigation measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, construction noise levels still above the NMLs. It is noted that none of the activities within the scope of this DNVIS would result in any noise impacts at receivers identified in Appendix B of the Infrastructure Approval, as such, the required at-property treatment triggered by Conditions E49 and E51 does not apply.

5.3.5 Managing site specific activities and cumulative noise impacts (Gatewave)

This DNVIS has established the overall impacts associated with the proposed works. A 3D construction noise and vibration management tool (Gatewave, www.gatewave.com.au) has been developed specifically for the SBT Works to allow specific work areas and activities to be assessed as construction works progress. It also allows cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, to be assessed and managed in accordance with relevant CoA.

Gatewave will be used regularly to plan, assess and manage works progressively.

Gatewave incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict construction noise in accordance with the International Standard ISO 9613-2:1996 implementing quality standard ISO 17534-1:2015. All sensitive receivers identified by the land use survey are integrated into the Gatewave tool.

5.3.6 Real-time and attended noise monitoring

To provide real time noise monitoring data to assess and confirm whether noise emission from site is within the predicted noise levels identified in this DNVIS and to satisfy CoA C15(d), long-term, unattended noise monitoring will occur at a fixed location at the Claremont Meadows Ventilation Facility worksite.

Attended noise monitoring is to be undertaken to verify that noise levels resulting from construction works are in accordance with the levels predicted in this report, subject to obtaining the property owner/occupier's consent to access the property (where required). Noise monitoring will be completed in publicly accessible areas on or near the nominated receivers, typically at ground floor level. Where, following community consultation, specific sensitive receivers are identified for additional monitoring, access to the property will be sought through the Stakeholder and Community Relations team.

Table 5.6: Nominated verification monitoring locations

Type of monitoring	NCA	Nominated receiver address
Fixed, real-time	On worksite	E 292050; N 6261250, to be confirmed subject to suitability of location on site
Attended	NCA04	[redacted]
Attended	NCA06	[redacted]
Attended	NCA06	[redacted]
Attended	NCA06	[redacted]

APPENDIX D.3 identifies the activities where monitoring should be carried out for each NCA.

Noise monitoring should follow the procedures outlined in the Noise and Vibration Monitoring Program (refer to Annexure A of the CNVMP). Note that monitoring at all properties may be undertaken from the property boundary to limit any inconvenience to property owners. Verification monitoring is required at 1 Water Street, Werrington and 5 Dolphin Close, Claremont Meadows, as these were identified as receivers where the predicted noise levels exceeded the OOH NMLs. Monitoring should be undertaken at a minimum of two of the most affected locations nominated in Table 5.6.

5.3.7 Complaints handling

Noise complaints received and responded to will be managed in accordance with the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002).

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

6 Construction vibration impacts

6.1 Minimum working distances for vibration intensive plant

From the plant and equipment listed in APPENDIX C, the site establishment activities with dominant vibration generating plant and equipment include:

Table 6.1: CEMP vibration intensive activities/ works

Activity	Aspect	Vibration intensive plant?
Compound	General worksite and car park	Nil
Ventilation Facility	Piling activities	Yes
	Shaft Excavation & Construction	Yes
Option Tunnel Invert	Tunnel Invert	Nil

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure. The recommended minimum working distances for vibration intensive plant in Table 6.2 are taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to the Project works as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Table 6.2: Minimum working distances (m) for continuous vibration

Plant item	Minimum working distance (m)		
	Pneumatic Hammer	Piling rig (bored)	Excavator (<35T) with rockhammer attachment
Cosmetic damage to structures			
Reinforced or frame non-heritage structures (Line 1)[1]	5[3]	5	5
Unreinforced or light framed non-heritage structures (Line 2)[1]	5[3]	5	5
Structurally unsound heritage structures[2]	5[3]	5	10
Human annoyance			
Critical areas[4,7]	15	20	40
Residences – Day[5]	15	15	25
Residences – Night[5]	20	15	30
Offices[6,7]	10	10	20
Workshops[7]	5	10	15

Notes: 1. Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.

2. In accordance with NVMP, a site inspection should determine whether a heritage structure is structurally unsound.

3. Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Pneumatic hammers likely to have minimum working distances smaller than 5 m.

4. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.

5. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.

6. Examples include offices, schools, educational institutions and place of worship.

7. Applicable when in use.

Site specific minimum working distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the recommended minimum working distances for cosmetic damage (Table 6.2).

6.2 Vibration assessment

6.2.1 Structural damage

The numbers of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6.3. More detailed results are presented in APPENDIX E. The figures in APPENDIX E identify the minimum working distances for vibration over aerial photographs that also show the work areas and the land uses.

Table 6.3: Number of buildings within minimum working distances for cosmetic damage

Worksite	Plant item	Number of buildings[1]	
		Screening criteria for non-heritage structures	Screening criteria for heritage structures
CMF	Pneumatic Hammer	0	0
	Piling rig (bored)	0	0
	Excavator (<35T) with rock hammer attachment	0	0

Note: 1. Site inspection should determine structural conditions of all potentially vibration affected buildings.

No sensitive structures are expected to be within the MWD for cosmetic damage during the vibration intensive works during bulk excavation and tunnelling works at the Claremont Meadows worksite. As a result, the risk of structural damage is considered negligible for these construction worksites.

Where plant is required to operate within minimum working distances, vibration monitoring is recommended to determine site specific minimum working distances and/or verify that vibration levels achieve compliance with the structural damage objectives.

If the monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels should be considered.

6.2.1.1 Heritage structures at Claremont Meadows

There are no potentially impacted heritage structures by the bulk excavation and tunnelling works at Claremont Meadows.

6.2.2 Human annoyance

The assessing vibration guideline [7] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control) and assume that the vibration has the potential to damage their building or contents.

However, it is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

At properties near the worksite, it is possible that the nearest receivers will be able to feel vibration levels when vibration-generating equipment is being utilised. Properties where vibration levels may be above the vibration disturbance goals in Table 6.2 and there is a probability of adverse comment are shown in Table 6.4. It is important to note that human comfort levels are much lower than vibration levels likely to result in property damage and people therefore may be disturbed by vibration with no potential to result in property damage. More detailed results are presented in APPENDIX E.

Table 6.4: Number of buildings within minimum working distances for human annoyance

Plant items	Worksite	Critical areas[1,4]	Residences[5]		Offices [3,4]	Workshop[4]
			Day[2]	Night[2]		
Pneumatic Hammer Piling rig (bored) Excavator (<35T) with rock hammer attachment	Claremont Meadows Ventilation Facility	0	0	0	0	0

Notes:
1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
2. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
3. Examples include offices, schools, educational institutions and place of worship.
4. Applicable when in use.
5. Hotels and childcare centres are included in the residence category.
6. Most vibration intensive plant (i.e. Excavator (<35T) with rock hammer attachment) has been used to estimate the maximum number of buildings within MWD for human annoyance.

As can be noted from the table above, there are no properties that may be exposed to vibration above the screening limit for human annoyance. The above assessment is based on vibration-generating equipment being operating at the closest location to nearby receivers. When vibration-generating equipment operates further from the closest point, the predicted vibration levels will reduce along with the probability of adverse comment.

Attended vibration measurements are proposed to be carried out proactively and in response to vibration complaints. If measurement results indicate events above the vibration objectives for human annoyance, vibration control and management measures will be provided to reduce vibration impact (see Section 6.3).

After applying all feasible and reasonable vibration mitigation measures, if vibration monitoring still identifies that measured vibration levels are above the relevant vibration criteria for human annoyance, appropriate additional mitigation measures should be considered (see Section 6.3.3).

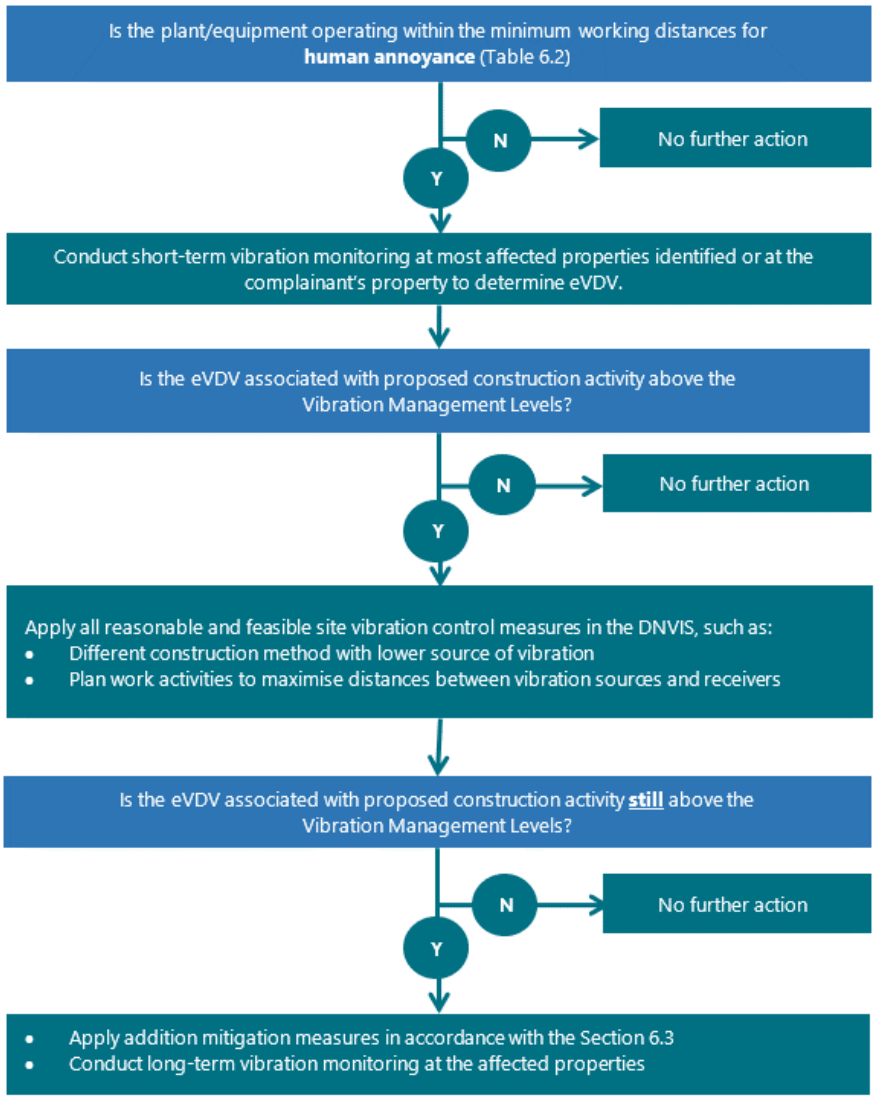
6.3 Vibration mitigation measures

6.3.1 Management and mitigation procedures

The procedure to manage and minimise potential structural damage impacts is presented in the Vibration Management Procedure Form.

The procedure to manage and minimise potential human annoyance vibration impacts is presented in Figure 6-1.

Figure 6-1: Management protocol for human annoyance impact



6.3.2 Vibration control and management measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort vibration and structural damage limits.

Table 6.5 Site vibration control measures

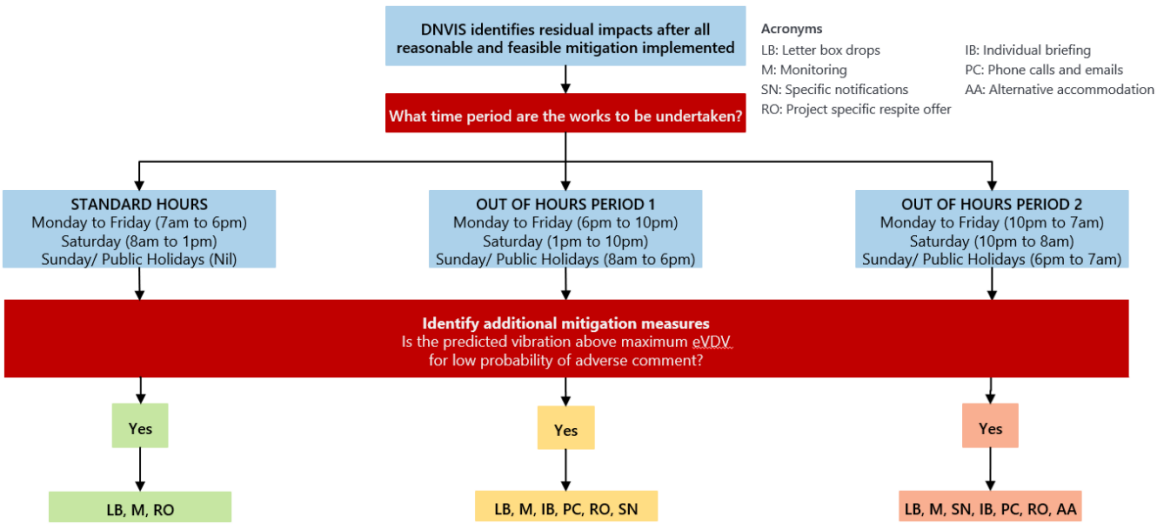
Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Construction Planning							
Building condition surveys	Undertake building dilapidation surveys on all buildings located at least within the minimum working distances established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).	This measure could be feasibly implemented. It is noted that no buildings within cosmetic damage MWDs have been identified.	Yes	Not cost effective. Does not outweigh potential adverse effects - economic cost not justified	No	No	No buildings have been identified within the MWD for cosmetic damage. As the MWDs in this assessment are conservative, the risk of cosmetic damage is considered low. Therefore it is not considered reasonable to conduct building condition surveys.
Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Updates will be distributed regularly for the duration of the project.
Equipment selection/ construction method	Use less vibration emitting construction methods where feasible & reasonable, for example: - Conduct impact piling at typical setting rather than high setting where possible	This measure could be feasibly implemented. It is noted that no receivers withing human annoyance MWDs have been identified.	Yes	Sufficient vibration reduction could be achieved at enough receivers. Not cost effective. Does not outweigh potential adverse effects - economic cost not justified	No	No	No receivers have been identified withing the MWD for human annoyance. As the MWDs in this assessment are conservative, exceeding the human annoyance criteria is considered low. Therefore it is not considered reasonable to change vibration emitting construction methods.
Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.	This measure could be feasibly implemented.	Yes	Sufficient vibration reduction could be achieved at enough receivers.	Yes	Yes	The laydown area has been selected to be as far away from sensitive receivers while still servicing the works. All works are outside the MWDs.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Complaints Management							
Construction Complaints Management System	Complaints would be managed in accordance with the Community Communication Strategy. Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of minimum working distances as mentioned above.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Implemented as part of the project.

6.3.3 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6.5, if vibration monitoring at representative locations still exceeds relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, based on the CNVS [1], presented in Figure 6-2, should be provided.

Figure 6-2: Additional vibration mitigation measures



6.3.4 Vibration monitoring

Attended vibration monitoring is to be undertaken to determine and verify site specific minimum working distances for cosmetic damage and human annoyance. Additional monitoring may be required in response to vibration complaints.

6.3.5 Complaints handling

Vibration complaints received and responded to will be managed in accordance with the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002).

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

7 Construction traffic noise assessment

7.1 Traffic sources

All heavy vehicles will access the Claremont Meadows worksite via Gipps Street, having arrived via the Great Western Highway. Heavy vehicles will depart via Gipps Street then onto the Great Western Highway.

Traffic noise impacts are not considered on Gipps Street as there are no residential receivers along the truck route. Traffic noise impacts have been calculated along the Great Western Highway as there are residential receivers along the heavy vehicle route. Note that there only limited proposed construction traffic during the night-time period.

Details of projected heavy vehicle movements associated with the construction works were provided by CPBG (See Table C.1 in APPENDIX C) and are further detailed in the Claremont Meadows Construction Traffic Management Plan (SMWSASBT-CPG-OHE-SF150-TF-PLN-000001).

Table 7.1: Summary of construction generated traffic based on Table C.1 in APPENDIX C

Activity/ Aspect	Vehicle type	Construction traffic movements – Total	
		Day (7am to 10pm)	Night (10pm to 7am)
Compound (Staff and deliveries)	Light vehicles	60 (30 per hour*)	-
Ventilation Facility (D-wall Plant)	Concrete trucks	150 (10 per hour)	-
Ventilation Facility (Shaft Excavation and Construction)	Delivery trucks	45 (3 per hour)	-
	Truck and Dog	75 (5 per hour)	-
Option Tunnel Invert	Concrete trucks	60 (4 per hour)	36 (4 per hour)
Peak construction	**Light vehicles**	**60 (30 per hour*)**	**-**
	Heavy vehicles	**330 (17 per hour)**	**36 (4 per hour)**
Off-Peak construction	**Light vehicles**	**60 (30 per hour*)**	**-**
	Heavy vehicles	**210 (13 per hour)**	**36 (4 per hour)**

NOTES:

* Busiest 1 hour before/after shift (6am to 7am; 6pm to 7pm)

OSD = Oversized deliveries that are restricted by the road authority from travelling on public roads during standard construction hours.

To predict road traffic noise levels on the existing road network, the most recent available traffic data for each road forming part of the site access route was obtained by reviewing the EIS Technical Paper 2: Noise and vibration [4]. Base traffic volumes based on the EIS are detailed in Table 7.1.

Table 7.2: Summary of traffic volumes – base (2023/2024) traffic volumes and base traffic volumes with construction traffic

Road	RNP Classification	Distance to nearest representative residential receiver	Posted speed limit	2023/2024 Base				2023/2024 Base + Construction traffic			
				Day (7am to 10pm)		Night (10pm to 7am)		Day (7am to 10pm)		Night (10pm to 7am)	
				Total vehicles	HV%	Total vehicles	HV%	Total vehicles	HV%	Total vehicles	HV%
Peak construction											
Great Western Highway (east of Gipps Street)	Arterial	200 m	80 km/h	44708	3%	7278	2%	45098	4%	7314	2%
Great Western Highway (west of Gipps Street)	Arterial	25 m	80 km/h	43257	3%	7042	2%	43647	4%	7078	2%
Gipps Street/ Kent Road (north of M4)*	Sub-arterial	15 m	80 km/h	21629	6%	3817	3%	22019	7%	3853	4%
Off-Peak construction											
Great Western Highway (east of Gipps Street)	Arterial	200 m	80 km/h	44708	3%	7278	2%	44978	3%	7314	2%
Great Western Highway (west of Gipps Street)	Arterial	25 m	80 km/h	43257	3%	7042	2%	43527	3%	7078	2%
Gipps Street/ Kent Road (north of M4)*	Sub-arterial	15 m	80 km/h	21629	6%	3817	3%	21899	7%	3853	4%

NOTES: * Existing roadside noise barrier on western side of Gipps Street, approx. 3.5 metres high

Table 7.3: Predicted construction traffic noise impacts – base (2023/2024) traffic volumes and base traffic volumes with construction traffic

Road	RNP Classification	Day (7am to 10pm)			Night (10pm to 7am)		
		Metric	2023/2024 Base	Base + Construction	Metric	2023/2024 Base	Base + Construction
Peak construction							
Great Western Highway (east of Gipps Street)	Arterial	$L_{Aeq(15\ hour)}$	59	59	$L_{Aeq(9\ hour)}$	51	51
Great Western Highway (west of Gipps Street)	Arterial	$L_{Aeq(15\ hour)}$	69	69	$L_{Aeq(9\ hour)}$	69	69
Gipps Street/ Kent Road (north of M4)*	Sub-arterial	$L_{Aeq(15\ hour)}$	69	70	$L_{Aeq(9\ hour)}$	61	62
Off-peak construction							
Great Western Highway (east of Gipps Street)	Arterial	$L_{Aeq(15\ hour)}$	59	59	$L_{Aeq(9\ hour)}$	51	51
Great Western Highway (west of Gipps Street)	Arterial	$L_{Aeq(15\ hour)}$	69	69	$L_{Aeq(9\ hour)}$	69	69
Gipps Street/ Kent Road (north of M4)*	Sub-arterial	$L_{Aeq(15\ hour)}$	69	70	$L_{Aeq(9\ hour)}$	61	62

NOTES: * Existing roadside noise barrier on western side of Gipps Street, approx. 3.5 metres high

Bold text indicates more than 2 dB(A) increase in road traffic noise levels as a result of construction traffic.

7.2 Predicted construction traffic noise

The potential impact of construction road traffic noise to nearby residential receivers has been estimated using the United Kingdom Department of Environment's 'Calculation of Road Traffic Noise' (1988) method. The method uses the average 1-hour traffic volume for the 'assessment period' (i.e. day or night) to predict the $L_{10, 1hour}$ noise levels. A correction of -3dB(A) is applied to obtain the $L_{eq, 1 hour}$ noise levels which equate to the L_{Aeq} noise levels for the 'assessment period'.

For this assessment, the model has considered:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- ground reference levels of the road and receivers;
- separation distances of the road to receivers;
- ground type between the road and receivers; and
- angles of view of the road from the receiver's position.

Table 7.3 above summarises the predicted construction traffic noise levels during day and night periods.

The predicted road traffic noise levels indicate less than 2dB(A) increase in $L_{Aeq(15h)}$ day on the Great Western Highway and Gipps Street during the peak and off-peak construction periods. Therefore, the total road traffic noise levels comply with the RNP traffic noise criteria set out in section 4.

The predicted road traffic noise levels indicate less than 2dB(A) increase in $L_{Aeq(9h)}$ night on the Great Western Highway and Gipps Street during the peak and off-peak construction periods. Therefore, the risk of construction traffic impacting the existing traffic noise at receivers on the Great Western Highway at night is low.

7.3 Traffic noise mitigation and management

None required when on public roads, provided traffic movements associated with construction are consistent with the assumptions outlined above.

The CPBG Heavy Vehicle Code of Conduct also includes several measures, including limiting of compression braking, which will ensure that noise impacts of heavy vehicle traffic on surrounding streets are minimised.

7.4 Complaints handling

Construction traffic noise complaints received and responded to will be managed in accordance with the CEMP, CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002) and Overarching Community Communications Strategy.

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

8 Impact classification

The CNVS requires that on completion of a DNVIS, the subjective classification of the noise (and vibration) impact is to be evaluated and documented as:

- Low Impact
- Moderate Impact
- High Impact.

The classifications are to be determined on a case-by-case basis with consideration of the items addressed in the table below and the requirements of SSI 10051 Condition E41 (b) which defines Low impact.

Table 8.1: Impact classification for bulk excavation and tunnelling works – Claremont Meadows Ventilation Facility worksite (CMF)

No.	Impact item description	Analysis	Classification
1	The location of the works in relation to NSRs with consideration of noise attenuation features such as noise barriers including topographical features (earth-mounds), buildings, dividing fences etc (distance of works from sensitive receiver(s)).	NSRs are typically not directly adjoining worksite. Noise barriers to be installed on site boundary near NSRs as part of site establishment works. Impacts reduce following noise wall installation.	Low
2	The type and sensitivity of the NSRs: - Low Impact: e.g. Commercial buildings/ Scattered Residential (low density) - Moderate Impact: e.g. Standard residential (typical density) - High Impact: e.g. Residential home for the elderly/high density unit blocks/ persistent complainers/ residents deemed to have "construction noise fatigue".	Standard residential (typical density and typically 1 to 2 storeys high) to the west, scattered density and parkland to the east.	Moderate to low
3	Land use zoning and planning amenity objectives for the area.	Residential land use west of worksite; Commercial and educational zone north of worksite	Moderate
4	Construction and architectural design of impacted building, particularly the presence of any existing noise mitigation including that provided under a Noise Abatement Program or required by the ISEPP, Council DCP or other planning instrument.	It is assumed most buildings are standard construction with no existing additional mitigation. Newer buildings may include noise mitigation under ISEPP or Australian Standard AS 2021:2015 Acoustics - Aircraft Noise Intrusion - Building Siting and Construction (to be confirmed)	Moderate
5	Existing ambient levels.	Low to moderate existing ambient noise levels during daytime ($L_{Aeq(15min)}$ 48 dB(A)); evening ($L_{Aeq(15min)}$ 49 dB(A)); and night ($L_{Aeq(15min)}$ 45dB(A)).	Low to Moderate
6	The extent of noise exceedance above Noise Management Level.	Mitigation measures including noise barriers have been implemented to reduce noise from the worksite. With the noise barriers installed, no residential receivers are expected to experience noise levels above 75 dB(A) during the bulk excavation (high impact) works. During typical activities there are no receivers predicted to be highly noise affected. Note that the level of impact would not be continuous as the location of construction activity will vary as the works progress.	Low
7	The likelihood for potential sleep disturbance (as described in the NPfI).	Small risk during concrete truck entry/ exit from worksite as part of the tunnelling support works. Noise levels are likely to be lower than predicted levels. Verification monitoring during the construction stage would confirm the likelihood of sleep disturbance occurring.	Low

No.	Impact item description	Analysis	Classification
8	The type of and intensity of noise emitted from works (i.e. tonal or impulsive): - Lower Impact: No high noise and/or vibration intensive activities - Moderate Impact: Short/intermittent high noise and/or vibration intensive activities - High Impact: Prolonged high noise and/or vibration intensive activities.	Most bulk excavation and tunnelling works will be 'typical impact', with no high noise and/or vibration intensive activities. During limited bulk excavation work there may be high impact works. All reasonable and feasible measures will be applied to minimise noise impacts. Respite periods will be provided as outlined in Section 5.3.1	Low to Moderate
9	The duration of any OOHW required.	Up to four months for concrete pours for the tunnel invert during the tunnelling support works.	Low
10	The time frames for any OOHW: - Lower Impact: 6.00 pm till 10.00 pm weekdays 1.00 pm till 10.00pm Saturdays 8.00 am till 6.00 pm Sundays or Public Holidays. - Moderate Impact: 10.00 pm to 7.00 am Weekday Nights 10.00 pm to 8.00 am Saturdays. - High Impact: 6.00 pm to 7.00 am Sundays and Public Holidays.	The site will be managed to meet the NMLs by limiting activities after 6pm, and further limiting activities after 10pm. There may be minor impacts (<5 dB(A)) above the NML at up to two (2) receivers during the OOHW period.	Low
11	As a result of noise classification and/or the noise level exceedances at sensitive receivers provided by the DNVIS reports, appropriate reasonable and feasible noise mitigation is to be adopted and implemented. For sites where works are predicted to significantly exceed noise goals and impact on receivers for a significant period of time, additional reasonable and feasible noise mitigation measures such as those outlined in Section 5 would be considered if practical to reduce the noise levels and impact on sensitive receivers.	Mitigation measures outlined in Section 5.3 will be implemented to manage and reduce impacts from construction works.	Low

Review of the overall noise impact of bulk excavation and tunnelling works at the Claremont Meadows worksite is considered **low**. Whilst there are some instances of moderate impact from high noise impact activity, this impact is short term in nature and will be managed through the mitigation and management measures outlined in Section 5.3, including suitable community notification regarding potential impacts from the works. Notably, the works assessed in this DNVIS will mostly be completed during standard construction hours. Mitigation and management measures will be implemented to reduce noise levels with the aim of achieving the NMLs.

At Claremont Meadows, properties at risk of vibration impact have been identified through the conservative screening process set out in the CNVS [1]. Vibration impact from the bulk excavation and tunnelling works are assessed as negligible. Vibration significant works will be managed in accordance with Section 6.3. The overall vibration impact of bulk excavation and tunnelling works at Claremont Meadows worksite is considered **low**.

9 Conclusion

In conclusion, construction works associated with the bulk excavation and tunnelling works at the Claremont Meadows Ventilation Facility worksite have been described in this DNVIS to identify potential environmental risks associated with construction noise and vibration. Construction noise and vibration objectives have been established consistent with the Conditions of Approval for the Project and the EIS.

Construction noise

The predicted noise levels indicate there are no highly noise affected receivers over the duration of all the bulk excavation and tunnelling works. The predicted levels indicate minor exceedances at two receivers that will need to undergo verification monitoring.

Noise mitigation and management measures, including noise monitoring requirements, have been presented in Section 5.3 to aid in providing additional noise reduction benefits where noise levels are above the NMLs.

Construction vibration

There are no buildings/structures within minimum working distances for cosmetic and human annoyance.

Construction traffic

The predicted noise impacts are assessed as low and generally within the minimum requirements in the CNVS.

Impact classification

The overall noise and vibration impact of construction works associated with the bulk excavation and tunnelling works at the Claremont Meadows Ventilation Facility worksite works project-wide is considered **low**.

References

[1] Sydney Metro Construction Noise and Vibration Standard Version 4.3 (SM-20-00098866) – 4 November 2020

[2] Transport for NSW Construction Noise and Vibration Strategy (ref: ST-157/4.1) April 2019

[3] Sydney Metro Western Sydney Airport Out-of-hours Work Protocol Version 2.0 (SM-21-00306108) – 8 November 2021

[4] M2A Joint Venture 2020 Sydney Metro - Western Sydney Airport - Technical Paper 2: Noise and Vibration October 2020

[5] M2A Joint Venture 2020 Sydney Metro - Western Sydney Airport – Submissions Report

[6] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline (ICNG)

[7] Environment Protection Authority 2017 NSW Noise Policy for Industry (NPfI)

[8] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy (RNP)

[9] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline

[10] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

[11] Australian Standard AS 2187.2-2006 Explosives - Storage and Use - Use of Explosives

[12] British Standard BS 7385 Part2-1993, Evaluation and measurements for vibration in buildings Part 2

[13] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures, December 2016

[14] ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40

[15] Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16

[16] Australian Standard AS/NZS 2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors*

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the 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.
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 point at which noise measurements are taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
AVTG	Assessing Vibration – a technical guideline (DEC 2006)
Background noise	Background noise is the term used to describe the underlying level of noise 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 meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
CNVS	Construction Noise and Vibration Standard (Sydney Metro 2021)
CoA	Condition of Approval
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
DEC	Department of Environment and Conservation (now EPA)
DECC	Department of Environment and Climate Change (now EPA)
DECCW	Department of Environment, Climate Change and Water (now EPA)
DNVIS	Detailed Noise and Vibration Impact Statement

DP&E	NSW Department of Planning and Environment
ECRTN	Environmental Criteria for Road Traffic Noise (EPA 1999)
EIS	Environmental Impacts Statement
EPA	NSW Environment Protection Authority
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
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 pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
GIS	Geographic Information System
ICNG	Interim Construction Noise Guideline (DECC, 2009)
INP	NSW Industrial Noise Policy (EPA, 2000)
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.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	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).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
MWD	Minimum Working Distance
NCA	Noise Catchment Areas
NML	Noise management levels
NSR	Noise Sensitive Receivers
OEH	Office of Environment and Heritage
OOHW	Out-of-Hours Works – work completed outside of standard construction hours
PPV	Peak Particle Velocity
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 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 of time and can be used for predicting noise at various locations.
RNP	NSW Road Noise Policy (DECCW 2011)

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 (SPL)	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level (SWP)	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Standard construction hours	Hours during which construction work is permitted by the CoA.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Sensitive receivers and noise management levels

B.1 NCAs and sensitive receiver identification

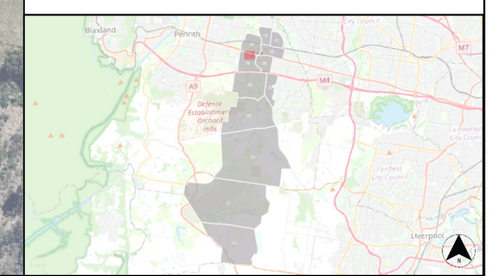
Land-Use file revision_date: r7_ 12/07/21

Plot Date: 30/06/22 - 09:50 Layout: TM0008 APPB&E (r0)

GIS File: R:\AssocSydProjects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\01 GIS\TM008-DA (r0).qgz

LEGEND

- Residential
- Mixed use
- Commercial
- Industrial
- Hotel/Motel/Hostel
- Medical facility
- Place of Worship
- Community centre
- Recording studio
- Library/Museum
- Childcare
- Educational
- Theatre/Auditorium
- Cinema
- Laboratory
- Flight simulator
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage
- Work area
- NCAs



0 20 40 60 80 100 120 140 160 180 200 m

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	30/06/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 60 120 180 m

1:3,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 1874 5 Generations of Tunnelers

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES
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SYDNEY METRO WESTERN SYDNEY AIRPORT
SBT Works

Land Use, Compounds and NCAs
Work area: Claremont Meadows

Sheet of

B.2 NCAs and noise management levels

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels (airborne noise) **CLAREMONT MEADOWS VENTILATION FACILITY**

			Existing Noise Levels, dB(A)						Airborne NMLs based on ICNG (external)				Sleep Dist. L_{Amax}		Comments
NCA	Receiver Type	Reference RBL	RBL Day	RBL Evening	RBL Night	LAeq_D	LAeq_E	LAeq_N	NMLDS	NMLDO	NMLE	NMLN	$L_{Aeq(15min)}$	L_{AFmax}	
Residential receivers															
NCA03	Predominantly Residential	NM02	37	37	36	55	59	51	47	42	42	41	41	52	
NCA04	Predominantly Residential	NM14	35	32	31	48	47	43	45	40	37	36	40	52	
NCA05	Predominantly Residential	NM05	40	40	40	54	51	50	50	45	45	45	45	55	
NCA06	Predominantly Residential	NM07	37	37	36	48	49	45	47	42	42	41	41	52	
Other sensitive receivers															
Studio building (music recording studio)									45	45	45	45	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Studio building (film or television studio)									50	50	50	50	-	-	Source: AS2107 'maximum', assuming 20 dB(A) facade loss
Theatre/ Auditorium (Drama Theatre)									50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Cinema space, theatre, auditorium									55	55	55	55	-	-	Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Classrooms at schools and other educational institutions									55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Childcare centre (indoor sleeping areas)									55	55	55	55	-	-	Source: CNVS Section 2.2.1, assuming a conservative façade loss of 10 dB(A)
Childcare centre (play areas)									65	65	65	65	-	-	Source: CNVS Section 2.2.1
Hospital wards and operating theatres									65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship									55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Library (reading areas)									65	65	65	65	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Hotel (Sleeping areas: Hotels near major roads)									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Hotel (bars and lounges)									70	70	70	70	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Community centres – Municipal Buildings									60	60	60	60	-	-	Source: AS2107 'maximum', assuming a conservative façade loss of 10 dB(A)
Bar/ Restaurant (Bars and lounges/ Restaurant)									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Café/ Coffee bar									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Railway platform and concourse areas									75	75	75	75	-	-	Source: AS2107 'maximum', assuming a conservative façade loss of 20 dB(A)
Passive recreation areas (e.g. area used for reading, meditation)									60	60	60	60	-	-	Source: ICNG
Active recreation areas (e.g. sports fields)									65	65	65	65	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)									70	70	70	70	-	-	Source: ICNG
Industrial premises									75	75	75	75	-	-	Source: ICNG

Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2

Table B2: Noise Sensitive Receivers and Construction Noise Management Levels (groundborne noise) **CLAREMONT MEADOWS VENTILATION FACILITY**

NCA	Receiver Type	Groundborne NMLs based on ICNG (internal) NMLDS	NMLDO	NMLE	NMLN	Comments
Residential receivers						
All	All residential receivers	Human comfort vibration		40	35	Source: ICNG
Other sensitive receivers						
Studio building (music recording studio)		25	25	25	25	Source: CNVS Section 2.2.1 & AS2107 'maximum
Studio building (film or television studio)		30	30	30	30	Source: AS2107 'maximum
Theatre/ Auditorium (Drama Theatre)		30	30	30	30	Source: CNVS Section 2.2.1 & AS2107 'maximum
Cinema space, theatre, auditorium		35	35	35	35	Source: AS2107 'maximum'
Classrooms at schools and other educational institutions		45	45	45	45	Source: ICNG
Childcare centre (indoor sleeping areas)		45	45	45	45	Source: CNVS Section 2.2.1
Childcare centre (play areas)		65	65	65	65	Source: CNVS Section 2.2.1
Hospital wards and operating theatres		45	45	45	45	Source: ICNG
Places of worship		45	45	45	45	Source: ICNG
Library (reading areas)		45	45	45	45	Source: CNVS Section 2.2.1 & AS2107 'maximum
Hotel (Sleeping areas: Hotels near major roads)		40	40	40	40	Source: CNVS Section 2.2.1 & AS2107 'maximum
Hotel (bars and lounges)		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Community centres – Municipal Buildings		40	40	40	40	Source: AS2107 'maximum'
Bar/ Restaurant (Bars and lounges/ Restaurant)		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Café/ Coffee bar		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Railway platform and concourse areas		55	55	55	55	Source: AS2107 'maximum'

Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
NS: night shoulder period from 10 pm to 12 am Monday to Sunday - OOHW P1

APPENDIX C Construction timetable/ activities/ management

C.1 Construction timetable/activities/equipment

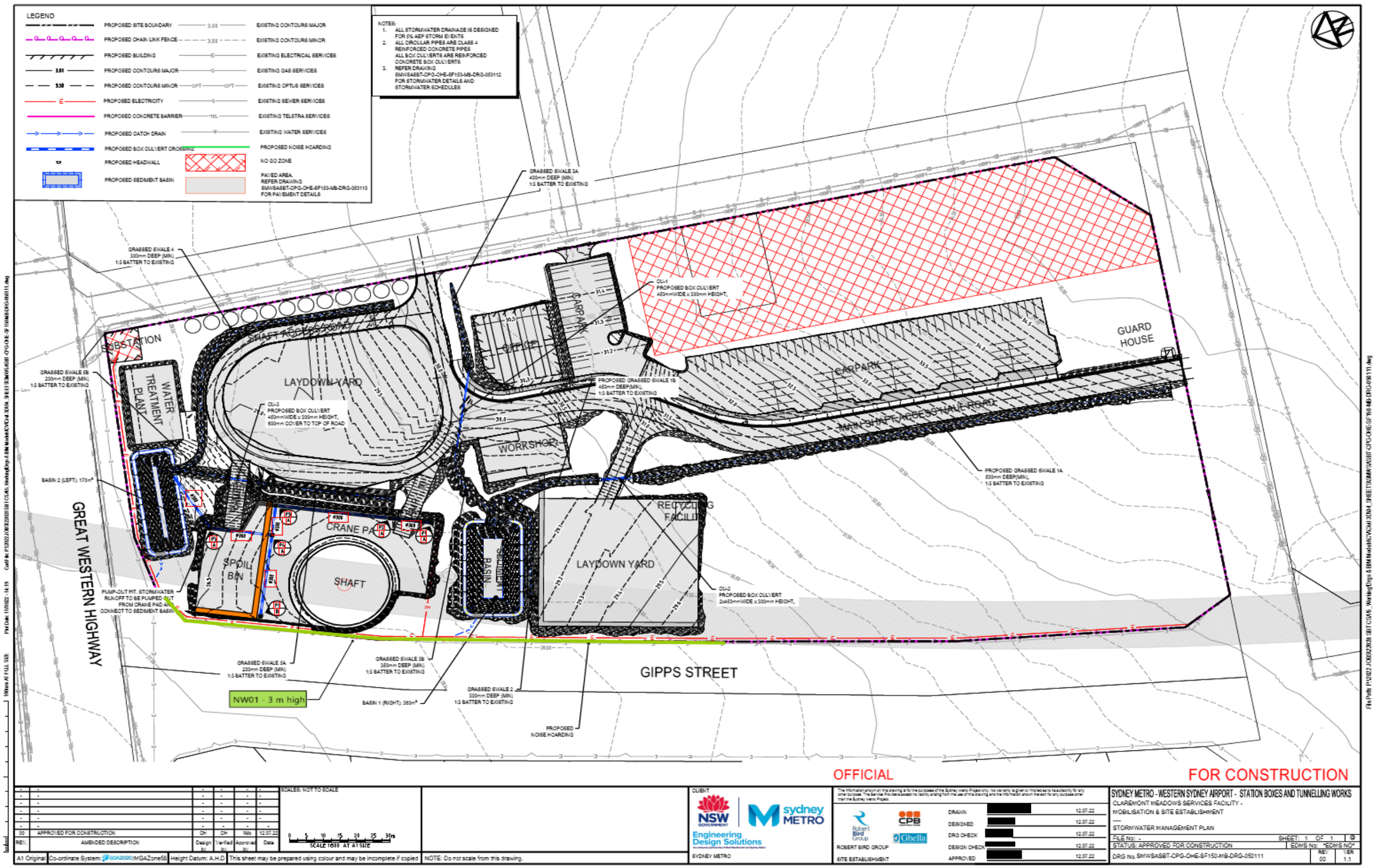
Table C1: Construction timetable/ activities/ equipment **CLAREMONT MEADOWS VENTILATION FACILITY**

Activity/ Work Area	Aspect	Plant/ Equipment (as provided by client)	Day	Evening	Night	Timing of Activity		Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant	Vibration intensive plant	Notes
			7am - 6pm	6pm - 10pm	10pm - 7am	Start Date	End Date	L_{Aeq}	Penalty	L_{Amax}			
COMPOUND													
Car Park	Car parking	Light vehicle	30 per hour			Jun-22	May-24	89	-	100	-	-	
		Water pump (diaphragm pump)	4	4	4			106	-	109	-	-	
CIVIL SITE													
Ventilation facility	Earthworks	Excavator 35T w bucket	2			Jun-22	Feb-23	103	-	108	-	-	
		Excavator 20T w bucket	1					103	-	108	-	-	
		Bogies	4					106	-	111	-	-	
		Truck and Dog	5 per hour					106	-	111	-	-	
		Water cart	1					107	-	111	-	-	
	Piling Activities	Piling Rig - bored	3	-	-	Aug-22	Dec-22	109	-	111	-	-	
		Concrete Agi	9 per day	-	-			108	-	111	-	-	
`		Concrete pump	2	-	-			103	-	107	-	-	
		Crawler crane 100T	1	-	-			105	-	108	-	-	
		Excavator 35T w bucket	2	-	-			104	-	108	-	-	
		Diesel Welder / Power	2	-	-			98	-	102	-	-	
		Delivery trucks	4 per day	-	-			98	-	102	-	-	
	Shaft Excavation & Construction	Excavator 35T w rockhammer	1			Nov-22	Feb-24	118	5	126	HN	X	
		Excavator 20T w rockhammer	1					118	5	126	HN	X	
		Telehandler 12T	1					98	-	102	-	-	
		Delivery trucks	3 per hour					106	-	111	-	-	
		Pneumatic Hammer	2					111	5	121	HN	X	
		Excavator 55T w bucket	3					106	-	111	-	-	
		Excavator 35T w bucket	2					103	-	108	-	-	
		FE Loader	2					110	-	115	-	-	
		Compressor	2					102	-	103	-	-	
		Generator	2					94	-	95	-	-	
		Mobile crane 250T	1					104	-	108	-	-	
		Tower crane	1					114	5	119	HN	-	
		Franna crane 20T	1					98	-	102	-	-	
		Scissor lift	3					95	-	98	-	-	
		Knuckle Boom	3					107	-	111	-	-	
		Forklift	1					99	-	103	-	-	
		Hand tools	5					105	-	118	-	-	
TUNNELLING SUPPORT SITE													
TBM Support	Tunneling and Support	Ventilation fan	2	2	2	Dec-23	Aug-24	98	-	102	-	-	On surface
Tunnel Invert	Tunnel Invert concrete pours	Concrete truck	4 per hour	4 per hour	4 per hour	Dec-23	Mar-24	108	-	111	-	-	Delivery to drop pipe on surface.
		Concrete pump	1	1	1			103	-	107	-	-	On surface

Figure C1: Site Layout and Hoardings

INDICATIVE NOISE MITIGATION

CLAREMONT MEADOWS VENTILATION FACILITY



C.2 Specific mitigation measures

Table C2: Construction Noise Management Schedule **CLAREMONT MEADOWS VENTILATION FACILITY**

Area to be Managed			Specific Mitigation/ Management Measure	Typical Details
1	Claremont Meadowa site			
1.1	Work during Standard Construction Hours	DAY:	Standard hours activities (as specified in Table C1)	
1.2	Work outside Standard Construction Hours	EVE:	EVE works (6 pm to 10 pm):	
		NGT:	NIGHT works (10 pm to 7 am):	see Table C1 for details
2	Noise Barriers	NW01 & NW02	Noise walls to be constructed as early as practicable.	see Table C3 for details
3	D-wall			
3.1	Work during Standard Construction Hours	DAY:	Standard hours activities.	see Table C1 for details
4	Shaft excavation			
4.1	Work during Standard Construction Hours	DAY:	Standard hours activities	
4.2	Work outside Standard Construction Hours	D(O)/EVE/ NGT:	If diaphram pumps need to operate OOH, silencers, enclosures and other acoustic treatments may be required.	see Table C5 for details
5	Tunnel invert option			
5.1	Work during Standard Construction Hours	DAY:	Standard hours activities	
5.2	Work outside Standard Construction Hours	D(O)/EVE/ NGT:	- Acoustic enclosure required for concrete drop zone. Temporary acoustic shed or acoustic tent.	see Table C4 for details
			- Limit vehicle route on site to minium travel between site access and drop zone, where practicable.	see Table C1 for details
			- Residulal impacts during the evening/ night period	

Table C3: Noise Wall / Hoarding Design Specifications **CLAREMONT MEADOWS VENTILATION FACILITY**

Noise wall reference	Location	Noise wall/ hoarding height	Proposed Construction	Acoustic Rating of Construction*
NW01	Western boundary, adjacent to worksite (see Figure C1)	3m	17 mm plywood hoarding	Rw 24

Notes:

Noise barrier performance: Low - Rw 10-15; Medium - Rw 15-20; Medium-High - Rw 20-25; High - Rw 25; Very High - Rw 30

* estimated by calculations and/or reference to other similar barrier type data

GENERAL

- The specified 'required rating' must be achieved by the product selected.
- By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the assembly, a higher rating implying a higher sound reduction performance.
- Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.
- The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
- Check design of all junction details with acoustic consultant prior to construction.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

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Table C4: Noise Shed / Enclosure Design Specifications **CLAREMONT MEADOWS VENTILATION FACILITY**

Area to be Mitigated	Construction component	Reference ID	Indicative element construction
Temporary enclosure - concrete drop zone	Walls	F002	1x 0.48mm BMT corrugated steel
	Roof	F002	1x 0.48mm BMT corrugated steel
	Acoustic lining	-	Acoustic lining with roofing blanket oninner facing insideshed: -underside of roof acoustic insulation with perforate foil (perforation facing inside of the shed)
	Opening	-	Opening should face away from neighbours (i.e. to the north-west)

Notes:

1. The final level of noise reduction required from an acoustic shed / enclosure is dependent on a number of factors, however one important factor is whether or not there are noisy plant on site which cannot be acoustically treated and operate outside the acoustic shed / enclosure. Depending on the number and noise emissions of such plant, it may be necessary to apply greater acoustic treatment to the acoustic shed / enclosure in order to keep its noise contributions down so that the total noise emissions from site meet the set environmental noise limits at neighbouring receptors.

LEGEND * estimated by calculations and/or reference to other similar wall type data. The client is advised not to commit to materials which have not been tested in an approved laboratory or for which an opinion only is available. Testing materials is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions.

GENERAL

- The underside of the roof and (where possible) internal walls should be lined with acoustic insulation to reduce the build-up of sound inside the shed
- The specified performances must be achieved by the product selected.
- `
- Check design of all junction details with acoustic consultant prior to construction.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.
- Only the buildings elements noted in Table C4 and Table C4a have been assessed. It is assumed that all other items will not impact the acoustic properties, or can be sufficiently acoustically treated.

9 per day

Table C4a: Specification for acoustic elements of noise sheds/ acoustic

CLAREMONT MEADOWS VENTILATION FACILITY

Reference	Sound transmission loss per octave spectrum dB							Indicative shed element construction
ID	63	125	250	500	1000	2000	4000	
F002	7	9	13	18	22	19	20	1x 0.48mm BMT corrugated steel

LEGEND * estimated by calculations and/or reference to other similar wall type data. The client is advised not to commit to materials which have not been tested in an approved laboratory or for which an opinion only is available. Testing materials is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions.

Table C4b: Fan & Silencer Design Specifications

CLAREMONT MEADOWS VENTILATION FACILITY

Site	Model	Sound Power Level - Octave Band dB								Overall		Notes
		63	125	250	500	1000	2000	4000	8000	dB	dB(A)	
FANS												
1 - Shaft Inlet & Outlet 2 - Shaft Inlet & Outlet	Tunnel FAN (ZITRON ZVN 1-14-132/4)+4.8m SIL w pod	99	110	107	94	84	82	90	**94**	**112**	102	

Site	Model	Insertion Loss - Octave Band dB								Overall		Notes
		63	125	250	500	1000	2000	4000	8000	dB	dB(A)	
RECTANGULAR ATTENUATORS												
1 - Inlet	TBC											
2 - Inlet	TBC											

Table C5: Plant noise level schedule

CLAREMONT MEADOWS VENTILATION FACILITY

Building/ Area to be Mitigated	Item	Acoustic Requirement	Lw dB(A)
Plant item	Pumps - water treatment plant	Acoustic silencing subject to achieve	94

Notes:

LEGEND * estimated by calculations and/or reference to other similar plant type data. The client is advised not to commit to fans which have not been tested in an approved laboratory. Testing plant is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions. The advice provided here is in respect of acoustics only.

GENERAL

- Sound power level of plant assumed based on sound power level of similar plant type, incorporating attenuation (acoustic attenuator/ muffler/ duct lining as required)
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Table C6: Managing Residual Impacts during 'out of standard hours' work **CLAREMONT MEADOWS VENTILATION FACILITY**

ID	Noise Mitigation/ Management Measure
1	At some receiver locations noise levels may exceed the NMLs after all reasonable and feasible mitigation measures have been incorporated into the design.
2	Tthe following at-property treatment measures are recommended:

Treatment package 0 (TP0)	
< 2 dB(A) reduction	Given the predictions are based on a worst-case scenario with everything operating at maximum capacity at the same time, it is likely that noise levels are lower than what has been predicted. It is recommended that no immediate action is undertaken for these properties.
Treatment package 1 (TP1)	
3-5 dB(A) reduction	Where external noise levels are less than 5dB(A) above the NML, the internal noise goals can be achieved by simply closing windows. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation (e.g. 240v Aeropac systems) would be considered to ensure fresh airflow inside the dwelling so to meet the ventilation requirements of the NCC. It is important to ensure that mechanical ventilation does not provide a new noise leakage path into the habitable room and does not create a noise nuisance to neighbouring residential premises.
Treatment package 2 (TP2)	
5-10 dB(A) reduction	Where external noise levels are less than 10dB(A) above the NML, the internal noise goals can be achieved with windows closed and wall vents sealed. Special acoustic grade seals may also need to be installed on windows and perimeter doors exposed to noise to enable the internal noise goals to be achieved with windows and doors shut. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation (e.g. 240v Aeropac systems) would be considered to ensure fresh airflow inside the dwelling so to meet the ventilation requirements of the NCC.
Treatment package 3 (TP3)	
10-12 dB(A) reduction	Where external noise levels are only slightly greater than 10dB(A) above the NML, then in addition to installing mechanical ventilation and sealing of wall vents (TP2), special acoustic grade seals should be installed on windows and perimeter doors exposed to road traffic noise to enable the internal noise criteria to be achieved with windows and doors shut.
Treatment package 4 (TP4)	
>12 dB(A) reduction	Where the predicted external noise level exceeds the NML by significantly more than 10dB(A), then upgraded windows and glazing and the provision of solid core doors would be required on the facades exposed to the works, in addition to the mechanical ventilation, sealing of wall vents and acoustic seals for windows and doors described in TP1, TP2 and TP3, respectively. Note that these upgrades are only suitable for masonry type buildings. It is unlikely that this degree of upgrade would provide significant benefits to light framed structures should there be no acoustic insulation in the walls.

3 The following at-property treatment may be required to reduce noise impact from the site:

Treatment Type			
Level of exceedance	**Treatment**	**Highly noise affected**	**No. Properties impacted by**
1-2 dB(A) exceedance	Treatment package 0	0	1
3-5 dB(A) exceedance	Treatment package 1	0	0
5-10 dB(A) exceedance	Treatment package 2	0	0
10-12 dB(A) exceedance	Treatment package 3	0	0
>12 dB(A) exceedance	Treatment package 4	0	0

*Number of Properties are **INDICATIVE** and subject to verification monitoring. Some receivers may have already received at-property treatment or designed for road noise

APPENDIX D Construction noise impacts

D.1 Predicted noise levels

The detailed predicted levels have been provided to CPBG in a spreadsheet table to more adequately mitigate and manage potential noise impacts.

D.2 Number of receivers above NMLs

The number of exceedances has been provided to CPBG in a spreadsheet table.

D.3 Additional mitigation measures

The additional mitigation measures have been provided to CPBG in a spreadsheet table to more adequately mitigate and manage potential noise impacts.

APPENDIX E Construction vibration impacts

Land-Use file revision date: r7 12/07/21

Plot Date: 30/06/22 - 09:39 Layout: TM0008 APPB&E (r0)

GIS File: R:\AssocSydProjects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\01 GIS\TM008-DA (r0).qgz

0 10 20 30 40 50 60 70 80 90 100 m

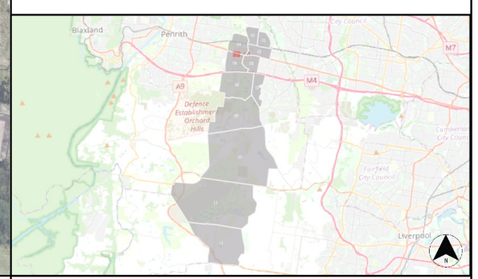
LEGEND

- Residential
- Mixed use
- Commercial
- Industrial
- Hotel/Motel/Hostel
- Medical facility
- Place of Worship
- Community centre
- Recording studio
- Library/Museum
- Childcare
- Educational
- Theatre/Auditorium
- Cinema
- Laboratory
- Flight simulator
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage

- Work area
- NCAs
- Receivers within MWD for cosmetic damage

MWD for cosmetic damage and human annoyance for 35T excavator with rockhammer attachment

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (day)



REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	30/06/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 40 80 120 m

1:2,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 1894 5 Generations of Tunnelers

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES
inspired to achieve
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SYDNEY METRO WESTERN SYDNEY AIRPORT
SBT Works

MWD for cosmetic damage and human annoyance
Work area: Claremont Meadows