Detailed Noise and Vibration Impact Statement

Westmead – Tunnel Support Activities

Sydney Metro West – Western Tunnelling Package

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Document Details

Document Title	**Detailed Noise & Vibration Impact Statement – Westmead – Tunnel Support Activities**
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DOCUMENT CONTROL

The current document version number and date of revision are shown in the document footer. All changes made to the document during its implementation on a live project are to be recorded in the amendment tables below.

Revision History

Revision	Date	Description of changes	Prepared by	Approved by
A	05/05/2023	Draft update submission		
B	19/05/2023	Reviewed to address Sydney Metro, ER and AA's comments		
C	24/05/2023	Reviewed to include figures and clarify the approval pathway		

Terms and Definitions

Term	Definition
AA	Acoustics Advisor
AA	Alternative Accommodation
AH	Approved Hours
AMM	Additional Mitigation Measures
BOM	Australian Bureau of Meteorology
CBD	Central Business District
CEMF	Construction Environmental Management Framework
CEMP	Construction Environmental Management Plan
CNVIS	Construction Noise & Vibration Impact Statement
CNVMP	Construction Noise & Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy
CSSI	Critical State Significant Infrastructure
dBA	Decibels – measurement of noise
DNVIS	Detailed Noise and Vibration Impact Statement
DPE	Department of Planning and Environment (NSW)
ECM	Environmental Control Map
EIS	Environmental Impact Statement
EMS	Environmental Management System (Integrated Management System)
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning & Assessment Act 1979 (NSW)*
EPL	Environmental Protection Licence
ER	Environmental Representative (ER)
GLC	Gamuda Australia and Laing O'Rourke Consortium
ICNG	Interim Construction Noise Guideline (DECC, 2009)
LA_{MAX}	the maximum sound level during a measurement period or a noise event
LB	Letter Box Drop
M	Monitoring
MCoA	Minister's Conditions of Approval
NCA	Noise Catchment Area
NML	Noise Management Levels
NVMoP	Constriction Noise and Vibration Monitoring Program
OOHW	Out Of Hours Work
POEO	*Protection of the Environment Operations Act 1997* (NSW)
RBL	Rating Background Level
RO	Respite Offer

Term	Definition
SMW	Sydney Metro West
SPL	Sound Powel Levels
TBM	Tunnel Boring Machine
WTP	Sydney Metro West Western Tunnelling Package Works (the Project)

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1 INTRODUCTION

This activity-specific Detailed Noise and Vibration Impact Statement (DNVIS) has been developed by Gamuda Australia Laing O'Rourke Consortium (GLC) to assess the potential noise and vibration impact of the proposed Westmead Tunnel Support Activities. It accompanies the Project wide DNVIS as well as the Noise and Vibration Management Plan (NVMP) as a sub-plan to the Construction Environmental Management Plan (CEMP) supporting the Sydney Metro West Stage 1 Western Tunnelling Package (WTP or 'the Project'). It also satisfies Ministers Conditions of Approval (MCoA) D43 and D44. A list of applicable requirements from the MCoA, Sydney Metro - Construction Environment Management Framework (CEMF) and the Sydney Metro CNVS is provided in Attachment 1.

The Project-wide DNVIS identifies the potential noise and vibration impacts from the Project based on noise and vibration modelling, as well as any noise and vibration mitigation measures required. The Project-wide DNVIS outlines the Project's full scope of works, approved construction hours and construction noise and vibration guidelines. The subject of this document is a site-specific DNVIS, which will act as an addition to the Project-wide DNVIS and should therefore be read in conjunction with this DNVIS. The Project-wide DNVIS can be found on the project website at https://gamuda.com.au/sydney-metro-west-western-tunnelling-package-wtp/

This DNVIS assesses the potential noise and vibration impact of the proposed Westmead Tunnel Support Activities. It has been developed to address the assessment requirements documented in the NSW Interim Construction Noise Guidelines (ICNG), Sydney Metro Construction Noise and Vibration Standard (CNVS), MCoA and any relevant Environmental Protection License (EPL) requirements.

This DNVIS has been developed in consultation with the Environmental Representative (ER) and Acoustic Advisor (AA). A copy of this DNVIS will be provided to the AA and ER before the commencement of associated works. The AA will endorse this DNVIS before implementation in accordance with MCoA A36(e).

2 SCOPE OF WORKS

During the EIS phase of the Project, the Westmead Metro Station construction site was identified as a tunnel boring machine (TBM) launch and support site. Since the EIS and following further detailed construction planning, the Westmead Metro Station construction site has now been identified as a TBM retrieval site, rather than a launch site.

As an identified retrieval site, tunnel support activities are required to be completed 24hrs a day seven days a week, to establish the mined caverns through which the TBMs will be eventually retrieved, in compliance with EPL condition L5.6 and Minister's Condition of Approval D37 d)

Tunnel support activities proposed to be undertaken from the eastern end of the station box at the Westmead Metro Station construction site covered in this DNVIS include:

- Rock anchoring/bolting
- Shotcreting
- Brown bolts for minded tunnel crown support
- Glass Fiber Reinforced Polymer (GFRP) bolts for mined tunnel face stability; and
- Probe drilling and initial ground investigation to validate tunnel support requirements.

The proposed tunnel support activities are illustrated in Figure 1, 2 and 3 below.

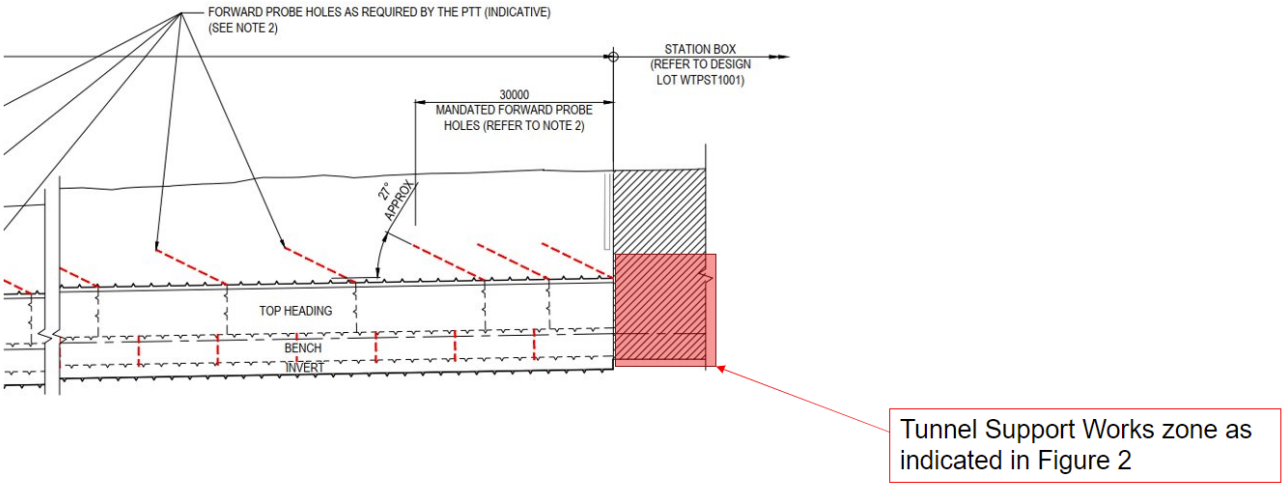

Figure 1: Longitudinal section of tunnel support work zone on the eastern side of the station box

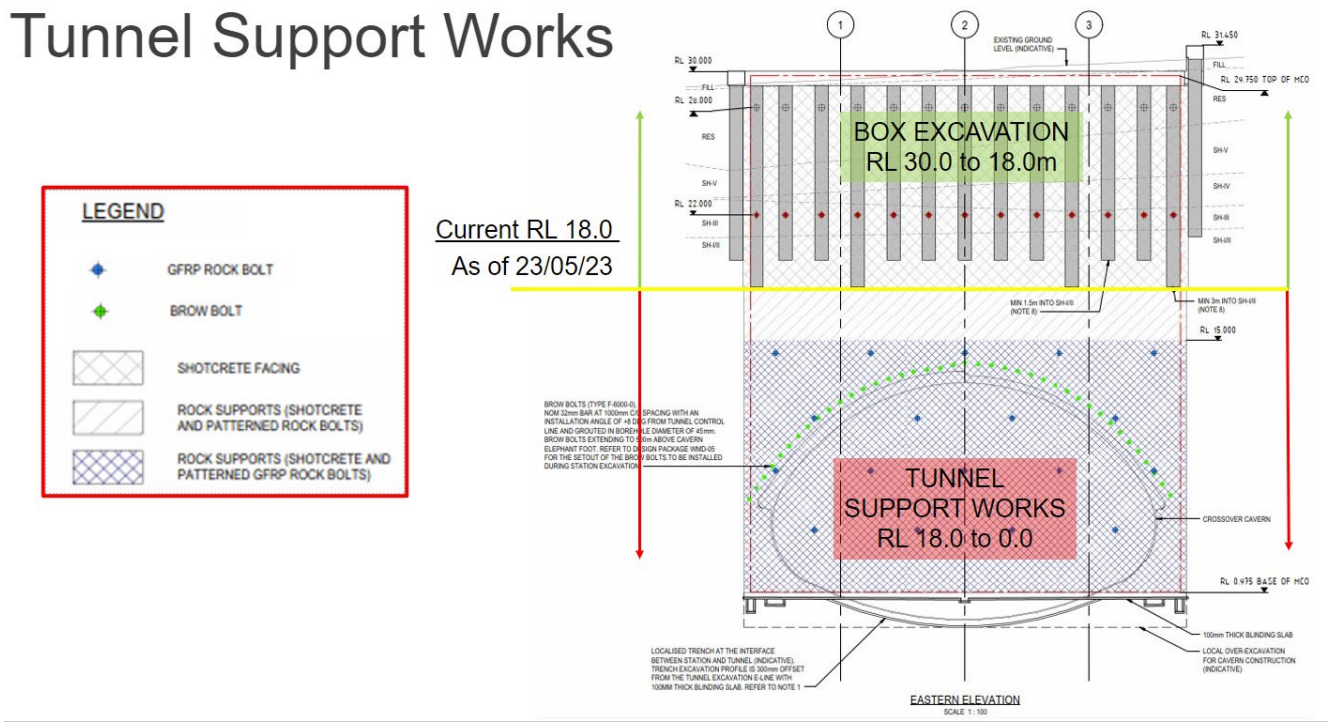

Figure 2: Tunnel support work zone from RL 18.0 to RL 0.0

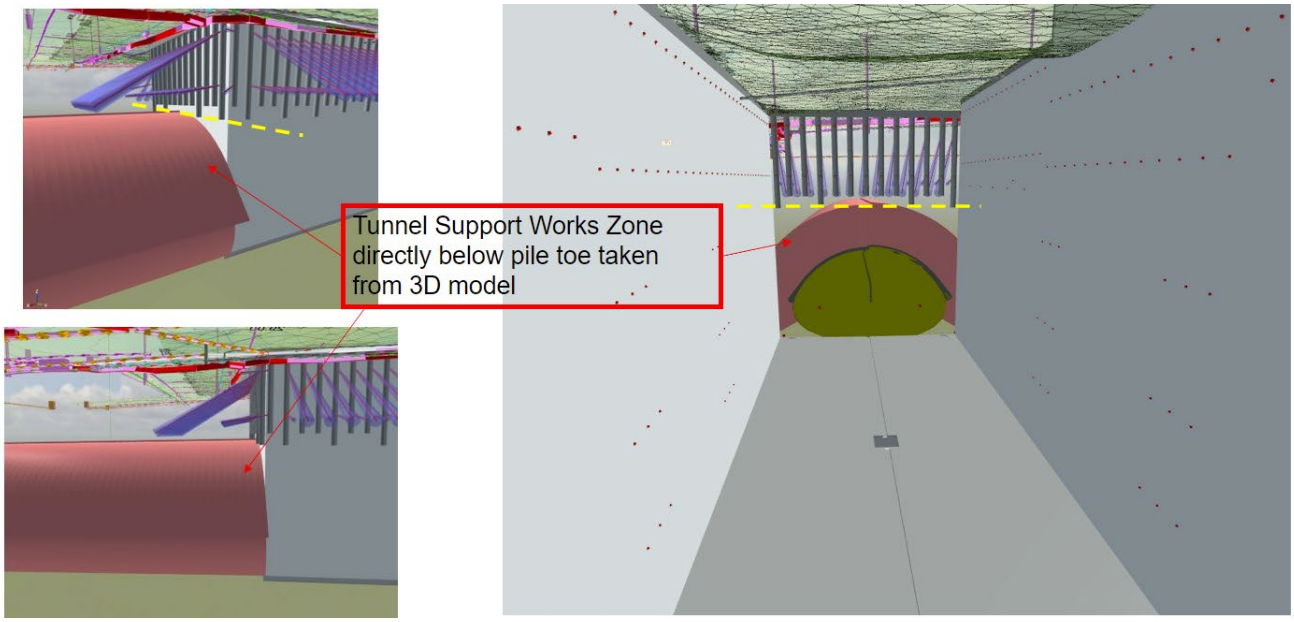

Figure 3: 3D model of tunnel support works zone on the eastern side of the station box

The change to the Westmead Metro Station construction site from a launch site to a retrieval site has had an overall significant reduction in the impacts from activities related to spoil removal and pre-cast segment deliveries has been recognised and summarised in Table 1.

Table 1: Westmead – Revised Volume of Deliveries to Support Tunnel Activities

Scope	Original Quantities	Revised Quantities	Movement Reductions
TBM Spoil Removal	7,567 tonnes/day	2,000 tonnes/day	230 truck and dogs per day
Pre-cast Segments	45 precast segments per day	Nil	8 semis per day
Support services	Varies	Nil	Up to 15 deliveries per day

Noise impacts may be apparent at the nearest receivers at certain times during the Project. For this reason, the Project should apply all feasible and reasonable mitigation measures to minimise their impacts on adjacent sensitive receivers. As identified in Chapter 9 of the EIS, tunnel works would be required to be completed for the Project and would define the overall Stage 1 duration. The EIS also identified that earlier completion of tunnelling works would bring considerable benefits to the community and in turn reduce the duration of construction related disruption.

During the planning phase for the Project, it was agreed that given the proximity of sensitive receivers to the Westmead Metro Station construction site, specific noise mitigation measures should be taken into account during all planning for the construction program, working hours and traffic management. With construction activities planned to be completed regularly 24 hours per day at the Westmead Metro Station construction site near sensitive receivers, the Project committed to the installation of an acoustic shed to cover all excavation and spoil handling activities. Acoustic panels will also be installed to cover the remainder of the cut and cover station box at the Westmead Metro Station construction site so a consistent acoustic treatment is provided for the works (see Figure 4).

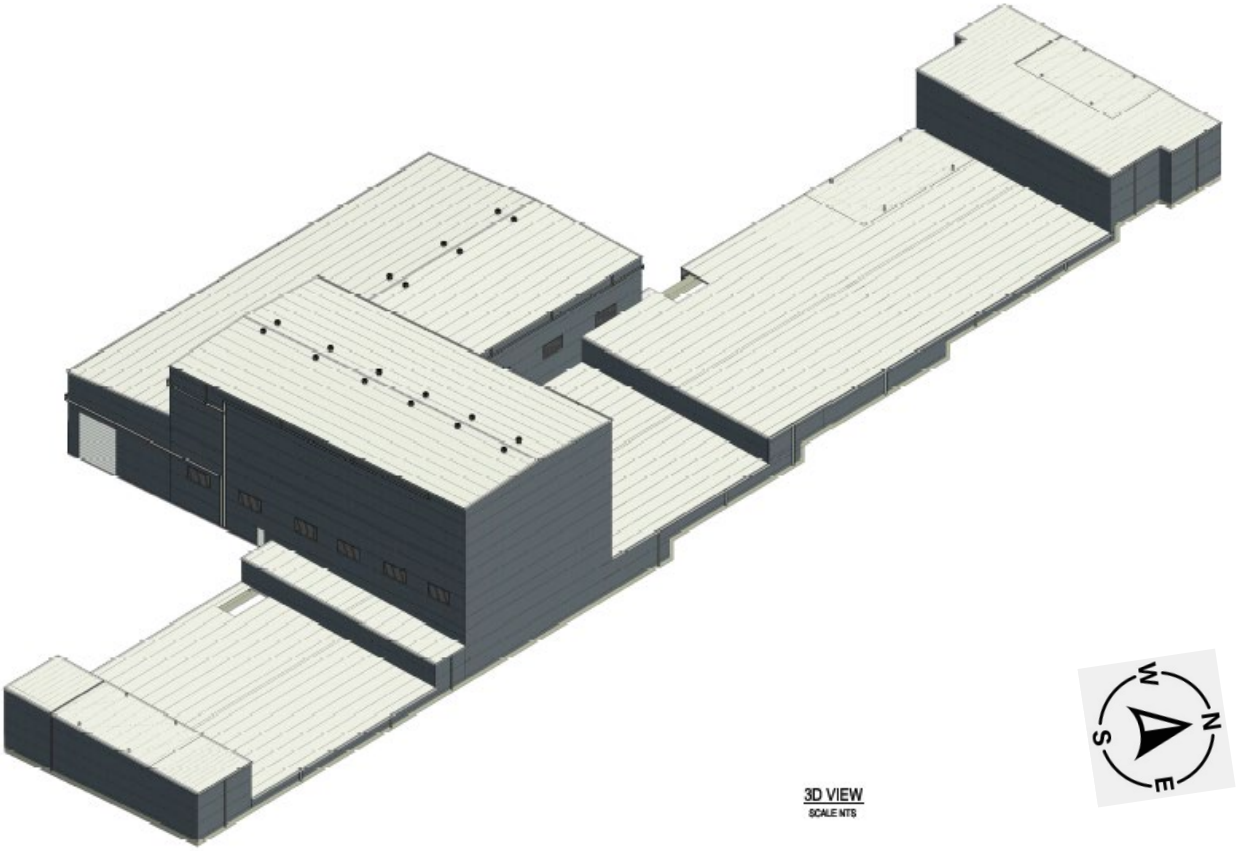

Figure 4: Westmead Metro Station Construction Site – Acoustic Shed and Cover Treatment

During the installation of the acoustic shed and cover over the eastern extent of the Westmead Metro Station box, access to complete tunnelling support works activities will be restricted. Indeed, with critical lifts required to complete the shed installation, exclusion zones are required to be put in place eliminating access to the eastern station box area during standard working hours. These temporary access restrictions will be in place for up to 15 weeks. The Westmead Metro Station construction site, tunnel support activities are proposed to be completed over the 15 weeks (i.e. short term) during OOHW Period 1, to ensure the overall duration of the Project is not extended, all whilst maintaining the installation of the acoustic shed to mitigate future longer term noise impacts to the surrounding community. Works are planned to be undertaken during OOHW 1 period, Monday to Saturday and Sunday 8am to 6pm.

Current site planning and installation sequencing is prioritising works associated with the acoustic shed structure. This prioritisation aims to accelerate the overall noise mitigation to the community from construction activities as early as reasonably practical with the acoustic shed walls on the eastern and southern sides of the station box sequenced to be erected first which will provide the mitigation benefit of the acoustic shed to the nearest affected receivers in Hassall and Bailey Streets With temporary access restrictions to complete tunnel support activities from the on-site sequencing of the acoustic shed, there is the potential that impacts to the mined tunnel program of up to 15 week may be recognised, therefore impacting the surety of overall TBM retrieval and a longer duration of impact on the adjacent community.

Due to restrictions being in place to undertake tunnel support activities in the eastern station box for up to 15 weeks during standard construction hours, the overall program for the delivery of the Westmead

Metro Station construction site is currently at risk. By completing the tunnel support activities during OOHW 1 period, delays to the overall tunnelling program can be mitigated and ensure the overall duration of the Project is not extended, all whilst maintaining the installation of the acoustic shed to mitigate future noise impacts to the surrounding community.

Tunnel support activities will be required to be completed over four (4) work zones at the Westmead Metro Station construction site. These works are shown in Figure 5 and summarised as:

- Stage 1 – installation of bolts (i.e CT bolts) to support newly excavated area. in Zones 1-3;
- Stage 2 – following bolt installation, mesh will be installed along the face of excavated area prior to shotcreting in Zones 1-3;
- Stage 3A – application of shotcrete over meshed area to provide safe support to newly excavated area in Zones 1-3;
- Stage 3B – delivery of concrete for shotcreting activities. Arrival will be via Hassall Street gate and exit via Hawkesbury Road gate; and
- Stage 4 –Use of bulldozer to push/move spoil into a suitable location for load out during standard construction hours in Zones 1-4.

Note: that some of these stages may occur concurrently and cumulative impacts experienced

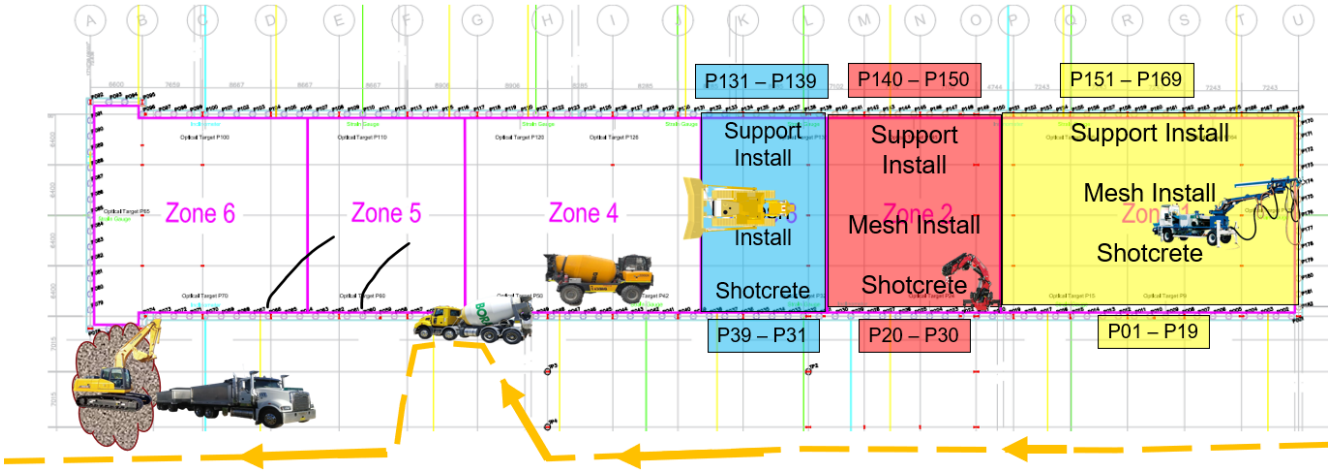

Figure 5: Westmead Metro Station Construction Site – Works Locations and Zones

Proposed construction program for these works is summarised in Table 2.

Table 2: Westmead Metro Station Construction Site – Tunnel Support Activities Program

Stage/Activity	May 2023	June 2023	July 2023	August 2023
Stage 1 – Support Installation (CT bolts) (Zones 1 – 3)	•	•	•	
Stage 2 – Support Installation (Mesh) (Zones 1 – 3)	•	•	•	

Stage/Activity	May 2023	June 2023	July 2023	August 2023
Stage 3A – Shotcrete installation (Zones 1 – 3)	•	•	•	•
Stage 3B – Shotcrete Delivery (Zone 5)	•	•	•	•
Stage 4 – Spoil Movement (Zones 1 – 4)		•	•	•

As part of the construction scheduling and programming, the construction team have considered alternatives to completing these tunnel support activities during OOHW Period 1 (see Table 2). These alternatives have included:

- Scheduling acoustic shed and panel construction works outside of standard construction hours instead – this option is not preferred as higher noise impacts are predicted to be received from the shed and panel construction activities. Plant and equipment being utilised to complete the shed and panel construction includes grinders, hammers, rattle guns and a 250T crawler crane. Activities being completed by this equipment would include cutting, sawing, hammering and lifting components which would be considered high noise impact works. Impacts from high noise impact works are not justified or permitted to be completed under the EPL. Note that these activities would also be completed on the surface and no attenuation recognised for completing works below the surface and outside the line of sight from adjacent receivers.

- Light spill from scheduling acoustic shed and panel construction works – with the close proximity of receivers to the site, the site team have recognised the potential for greater light spill during shed and panel installation activities should they be completed outside of standard construction hours. With significant temporary lighting required to illuminate the shed installation work area on the surface, light spill would be recognised by adjacent receivers. At the Westmead Metro Station construction site, mains powered lighting has been provided for the station box excavation with lights angled down below the ground illuminating the excavation area.

- Optimised design for acoustic shed and panel construction – due to restrictions on accessing the Westmead Metro Station construction site, large pre-fabricated elements are unable to be transported and stored on-site prior to assembly. Early in the construction program, the construction team investigated the option of large pre-fabricated modules for the acoustic shed and panels being constructed off-site and transported to site for assembly in final location. Due to traffic restrictions on adjoining public roads, any modules greater than 19m in length would need to be delivered outside of standard construction hours, further increasing potential impacts on adjoining receivers. Spatial restrictions at the site also mean that large modules cannot be successfully stored on the Westmead Metro Station construction site.

- Optimised design to minimise overlap of construction activities - early in the design process, the construction team proactively overlayed the Westmead Metro Station box design with the acoustic shed design to identify any elements that could be installed early in delivery. This review resulted in tie-down bolts and gantry crane supports being installed as part of earlier

works, in turn allowing pre-fabricated elements to be incorporated into the shed delivery program, where possible.

- Prioritisation of the acoustic shed and panel installation during standard construction hours to mitigate future impacts – current site planning and installation sequencing is prioritising works associated with the acoustic shed structure over other construction activities. This prioritisation aims to accelerate the overall noise mitigation to the community from these other construction activities as early as reasonably practical and for the longer-term duration. Should the construction team prioritise activities including the tunnel support works over the shed installation, longer timeframes without acoustic treatment would be recognised for adjacent receivers. It should also be noted that prioritising the installation of the acoustic shed will recognise attenuation earlier in the construction program and at a shallower depth of box excavation with the original Project DNVIS only modelling for the enclosure at depths of >6.0m.

- Acoustic treatments designed to include best practice attenuation measures– the design for the acoustic shed and panels has incorporated the installation of acoustic cladding/tiles which aim at absorbing and providing transmission loss to noise levels. As part of the original DNVIS, properties for acoustic sheds were included as Appendix F. These standard properties included the installation of acoustic cladding/tiles but only up to a height of 5.0m above floor surface level. At the Westmead Metro Station construction site, the acoustic cladding/tiles has been installed throughout the ~20m height of the acoustic shed. Note also, the fan box units which were designed to be installed on the surface have now been fully encapsulated into the acoustic shed structure.

3 EXISTING NOISE ENVIRONMENT

The Project area has been divided into nine (9) Noise Catchment Areas (NCAs) as defined in the Sydney Metro West – Westmead to the Bays Concept and Stage 1 EIS. These NCAs reflect the ambient noise environment of that area, as well as the noise and vibration sensitivity of the surrounding land uses. Tunnel support activities for the Westmead Metro Station construction site are proposed to be completed within Westmead which is across two (2) of the identified NCAs.

Summary of the in Table 3 and shown on Figure 3

Table 3: Noise Catchment Areas – Westmead Metro Station Construction Site - Tunnel Support Activities

NCA	Description
NCA01	North of the existing rail corridor in Westmead and mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.
NCA02	South of the existing rail corridor and mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.

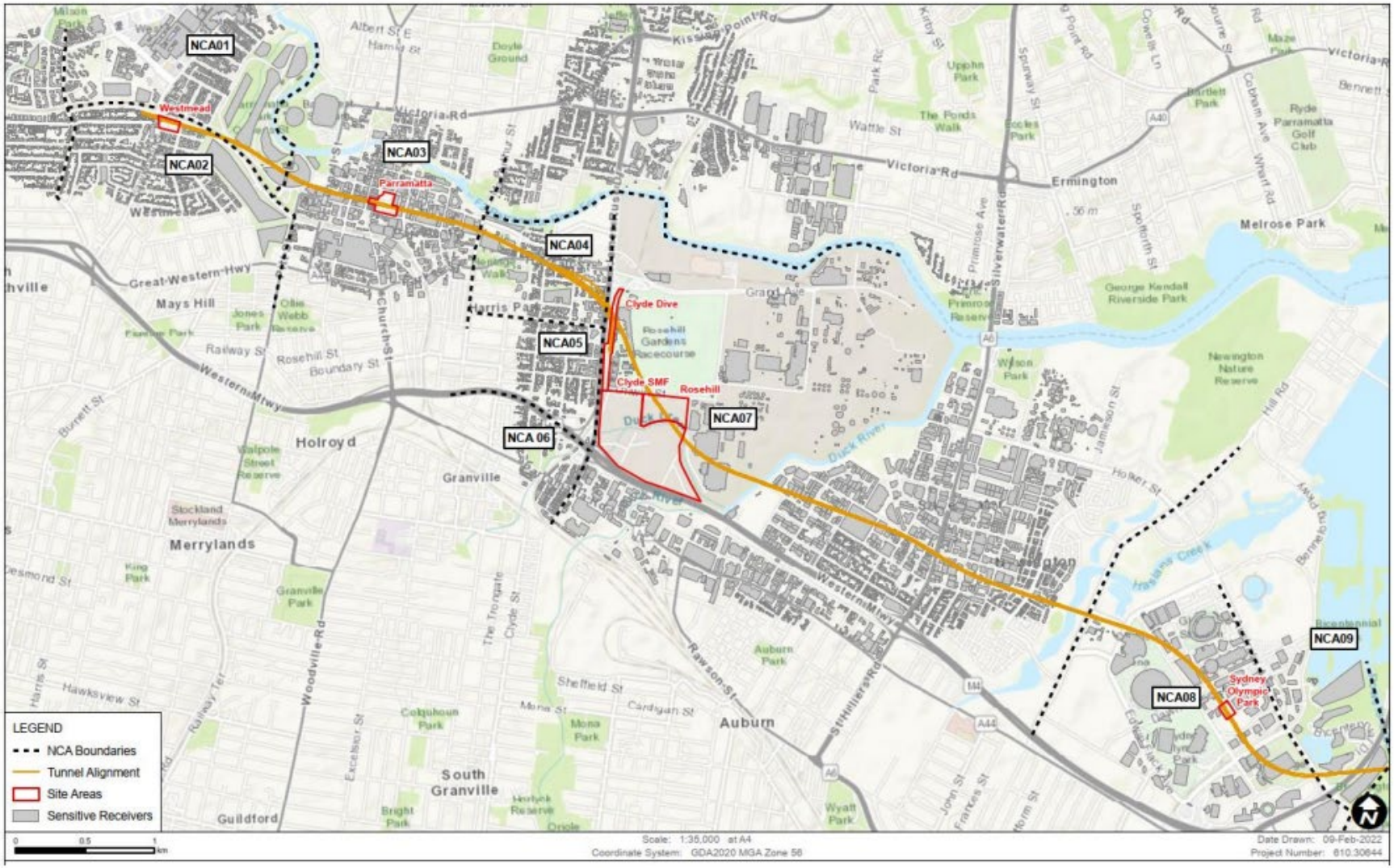

Figure 3: Noise Catchment Areas

The NMLs for residential Table 4 and "other sensitive receivers Table 5 have been adopted from the Project's NVMP and DNVIS. Project-specific NMLs for residential receivers were determined for each NCA. During OOHW the residential NML is determined as 5dB above the Rating Background Level (RBL) (i.e., RBL + 5dB).

NMLs for other sensitive receivers have been adopted from the *Interim Construction Noise Guideline* (ICNG), *Sydney Metro - Construction Noise and Vibration Standard* (CNVS), *AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors*, and previous assessments undertaken for the Sydney Metro West Project (e.g., EIS and modification reports).

Table 4: Project Residential NMLs

NCA	Receiver Type	Representative Logger Location	Noise Management Level ($L_{Aeq(15minute)}$ – dBA)				Sleep Disturbance Screening Level (52 dBA or RBL +15 dB whichever is higher) (L_{Amax} dBA)
			Approved Construction Hours (RBL+10dB)	Out of Hours (RBL+5dB)			
			Daytime	Daytime[1]	Evening	Night-time	Night-time
NCA01	Residential	B.02	58	53	51	46	56
NCA02	Residential	B.01	59	54	52	42	52

Table 5: NMLs for Other Sensitive Receivers – ICNG

Land Use	Assessment Period	Noise Management Level $L_{Aeq(15minute)}$ (dBA)	
		Internal	External
ICNG 'Other Sensitive' Receivers			
Classrooms at schools and other educational institutions	When in use	45	55[1]
Hospital wards and operating theatres	When in use	45	65[2]
Places of worship	When in use	45	55[1]
Active recreation areas (characterised by sporting activities and activities which generate noise)	When in use	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	When in use	-	60
Commercial	When in use	-	70
Industrial	When in use	-	75
Non-ICNG 'Other Sensitive' Receivers			
Hotel[3]	Day / Evening	50	70[2]
	Night-time	40	60[2]
Café / Bar / Restaurant[3]	When in use	50	70[2]
Child Care Centres – Sleeping areas[4]	When in use	40	50[1]
Public Building	When in use	50	60[1]
Recording Studio	When in use	25	45[2]
Theatre/Auditorium	When in use	30	50[2]
Rosehill Gardens Racecourse Stables[5]	When in use	-	60

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 3: Adopted from AS2107.

Note 4: Adopted from *Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment*.

Note 5: Adopted from the ICNG – passive recreation.

4 AIRBORNE NOISE IMPACT ASSESSMENT

4.1 Construction Noise and Vibration Modelling Strategy

To assess the noise and vibration impacts for the proposed tunnel support activities during OOHW Period 1 (see Table 2) at the Westmead Metro Station construction site, five (5) individual construction noise and vibration impact assessments (CNVISs) have been prepared as follows:

- Sydney Metro West WTP CNVIS – Stage 1 – Support Installation (CT Bolts) (dated 20th April 2023) – see Attachment 2; and
- Sydney Metro West WTP CNVIS – Stage 2 – Support Installation (Mesh) (dated 20th April 2023) – see Attachment 3; and
- Sydney Metro West WTP CNVIS – Stage 3A – Shotcrete Installation (dated 20th April 2023) – see Attachment 4; and
- Sydney Metro West WTP CNVIS – Stage 3B – Delivery of Shotcrete (dated 20th April 2023) – see Attachment 5; and
- Sydney Metro West WTP CNVIS – Stage 4 – Spoil Movements (dated 20th April 2023) – see Attachment 6.

As some of these stages of work may also occur concurrently, CNVIS's have been prepared to identify cumulative impacts that may be experienced as follows:

- Sydney Metro West WTP CNVIS – Stages 1 & 2 (dated 20th April 2023) – see Attachment 7; and
- Sydney Metro West WTP CNVIS – Stage 2 & 3 (dated 20th April 2023) – see Attachment 8; and
- Sydney Metro West WTP CNVIS – Stage 1, 2 & 4 (dated 20th April 2023) – see Attachment 9; and
- Sydney Metro West WTP CNVIS – Stage 2, 3 & 4 (dated 20th April 2023) – see Attachment 10.

4.1.1 Tunnel Support Activities

To accommodate the variable noise and vibration impact from the four (4) stages of works proposed to be completed within the Westmead Metro Station construction site, works were modelled as five (5) independent work activities. As some of these stages of work may also occur concurrently, cumulative impacts that may be experienced during four (4) scenarios as outlined in Table 6. This has been considered in the cumulative impact to receivers and identifying opportunities to reduce impacts through progressive works.

The CNVIS's prepared for the four (4) stages of construction works for the tunnel support activities indicate that surrounding receivers will be impacted by noise. These predicted noise impacts are likely to occur across all four (4) stages of construction and have been summarised in Table 7.

Table 6: Westmead Metro Station Construction Site – Tunnel Support Activities – Cumulative Scenarios

		Cumulative Scenarios during Stages of Works				
		Stage 1	Stage 2	Stage 3A	Stage 3B	Stage 4
Stages of work	Stage 1		●			●
	Stage 2	●		●	●	●

		Cumulative Scenarios during Stages of Works				
		Stage 1	Stage 2	Stage 3A	Stage 3B	Stage 4
	Stage 3A		●		●	●
	Stage 3B		●	●		●
	Stage 4	●	●	●	●	

4.1.2 Predicted Noise Impacts

The CNVIA's prepared for the four (4) stages of construction works for the tunnel support activities indicate that surrounding receivers will be impacted by noise. These predicted noise impacts are likely to occur across all four (4) stages of construction and have been summarised in Table 7.

While CNVIS's have been prepared for each of the four (4) stages of construction works for the tunnel support activities, some of these stages of work may also occur concurrently. CNVIA's have been prepared to identify cumulative impacts and also indicate that surrounding receivers will be impacted by noise. These cumulative noise impacts are likely to occur across four (4) stages of construction and have been summarised in Table 8.

Table 7: Construction Noise Assessment – Westmead Metro Station Construction Site - Tunnel Support Activities

Stage/Activity	Stage 1 – Support Installation (CT Bolts)	Stage 2 – Support Installation (Mesh)	Stage 3A – Shotcrete Installation	Stage 3B – Shotcrete Deliveries	Stage 4 – Spoil Movements
OOHW1 **Note 1: NML during OOH1 Periods:** - **NCA-01 = 51dBA** - **NCA-02 = 52dBA** **Note 2: as works are being completed during OOHW1 period, no sleep disturbance impacts are predicted.**					
Worst-case Residential receiver – noise level	67dBA	56dBA	59dBA	56dBA	70dBA
Worst case Residential receiver – exceedance above NML	Up to 15dBA	Up to 4 dBA	Up to 7dBA	Up to 4dBA	Up to 18dBA
Number of Residential Receivers above NML	41 Receivers (14 separate apartment buildings)	2 Receiver (1 apartment building)	2 Receivers (1 apartment building)	3 Receivers (2 separate apartment buildings)	68 Receivers (18 separate apartment buildings & 4 houses)
Summary of NML exceedance ranges for OOHW Period 1					
Noticeable 0<=10dBA above NML	39	2	2	3	65
Clearly Audible 10 <=20dBA above NML	2	Nil	Nil	Nil	3
Moderately Intrusive 20 <=30dBA above NML	Nil	Nil	Nil	Nil	Nil
Highly Intrusive >30dBA above NML	Nil	Nil	Nil	Nil	Nil

While CNVIA's have been prepared for each of the four (4) stages of construction works for the tunnel support activities, some of these stages of work may also occur concurrently. CNVIA's have been prepared to identify cumulative impacts and also indicate that surrounding receivers will be impacted by noise. These cumulative noise impacts are likely to occur across four (4) stages of construction and have been summarised in Table 8.

Table 8: Construction Noise Assessment – Westmead Metro Station Construction Site – Cumulative Impacts from Concurrent Tunnel Support Activities

Stage/Activity	Stage 1 & 2	Stage 2, 3A & 3B	Stage 1, 2 & 4	Stage 2, 3A, 3B & 4
OOHW1 **Note 1: NML during OOH1 Periods:** - **NCA-01 = 51dBA** - **NCA-02 = 52dBA** **Note 2: as works are being completed during OOHW1 period, no sleep disturbance impacts are predicted.**				
Worst-case Residential receiver – noise level	67dBA	62dBA	72dBA	70dBA
Worst case Residential receiver – exceedance above NML	Up to 15dBA	Up to 10dBA	Up to 20dBA	Up to 18dBA
Number of Residential Receivers above NML	42 Receivers (14 separate apartment buildings)	10 Receivers (4 separate apartment buildings)	107 Receivers (33 separate apartment buildings & 6 houses)	79 Receivers (28 separate apartment buildings & 4 houses)
Summary of NML exceedance ranges for OOHW Period 1				
Noticeable 0<=10dBA above NML	40	10	101	75
Clearly Audible 10 <=20dBA above NML	2	Nil	6	4
Moderately Intrusive 20 <=30dBA above NML	Nil	Nil	Nil	Nil
Highly Intrusive >30dBA above NML	Nil	Nil	Nil	Nil

Under the current EPL conditions and subsequent program of works, the duration of impacts where NMLs are expected to be exceeded and the resulting program for the community would be:

- Up to 75 shifts duration = over a period of up to 15 weeks or four (4) months.

The program of works summarised in Table 2, would commence in May 2023 and is proposed to be completed by August 2023.

4.1.3 Predicted Vibration Impacts

Construction activities may have the potential to generate vibration. Impacts may be recognised from activities that relate to:

- Human comfort - goals established from Environmental Noise Management – Assessing Vibration: A Technical Guideline (DECC: 2006);
- Cosmetic damage – criteria applied from BS 7385 Part 2 – 1993 Evaluation and Measurement for Vibration in Buildings (Part 2);
- Structural damage– criteria applied from BS 7385 Part 2 – 1993 Evaluation and Measurement for Vibration in Buildings (Part 2); and/or
- Heritage buildings – DIN 4150 – Vibration in Buildings (Part 3).

Based on the proposed works locations and selected equipment, no indicative exceedances of vibration criteria are expected from the tunnel support activities. The potential for exceedances are based on recommended working distances from vibration intensive equipment listed in Appendix D of the CNVS (TfNSW: 2019).

5 NOISE AND VIBRATION MANAGEMENT AND MITIGATION MEASURES

5.1 Specific Mitigation Measures

Noise and vibration for the scope of works outlined above will be managed in accordance with the Project EPL and Planning Approval, specifically as detailed in the following Project documents:

- CNVMP – Sydney Metro West Western Tunnelling Package; and
- Construction Noise and Vibration Monitoring Program (NVMoP); and
- DNVIS.

Key mitigation strategies will continue to be implemented across all worksites including tunnel support activities at the Westmead Metro Station construction site as follows:

- Staff and subcontractors will receive specific training on the required noise and vibration controls for these works including:
  - Permissible hours of works;
  - Limits on high noise generating activities;
  - Locations of works and adjacent sensitive receivers;
  - EPL and MCoA approval pathways;
  - Work staging and modelled equipment usage; and
  - Appropriate site behaviour and practices.

  This information will be conveyed through specific toolbox presentations and pre-start briefings with the work crews undertaking the work activities.

- Pro-active engagement and consultation with affected communities. Where predicted mitigated noise levels remain above Project NMLs, consultation will form an important part of the noise management strategy. Since the project start, consultation has included a combination of regular letterbox drops, specific notifications, doorknocks and/or phone calls. The early consultation specific to these tunnel support works has been summarised in Attachment 11. During the early consultation, no concerns were raised by the community about those works and no additional specific mitigation measures were identified. Further consultation will be undertaken post approval of this DNVIS and will include additional mitigation measures including address-specific noise monitoring or project-specific respite offers (RO) if required. Signage is also provided on site perimeter hoarding displaying a 24-hour contact number.

  The WTP Community and Stakeholder Relations team have reviewed the predicted impacts on receivers adjacent to these proposed tunnel support activities and developed a communications strategy. Specific outcomes of this strategy will be included with each OOHW permit, to ensure all consultation is being completed in accordance with the Project approval.

- 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. With these types of "Other Receivers" including the Westmead Public School in close proximity to the Westmead Metro Station construction site, timetabling these tunnel support activities during the OOHW Period 1 times, shows the Project's commitment to carrying out noise-generating works outside of sensitive periods.

- Noise attenuation structures will be implemented. These structures include the site perimeter hoarding installed along the boundaries of site which has been increased to 3.0m from 2.4m to provide further mitigation; portable noise barriers being installed around particularly noisy works or equipment; and the strategic placement of structures on-site to shield adjacent receivers including double-stacked office buildings and storage containers.

- Acoustic treatments including spoil sheds and panel covers will be installed at the Westmead Metro Station construction site. The acoustic shed and panel covers have been scheduled to be installed over the duration of these tunnel support works. The current sequence of shed construction commences from the eastern/south side of the box excavation and progresses towards the west/north, providing mitigation benefits for the nearest affected receivers on Hassall and Bailey Streets earlier in the schedule. Note that tunnel support activities are planned to be conducted in the eastern/southern extent of the station box and mitigation from the shed and panel installation is already being recognised with installation already underway. Note also that construction works on the acoustic shed commenced prior to these tunnel support works with tie-down bolts installed as part of the box ground support to facilitate an accelerated shed build concurrently with box excavation.

- Noise source mitigation will be used where possible, including:
  - Use of temporary noise barriers including noise blankets (or similar) to shield high noise impact works;
  - Appropriately-sized and maintained equipment and used to complete the works;
  - Ensuring plant and equipment Sound Power Levels (SWLs) are compliant with those predicted in the specific CNVIS;
  - Substitution for low-impact construction equipment including the use of battery and/or solar powered generators over the use of diesel-powered equipment. Note that fixed lighting powered by mains power will be utilised over the use of powered lighting plants;
  - Substitution for lower-impact construction techniques including the use of a bulldozer to rip and remove spoil materials over the use of hydraulic excavators with hammers breaking the rock. Productivity benefits are being recognised by this substitution of plant with the bulldozer completing spoil movement activities in up to 1/3 of the time (i.e. excavation in 2-3 days with excavators using hydraulic hammers is being recognised in 1 day with bulldozer). Note that should hydraulic hammering still be required, the construction team will only be completing these works in standard construction hours. No load out of spoil is planned to be completed outside of standard construction hours either, with spoil materials being pushed-up below the ground surface level but not loaded out until standard construction hours.
  - Keep dozer in low gear if practicable;
  - Stationary noise sources such as generators being located away from sensitive receivers and where possible, shielded using portable noise blankets;
  - Set-up of work areas to minimise reversing plant and vehicles;
  - Scheduling works in locations that will provide the maximum shielding to noise sensitive receivers (where possible);
  - No vibration-intensive activities are planned to be completed, minimising the ground-borne noise impacts to adjacent buildings.
  - Non-tonal/broadband reverse alarms for all equipment supporting the works; and
  - Correct use and maintenance of manufacturer supplied noise suppression devices.

5.2 Additional Mitigation Measures

Where the predicted 'mitigated' construction noise levels are above the project-specific NMLs, the Additional Mitigation Measures (AMM) identified in the Sydney Metro CNVS are to be implemented. The AMM for ground-borne noise and construction vibration are also applicable where predictions are above the relevant management levels. The approach, guided by the AMM, is primarily aimed at pro-active engagement with affected sensitive receivers rather than additional noise reducing mitigation. The AMM applies to all receiver types where these receivers are in-use. The types of additional mitigation measures for construction noise are listed in Table 9 and further described in the Sydney Metro CNVS. The AMMs for construction noise are identified in Table 10.

Table 9: Additional Mitigation Measures

Mitigation / Management Measure	Abbreviation
Alternative accommodation	AA
Monitoring	M
Individual briefings	IB
Letter box drops	LB
Project-specific respite offer	RO
Phone calls and emails	PC
Specific notification	SN

Table 10: Additional Mitigation Measures Matrix – Construction Noise

Time Period		Mitigation Measures Predicted $L_{Aeq(15minute)}$ noise level above NML			
		0 to 10 dBA	11 to 20 dBA	21 to 30 dBA	> 30 dBA
Approved Hours	Mon-Fri (7am – 6pm)	-	LB	LB, M, SN	LB, M, SN
	Sat (8am – 6pm)				
	Sun/Pub Hol (Nil)				
OOHW (Evening)	Mon-Fri (6pm – 10pm)	LB	LB, M	LB, M, SN, RO	LB, M, SN, IB, PC, RO
	Sat (6pm – 10pm)				
	Sun/Pub Hol (8am -6pm)				
OOHW (Night)	Mon-Fri (10pm – 7am)	LB	LB, M, SN, RO	LB, M, SN, IB, PC, RO, AA	LB, M, SN, IB, PC, RO, AA
	Sat (10pm – 8am)				
	Sun/Pub Hol (6pm -7am)				

As part of the planning for these proposed works, AMM outlined in the CNVS will be implemented where reasonable and feasible, unless other agreements are in place with the potentially impacted Receiver. Predicted noise impacts for the stages are summarised in Table 7 and Table 8 respectively. Worst case scenario, predicted impacts are up to 10-20dBA above the NML in OOHW1 period requiring letter box drops (LB) and monitoring (M) only.

5.3 Noise and Vibration Monitoring

Noise and vibration for the Sydney Metro WTP will be managed in accordance with the Noise and Vibration Monitoring Program – Sydney Metro West Western Tunnelling Package (NVMoP).

In accordance with MCoA C14, a noise monitoring program has been designed to include noise monitoring at sensitive receivers during critical periods of high-risk noise events.

In accordance with MCoA C16 real-time noise and vibration monitoring will be the focus of monitoring. Vibration monitoring devices will be installed between the works and any at sensitive structures when safe working distances of vibration generating activities are imposed upon. Real-time noise monitoring will be undertaken at locations representative of the nearest and potentially most affect receivers.

GLC will utilise SiteHive real-time environmental management technology capturing data 24/7 at the Westmead Metro Station Construction Site. Noise and vibration data will be captured for analysis and reporting in the SiteHive platform. The benefits of this include:

- Proactive real-time environmental management ensures potential issues are addressed before they occur, allowing streamlined operations and significant reduction in manual work.
- Project teams can access live environmental data from site, wherever they are, allow quick confident decisions to be made, informed by rich data.
- Network of SiteHive data across metropolitan areas, including data from EPA & Bureau of Meteorology (BoM) stations, allows trends to be analysed to determine site activity vs ambient conditions.
- Transparency and collaboration with stakeholders greatly increased through real-time data sharing, creating a much more productive and positive delivery environment.

As per MCoA C16 real time monitoring data will be readily available to the construction team, Sydney Metro, the ER and the AA. Monitoring data will also be made available to the Planning Secretary and EPA on request.

To verify predicted noise levels are in accordance with those modelled, attended noise monitoring will be conducted at noise sensitive receivers during OOHWs where the monitoring has been identified as an "additional mitigation measure". Monitoring locations will be outlined in a noise monitoring plan developed to cover the specific works and included with the OOHW protocol for the works.

Monitoring will also be undertaken in the event of a complaint being received.

6 CONCLUSION

This assessment has been prepared to accompany the Project-wide DNVIS and CNVMP and to comply with MCoA D43 and D44. The CNVMP was developed as part of the delivery of the Project,

Consistent with other major infrastructure projects in suburban/urban areas, noise and vibration impacts during construction are inevitable as works require the use of noise and vibration intensive equipment in proximity to sensitive receivers.

The airborne noise impact assessment finds that noticeable to clearly audible impacts are generally predicted from tunnel support activities at the Westmead Metro Station construction site. As construction activities are proposed to occur during out of hours OOHW Period 1, there is no potential for sleep disturbance impacts for receivers adjacent to the Westmead Metro Station construction site. Reasonable and feasible construction management and mitigation measures will be implemented to reduce noise events as far as practicable. These will be focused on training and information for personnel, proactive engagement and consultation with affected community, timetabling of noise-generating activities outside of sensitive periods, noise attenuation structures and treatments and noise source controls implemented for the specific plant and equipment being utilised. As the predicted 'mitigated' construction noise levels are above the project-specific NMLs, AMM's required to support these works. Worst case scenario predicted impacts are up to 10-20dBA above the NML in OOHW Period 1 requiring letter box drops and monitoring to be completed.

The construction vibration assessment found that due to the activities being completed and distance to receivers, no indicative exceedances of vibration criteria are expected from the tunnel support activities.

Based on the outcomes of the assessment, completing tunnel support works at the Westmead Metro construction site during OOHW Period 1 may be noticeable to clearly audible at a number of adjacent receivers. No vibration impacts from these works are predicted. Feasible and reasonable mitigation measures will be put in place during tunnel support works at the Westmead Metro Station construction site to control and minimise the impacts during construction as far as reasonably practicable in accordance with the CNVMP and the CNVS.

ATTACHMENTS

Attachment 1 – Requirements Matrix

This DNVIS has been developed to satisfy the requirements of the MCoA D43 and D44. A list of applicable requirements from the MCoA, Sydney Metro - Construction Environment Management Framework (CEMF) and the Sydney Metro CNVS is provided below

ID No.	Requirements	Reference
Ministers Conditions of Approval (MCoA)		
D35	Work must only be undertaken during the following hours: (a) 7:00am to 6:00pm Monday to Fridays; and (b) 8:00am to 6:00pm Saturdays; and (c) at no time on Sundays or Public Holidays.	Project-wide DNVIS (Section 1.1.5)
D37	Notwithstanding Conditions D35 and D36 of this schedule, work may be undertaken outside the hours specified in the following circumstances: (a) By prescribed activity, including: (i) Tunnelling (excluding cut and cover tunnelling and surface works) are permitted 24 hours a day, seven days a week	Section 2
D39	All reasonable and feasible 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 ICNG (DECC, 2009)	Section 3, Project-wide DNVIS (Section 3.2).
	(b) Vibration criteria established using the *Assessing Vibration: A Technical Guideline* (DEC, 2006) for human exposure	Not applicable – no vibration is expected from the tunnel support activities being proposed
	(c) Australian Standard AS 2187.2: 2006 "Explosives – Storage and Use – Use of Explosives" (for human exposure)	Not applicable – blasting not part of Project design
	(d) BS 7385 Part 2-1993 'Evaluation and measurement for vibration in Buildings – Part 2" as they are applicable to Australian conditions; and	Not applicable – no vibration is expected from the tunnel support activities being proposed
	(e) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration – Effects of Vibration on Structures (for structural damage for structurally unsound heritage items.	Not applicable – no structurally unsound heritage items in vicinity of the Westmead Station Metro construction site.

ID No.	Requirements	Reference
	Any work identified as exceeding the NMLs and/or vibration criteria must be managed in accordance with the Project NVMP. Note that the ICNG identifies "particularly annoying: activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML.	Section 4
D41	Noise generating works 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 institution are made at no cost to the affected institution.	Section 4
D42	Industry best practice construction methods must be implemented where reasonably practicable to ensure that noise levels are minimised around sensitive land user(s). Practices must include, but are not limited to: (a) use of regularly serviced, low sound power equipment;	Section 4
	(b) temporary noise barriers (including the arrangement of plant and equipment) around noisy equipment and activities such as rock hammering and concrete cutting; and	Section 4
	(c) use of alternative construction and demolition techniques.	Section 4
D43	Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed NMLs, vibration criteria and/or ground borne noise levels specified in Conditions D39 and D40 of this schedule at any residence outside of construction hours identified in Condition D35 of this schedule, or where receivers will be highly noise affected. The DNVIS will 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 AA and 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 4 Attachment 10
D44	DNVIS must be prepared for each construction site before construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive land users.	This document
D45	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	Not applicable – no vibration is expected from the tunnel

ID No.	Requirements	Reference
	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.	support activities being proposed
D46	Vibration testing must be conducted during vibration generating activities that have the potential to impact on Heritage items to identify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and 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	Not applicable – no vibration is expected from the tunnel support activities being proposed
D49	If a heritage item is found to be structurally unsound (following inspection) a more conservative cosmetic damage criterion of 2.5 mm/s peak component particle velocity (from DIN 4150) must be applied	Not applicable – no structurally unsound heritage items in vicinity of the Westmead Station Metro construction site.
D63	Appropriate equipment to monitor areas in proximity of construction sites and the tunnel route during construction must be installed with particular reference to at risk buildings, structures and utilities identified in the condition surveys required by Condition D60 of this schedule and / or geotechnical analysis as required. If monitoring during construction indicate exceedance of the vibration criteria identified in the DNVIS prepared under Condition D43 of this schedule, then all construction affecting settlement must cease immediately and must not resume until fully rectified or a revised method of construction is established that will ensure protection of affected buildings.	Not applicable – no vibration is expected from the tunnel support activities being proposed
Sydney Metro – Construction Environmental Management Framework (CEMF)		
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 EPL's and applications to relevant agencies).	This document
Sydney Metro – Construction Noise and Vibration Standard (CNVS)		
3.1	Detailed Noise & Vibration Impact Statements (DNVIS)	Section 4

ID No.	Requirements	Reference
	• Identify sensitive receivers	
	• Determine background noise levels	Section 4
	• Determine noise and vibration management levels	Section 4
	• Determine source noise levels and construction scenarios	Section 4
	• Identify mitigation and measures	Section 5
	• Classify impacts	Section 4.1.2 & 4.1.3
4	Standard Noise and Vibration Measures For all Sydney Metro construction projects, the standard mitigation measures in Table 11 (of the CNVS) shall be applied by default where feasible and reasonable in order to minimise the potential noise and vibration impacts at the surrounding noise sensitive receivers.	Section 5, Project-wide DNVIS (Section 8.1)
9	Documentation Requirements • Acoustic terminology/glossary	Terms & Definitions
	• Overview of the Project/Works	Section 2
	• Secretary's Environmental Assessment Requirements	Attachment 1
	• Site Plan and Sensitive Receivers	Section 3
	• Ambient Noise Monitoring	Project-wide DNVIS (Section 2.3)
	• Construction Noise and Vibration Assessment	Attachments 2-10
	• Summary of Noise and Vibration Impacts	Section 4 & 6
	• References	Within Document

Attachment 2 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities– Stage 1 – Support Installation (CT Bolts)

Attachment 3 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Stage 2 – Support Installation (Mesh)

Attachment 4 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Stage 3A – Shotcrete Installation

Attachment 5 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Stage 3B – Shotcrete Deliveries

Attachment 6 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Stage 4 – Spoil Movements

Attachment 7 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Cumulative Assessment – Stages 1 & 2

Attachment 8 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Cumulative Assessment – Stages 2 & 3

Attachment 9 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Cumulative Assessment – Stages 1, 2 & 4

Attachment 10 – Construction Noise & Vibration Assessment – Westmead Metro Station Construction Site – Tunnel Support Activities – Cumulative Assessment – Stages 2, 3 & 4

Attachment 11 – Consultation Summary

On Wednesday 17th and Thursday 18th May 2023, the Project Team undertook doorknocking at the following properties:

Property address	Results
10-12 Hassall Street	Spoke to 8 residents out of 13 properties
23-25 Hassall Street	Spoke to 4 residents out of 8 properties
13-17 Bailey Street	Spoke to 16 residents out of 24 properties
22-24 Bailey Street	Spoke to 8 residents out of 14 properties
26-30 Bailey Street	Spoke to 13 residents out of 19 properties
123-129 Hawkesbury	Spoke to 6 residents out of 9 properties
154 Hawkesbury Rd	Spoke to resident
156 Hawkesbury Rd	Spoke to resident

Success rate: 57 of 89

The discussion related to the progression of tunnelling activities at the Westmead Construction Site. Work activities discussed were:

- Construction and installation of the project's acoustic shed is currently underway.
- delivery of up to 8 concrete trucks a night between 6pm and 10pm Monday to Friday to progress the tunnelling activities.
- work activities within the station box excavation, including mesh installation and shotcrete.
- Residents advised they would receive notification of commencement of this work shortly. Scheduled to commence within next couple of weeks.
- Residents advised noise monitoring would be carried out when these works commence. Noise monitoring is also ongoing at the project.

During the door knock, the residents were also asked if they had any questions or issues arising from the project works.

Overall, the response from the residents was really positive.

Comments received from residents included:

- Looking forward to having the acoustic shed in place as this will assist in reducing noise from work activities
- Installation of the fan shed (much shorter than the acoustic shed will be) has already reduced noise to resident opposite site.
- One resident stated it was too quiet during the Easter break when we were not working
- Couple of people commented that our work activities have now become part of their background noise

- No resident had any concerns about the concrete trucks coming in between 6pm and 10pm
- One resident advised his children went to bed at 7.30pm and we discussed the noise assessment carried out identifying minimal impact. Resident advised to contact the 1800 number if he had any concerns once this activity commenced
- A couple of general enquiries on the construction timeline for the overall Metro project (2030)
- Two residents also asked about installation of the acoustic treatment at their resident property. Residents were referred to Sydney Metro to progress

Note that Sorry We Missed You cards were left at properties where no-one was home, requesting they contact GLC via the 1800 number to discuss forthcoming works. Any additional feedback received will be taken into consideration.