

Table 2 Work Activities

Work ID	Scenario	Description ¹	Hours of Work ²	Approximate Schedule
S1 (a, b and c) ¹	FRP works (west opening)	Steel fixing and/or falseworks operations taking place in the cross over caverns with the western enclosure of acoustic shed removed	AH, OOHW1, OOHW2	2 Weeks
S2 (a, b and c) ¹	FRP works (west and east opening)	Steel fixing and/or falseworks operations taking place in the cross over covers with western and eastern enclosure of acoustic shed removed	AH, OOHW1, OOHW2	2 Weeks
S3	FRP works (no enclosures)	Steel fixing and falseworks operations taking place in the cross over caverns with the entire acoustic shed and enclosures are removed	AH, OOHW1, OOHW2	12 Weeks
S4a	Shotcreting works (west opening)	Shotcrete works taking place in the station box excavation with the western acoustic shed removed	AH, OOHW1	2 Weeks
S4b	Shotcreting works (west and east opening)	Shotcrete works taking place in the station box excavation with the western and eastern acoustic shed removed	AH, OOHW1	2 Weeks
S5	Acoustic shed removal	Removal of the acoustic shed during approved hours Removal of the eastern fan box portion during easter weekend public holiday	AH, OOHW1 - Day (Public Holiday)	8 weeks
S6a	Shed Demolition – without Crane	Removal acoustic shed covering gantry crane without crane	AH, OOHW1, OOHW2	1 - 2 Weeks
S6b	Shed Demolition – with Crane	Removal acoustic shed covering gantry crane including 150 tonne crane		
S7	Fassi crane operation	Operation of the Fassi crane to conduct lifting from the box	AH, OOHW1, OOHW2	12 Weeks

Note 1: Steel fixing and falseworks operations have been assessed as separate activities under scenarios S1a/S2a and S1b/S2b respectively. S1c/S2c represents both steel fixing and falseworks operations occurring concurrently.

Table 3 Construction Scenarios and Equipment

Equipment			Total Lw - LAeq (dBA)	Lw - L _{max} (dBA)	Circular Saw ¹	Compressor	Concrete agitator truck (tunnel)	Crane (mobile) – Up to 150t	Crane (mobile) – Up to 750t	Crane – Fassi – Beam Mounted (Electric)	Elevated Work Platform	EWP - Scissor Lift	Excavator - Tracked (40t) (With Shear and Grabs Attachment)	Excavator - Tracked (50t) (With Shear Attachment)	Gantry Crane	Grinder ¹	Hammer Drill (Handheld)	Industrial Fans with Attenuators	Hand tools	Light Vehicle - Idling	Lighting - Day maker	Rattle Gun (handheld)	Shotcrete Rig	Safety Lifting Siren	Telehandler	Truck – Medium Rigid (20 tonne)	Truck – Semi Trailer (30 tonne)	Welding Equipment
Sound Power Level (Lw) ²					112	109	105	104	106	82	97	98	115	115	98	105	109	88	102	82	98	104	108	90	95	103	108	110
Estimated utilisation in 15min period (%)					25	100	100	30	30	30	30	100	100	100	100	20	30	100	100	100	100	50	50	5	50	100	100	50
ID	Construction Scenario	Assessment Period																										
S1a	Steel fixing (west opening)	AH/OOHW1/OOHW2	109	118 ^{3,7}	-	-	-	-	-	-	-	-	-	-	1 ⁴	2 ⁵	-	2	-	-	-	-	-	-	1 ^{4,5}	-	-	1 ⁵
S1b	Falseworks Operation (west opening)	AH/OOHW1/OOHW2	116	120 ^{3,7}	3 ⁵	-	-	-	-	-	-	4 ⁵	-	-	1 ⁴	2 ⁵	2 ⁵	2	6 ⁵	-	-	6 ⁵	-	-	1 ^{4,5}	-	-	-
S1c	FRP Works (S1a + S1b)	AH/OOHW1/OOHW2	116	120 ^{3,7}	3 ⁵	-	-	-	-	-	-	4 ⁵	-	-	1 ⁴	2 ⁵	2 ⁵	2	6 ⁵	-	-	6 ⁵	-	-	2 ^{4,5}	-	-	1 ⁵
S2a	Steel fixing (west + east opening)	AH/OOHW1/OOHW2	109	118 ^{3,7}	-	-	-	-	-	-	-	-	-	-	1 ⁴	2 ⁵	-	2	-	-	-	-	-	-	1 ^{4,5}	-	-	1 ⁵
S2b	Falseworks Operation (west + east opening)	AH/OOHW1/OOHW2	116	120 ^{3,7}	3 ⁵	-	-	-	-	-	-	4 ⁵	-	-	1 ⁴	2 ⁵	2 ⁵	2	6 ⁵	-	-	6 ⁵	-	-	1 ^{4,5}	-	-	-
S2c	FRP Works (S2a + S2b)	AH/OOHW1/OOHW2	116	120 ^{3,7}	3 ⁵	-	-	-	-	-	-	4 ⁵	-	-	1 ⁴	2 ⁵	2 ⁵	2	6 ⁵	-	-	6 ⁵	-	-	2 ^{4,5}	-	-	1 ⁵
S3	FRP works (no enclosures)	AH/OOHW1/OOHW2	115	120 ^{3,7}	3 ⁵	-	-	-	-	-	-	4 ⁵	-	-	-	2 ⁵	2 ⁵	-	6 ⁵	-	-	-	-	-	2 ⁵	-	-	1 ⁵
S4a	Shotcreting Works (west opening)	AH/OOHW1	112	9	-	1 ⁸	1 ⁸	-	-	-	1 ⁸	1 ⁸	-	-	-	-	-	-	-	-	4 ⁸	-	1 ⁸	-	1 ⁸	-	-	-
S4b	Shotcreting Works (west + east opening)	AH/OOHW1																										
S5	Acoustic shed removal	AH/OOHW1 (Day – Public Holiday)	121	9	-	-	-	1	1	-	4	1	2	1	-	-	-	-	3	-	-	3	-	-	-	-	3	3
S6a	Shed Demolition – without Crane ⁶	AH/OOHW1/OOHW2	110	112 ⁷	-	-	-	-	-	-	-	2	-	-	-	-	2	-	1	3	2	-	-	-	-	1	-	-
S6b	Shed Demolition – with Crane ⁶	AH/OOHW1/OOHW2	111	112 ⁷	-	-	-	1	-	-	-	2	-	-	-	-	2	-	1	3	2	-	-	-	-	1	-	-
S7	Fassi crane operation	AH/OOHW1/OOHW2	103	100 ⁷	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3 ⁸	-	-	1	-	-	-	-

- Note 1: Equipment classed as ‘annoying’ in the ICNG and requires a 5 dB correction.
- Note 2: Individual Sound Power Levels (Lw) for key activities have been adopted from the DEFRA Noise Database, AS2436, TfNSW Construction Noise and Vibration Strategy and Sydney Metro Construction Noise and Vibration Standard.
- Note 3: L_{max} events for sleep disturbance assessment are located within shed/tunnel.
- Note 4: Equipment in use within shed. Gantry Crane within acoustic shed considers tonal alarm.
- Note 5: Equipment operating within tunnel (crossover cavern).
- Note 6: Traffic diversion activities along Alexandra Avenue during S6 (Gantry Crane Shed Removal) has been considered. Traffic diversion activities would include idling traffic control vehicles, signage, barrier and cone deployment along the roadway.
- Note 7: L_{max} is based on loudest item of plant in operational during work scenario
- Note 8: Equipment in use within excavation box.
- Note 9: Work scenario does not occur during the night-time period..

Figure 1 Location of Works – S1 (FRP Works – Steel Fixing and Falsework Operation)

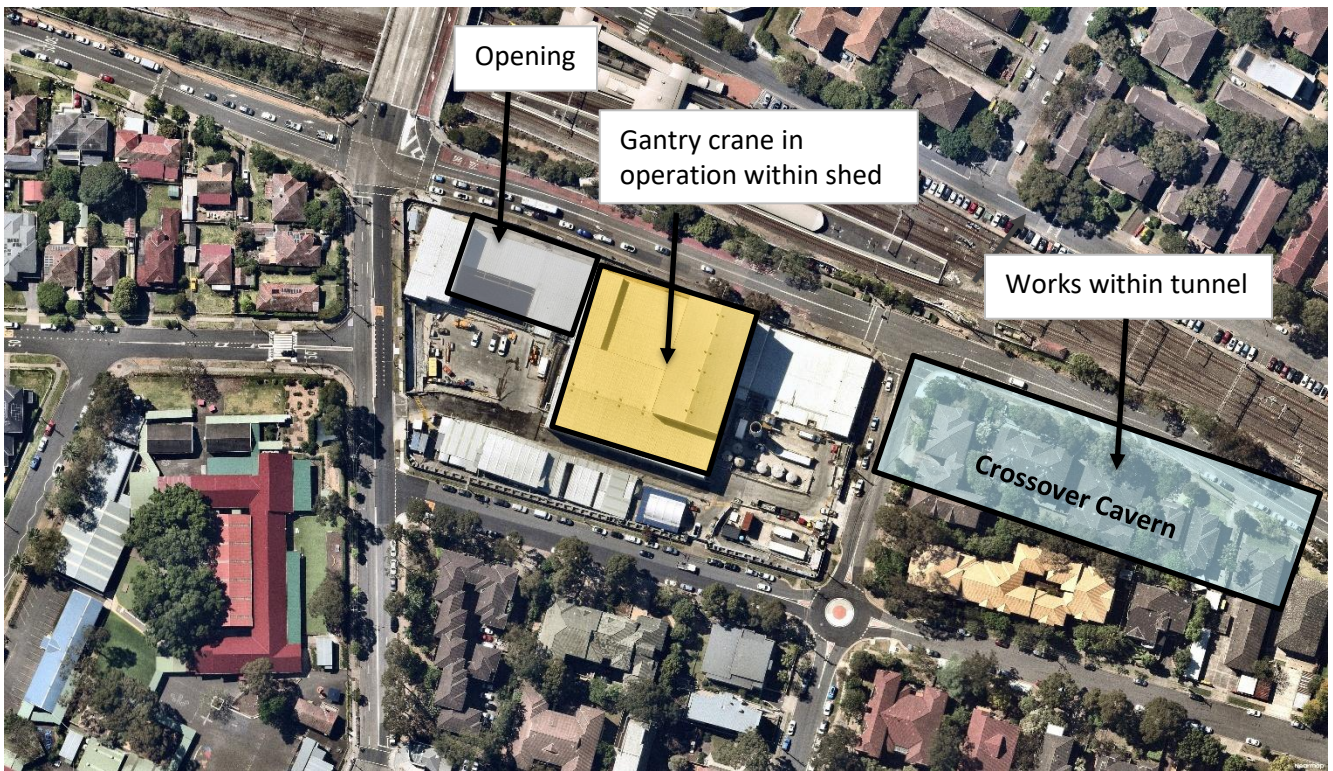


Figure 2 Location of Works – S2 (FRP Works – Steel Fixing and Falsework Operation)



Figure 3 Location of Works – S3 - FRP Works (No enclosures)

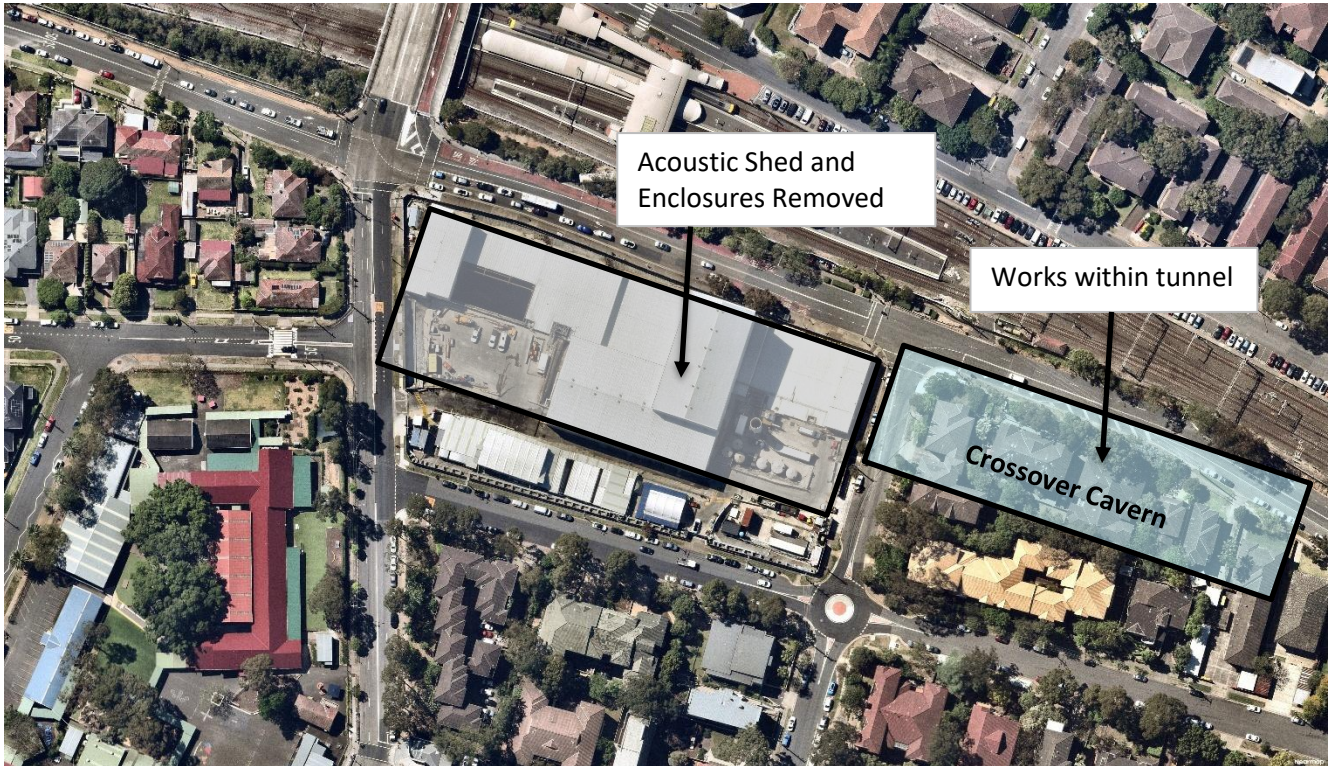


Figure 4 Location of Works – S4a - Shotcreting Works (Only West Enclosure Removed)



Figure 5 Location of Works – S4b - Shotcreting Works (West and East Enclosures Removed)



Figure 6 Location of Works – S5 - Acoustic Shed Removal

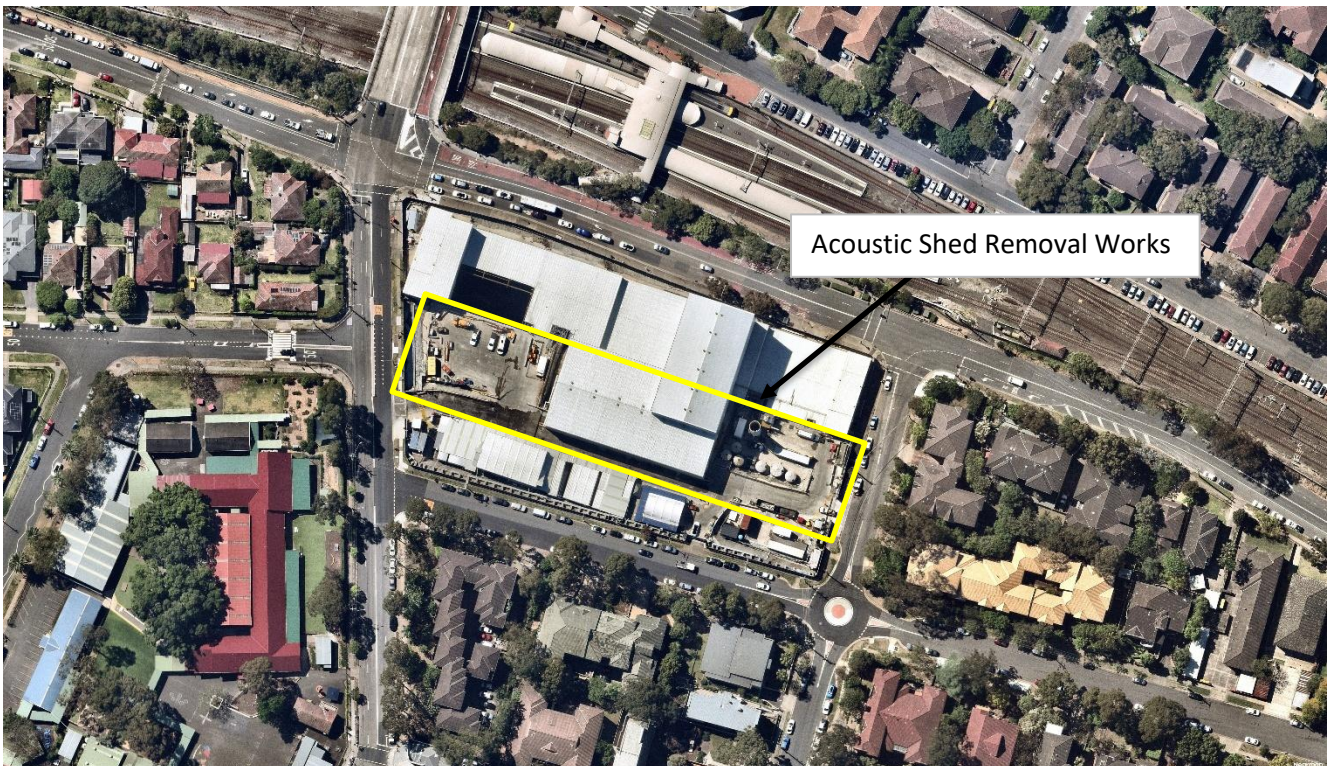


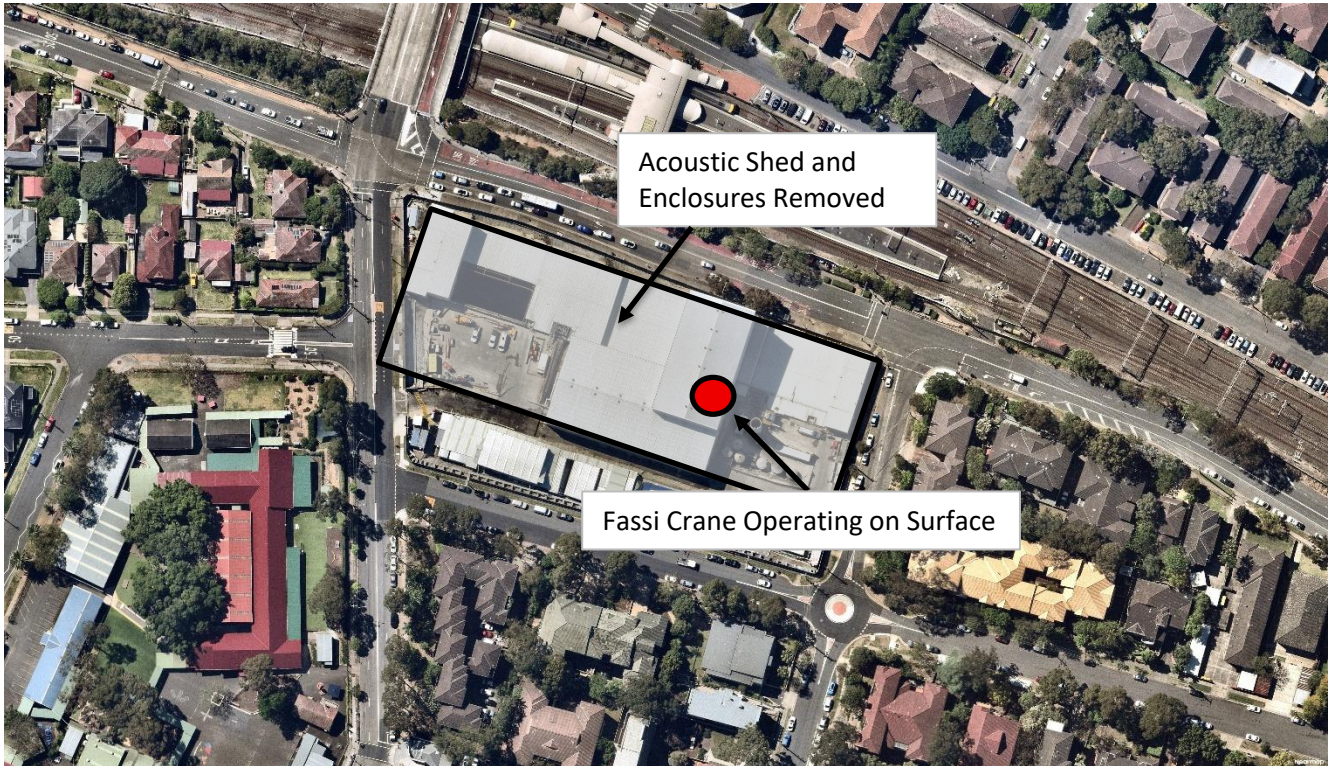
Figure 7 Location of Works – S6a – Shed Demolition (without 150t Crane)



Figure 8 Location of Works – S6b – Shed Demolition (with 150t Crane)



Figure 9 Location of Works – S7 – Fassi Crane Operation



3 Assessment Criteria

3.1 Noise Management Levels

The noise management levels (NMLs) for residential (**Table 4**) and other sensitive receivers (**Table 5**) have been adopted from the Construction Noise and Vibration Management Plan (CNVMP). Project-specific NMLs for residential receivers were determined for each Noise Catchment Area (NCA). During out-of-hours work (OOHW) the residential NML is determined as 5 dB above the Rating Background Noise level (RBL) (ie 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 (eg 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)			
				Day	Day ¹	Evening	
NCA01	Residential	B.02	58	53	51	46	56
NCA02	Residential	B.01	59	54	52	42	52

Note 1: Daytime out of hours is 7 am to 8 am on Saturday, and 8 am to 6 pm on Sunday and public holidays

Table 5 NMLs for ‘Other Sensitive’ Receivers

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

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.

3.2 Vibration Guidelines

The effects of vibration from construction work can be divided into three categories:

- Those in which the occupants of buildings are disturbed (**human comfort**). People can sometimes perceive vibration impacts when vibration generating construction work is located close to occupied buildings. Vibration from construction work tends to be intermittent in nature and the AVTG (DEC, 2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV), as shown in **Table 6**.
- Those where the integrity of the building may be compromised (**structural/cosmetic damage**). If vibration from construction work is sufficiently high, it can cause cosmetic damage to elements of affected buildings. Industry standard cosmetic damage vibration limits are specified in British Standard BS 7385. The limits are shown in **Table 7**.
- Those where building contents may be affected (**building contents**). People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents. Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes or medical imaging equipment, are in buildings near to construction work, refer Sydney Metro *Construction Noise and Vibration Standard*. No such items of equipment have been identified in the study area for this assessment.

Table 6 Human Comfort Vibration – Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value ¹ (m/s ^{1.75})	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods and is dependent on the level of vibration as well as the duration.

Table 7 Cosmetic Damage – BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

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

4 Assessment Findings

4.1 Airborne Noise Impact Assessment

Noise modelling was conducted in accordance with the method outlined in the overarching DNVIS. A summary of the number of buildings where NML exceedances were predicted for the various work scenarios is shown in **Table 9**. Maps of the predicted noise levels are presented in **Appendix A**.

The assessment shows the predicted impacts based on the exceedance of the management levels, as per the categories in **Table 8**.

Further details on the applicable additional mitigation/management measures, based on the impact categories presented in **Table 8**, are provided in **Section 6**.

Table 8 Exceedance Bands and Impact Colouring

Exceedance of Management Level	Impact Colouring
No exceedance	
1 to 10 dB	
11 dB to 20 dB	
21 dB to 30 dB	
>30 dB	

The assessment is generally considered conservative as the calculations assume several items of construction equipment are in use at the same time within individual scenarios.

The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that is likely to occur for each work scenario. The exceedances shown in **Table 9** are therefore representative of a 'realistic worst-case' 15-minute period and are unlikely to occur for extended periods of time throughout the construction period at any given receiver.

Table 9 Construction Noise Assessment

Receiver Category	NCA	Total	Exceedance Category	Number of Receivers with NML Exceedance																											
				S1a, S2a	S1b, S2b	S1c, S2c	S3	S4a	S4b	S5	S6a	S6b	S7	S1a, S2a	S1b, S2b	S1c, S2c	S3	S4a	S4b	S5	S6a	S6b	S7	S1a, S2a	S1b, S2b	S1c, S2c	S3	S6a	S6b	S7	
				AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	OOHW1	OOHW1	OOHW1	OOHW1	OOHW1	OOHW1 (Daytime Only)	OOHW1	OOHW1	OOHW1	OOHW1	OOHW2	OOHW2	OOHW2	OOHW2	OOHW2	OOHW2	OOHW2
Residential	NCA01	116	1-10 dB	-	-	-	-	-	-	13	4	4	-	-	-	-	-	-	-	19	14	14	-	-	-	-	-	15	14	-	
			11-20 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	8	9	-
			21-30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			>30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		HNA ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SD ²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	-	
	NCA02	104	1-10 dB	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	26	1	1	-	-	-	-	-	12	21	-	
			11-20 dB	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	2	5	-	
			21-30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			>30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HNA ¹		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
SD ²		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	11	-		
Other Sensitive	All NCA	52	1-10 dB	-	-	-	-	-	-	18	1	1	-	-	-	-	-	-	18	1	1	-	-	-	-	-	1	1	-		
			11-20 dB	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
			21-30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			>30 dB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: Highly Noise Affected, as defined in the ICNG. Relates to construction noise levels of >75 dBA and is the point above which there may be strong community reaction to construction noise levels.

Note 2: Sleep disturbance (see Table 4).

The assessment of the predicted worst-case noise levels shows:

- The predicted noise levels at the nearest receivers are at or below the NML during the following scenarios:
 - S1 (a, b and c) and S2 (a, b and c), S3 and S7 during all assessment periods.
 - S4 (a and b) during AH and OOHW1.

This is due to the noisiest works being conducted underground, within the tunnel (crossover cavern) (S1 to S3) , station box (S4) or due to the use of less noise-intensive equipment (S7).

- The following worst-case NML exceedances are predicted when Acoustic Shed Removal (S5) is taking place:
 - Up to '11-20 dB' at the nearest residential receivers in NCA01 and NCA02.
 - Up to '11-20 dB' at the nearest other-sensitive receivers.
- The following worst-case NML exceedances are predicted when Shed Demolition Works (S6a and S6b) are taking place during all assessment periods:
 - Up to '11-20 dB' at the nearest residential receivers in NCA01 and NCA02 during OOHW2.
 - Up to '1-10 dB' at the nearest other-sensitive receivers
- Sleep disturbance impacts are predicted at the nearest residential receivers in NCA01 and NCA02 when Shed Demolition Works (S6a and S6b) are taking place during the night-time period (OOHW2).
- No receivers are predicted to be highly noise affected.

4.2 Vibration Assessment

Based on the equipment and activities identified for this DNVIS, vibration impacts are not expected for human comfort, structural/cosmetic damage or building contents. Given the limited potential for any vibration impacts to occur, no further assessment of construction vibration is considered necessary.

5 Mitigation Measures Identified Through Consultation

As outlined in the overarching DNVIS, in accordance with Condition of Approval (CoA) D43 and D44, ongoing consultation with affected sensitive land users will identify any further mitigation and management measures.

GLC is committed to undertaking consultation in accordance with CoA D44 for any activity predicted to generate noise levels above NMLs and outside the approved project hours (in CoA D35). This consultation will occur prior to the activity commencing, and any specific mitigation measures identified during this consultation will be implemented.

Community consultation has been undertaken in accordance with the Community Communication Strategy (CCS). The CCS outlines key risks and issues associated with the Project. A summary of the identified issues related to noise and vibration is as follows:

- Information about construction
- Construction noise and vibration
- Concerns about property damage
- Cumulative impacts of other projects

In addition to the measures identified and summarised in the project-wide DNVIS, a range of proposed community consultation/management measures have been identified in relation to the scope summarised in this DNVIS. These measures include:

- Coordination with other nearby projects.
- Inclusion of work details in monthly notifications
- Specific notification to nearby residents one week before works are due to commence, which details opportunities of the affected receivers to submit concerns, questions or other matters related to the works.
- Offers of respite to impacted residents one week prior to impactful works
- Out of hours work e-blast in the week prior to works and weekly during the works.
- The use of battery or solar powered lighting would be prioritised and implemented where practical.
- Additional mitigation measures outlined in the overarching DNVIS (ie Letter Box Drops, Monitoring, Specific Notifications & Respite Offers).

6 Additional Mitigation/Management Measures

As outlined in the CNVMP and overarching DNVIS, where the predicted ‘mitigated’ construction noise levels are above the project specific noise management levels (NMLs), a number of additional measures to mitigate such exceedances as identified in the Sydney Metro CNVS would be explored and implemented as required. Implementation of the Additional Mitigation Measures (AMM) will consider prediction as well as results of validation monitoring. 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 are listed in **Table 10** and described in the Sydney Metro CNVS. The AMM for construction noise is identified in **Table 11**.

Table 10 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 11 Additional Mitigation Measures Matrix - Construction Noise

Time Period		Mitigation Measures			
		Predicted LAeq(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)				
OOHW1 (Day/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)				
OOHW2 (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)				

7 Conclusion and Recommendations

Noise emissions from the project have been predicted at the surrounding receivers. Worst-case noise levels are expected to exceed the noise management level (NML) by up to '11- 20 dB' at the closest residential receivers and the closest 'other sensitive' receiver.

A number of mitigation and management measures have been recommended below. Where feasible and reasonable, these should be applied to the project to control and minimise the impacts during construction as far as practicable.

GLC will consider the following recommendations (where feasible and reasonable) during the commencement of work:

- Implement mitigation measures identified within the CNVMP and overarching DNVIS.
- Implement additional mitigation measures identified within the CNVMP and overarching DNVIS.
- Ensure the minimum sized equipment necessary to complete the work is used.
- Shut down plant and machinery, including vehicles, when not in operation.
- Shed materials are to be lowered in a controlled and gradual manner to the ground or into trucks (ie avoid dropping from height) to prevent excessive impact noise.

Checked/ Authorised by: SL

APPENDIX A – NOISE IMPACTS

Figure A1 S5 – Acoustic Shed Removal – AH



Figure A2 S5 – Acoustic Shed Removal – OOHW1 - Day



Figure A3 S6a – Shed Demolition (without 150 t Crane) – AH



Figure A4 S6b – Shed Demolition (with 150 t Crane) – AH



Figure A5 S6a – Shed Demolition (without 150 t Crane) – OOHW1



Figure A6 S6b – Shed Demolition (with 150 t Crane) – OOHW1



Figure A7 S6a – Shed Demolition (without 150 t Crane) – OOHW2



