ACOUSTICS ADVISOR ENDORSEMENT
SYDNEY METRO WEST (SSI 10038)

Review of	**Central Tunnelling Package:** DNVIS for Sydney Olympic Park	**Reviewed document reference:**	21028-NV-RP-6-11 Revision 11 Dated: 24 August 2024
Prepared by:	[redacted] Alternate Acoustics Advisor		
Date of issue:	5 September 2024 (Rev 11)		

As approved alternate Acoustics Advisor (AA) for the Sydney Metro West project, I reviewed and provided comments on previous versions of Rev 11 of the Sydney Metro West – Central Tunnelling Package (CTP) – Detailed Noise and Vibration Impact Statement (DNVIS) for Sydney Olympic Park (SOP).

Revision 11 is an update to include details for Tunnel Boring Machine (TBM) retrieval and associated activities that are part of tunnelling, and site demobilization.

I am satisfied that my comments have been adequately addressed and I endorse Rev 11 of CTP's DNVIS for SOP, in accordance with Condition of Approval A36(e).

[redacted]

[redacted]

A.1

Acciona Ferrovial Joint Venture
Sydney Metro West Central Tunnelling Package
Sydney Olympic Park

Detailed noise and vibration impact statement
August 2024

Doc no. 21028-NV-RP-6-11

Detailed noise and vibration impact statement

Client	Acciona Ferrovial Joint Venture
Project	Sydney Metro West Central Tunnelling Package
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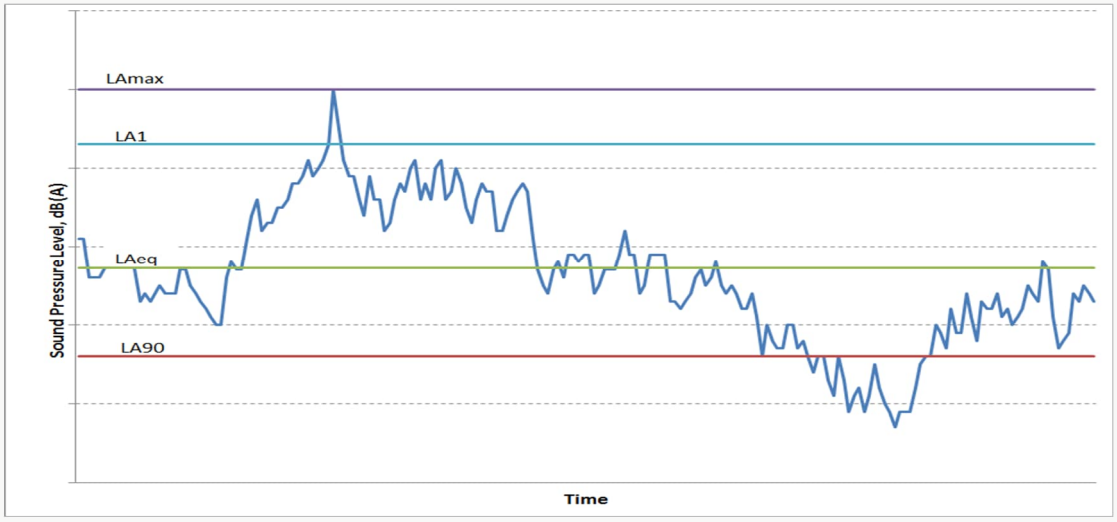
Revision history

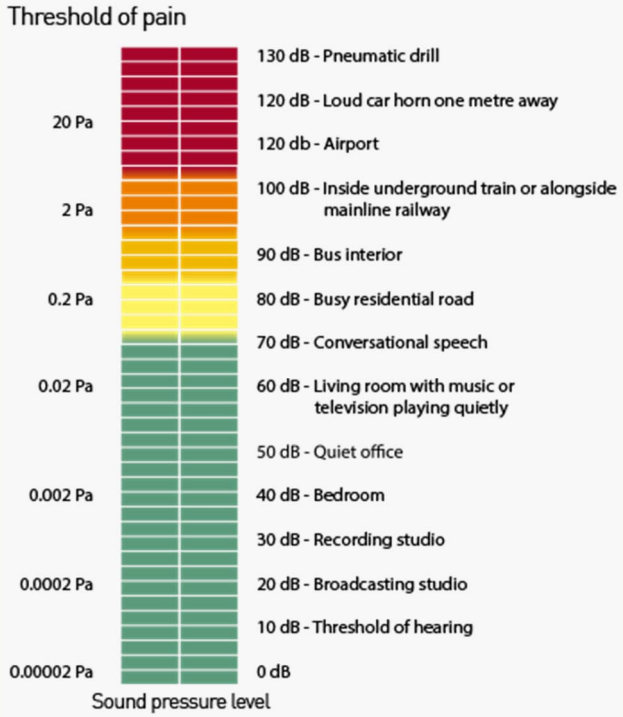
0	16 November 2021	Draft report to client
1	16 December 2021	Updated as per client comments
2	17 January 2022	Amendments following client and AA comments
3	17 February 2022	Amended following client comments
4	11 April14 2022	Updated to include rock hammering during demolition
5	2 May 2022	Updated comments sections
6	19 May 2023	Updated nozzle activity equipment list
7	19 July 2023	Updated to address AA/ER comments
8	14 August 2023	Updated Table 6-2 for stockpile and nozzle results
9	30 July 2024	Updated including TBM Retrieval and site demobilisation details
10	13 August 2024	Updated for AA comments
11	28 August 2024	Updated for AA comments

Contents

Definition of acoustic terms and acronyms

AA	Acoustic Advisor
AMM	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
Assessment period	The period in a day over which assessments are made.
Background noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation.
CSSI	Critical
Decibel (dB)	A measure of sound equivalent to 20 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure, and 10 times the logarithm (to base 10) of the ratio of a given sound power to a reference power.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
dB(C)	Unit used to measure 'C-weighted' sound pressure levels, an adjustment made to sound level to approximate low frequency noise between 10 Hz and 200 Hz.
DPIE	NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
Extraneous noise	Noise resulting from activities that are not typical of the area such as construction, and traffic generated by holiday periods or special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Highly affected receivers	Residential receivers are considered to be highly noise affected where construction activities are determined to have an L_{Aeq}, 15 minute noise level of 75 dB(A) or higher.
Highly noise intensive works	Construction activities which are defined as annoying under the ICNG. See Section 2.1.2.
ICNG	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
Noise assessment criteria	A standard rule or test by which the acceptability of the nature and characteristics of noise may be judged or evaluated. Criteria are generally based on guidelines or standards developed by Government agencies (eg EPA) to protect the majority of people for the majority of the time from adverse impacts.
NCA	Noise Catchment Area

Noise level statistics	L_{A90} - The A-weighted sound pressure level exceeded 90% of the monitoring period. This is considered to represent the background noise. L_{Aeq} - The equivalent continuous A-weighted noise level—the level of noise equivalent to the energy average of noise levels occurring over a measurement period. L_{A1} – The A-weighted sound pressure level exceeded 1% of the monitoring period. L_{Amax} – The maximum A-weighted noise level associated with the measurement period. 
NML	Noise Management Level
PPV	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
RBL	Rating Background Level - a single figure that represents the background noise level for assessment purposes
ROL	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
Sound Power Level (SWL)	The A-weighted sound power level is a logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.

Sound Pressure Level (SPL)	This is the level of noise, usually expressed in dB(A), as measured by a standard sound level meter with a pressure microphone. The sound pressure level in dB(A) gives a close indication of the subjective loudness of noise. A technical definition for the sound pressure level, in decibels, is 20 times the logarithm (base 10) of the ratio of any two quantities related to a given sound pressure to a reference pressure (typically 20 µPa equivalent to 0 dB). Examples of typical sound pressure levels are shown below.  Source: https://www.osha.gov/dts/osta/otm/noise/health_effects/soundpropagation.html
Tonal noise	Noise with perceptible and definite pitch or tone
VDV	Vibration dose value – used when assessing intermittent vibration as it is sensitive to peaks in vibration acceleration and accumulates the vibration energy received over the daytime and night-time periods

***Note: Additional definitions for construction related terms can be found in the Project Conditions of Approval.**

1. Introduction

1.1 Project overview

Sydney Metro is Australia's biggest public transport program comprising four main packages of work including Metro North West Line, Sydney Metro City and Southwest, Sydney Metro West and Sydney Metro Greater West. The Sydney Metro West component involves the construction and operation of a metro rail line, around 24km in length, between Westmead and the Sydney CBD.

The planning approvals and environmental impact assessment for Sydney Metro West has been split into a number of stages recognising the size of the project. This includes:

- Stage 1 – Concept and all major civil construction works including station excavation and tunnelling between Westmead and The Bays. Planning approval for this stage was granted in March 2021. ·
- Stage 2 – All major civil construction works including station excavation and tunnelling from The Bays to Sydney CBD ·
- Stage 3 – Tunnel fit-out, construction of stations, ancillary facilities and station precincts, and operation and maintenance of the Sydney Metro West line.

Acciona Ferrovial Joint Venture (AFJV) was commissioned to deliver the Central Tunnel Package of Stage 1, comprising excavation of five station boxes and around 11.5 kilometres of twin-bore tunnel between The Bays and Sydney Olympic Park (the Project). An overview of the Project is presented in Figure 1-1, which includes the tunnel alignment and location of the station boxes at:

- The Bays
- Five Dock
- Burwood North
- North Strathfield
- Sydney Olympic Park

This Detailed Noise and Vibration Impact Statement (DNVIS) covers activities for construction of Sydney Olympic Park Station box located adjacent to the existing Sydney Olympic Park train station and comprises several phases including:

- Site establishment
- Excavation of the station box
- Tunnelling:
    - TBM Retrieval
    - Waterproofing
    - Concrete Lining
    - Tunnelling Support
- Site Demobilisation
- Demolition.

An overview of the current site layout of Sydney Olympic Park is presented in Figure 1-2.

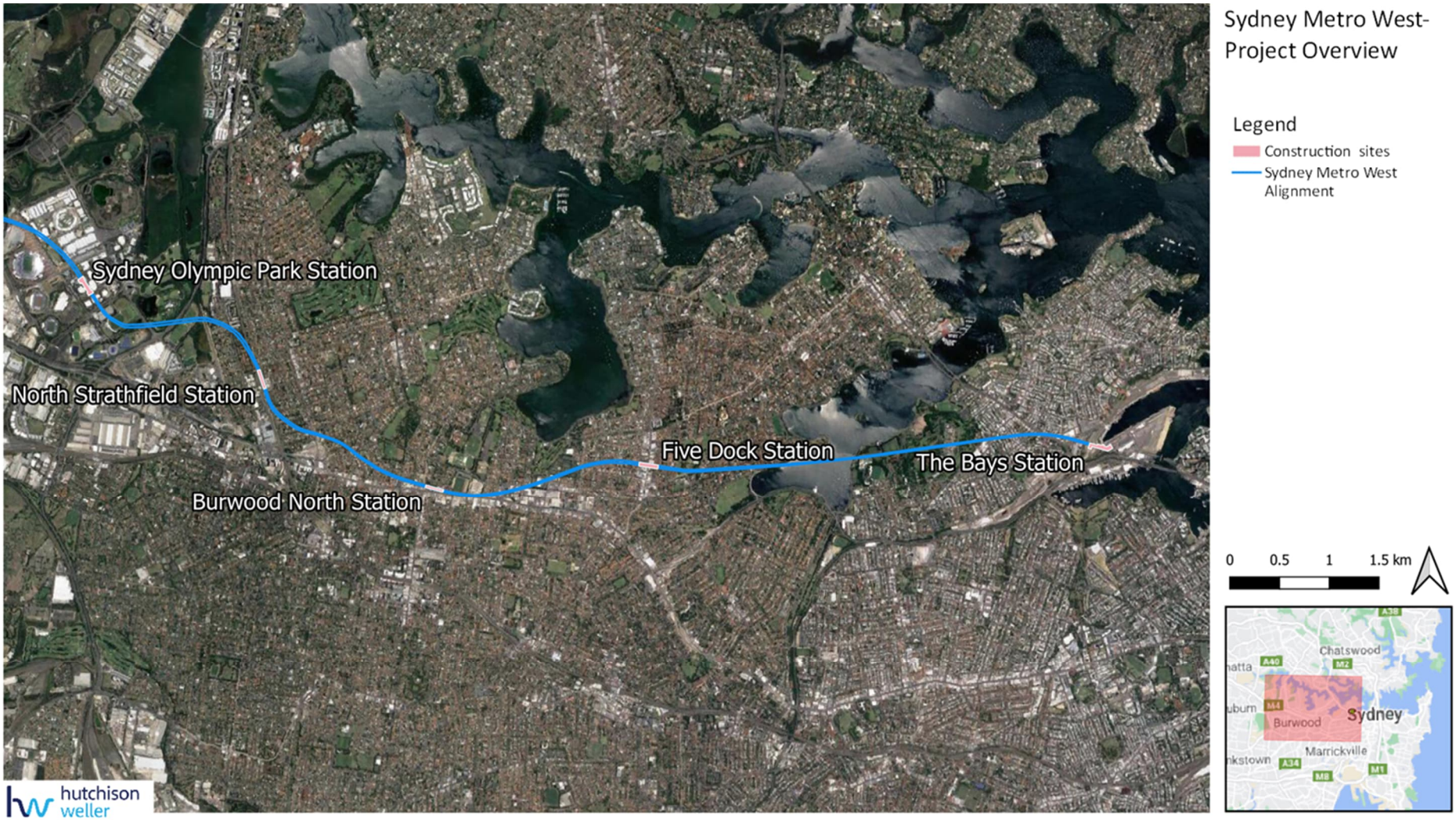


Figure 1-1 Overview of the CTP of Stage 1 of the Sydney Metro West Project.

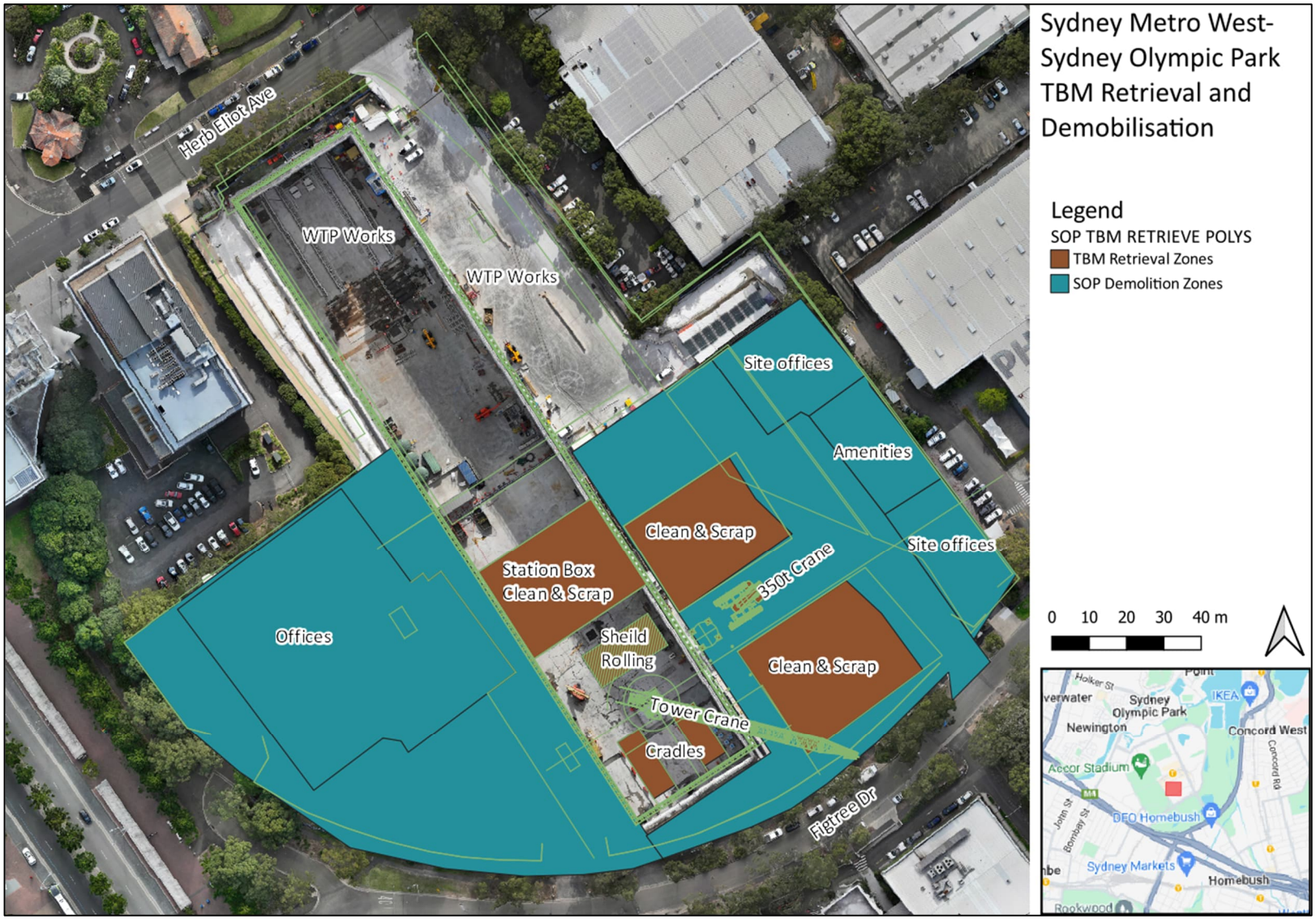


Figure 1-2 Sydney Olympic Park site

1.2 Detailed noise and vibration impact statement

Considering the risk of noise and vibration impact is necessary to ensure appropriate mitigation and management measures can be applied. This Detailed Noise and Vibration Impact Assessment (DNVIS) has been prepared in accordance with the Sydney Metro (2020) Construction Noise and Vibration Standard, v 4.3 (CNVS) and supplements the Project's Construction Noise and Vibration Management Plan (CNVMP) as required in the Project's Condition of Approval (CoA) D43.

The objective of the DNVIS is to establish the location, nature and scale of proposed works, assess the level of impact on the community's amenity and include mitigation measures identified through consultation with affected sensitive land users.

The structure of this DNVIS meets the requirements of the Condition of Approval D43 and the CNVS and includes:

- Section 2 – Construction works and hours
- Section 3 – Identification of noise and vibration sensitive receivers and existing noise levels
- Section 4 – Construction noise and vibration objectives
- Section 5 – Description of planned works, equipment and sound power levels
- Section 6 – Construction noise assessment – predicted noise levels and exceedances of objectives, including sleep disturbance
- Section 7 – Construction vibration assessment
- Section 8 – Traffic noise assessment
- Section 9 – Mitigation and management, including consultation

2. Construction works and hours

2.1 Planned works

Activities associated with construction of the Sydney Olympic Park station box are summarised in Table 2-1. The main phases of site establishment and excavation of the station box have been completed and site preparations for the TBM arrival and retrieval are currently underway.

Works commenced in November 2021 and are expected to be completed by around July of 2025. The current program is illustrated in Table 2-2 and shows the duration of each of the remaining phases of work.

The site has completed all activities for the initial phases of work including, site establishment, station box excavation and nozzle excavation. Additional concrete works will follow after the retrieval of the TBM.

TBM arrival at the Sydney Olympic Park site is expected to occur around September 2024. Following the removal of the TBMs, and completion of remaining works scope, the site will be demobilised (temporary infrastructure such as site offices removed), hard stand areas will remain to the extent agreed with Sydney Metro and the remaining existing site building at 7 Figtree Drive will be demolished.

The next phase of work to be completed will be the TBM retrieval, dismantling and subsequent removal from site. The removal of the TBM from the station box will take approximately 12 weeks and will be completed with the following activities and indicative timeframes:

- From Week-1 to Week-2: the TBM is cleaned and its main shield components (cutterhead, front shield and gripper shield) are split within station box using air and hydraulic tools and is prepared for lifting. The same process is applied to the other TBM directly following the first.

- From Week-3 to Week-6: The TBM's shields are lifted and rotated from horizontal to vertical within the station box. The front shield and gripper shield are split-up and broken down into smaller sections by oxy/acetylene cutting and air tools. These works will be undertaken both within the station box and on the surface. Cranes (tower and crawler) lifts within the station box and on the surface will be undertaken during day time and night time as required. Breakdown of the TBM will be prioritised to take place within the station box and during daylight hours where reasonable and feasible.

- From Week-7 to Week-12: all the TBM gantries are removed from the tunnel and located in the scrapping area of the station for stripping and cleaning. There are 13 gantries per TBM with a total length of 140m. When the gantries are lifted to the surface, they may still require additional cleaning, disassembly and prepping for road transport using the tower or crawler crane.

Demobilisation of the Olympic Park site is expected to take around 6 months and will commence once the tunnelling and headwall works are completed. Activities will include:

- Removal of temporary works not required for handover
- Dismantling and removal of site offices/cribs/Water treatment plant
- Demolition of the main office on 7 Figtree Drive
- Final surface reinstatement (earthworks, DGB, Concrete).
- Final installation of barriers, fencing and hoarding.

<u>TBM tunnelling</u>

Under Planning Approval Condition D37 (d) tunnelling is considered a prescribed activity and permitted 24/7.

Within EIS Technical Paper 2 Noise and Vibration Table 25, TBM launch, support and extraction; mucking out and spoil handling; and construction traffic for material supply to and spoil removal from tunnelling and underground excavation (station and ancillary facility sites) were considered aboveground construction activities proposed 24 hours per day, seven days per week. Additionally, tunnelling works were proposed 24 hours per day, seven days per week and the table noted "activities that support tunnelling may need to occur 24 hours per day, up to seven days per week."

This is also supported by Table 13 of the SSI Assessment Report (DPIE, March 2021) which notes that aboveground long-term activities to support tunnelling will be undertaken 24 hours a day seven days a week / outside standard construction hours.

EIS Technical Paper 2 Noise and Vibration Table 26 provides the following justification for out of hours work for tunnelling (including cross passages) and tunnelling support activities (including tunnel boring machine launch/retrieval and spoil handling):

> Tunnelling and excavation works would define the overall Stage 1 duration. Earlier completion would bring considerable benefits to the community and would reduce the duration of construction related disruption.
>
> Other aspects of the justification for out of hours tunnelling and support operations include:
>
> - Need to install ground support systems immediately following excavation.
> - Need to construct cross passages closely following the progress of the TBMs to provide a critical secondary egress for people to evacuate and access for emergency services in the event of an incident
> - Reducing peak demand on the electricity network
> - Need to handle the spoil produced by the 24/7 operation of the tunnel boring machines and the proposed out of hours transport of spoil

On this basis, the proposed activities required for TBM tunnelling, both aboveground and underground, are considered tunnelling under condition D37 (d) and therefore permissible outside Condition D35 construction hours.

Following the arrival of the TBM, tunnelling activities proposed at Sydney Olympic Park outside Condition D35 construction hours below ground level will include:

- spoil transfer via MSV's
- Multi Service Vehicles (MSV) delivering segments/personnel to the TBM
- Use of other support vehicles as required.
- Use of various tools and machinery within the station box.

The TBM is scheduled to arrive at the Sydney Olympic Park station box in Q4 2024. After breaking through into the station box, the TBM will traverse approximately 60 meters before being disassembled into liftable segments, for cranage and removal from site. This operation will take approximately 4-5 months to be completed and requires 24-hour work.

During TBM disassembly, a number of cutting, lifting and disassembly works will be in conducted in the station box, in order to minimise processing at surface level. This disassembly is likely to include, but not limited to; cutting and welding of steel, use of pneumatic and electric tools, use of generators and hydraulic power packs. For TBM disassembly to be carried out, the team will require the use of mobile plant and hand tools. This could include forklifts, cranes, telehandler, EWP's and people moving light vehicles. Hand tools are likely to include welding equipment, electric saws and grinders, torque wrenches, drills and pneumatic tooling. TBM disassembly

may occur outside standard construction hours but will be undertaken within standard construction hours where reasonable and feasible.

The TBM tunnelling phase of the project at Sydney Olympic Park will include TBM tunnelling support to transport spoil from the tunnel face and transport personnel and materials including concrete to the Cross passage works. Concrete & materials will be transported using MSV's and tunnel agitators that will operate up to 24 hours 7 days per week. This will include activities that are permitted by condition D37(d).

Alarms and sirens are important for the safety of personnel working in or near the TBMs and conveyors. A risk assessment was undertaken to identify routine TBM alarms that can be replaced with beacon lights as a visual administration control rather than an audible siren during evening and night shift. Evacuation and emergency alarms are still required to be audible in the event of an emergency.

During tunnel and cross passage operation periodic maintenance may be required on the spoil conveyor and boosters which could involve the use of EWP's, hand tools and plant such as forklifts/telehandlers.This DNVIS addresses the activities and impacts from the construction work phases 4, 5 and 6 as detailed in Table 2-1 .

Table 2-1 Summary of proposed activities at Sydney Olympic Park

Construction phase	Activity			Outside approved hours?
1. Site Establishment *Completed*	1a	General activities		No
	1b	Demolition/Earthworks		No
	1c			
	1d	Fencing & hoarding		No
	1e	Utilities disconnection/relocation		No
	1f	Site Concrete Works		No
2. Station Box Excavation *Completed*	2a	Piling		No
	2b	Capping beams	Detailed excavation, break back & capping beam	No
	2c	Active anchors	Ground stabilisation	No
	2d	Excavation	Other Than Rock (OTR) – Dozer (No ripping)	No
	2e		Rippable – Dozer (Ripping)	No
	2f		Non-rippable – Excavators with hammers or eccentric rippers	No
	2g		Grouting	No
3. Mucking out & Tunnel Nozzle	3a	Spoil handling	Clearing during OTR – No Kibble	No
	3b	Tunnel Nozzle Excavation		No
	3c	Headwall waterproofing		No
	3d	Tunnel Nozzle Concrete Lining		No
	3e	Nozzle concrete pour (surface)		Yes
4. TBM Retrieval	4a	Retrieval – Surface works Handling		Yes
	4ai	Retrieval – Surface works handling + tower crane		Yes
	4b	Retrieval – Surface works Prep work		Yes
	4c	Retrieval – Surface works Loading		Yes
	4d	Retrieval – Station Box works		Yes
Site demobilisation	5a	TBM services removal	Removal of modules/TBM services	No
	5b		Removal of concrete plinths and tower crane	No
	5c	Clean-up/Restoration	Reinstate concrete foundations	No

Construction phase	Activity			Outside approved hours?
	5d		Plant and equipment removal	No
	5e		Site clean-up removal of materials	No
	5f		Removal/disconnection of amenities/utilities	No
	5g		Pavement restoration	No
Building demolition	6a	Clearing and grubbing	Tree lopping	No
	6b	Demolition	Soft demolition	No
	6c		Hard demolition	No
	6d	Clean up/Restoration	Final reinstatement (earthworks and fences)	No

Additional out of hours work may be required for any of the aforementioned works which will only be approved providing adequate justification can obtained as per CoA D37 and the EPL. These activities would be assessed and managed through the out of hours work process.

Table 2-2 Anticipated completion program for Sydney Olympic Park

	Sydney Olympic Park	2024												2025											
Phase	Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4	TBM retrieval readiness																								
	TBM retrieval																								
3	Waterproofing																								
	Concrete lining																								
5	Site demobilisation																								
6	Building demolition																								

2.1.1 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2-3. Use of power saws, rock breakers, drills and other tonal or impulsive activities are defined as annoying under the Interim Construction Noise Guideline (ICNG) and are 'highly noise intensive works'.

Table 2-3 Approved construction hours

CoA	Construction activity	Monday to Friday	Saturday	Sunday / Public holiday
D35	Approved construction	7:00 am to 6:00 pm	8:00 am to 6:00 pm	No work (unless approved under out-of-hours work protocol)
D36	Highly noise intensive works	8:00 am to 6:00 pm[1]	8:00 am to 1:00 pm[1]	No work (unless approved under out-of-hours work protocol)

Notes:

1. if continuously, then not exceeding three hours, with a minimum cessation of work of not less than one hour.

2.1.2 Variations to work hours

In some circumstances, the planned construction activities would be undertaken outside the hours described in CoA D35 and D36. As specified in the Conditions of Approval, these activities include those which are:

- Low impact as described in CoA D37b), 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 LAFmax(15 minute) noise levels no more than 15 dB(A) above the rating background level at any residence; or
  - iii. 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).

- By Prescribed Activity, as described in CoA D37d) and applying to Sydney Olympic Park construction scenarios:
  i. tunnelling (excluding cut and cover tunnelling and surface works) which is permitted 24 hours a day, seven days a week; or
  ii. delivery of material that is required to be delivered outside of standard construction hours in Condition D35 of this schedule to directly support tunnelling activities
  iii. where there is no exceedance of noise levels under Low impact circumstances identified.

3. Existing environment

3.1 Existing environment

The Sydney Olympic Park site is in the heart of Sydney Olympic Park at the intersection of Olympic Boulevard and Figtree Drive and covers an area of around 3 hectares. Adjacent land uses to this site are mostly commercial with some mixed-use commercial/ residential buildings. There are additionally three hotels located directly adjacent to the site to the north west.

The closest residences are located along Figtree Drive and Australia Avenue. These residences are high rise apartments that are likely to overlook the construction site. To the north of the site is also the heritage conservation area 'State Abattoirs' which comprises the area bounded by Herb Elliott Avenue, Showground Road, Dawn Fraser Avenue and the Railway Garden, containing the Avenue of Palms, administration building precinct and landscaped gardens.

The acoustic environment in all areas is described in the EIS as dominated by road traffic noise along transport corridors such as Sarah Durack Avenue, and the adjacent Western Motorway.

To assess and manage construction noise and vibration impacts, a detailed land use survey was prepared for the Project in line with CoA D34, with results of the survey provided in the Construction Noise and Vibration Management Plan (CNVMP) and relevant land uses to Sydney Olympic Park presented in Appendix A of this DNVIS.

3.2 Heritage items

There was one area of heritage value directly adjacent to the construction site identified in the EIS. This item will be considered for impacts of vibration-intensive activities.

- Heritage Conservation Area- State Abattoirs this includes an assortment of attractive Federation era brick buildings with terracotta tiled roofs and plastered walls, a carriage loop, palm grove, garden beds, interpretive elements, and other landscaping.

3.3 Noise catchment areas

To facilitate the assessment of noise impacts from the project and to apply representative Noise Management Levels (NMLs) to all receivers, receivers adjacent to the Sydney Olympic Park sites have been divided into Noise Catchment Areas (NCAs). The Sydney Olympic Park site contains two noise catchments (NCA08 and NCA09).

NCAs group individual sensitive receivers by representative traits such as existing noise environment and potential exposure to noise and vibration from the Project.

NCAs established as part of the EIS are summarised in Table 3-1 and illustrated in Figure 1-1. Background noise monitoring has been completed as part of the EIS to apply appropriate NML to each NCA (see Section 4.2).

Table 3-1 Summary of work areas, Noise Catchment Areas and land uses

NCA	Location	Description	Ambient noise influences
NCA08	Olympic Park, western portion	Covers the western portion of Olympic Park near the existing Olympic Park Station. This catchment is mainly of commercial and sporting related uses, with some 'other sensitive' receivers including hotels and educational facilities. Residential apartment blocks are in the south, east and west.	Existing noise is controlled by distant road traffic noise from the M4 Motorway and Homebush Bay Drive, some rail noise, and general noise from the sports and entertainment complex.
NCA09	Olympic Park, eastern portion	Covers the eastern portion of Olympic Park and is a mixture of commercial and residential. There are several high-rise residential apartment buildings near Australia Avenue.	

3.4 Background noise survey

Background noise monitoring was undertaken as part of the Sydney Metro West Project EIS (Section 2, Technical Paper 2) through unattended background noise monitoring at representative locations. Monitoring was completed in March and July 2019 for each of the NCAs listed in Table 3-1.

Ambient noise around Sydney Olympic Park is heavily influenced by traffic flows that generate lower noise levels during the night-time than the daytime and evening periods. This pattern of reduced noise levels in the evening and night time is characteristic of urban and suburban areas, where there is no industrial or infrastructure noise influences.

The baseline information was used to establish the Rating Background Level (RBL), which represents the average minimum background sound level for each measurement period, averaged over the measurement days. The RBL at each NCA is provided in Table 3-2.

Table 3-2 Background noise levels

	Noise level (dBA)[1]		
NCA	Day[2]	Evening[2]	Night[2]
NCA08	48	48	46
NCA09	48	46	41

Notes:

1. The RBL values have been extracted from the EIS; refer to Table 4 in the EIS Technical Paper 2.
2. Daytime is 7:00am to 6:00pm, evening is 6:00pm to 10:00pm and night-time is 10:00pm to 7:00am.

4. Noise and vibration assessment criteria

4.1 Overview

Project CoA D43 requires works to be assessed within this DNVIS where they may exceed the NMLs, vibration criteria and/or ground-borne noise levels specified in CoA D39 and D40 at any residence outside construction hours identified in CoA D35, or where receivers will be highly noise affected.

This DNVIS includes specific mitigation measures identified through consultation with affected sensitive land user(s) and these mitigation measures will be implemented for the duration of site establishment and shaft construction activities.

This DNVIS has been provided to the AA and ER before the commencement of the planned works.

CoA D39 requires noise and vibration from construction activity to be managed with guidance from:

- Noise: the Interim Construction Noise Guideline (ICNG, DECC 2009)
- Vibration for human exposure: Assessing Vibration: A Technical Guideline (DEC, 2006)
- Vibration for building damage: BS 7385 Part 2-1993 – Evaluation and measurement for vibration in buildings Part 2, and
- Vibration for damage of unsound heritage items: DIN 4150-3 Structural Vibration – effects of vibration on structures.

The over-arching document for assessment and management of noise and vibration impacts on this Sydney Metro project is the Sydney Metro *Construction Noise and Vibration Standard* (CNVS, vers. 4.3, Transport for NSW 2020). The following sections outline the framework of these guidelines and the way this DNVIS will assist to assess and manage impacts.

4.2 Noise

4.2.1 ICNG

The CNVS refers to the *Interim Construction Noise Guideline* (ICNG) (DECC 2009), which provides guidance on management of construction noise. The ICNG notes noise that exceeds background noise levels may result in adverse impacts and an increased likelihood of complaints.

During approved hours, where construction noise is within 10 dB(A) of the RBL, impacts are considered acceptable. Where construction noise is more than 10 dB(A) above the RBL, a residential receiver is taken to be noise affected and the proponent should undertake all reasonable and feasible steps to manage the impact and consult with the affected community.

Above a $L_{Aeq,\ 15\ minute}$ noise level of 75 dB(A), a residential receiver is considered to be highly noise affected, requiring respite to be given in consultation with the regulatory authority and the community.

Outside approved construction hours, construction noise at a residential receiver more than 5 dB(A) above the RBL is taken to be noise affected.

In addition, noise from activities/equipment such as rock hammers, impact piling, or other impulsive noise sources usually result in greater annoyance than continuous construction noise. A 5 dB(A) penalty is applicable to such activities prior to comparison with the NMLs and a 3 hours on, 1 hour off respite schedule applies.

A noise level above $L_{Aeq\ 15min}$ 70 dB(A) at a commercial property is considered to warrant noise mitigation. Similarly, an industrial facility would warrant noise mitigation at $L_{Aeq\ 15\ minute}$ noise levels above 75 dB(A).

Table 4-1 presents management levels for noise at other relevant sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed.

Internal noise levels are assessed at the centre of the occupied room. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for buildings other than residences.

Table 4-1 NMLs for non-residential sensitive receivers

Sensitive receiver type	NML applicable when in use, LAeq, 15 min
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Childcare centres - sleeping areas - play areas	 Internal noise level 45 dB(A) External noise level 65 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

4.2.2 Sleep disturbance

The CNVS requires maximum noise levels to be analysed in terms of the extent and number of times the maximum noise exceeds specific noise trigger levels, in general accordance with the Noise Policy for Industry (nPfI) (EPA 2017). These triggers are:

- LAeq, 15 minute 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- lAmax 52 dBA or the prevailing RBL plus 15 dB, whichever is greater.

The nPfI also recommends the DECCW (2011) Road Noise Policy (RNP) be reviewed for further risk assessment. The RNP recommends maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep and one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

4.2.3 Ground-borne noise

CoA D40 requires all reasonable and feasible mitigation measures to be applied when the following residential ground-borne noise levels are exceeded. These levels are only applicable when ground-borne noise levels are higher than airborne noise levels at residential receivers during the evening and night periods.

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).

4.2.4 Construction traffic

While operating within the construction site, construction vehicles are assessed as part of the construction activity of which they are a part. However, once these vehicles leave the construction site and enter public roads, they are assessed as road traffic.

The Road Noise Policy (RNP) is generally adopted to assess the impact of construction traffic on public roads. A screening test is first applied to establish whether existing road traffic noise levels will increase by more than 2 dB due to construction traffic. Where any noise increase is less than 2 dB, the objectives of the Road Noise Policy have been met.

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

In considering feasible and reasonable mitigation measures, the actual noise levels associated with construction traffic and whether these levels comply with the road traffic noise criteria in the RNP would be reviewed.

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

4.2.5 Additional mitigation measures

The CNVS builds on the guidance provided by the ICNG and recommended further mitigation measures where all reasonable and feasible mitigation measures to minimise noise at the nearest receivers have been implemented and construction noise is still predicted to exceed the noise or vibration objectives. The Additional Mitigation Measures Matrix (AMMM) for airborne and ground-borne noise taken from the CNVS are presented in Table 4-2 and.

Table 4-2 Additional Mitigation Measures Matrix for airborne noise (CNVS)

Construction hours	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	0 to 10	-
	10 to 20	LB
	20 to 30	LB, M, SN
	>30	LB, M, SN
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	0 to 10	LB
	10 to 20	LB, M
	20 to 30	LB, M, SN, RO
	> 30	LB, M, SN, IB, PC, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	0 to 10	LB
	10 to 20	LB, M, SN, RO
	20 to 30	LB, M, SN, IB, PC, RO, AA
	> 30	LB, M, SN, IB, PC, RO, AA

Notes: PN = Project notification; SN = Specific notification; M = monitoring; LB = Letterbox drops; IB = Individual briefings; DR = Duration reduction; AA = Alternative accommodation; RO = Project specific respite offer

Table 4-3 Additional Mitigation Measures Matrix for ground-borne noise (CNVS)

Construction hours	dB above NML	Additional management measures
Approved hours Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	No NML for ground-borne noise during standard hours (refer to Table 4-7)	
Evening Monday – Friday: 6pm – 10pm Saturday: 7am – 8am, 6pm – 10pm Sunday / PH: 8am – 6pm	0 to 10	LB
	10 to 20	LB, M, SN
	> 20	LB, M, SN, IB, PNN, RO
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am) Sunday / PH: 6pm –7am	0 to 10	LB, M, SN
	10 to 20	LB, M, SN, IB, PC, RO, AA
	> 20	LB, M, SN, IB, PC, RO, AA

Notes: PN = Project notification; SN = Specific notification; M = monitoring; LB = Letterbox drops; IB = Individual briefings; DR = Duration reduction; AA = Alternative accommodation; RO = Project specific respite offer

4.3 Project-specific construction noise management levels

Based on the measured RBLs for each NCA and requirements of the ICNG and CNVS, project-specific NMLs are summarised in Table 4-4. NMLs for non-residential receivers are described in Table 4-1.

Table 4-4 Noise management levels

NCA	Noise Management Level, $L_{Aeq\ 15\ minute}$						
	Approved hours		Outside approved hours				
	Noise affected	Highly noise affected	Day	Evening	Night	Sleep disturbance (CNVS)	
						$L_{Aeq,\ 15\ minute}$	L_{Amax}
NCA08	58	75	53	53	51	51	61
NCA09	58	75	53	51	46	46	56

4.4 Vibration management

4.4.1 Human comfort

When assessing human exposure to construction-related vibration, the CNVS requires vibration goals to be established using *Environmental Noise Management Assessing Vibration: A Technical Guideline* (DECC 2006), which provides criteria for the assessment of vibration impacts on humans.

Construction activities typically generate vibration of an intermittent nature, which is assessed using a Vibration Dose Value (VDV). Acceptable values of vibration doses are presented in Table 4-5 for sensitive receivers.

Table 4-5 VDV Vibration criteria

Receiver type	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings – 16 hour day (7am to 11pm)[1]	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am)[1]	0.13	0.26	0.51

Note 1: Day time and night time as described in BS6472:1992 (as referenced in the CNVS), i.e. a daytime period of 16 h or a night time period of 8 h, for example 23.00 h to 07.00 h.

4.4.2 Buildings

Potential building damage from construction vibration requires the application of values in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings* Part 2. These values are presented in Table 4-6 and relate to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Table 4-6 Guideline values for vibration velocity for the effects of short-term vibration on structures (BS 7385).

Line	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	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz to 50 mm/s at 40 Hz and above

Where vibration may give rise to magnification due to resonance, especially at lower frequencies where lower guide values apply, the guide values may be reduced by 50%. The CNVS describes rock breaking/hammering and sheet piling activities as having potential to cause dynamic loading in some structures (e.g. residences).

For activity involving rock breakers, piling rigs, vibratory rollers, excavators, vibration predominantly occurs at frequencies in the 10 Hz to 100 Hz range. On this basis, a conservative vibration damage screening level is:

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

4.4.3 Heritage

Heritage buildings and structures would be assessed under a conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (from DIN 4150). Where vibration levels at heritage items are identified as exceeding this screening level, structural assessment would be completed by the Project team to confirm the structure's sensitivity to vibration. If a heritage building or structure is found to be structurally unsound

(following inspection) the conservative criterion would stand. Where the structure is suitably sound, the guideline values from Table 4-6 would be applicable.

4.4.4 Additional mitigation measures

The CNVS recommends additional mitigation measures where all standard mitigation measures to minimise vibration at the nearest receivers have been implemented and vibration is still predicted to exceed the maximum guideline values. The Additional Mitigation Measures Matrix (AMMM) for vibration from the CNVS is presented in Table 4-7. Acronyms are defined at Table 4-2.

Table 4-7 Additional Vibration Mitigation Measures (CNVS)

Construction hours	Mitigation measures where predicted vibration levels exceed maximum levels
Approved hours Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
Evening Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
Night Monday – Saturday: 10am – 7am Saturday: 10pm –8am); Sunday / PH: 6pm –7am	LB, M, IB, PC, RO, SN, AA

5. Impact assessment

5.1 Plant and equipment

A summary of proposed activities at the Sydney Olympic Park site is provided in Table 2-1. Nominal equipment and estimated sound power levels of each item and activity are presented in Appendix C. During the TBM retrieval process some work is proposed outside the approved construction hours.

Sound power levels (SWLs) and predicted noise levels depend on the number of plant items operating at any one time and their precise location relative to a sensitive receiver. The SWLs include item quantities and nominal usage factors (proportion of a 15-minute assessment period the equipment would be operating at its maximum noise output).

5.2 Noise modelling

SoundPlan noise modelling software was used to calculate noise impacts in accordance with the ISO9613 prediction method at all identified noise-sensitive receivers. The model included:

- Topography – 1 metre DEM based on LPI Lidar data.
- Individual buildings for façade calculations and to account for shielding and reflections. Building heights are also taken from Lidar data.
- Individual sensitive receivers – One receiver location representing each residential dwelling and located 1.5 metres above most affected floor level (e.g. level 2) and most-affected façade at up to around 600 metres radius.
- Construction noise sources –Activities and equipment included in the noise model as area sources in locations specified by AFJV. SoundPlan takes the worst-case point within each area to perform its calculations, a conservative approach. Sound power levels in Appendix C. Source is modelled at 1.5 metres above ground.
- Shaft excavation depth was accounted for in the modelling.
- Meteorology –worst-case conditions: gentle breeze (3-5 m/s) source to receiver and stable conditions (conducive of temperature inversion).

5.3 Mitigation measures included in the modelling

Mitigation measures would be implemented to ameliorate noise impacts where practicable during the TBM retrieval and demobilisation of the site. Mitigation measures, which may affect the predicted levels include the following, which have been incorporated in the assessment as base assumptions for noise predictions.

- Source noise control strategies:
  - Where the NML outside approved hours cannot be achieved, work is not proposed to be undertaken unless unavoidable and completed under the procedures contained in the CNVMP.
  - Equipment sound power levels will not exceed those described in Appendix B.
  - Residential grade mufflers fitted to all mobile plant, with equipment maintained and operated effectively.
  - 'Damped' rock hammers with reductions of around 10 dB in comparison to similar sized un-damped hammers
  - No shouting or swearing or playing of loud radios
  - Engine and exhaust brakes avoided
  - Stationary plant placed behind larger objects or as far from receivers as possible

- Engines switched off when not in use for extended periods (15 minutes) and no idling trucks in front of residences
- Dropping of heavy objects or metal-on-metal impacts avoided
- Non-tonal reverse alarms installed on all mobile equipment regularly used on the project.

The above measures have been included in the assessment and are reiterated in Section 7.

- Noise barrier control strategies:
  - No hoarding has been considered in the modelling of noise from the Sydney Olympic Park site. The location of adjacent multi-story buildings reduces the effectiveness of hoarding around the boundary, which in some instances is over 100 metres from the noise source in the direction of the receivers.
  - Temporary noise barriers such as noise blankets on ATF will be installed on a case by case basis where reasonable and feasible.

6. Predicted noise levels

6.1.1 Overview

The final stages Construction work at Sydney Olympic Park is to be undertaken largely during standard operating hours. A summary of predicted noise levels for approved hours works is provided in the following sections for each construction phase. Detailed results for all sensitive receivers are provided in Appendix E.

Noise contours for typical noisy activities are presented in Appendix D. The contours demonstrate the extent of the worst-case cumulative impacts and illustrate buildings around the work sites generally providing good noise screening.

6.1.2 Phase 1 - Site establishment

Site establishment works have been completed. See earlier revisions of this document for detail of completed activities.

6.1.3 Phase 2 – 3 Station box construction and nozzle excavation

Station box excavations have been completed. See earlier revisions of this document for detail of completed activities. Nozzle arch lining is complete, with nozzle headwall and associated concrete pours to be completed post TBM breakthrough. These works are expected to occur during standard construction hours with concrete pours for activity 3e extending into the evening and night. There are no exceedances of the NML predicted for OOH concrete pours.

A summary of noise level impacts for the excavation phase of works is presented in Table 6-1.

6.1.4 Phase 4 - TBM Retrieval and Support Phases.

TBM retrieval will take place simultaneously on the surface and in the station box until all components are removed from the station box floor. Additional equipment and items including cross passage ramps will be retrieved from the tunnels during the final phase of this work.

A diesel tower crane will be mobilised to site to assist the disassembly, lifting and haulage of TBM components. The tower crane will be floated to site in segments via oversized delivery and assembled using a 400T mobile crane during days only. Retrieval activities will also be supported on the surface with a crawler crane where required.

OOHW will be required during this phase of work to load and move oversized sections of the TBMs. During the night, surface works using a reduced equipment inventory for cleaning and scrapping of TBM components are expected to generate a single exceedance of the NML in the 0-10 dB(A) range. This impact is expected to increase to about 4 exceedances where the tower crane is operational for surface works during OOH periods. Cleaning and scrapping activities at surface level will be minimised where possible, however must be included as a contingency as they are essential to ensuring the safe transport of materials off site.

The predicted noise levels for surface works account for equipment based noise impacts. Additional activity related noise (such as metal on metal) is also possible when moving and loading scrap and components on to trucks. During OOH periods the number of exceedances and the potential for sleep disturbance during the night also increase with these impacts. The extent of potential non-equipment related impacts cannot be directly modelled for this scenario as the level, location, duration and frequency of any potential events are unknown. Supervisors will be briefed of this risk and required to monitor all loading operations to mitigate unnecessary

noise. Monitoring of any OOHW will be required to confirm compliance with the predicted noise levels for Phase 4 works detailed in Table 6-2.

Where any surface works are undertaken during the TBM retrieval, noise impacts are expected to exceed the NML criteria for all periods. Work wholly within the station box for activity 4b and 5a is expected to be NML compliant at all but 2 locations for activity 4b during OOHW periods.

As per condition D39 any work identified as exceeding the noise management levels and / or vibration criteria will be managed through application of reasonable and feasible mitigation measures and in accordance with the Noise and Vibration CEMP Sub-plan. Additional mitigation measures from Sydney Metro's CNVS will be applied where NML's are not achieved (refer to section 4.2.5 and 4.4.4).

6.1.5 Phase 5 - Demobilisation

Removal of the hard stand and some infrastructure may, however, commence prior to the complete retrieval of the TBM.

Final removal of concrete plinths and reinstatement of hardstand areas within the site would begin once the TBM retrieval is complete. Complete site demobilisation will be undertaken using cranes at surface level to remove plant and waste materials from the station box area, which will then be loaded onto floats and trucks and transported from the site. The highest impacts will occur where hard demolition of buildings and hardstand are completed during the final stages of demobilisation of the 7 Figtree Drive building (this hard demolition will not occur until after all other site works are complete).

Activities that require the use of rock hammers and vibratory compaction such as equipment removal and road works are expected to have the highest noise impacts with up to 30 receivers in the 0-10 dB(A) range and 10 receivers in the 10-20 dB(A) range. The demobilisation works and therefore all noisy activities are programmed for standard construction hours only.

Demobilisation of the whole site is expected to be completed by about July 2025.

A summary of noise level impacts for this phase of works is presented in Table 6-2.

Table 6-1 Summary of predicted NML exceedances for Phase 3 –Nozzles

Activity		Maximum level, dBA			Predicted no. receivers with exceedance of NML															
					Approved hours			Outside approved hours - Day				Outside approved hours - Evening				Outside approved hours - night			
		Res	Non-res	Rec. >75	0-10	10-20	20+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+
3a	Headwall waterproofing	30	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3b	Nozzle - Concrete lining	32	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3e	Nozzle - Concrete pour	50	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-2 Summary of predicted NML exceedances for Phase 4-6– Demobilisation activities

Activity		Maximum level, dBA (Day)			Predicted no. receivers with exceedance of NML															
					Approved hours			Outside approved hours - Day				Outside approved hours - Evening				Outside approved hours - night			
		Res	Non-res	Rec. >75	0-10	10-20	20+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+
4a	TBM Surface works - Handling	68	77	4	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4a(i)	Surface work + Tower crane	68	77	4	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4b	TBM- Prep work (Surface)	58	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4c	TBM - Loading (Surface)	50	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4d	TBM Station box works	53	60	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
5a	Remove modules/services	43	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5b	Tower crane/plinth removal	61	68	-	2	-	-	Daytime Only											
5c	Reinstate concrete foundations	58	71	-	2	-	-												
5d	Plant and equipment removal	71	84	9	19	5	-												
5e	Site clean-up	73	86	11	18	11	-												
5f	Removal of amenities/utilities	71	82	5	11	5	-												
5g	Pavement restoration	59	67	-	1	-	-												
6a	Tree lopping	61	77	3	8	-	-												
6b	Soft demolition	57	73	-	3	-	-												
6c	Hard demolition	73	89	11	30	10	-												
6d	Final reinstatement (earthworks)	61	77	3	8	-	-												

6.2 Ground-borne noise

The requirement to consider ground-borne noise is applicable to tunnelling or other subterranean works which have the potential to generate internal noise impacts within a sensitive receiver. However, as discussed in Section 4.2.3, ground-borne noise is only assessed for the evening and night periods in residential locations. During excavation of the station box, vibration-intensive equipment such as rock hammers and rock bolters would be used but these would only be during standard hours and airborne noise is expected to result in noise levels greater than the ground-borne noise component.

Therefore, ground-borne noise has not been considered further in this DNVIS. Once tunnelling commences, this matter will be reviewed as part of the revised DNVIS for activities outside approved hours.

6.3 Vibration impact assessment

6.3.1 Assessment method and reference data

Vibration-intensive surface works during demobilisation will occur during demolition of buildings and the existing concrete structures and foundations surrounding the site. Potential items of plant that can generate vibration impacts are:

- Rock Hammers
- Vibratory rollers
- Plate compactors

To assess the likelihood of impacts on human comfort and structures, reference vibration levels are summarised in Table 6-3 and curves of vibration with distance are presented in Figure 6-1. Reference vibration levels are based on previously measured levels.

Table 6-3 Summary of vibration-intensive activities

Activity	Typical equipment	Typical PPV vibration emission levels	Source
Demolition/Rock breaking	15-20 t Excavator with hammer	1.3 mm/s at 10 m	Site measurement
	47t - 49t excavator with hammer	4.8 mm/s at 10 m	Site measurement
Site compaction	Vibratory roller 20 t	4.5 mm/s at 10 m	Site measurement

Based on the estimated vibration emission levels of each activity and the following equation for geometric damping (conservatively ignoring material damping), levels of vibration with distance can be estimated.

$$PPV_2 = PPV_1 \left(\frac{R_1}{R_2}\right)^n$$

Where:
PPV – Peak Particle Velocity at the source (PPV_1) and Receiver (PPV_2)
R – distance from source of reference level (R_1) and distance from source of receiver (R_2)
n – ground factor assumed as 1.7 for body waves near the ground surface

Predicted levels of vibration over distance are summarised in the following sections.

6.3.2 Risk of cosmetic damage

Predicted levels of vibration over distance are illustrated in Figure 6-1. Considering the vibration guideline values prescribed in the CNVS of 25 mm/s for reinforced structures such as the commercial buildings near the site, the risk of cosmetic damage is low for equipment outside 5 metres from the source. Where unsound heritage items are present, with a guideline value of 2.5 mm, the risk of damage increases below about 15 metres.

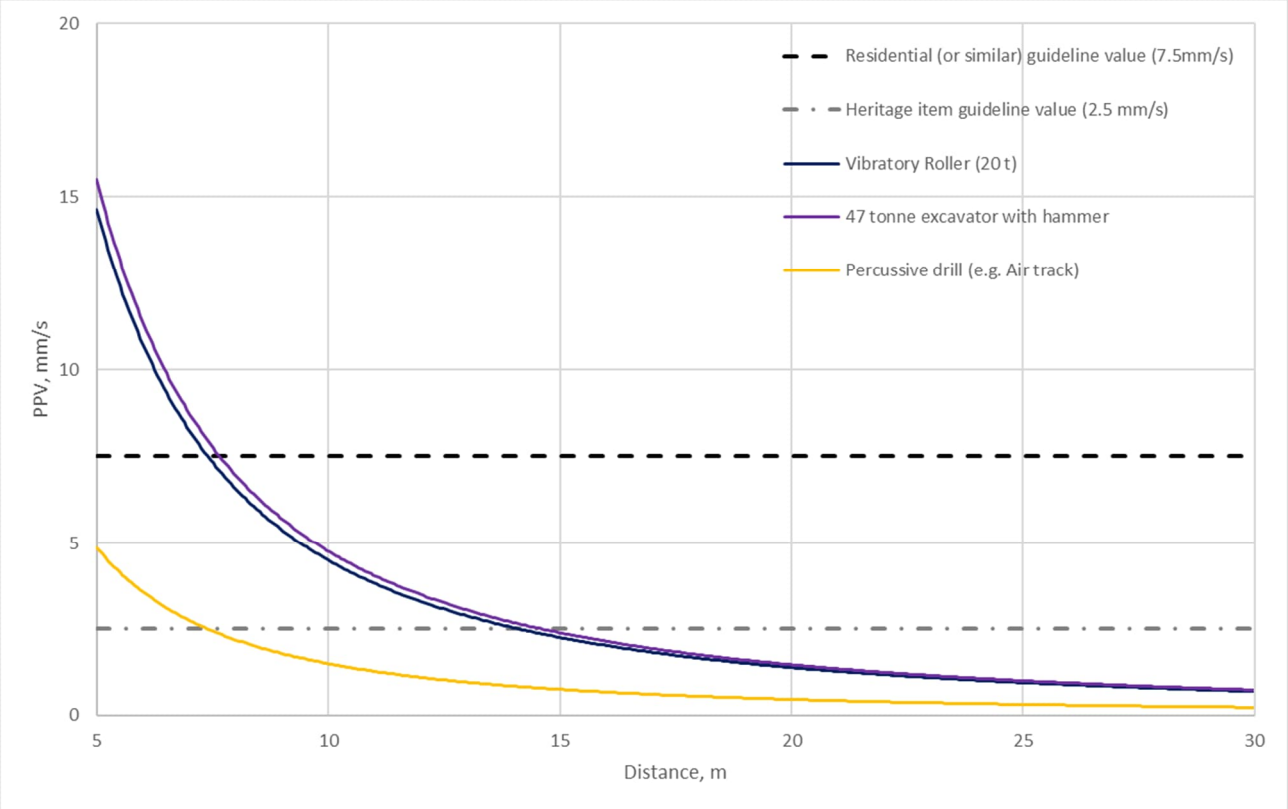


Figure 6-1 Curves of vibration with distance from the source

Contours representing the distance at which the vibration guideline values for each item are predicted to be achieved are presented in Appendix D. Where sensitive structures are within the buffer distance, trial monitoring should be undertaken prior to any works commencing to determine actual vibration levels.

The nearest buildings are commercial structures, outside the nominal buffer distances and the risk of vibration impact is low. The heritage structures to the north of the site are also outside the nominal buffer.

Where equipment changes, monitoring and establishment of a site-specific vibration curve would be undertaken.

Consideration of vibration generating activities should include alternative methods where necessary to minimise vibration risk, such as:

- Employ non-vibratory (static) rolling methods for compaction where practicable.
- Use a ripper and bucket in place of a hammer where possible.
- Use smallest available excavator and hammer combination when breaking concrete or rock.

Details of the locations for monitoring will be included in a specific vibration monitoring programme for the Sydney Olympic Park site to be developed in conjunction with the appropriate stakeholders as part of the noise and vibration monitoring programme detailed in the Project CEMP.

6.3.3 Human exposure

The CNVIS applies vibration dose value (VDV) criteria to residential buildings over the day and night periods. No residential buildings are in the vicinity of the site; however, for completeness, acceptable VDV for intermittent vibration from *Assessing Vibration: A technical Guideline* (DEC 2006) have been referred to. These guidelines require a maximum VDV of 0.8 $m/s^{1.75}$ in offices.

Over site establishment, typical vibration-intensive activities such as rolling, drilling and demolition are unlikely to result in extended periods of vibration that would exceed the nominal VDV. However, excavation of the station box by rock hammering may generate vibration over an extended time during approved hours.

To estimate the vibration dose value of hammering, the estimated VDV (eVDV) equation from DEC 2006 has been used:

$$eVDV = 1.4 \times a \times t^{0.25}$$

where *a* represents the root mean square (rms) vibration acceleration in m/s^2 and t is the duration of the activity in seconds. Since we only have velocity values for vibration, acceleration is substituted for velocity by the following equation:

$$a_{rms} = 2 \times \pi \times f \times v_{rms} /1000$$

where f is the dominant frequency of the vibration and v is the root mean square (rms) velocity.

The rms velocity was derived from the peak particle velocity assuming a crest factor (the ratio of the peak value to its rms value) of 4. The dominant frequency of hammering is taken as 80 Hz.

eVDVs for durations of hammering of between 1 hour and 8 hours, are presented in Figure 6-2 and show the VDV at various distances from the source for a range of exposure durations. From the graph, hammering in the daytime would result in possible adverse comment within about 15 metres from the source for a total of up to 8 hours of work. For shorter durations, the buffer distance would be smaller.

Human exposure to vibration applies when a sensitive receiver is impacted in a habitable room, where no receiver is present, human comfort criteria would not apply. In addition, where the work moves further from the impacted building a reduced impact would be predicted and duration of exposure would increase proportionally.

Human comfort should be assessed inside the residence at the centre of a habitable room. Therefore, the building's construction, how many floors, how the building is coupled to the ground and the distance to the nearest habitable room would influence the actual levels measured during compaction and would likely be lower than predicted.

Vibration contours are presented in Appendix C and illustrate the receivers that may fall within the 15 metre contours for possible adverse comment during daytime hours. No receivers are predicted to experience vibration in excess of human comfort criteria.

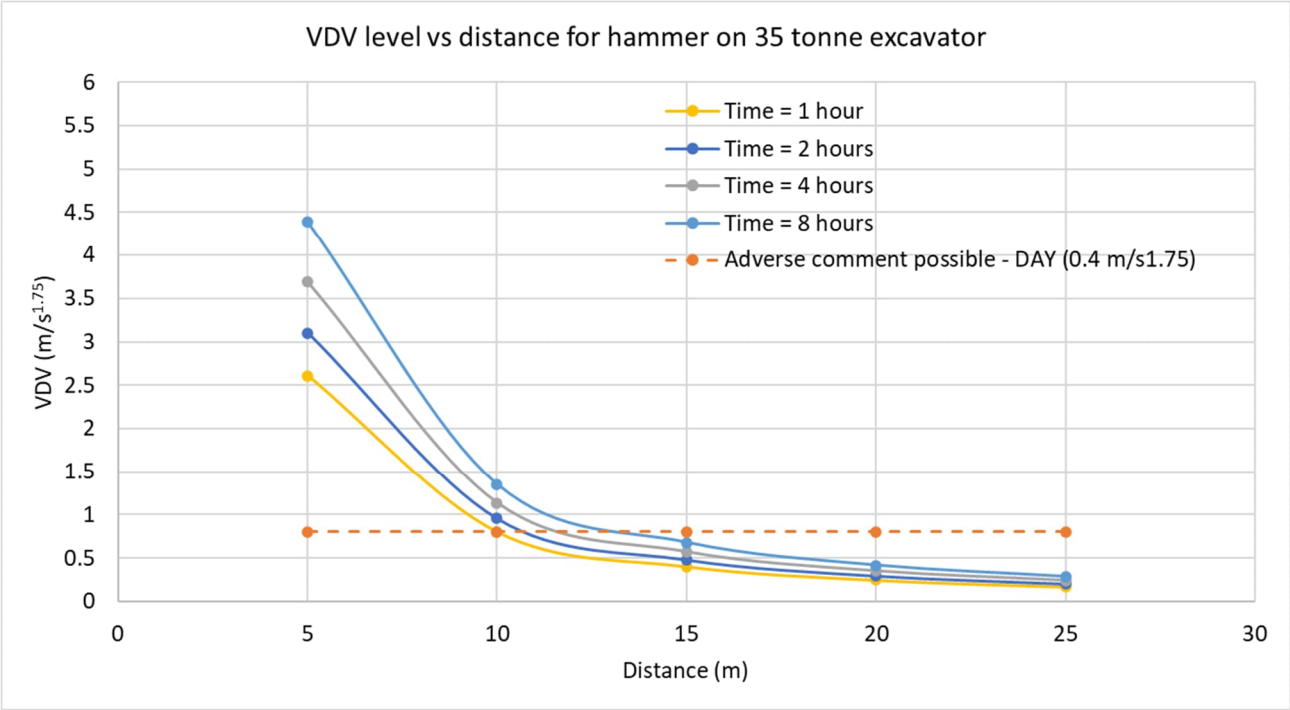


Figure 6-2 VDV curves for excavator and hammer

6.4 Construction traffic

Heavy vehicle movements related to Sydney Olympic Park demobilisation activities will comprise of a limited number of deliveries of materials and equipment as well as concrete trucks for reinstating works. Additional truck movements during the TBM retrieval phase would include daily truck movements of scrap and parts from the TBMs and also several oversized truck movements during the night time, required for some of the larger parts.

Figure 6-3 presents primary and alternate inbound and outbound haul routes. The primary routes would cater for daily ingress and egress of the site and would be used by all vehicles. Alternative routes for site access would be used only during special events to ensure no traffic congestion impacts on Olympic Boulevard at these times.

For the primary routes, all heavy vehicles would enter the site via Sarah Durack Avenue onto Olympic Boulevard and then into Herb Eliot Avenue. Sensitive receivers for this route include the Ibis Hotel located 11A Olympic Boulevard and the Pullman Hotel at 9 Olympic Boulevard situated on the corner of Herb Elliot Avenue, both multi storey towers; however there are no residential receivers identified for Olympic Boulevard.

Vehicle exit is via Figtree Drive onto Olympic Boulevard and returning along Sarah Durack Avenue. This route creates a circular traffic flow through the site, minimising the number of heavy vehicles returning along Olympic Boulevard, passing the hotels for a second time.

The EIS noted construction related traffic has the potential to temporarily increase road traffic noise levels at receivers adjacent to construction haulage routes. However, at the Sydney Olympic Park site it was noted that no roads were anticipated to have a greater than 2 dB increase. Based on nominal activities, approximately 150 heavy vehicles are expected to access and leave the site each day during the peak excavation period. These movements would be during approved hours only.

The haul routes along Olympic Boulevard and Herb Elliot Avenue leading to the construction site are defined as local roads and appropriate criteria for daytime traffic noise from the Road Noise Policy would be 55 dB L_{Aeq} 15hr. Australia Avenue is an arterial road, therefore the appropriate criteria for daytime traffic noise would be 60 dB L_{Aeq} 15hr. To calculate noise levels for potentially impacted receivers, an assessment against the RNP criteria has been undertaken using the Calculation of Road Traffic Noise (CoRTN) methodology.

To calculate the comparable L_{Aeq} 15 hr noise level, noise emissions from 150 vehicles are evenly spread across the 15hour assessment period.

Based on a speed limit of 40km/h for vehicles entering and exiting the sites, predicted noise levels at 10 metres for the average peak periods of construction-related heavy vehicles are as follows:

- Australia Avenue – 62.6 L_{Aeq} 15hr
- AllAll other roads - 59.5 L_{Aeq} 15 Hr

At the nearest receivers along the primary access routes through Olympic Boulevard and Herb Elliot Avenue, incoming vehicles would be about 151 metres from the nearest building facade on either side of the road and further for floors higher than ground level. At these distances, the noise levels are expected to reduce by a further 11.5 dB(A) indicating a traffic noise level of around L_{Aeq} 15hr 588 dB(A) for heavy vehicle movements.

For multi storey residential that back onto Sarah Durack Avenue, outbound trucks would be approximately 57 metres from the nearest residences plus additional shielding from infrastructure not accounted for. At this distance, the noise from truck movements would reduce by around 7.5 dB(A) indicating a façade noise level of L_{Aeq} 15hr 52 dB(A).

The alternate route along Australia Avenue would experience double the daily traffic as both inbound and outbound vehicles would use this road, hence the higher predicted base noise level. The facade setback of the residential buildings along this route is around 20 metres as an average between north and south bound lanes, resulting in around a 2-3 dB(A) reduction of the base level.

For the primary routes, construction traffic noise levels are expected to exceed the local road criteria for Olympic Boulevard/Herb Elliot Avenue by around 3 dB(A) at the most affected facades, during peak periods. Generally a 2 dB(A) or greater exceedance of the criteria would require a review of mitigation options. While a theoretical exceedance is possible for these locations, the following factors would influence the need for mitigation measures at these locations:

- The nature of the business ensures that affected receivers are only impacted on a short-term basis depending on length of stay ***and*** only during daytime hours
- Construction of the hotel buildings is expected to be in accordance with building code requirements, meaning a commercial-style façade with substantial transmission losses (e.g. 25 dB), sealed windows and air conditioning. Therefore treatments to mitigate an additional 3 dB(A) exceedance would not be reasonable.

For the alternate route along Australia Avenue, traffic noise levels during special event periods are expected to be at or marginally below the RNP criteria for an arterial road. As these traffic noise levels are expected to be about equal to the criteria and additionally, would only occur during a few days of the year, no further mitigation is recommended at this stage of the project.

These impacts are the predicted worst case during peak vehicle movements and are therefore not representative of the longer-term trends from construction traffic noise which would be lower during some

periods. Where complaints are received regarding construction traffic noise, an additional review of actual traffic noise following a monitoring survey would be required.

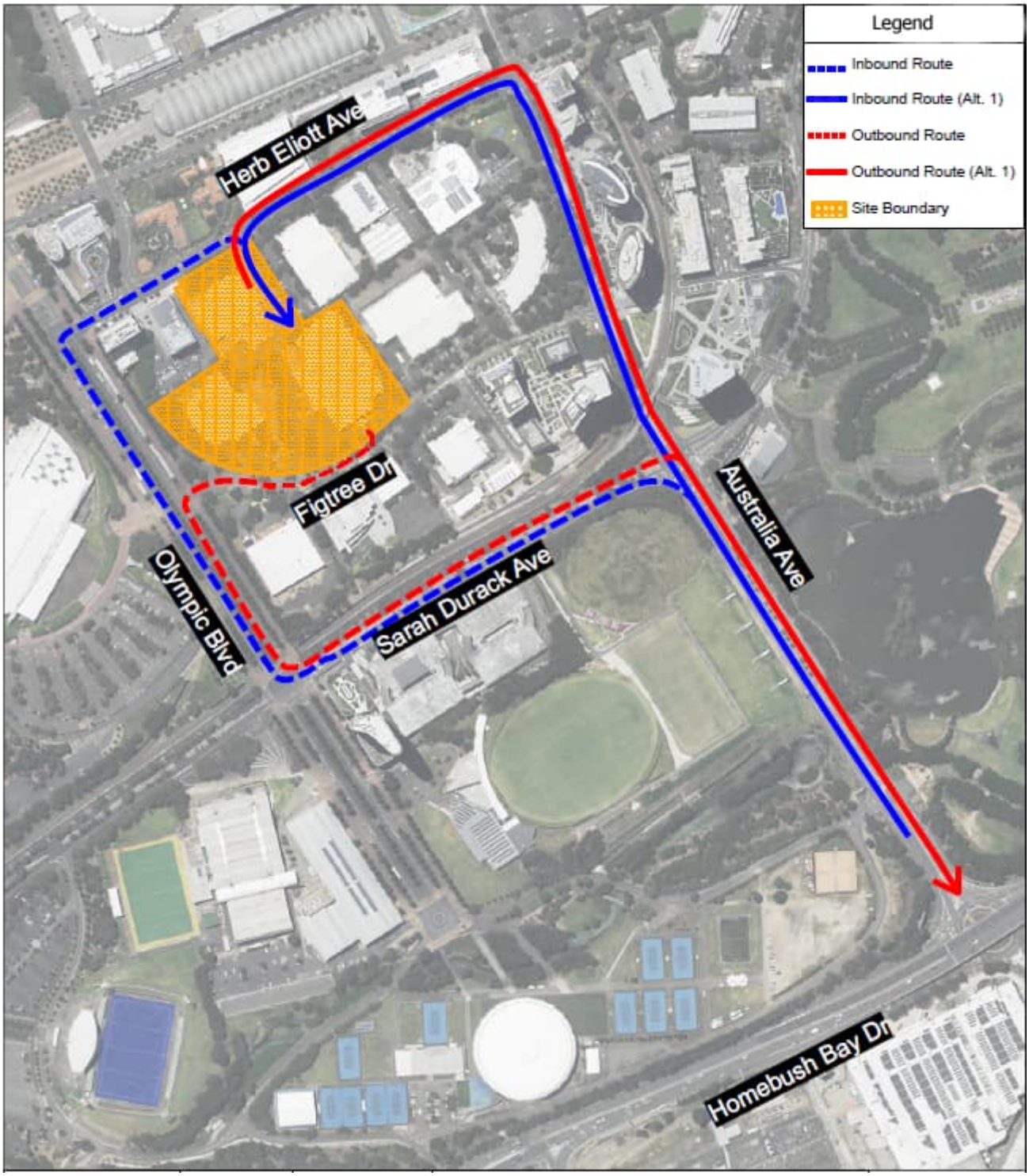


Figure 6-3 Sydney Olympic Park construction traffic movement

7. Summary and recommendations

7.1.1 Impact summary

This DNVIS has established that where works are completed during OOH periods for the TBM retrieval, noise is unlikely to result in adverse impacts on the closest receiver locations.

Predicted noise levels for this assessment identify typical equipment combinations from the overall equipment list, working in the dedicated areas within the site.

This provides a conservative 'worst case' noise level that may be reasonably expected over the course of the modelled construction activity. The impacts from these activities will vary based on the location and type of building for each noise sensitive receiver.

In Sydney Olympic Park the local community is largely comprised of commercial buildings with some residential high-rise buildings located around 100 metres away from the site boundary and around 160 metres to the station box activities, although being multi storey residential, the receivers may overlook the site.

There are two multi storey hotels within about 65-100 metres of the station box works with direct line of site from some floors to the construction zones. At times the location of the works will be within the station box and will have some shielding benefit offered by the adjacent commercial buildings that will reduce the overall levels of the predicted noise impacts.

The demobilisation works are programmed for daytime only and therefore, impacts outside approved hours for residential receivers or the nearby hotels are not expected. Commercial buildings directly adjacent to the works will experience the greatest level of impact; however during the demobilisation works, the location of equipment will vary providing some benefit during this time.

Based on the predicted noise levels, proposed construction program and sensitivity of the community to noise and vibration, this site is classed as a low risk and mitigation measures in line with this classification are proposed. This would include substitution of noisy equipment where practicable and regularly scheduled respite periods during noisy works.

Vibration impacts from surface works may be perceptible where vibration generating equipment such as rock hammering or vibratory rolling is undertaken. However, cosmetic damage and human exposure risks are low and there are no heritage structures identified within the nominal buffer zones.

Out of hours work may be required for works outside the scope of this DNVIS such as out of hours utility relocations, oversized plant deliveries, and any other works undertaken in conjunction with CoA D37 and EPL 21610. These works will be assessed on a case-by-case basis through the AFJV out of hours work process. These activities may cause impacts above NML and sleep disturbance levels. Mitigation measures such as offering alternative accommodation will be implemented as required.

The Project CEMP requires the development of a noise and vibration monitoring plan at key locations. These plans will be site specific and will be determined in conjunction with the appropriate stakeholders for each site.

7.1.2 Standard mitigation

Standard noise mitigation measures described in Table 7-1 should be implemented at all stages of the project in addition to those described in the project Construction Noise and Vibration Management Plan (CNVMP).

In line with CoA D42 best practice construction methods will be implemented where reasonable and feasible to ensure noise is maintained at a practical minimum. Practices will include:

- use of regularly serviced low sound power equipment;
- temporary noise barriers (including the arrangement of plant and equipment) around noisy equipment and activities; and
- use of alternative construction techniques.

Hoarding has been installed around the perimeter of the site to provide both an acoustic benefit and a visual indicator to the public that all reasonable and feasible measures are being undertaken for specific activities.

Equipment should be selected with consideration of noise emissions and the quietest equipment that can do the job should be chosen.

Alternatives to hammering on pile caps was investigated, such as cropping, and were implemented where reasonable and feasible.

As required by CoA D37, any night works predicted to exceed the NML would be undertaken under the out-of-hours works protocol, requiring review and endorsement by the ER and AA.

Consultation will be critical in ensuring the community's expectations are managed, with impacts and durations clearly conveyed, resident's concerns heard, appropriate respite and other mitigation is offered and/or implemented and works outside of hours are not unexpected. Refer to Section 7.1.5 for more details on consultation.

Table 7-1 Standard mitigation measures

Measure	Description
Administrative	
Construction hours	• As much work as possible will be programmed during approved hours. Where work outside approved hours is proposed, this will be completed in line with the CNVMP and Out of hours works protocol.
	• • In accordance with CoA D36, noisy activities as defined in the ICNG, such as concrete cutting, will be undertaken on a 3 hours on, with a minimum cessation of work of not less than one (1) hour., unless otherwise approved.
Community consultation	• In line with the CNVMP, nearby receivers should be notified of the upcoming works, including the duration and predicted level of impact.
	• In line with the CNVS, community consultation will be undertaken regarding the DNVIS and proposed mitigation such as respite offers
Site induction	• Site Environmental Induction should be delivered to the team and should include consideration and awareness of noise impacts.
Cumulative impacts	• Programming for works undertaken outside approved hours will also consider works being undertaken by third parties
Behaviour	• Avoid yelling and swearing near sensitive receivers.
Noise control	
	• Priority will be given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable.

Measure	Description
Equipment selection	• All equipment shall be well maintained, including mufflers and any noise suppression
	• All equipment will meet the maximum sound power requirements of Table 13 of the CNVS.
	• Trucks approaching construction sites will avoid the use of compression braking, especially in the night period
	• Traffic management signage vehicles shall be padded to reduce rattling as much as possible.
Noise barriers	• Use temporary noise screens and enclosures as much as possible to reduce noise emissions from equipment when stationary or operating in one location for a reasonable duration. Screens (such as Echo barrier) should be placed between source and receivers, be continuous (without gaps) and installed according to manufacturer directions.
Use and siting of plant	• Plant used intermittently to be throttled down or shut down. Switch engines off when not in use for a short time (e.g. 15 minutes) • Noise-emitting plant to be directed away from sensitive receivers where possible. • Stationary plant should be located behind a structure or enclosed if practicable. • Avoid compression breaking on approach to the site.
Non-tonal reversing alarms.	• Non-tonal reversing beepers (or equivalent) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Monitoring	
Noise monitoring	• Noise monitoring shall be completed to: - verify assumptions of this DNVIS regarding estimated equipment noise emissions, - ensure compliance with the NMLs, - as required by the AMM for each assessed activity and - as required by the NVMP and associated monitoring program.
Vibration monitoring	• Attended vibration measurements would be undertaken at the commencement of vibration generating activities within safe working distances shown in Appendix B. Where there is potential for exceedances of criteria vibration, site law investigations would be undertaken to determine site-specific safe working.

7.1.3 Additional mitigation measures

Additional noise mitigation measures described in the CNVS AMMM should also be implemented as indicated in Appendix A for each receiver. AMM for each receiver is indicated by colour-coding as per the AMMM in Table 4-2.

For vibration, AMM should be applied for sensitive receivers where measurement indicates it is applicable. In this case, measurement means either at a single location, which also indicates the likely level (and relevant AMM) at other similarly exposed locations or as established by site law measurements to indicate which receivers would be within the site-specific safe working distances.

7.1.4 Monitoring

Noise and vibration monitoring will be undertaken in line with the Noise and Vibration Monitoring Program and out-of-hours protocol as appropriate.

7.1.5 Consultation

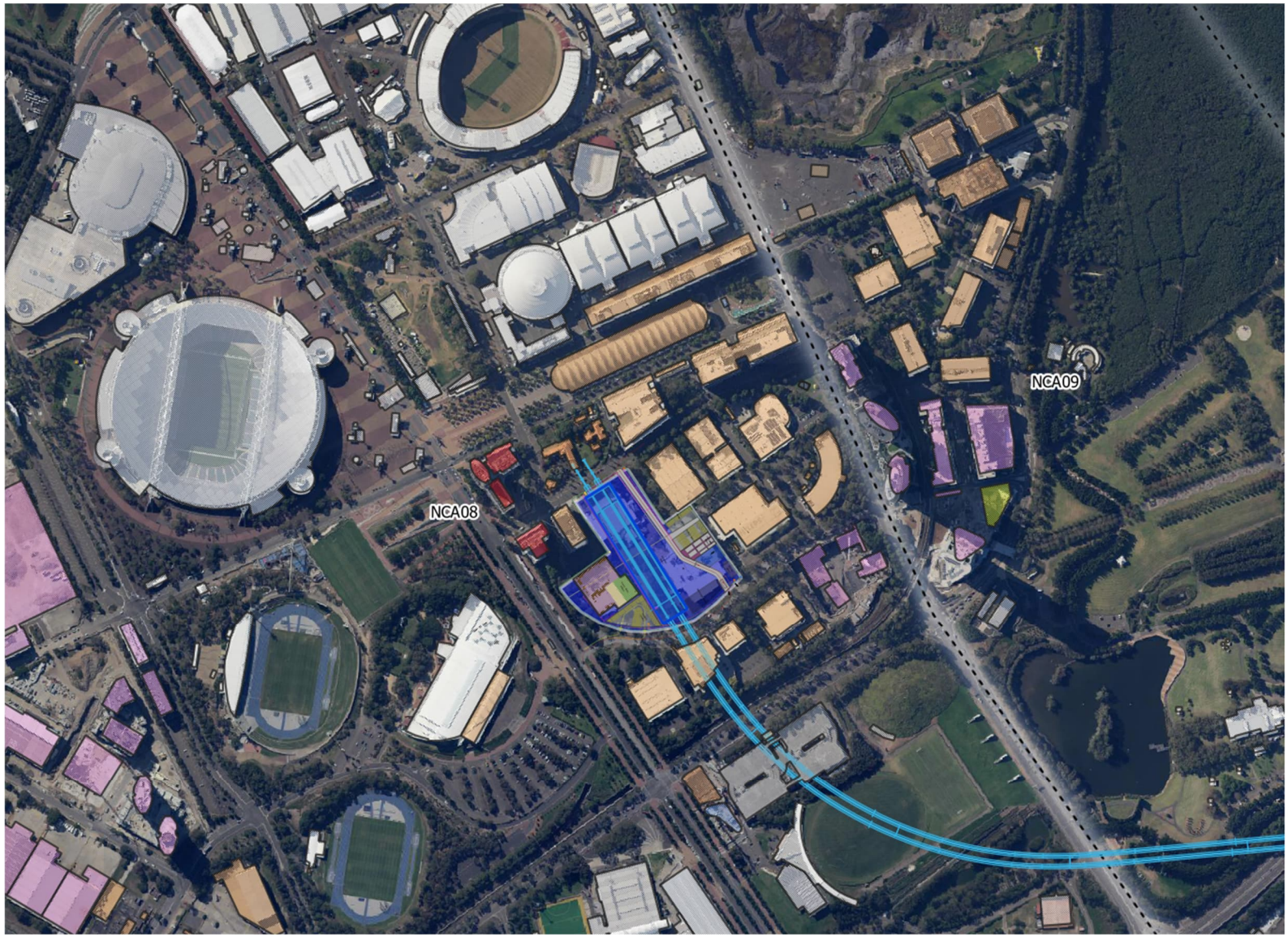
Condition of Approval D43 requires mitigation measures presented in this DNVIS to be identified through consultation with the affected community. This applies to standard hours and works outside standard hours.

AFJV will continue to consult with the community about planned out of hours work by providing regular updates to the community about upcoming out of hours activities, associated impacts and mitigation

measures being implemented as well as invite ongoing feedback to be provided via email, 24-hour phone line or in person meetings.

AFJV will issue Sydney Olympic Park site-specific newsletters /notifications which include information about expected out of hours work and any associated impacts. Information obtained from the ongoing engagement will be considered as the out of hours scope of work is confirmed and where appropriate, targeted mitigation measures would be implemented.

Appendix B. **Land use survey and NCA maps**



Sydney Olympic Park
Land use survey

Site footprint
Sydney Olympic Park NCA
Sydney Metro West

Land uses
Childcare
Commercial/Business
Commercial/Residential
Community Use
Community/Residential
Education
Hotel
Industrial/Utilities
Recreational/Open Space
Residential
Medical
Place of Worship
Recreational Passive
None

0 50 100 150 200 m

Appendix C. **Proposed equipment and sound power levels**

C.1 Station box

Phase		Activity/ Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	SWL	Adjusted SWL, LAeq,15 minute			Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Eve	Night	Day	Eve	Night
3	Tunnel nozzle	Nozzles/Headwalls	3c	Waterproofing	25tn mobile franna	1			98	0.4		0	103	94	0	0	100	0	0
					100tn mobile crane	1			98	0.4		0	103	94	0	0			
					EWP	2			89	0.3		0	94	84	0	0			
					Telehandler	2			100	0.4		0	105	96	0	0			
					Handtools	1			94	0.2		0	99	87	0	0			
			3d	concrete lining	Telehandler	1			100	0.4		0	105	96	0	0	102	0	0
					Elevated work platform	2			89	0.3		0	94	0	0	0			
					Diesel Concrete Line Pump	2			108	0.3		0	113	0	0	0			
					Concrete Trucks (at Surface level)	2			103	0.3		0	108	0	0	0			
					100 T crane	1			98	0.4		0	103	0	0	0			
					Hand tools	1			94	0.2		0	99	90	0	0			
					2 x concrete truck (in station box)	1			103	0.4		0	108	101	0	0			
			3e	Concrete deliveries	2 x concrete truck (surface)	2	2	2	103	0..4		0	108	102	102	102	102	102	102

C.1 TBM Retrieval & Demobilisation

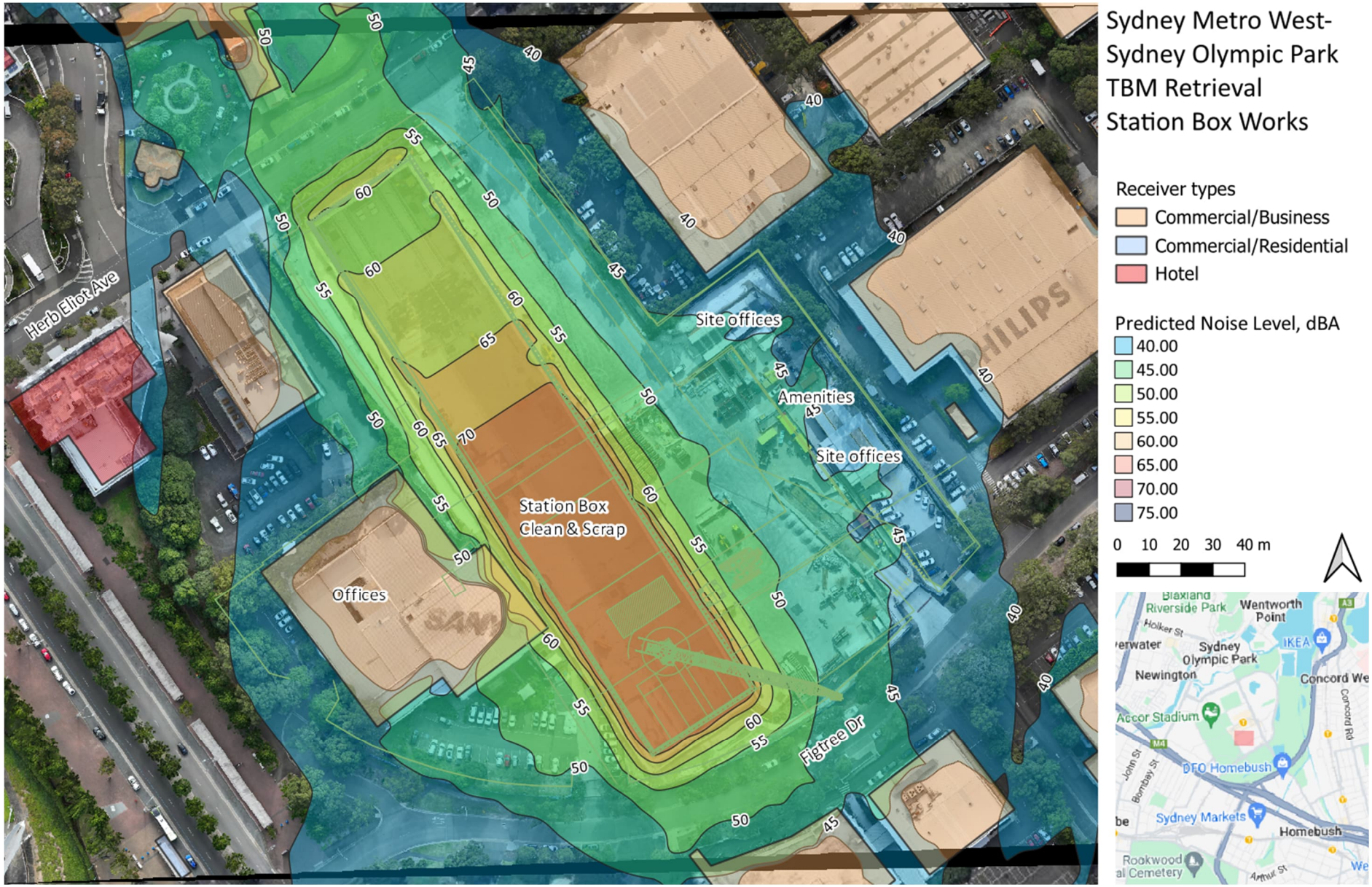
Phase		Activity/ Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	SWL	Adjusted SWL, LAeq,15 minute			Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Eve	Night	Day	Eve	Night
14	TBM Retrieval	Surface works	4a	Handling	Tower Crane (Favco M2480D)	1	1	1	100	0.4		0	105	96	96	96	116	100	97
					Crane (up to 400t)	1	0	0	105	0.4		0	110	101	0	0			
					Hammering steel	4	0	0	115	0.1		5	123	116	0	0			
					Air Arc gouging	4	1	0	97	0.5		0	102	100	94	0			
					Franna including up to a 40t	1	1	0	98	0.4		0	103	94	94	0			
					Road truck (deliveries to site)	1	0	0	107	0.3		0	112	102	0	0			
					Oversized road truck leaving site	0	1	1	94	0.3		0	99	0	89	89			
			4b	Prepping	Oxy Cutting	4	1	1	97	0.5		0	102	100	94	94	105	101	98
					Air / Power Tools	2	1	1	94	0.2		0	99	90	87	87			
					Hydraulic tooling	2	1	1	94	1		0	95	97	94	94			
					Mig/Arc welding machines	4	1	0	100	0.2		0	105	99	93	0			
					Hydraulic Power pack on surface	1	1	0	101	0.3		0	104	96	96	0			
					High pressure water cleaning on surface	2	1	1	94	0.4		0	97	93	90	90			
					Diesel 60ft EWP on surface	1	1	1	86	0.3		0	91	81	81	81			
					Electric scissor lift on surface	1	1	1	89	0.3		0	94	84	84	84			
			4c	Loading	3T forklift	1	1	1	100	0.2		0	105	93	93	93	98	98	98
					7T Telehandler	1	1	1	100	0.4		0	105	96	96	96			
		Station Box works	4d	Station Box works	Hydraulic Crane up to 150t	1	1	1	109	0.4		0	114	105	105	105	112	112	112
					Hammering steel	4	1	1	115	0.1		5	123	116	110	110			
					Air / Power Tools	2	1	1	94	0.2		0	99	90	87	87			
					Hydraulic tooling	2	1	1	101	1		0	104	104	101	101			
					Mig/Arc welding machines	4	1	1	100	0.2		0	105	99	93	93			
					Oxy Cutting	4	2	2	97	0.5		0	102	100	97	97			
					Air Arc Gouging	4	1	0	97	0.5		0	102	100	94	0			
					Diesel 60ft EWP in box	2	2	2	89	0.3		0	94	87	87	87			
					Electric scissor lift in box	1	1	1	86	0.3		0	91	81	81	81			
					3T forklift	1	1	1	100	0.2		0	105	93	93	93			
					Hydraulic Power pack in box	1	1	1	94	1		0	95	94	94	94			
					High pressure water cleaning in box	2	1	1	94	0.4		0	97	93	93	93			
					10t Diesel winch	2	1	1	102	1		0	105	105	102	102			
5	Site Demobilisation	Removal of modules/ TBM services and brackets	5a	Demolition	100 ton crawler crane	1			99	0.4		0	104	95	0	0	102	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Telehandler (1 x Surface, 1 x Box)	2			100	0.4		0	105	99	0	0			
					Semitrailer	2			100	0.3		0	105	98	0	0			
		Removal concrete decks/plinths/Crane	5b		30t excavator + hammer (Stn Box)	1			120	0.3		5	128	120	0	0	120	0	0
					100t Crawler crane	1			99	0.4		0	104	95	0	0			
					25t Franna (Stn Box)	2			98	0.4		0	103	97	0	0			
					Positrak (Stn Box)	2			107	0.3		0	112	105	0	0			
					Telehandler (1 x Surface, 1 x Box)	2			100	0.4		0	105	99	0	0			
					Jackhammer	1			111	0.2		5	119	109	0	0			
					Rigid trucks	1			107	0.3		0	112	102	0	0			

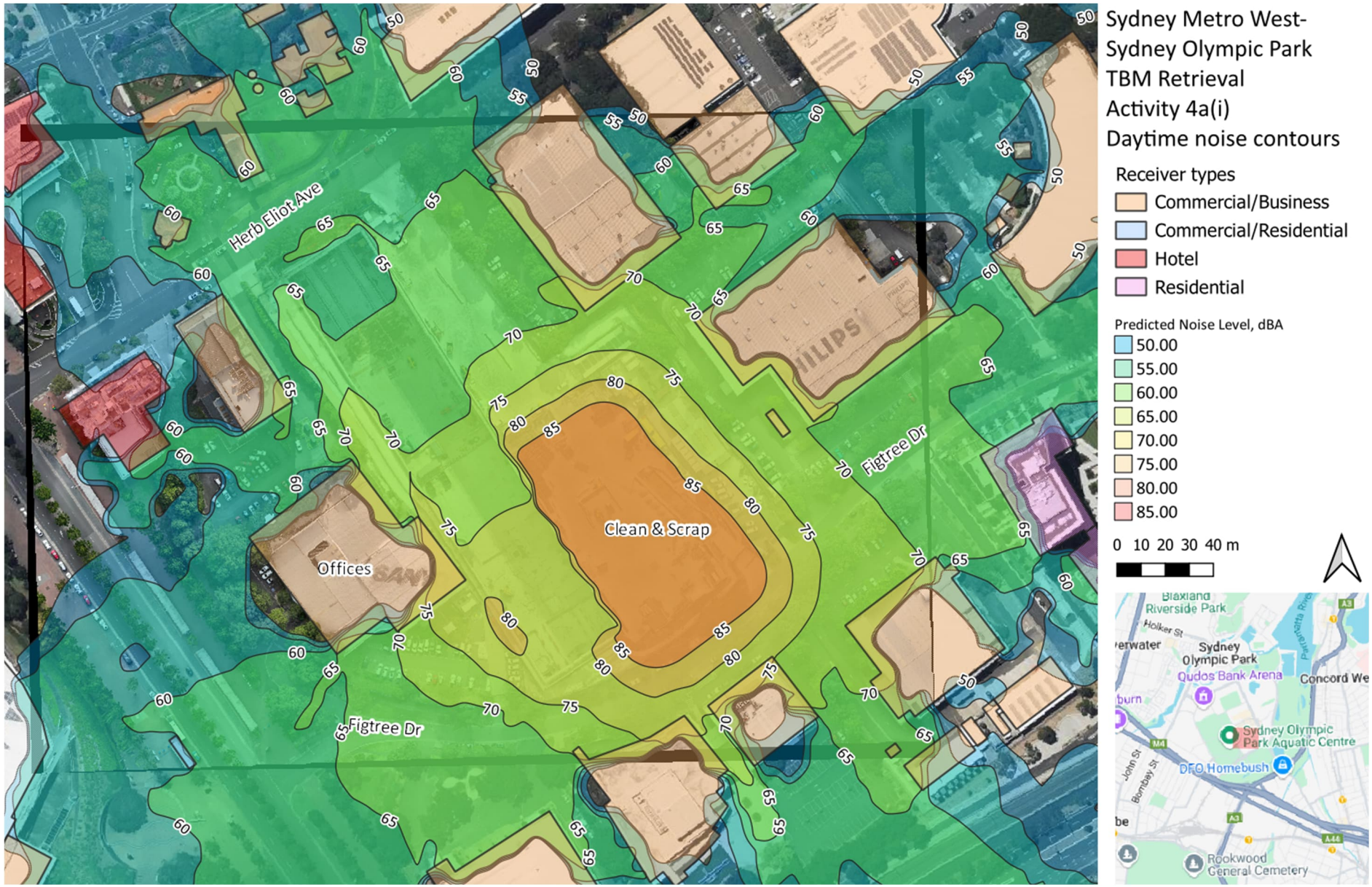
Phase	Activity/ Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	SWL	Adjusted SWL, LAeq,15 minute			Activity LAeq, 15 min SWL		
					7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Eve	Night	Day	Eve	Night
		Reinstate concrete foundations	5c	Concrete agis (surface)	1			103	0.3		0	108	98	0	0	107	0	0
				Concrete pump (surface	2			108	0.3		0	113	106	0	0			
				Concrete vibrators	2			100	0.4		0	105	99	0	0			
		Plant and equipment removal	5d	100 ton Crane	1			99	0.4		0	104	95	0	0	120	0	0
				30t excavator + Hammer + Bucket;	1			120	0.3		5	128	120	0	0			
				Telehandler/ 25t Franna	1			100	0.4		0	105	96	0	0			
				EWP	1			86	0.3		0	91	81	0	0			
				Hand tools	1			94	0.2		0	99	87	0	0			
				Semi-trailer/Truck and dog	2			108	0.2		0	113	104	0	0			
		Site clean-up/removal of materials	5e	Watercart	2			103	0.4		0	108	102	0	0	122	0	0
				Sweeper	2			100	0.4		0	105	99	0	0			
				Bobcat	1			107	0.3		0	112	102	0	0			
				Rigid truck	2			93	0.3		0	98	91	0	0			
				15t excavator + Hammer + Bucket;	2			118	0.4		5	126	122	0	0			
		Site amenities removal and utilities disconnection	5f	Sucker truck	1			109	1		0	114	109	0	0	121	0	0
				Watercart	1			103	0.4		0	108	99	0	0			
				100tn mobile crane	2			98	0.4		0	103	97	0	0			
				15tn excavator + hammer	1			118	0.4		5	126	119	0	0			
				Handtools	2			94	0.2		0	99	90	0	0			
				25kVA generator	1			94	1		0	95	94	0	0			
				Road saw	1			114	0.2		5	122	112	0	0			
				Wacker packer	1			108	0.2		0	113	101	0	0			
				8tn roller	2			105	0.4		5	113	109	0	0			
		Permanent asphalt restoration (site compound)	5g	Spray seal/ Paver	1			106	0.4		0	111	102	0	0	108	88	0
				Rigid trucks	1	1		93	0.3		0	98	88	88	0			
				8t Roller	1			105	0.4		5	113	106	0	0			
6	Building Demolition	Tree lopping	6a	EWP	1			86	0.3		0	91	81	0	0	113	0	0
				Woodchipper	1			114	0.6		0	119	112	0	0			
				30tn excavator	2			109	0.4		0	114	108	0	0			
				Tree milling saw	1			100	0.4		0	105	96	0	0			
		Soft demolition	6b	EWP	1			86	0.3		0	91	81	0	0	109		
				Rigid trucks	1			93	0.3		0	98	88	0	0			
				Handtools	1			94	0.2		0	99	87	0	0			
				Generator 25kVA	1			94	1		0	95	94	0	0			
				Compressor 100cfm	2			94	0.5		0	99	94	0	0			
				Sucker truck	1			109	1		0	114	109	0	0			
		Hard demolition	6c	EWP	1			86	0.3		0	91	81	0	0	125	0	0
				Rigid trucks	1			93	0.3		0	98	88	0	0			
				100tn mobile crane	2			98	0.4		0	103	97	0	0			
				45tn excavator + hammer	2			122	0.3		5	130	125	0	0			
				Watercart	1			103	0.4		0	108	99	0	0			
				Road saw	1			114	0.2		5	122	112	0	0			
				Water jetter	1			109	0.4		0	114	105	0	0			
				Jackhamer (incl compressor)	1			111	0.2		5	119	109	0	0			

Phase		Activity/ Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	SWL	Adjusted SWL, LAeq,15 minute			Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Eve	Night	Day	Eve	Night
		Final reinstatement (earthworks)	6d	Clean-up and restoration	Grader	1			108	0.4		0	113	104	0	0	112	0	0
					Positrack	1			107	0.3		0	112	102	0	0			
					15tn smooth drum roller	1			105	0.4		5	113	106	0	0			
					15tn padfoot roller	1			109	0.6		0	117	107	0	0			
					Rigid trucks	1			93	0.3		0	98	88	0	0			
					30tn excavator	1			109	0.4		0	114	105	0	0			
					Sucker truck	1			109	1		0	114	109	0	0			

Appendix D. **Construction noise and vibration contours**

D.1 Construction noise contours


Sydney Metro West-
Sydney Olympic Park
TBM Retrieval
Station Box Works
Receiver types
Commercial/Business
Commercial/Residential
Hotel
Predicted Noise Level, dBA
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
0 10 20 30 40 m
Herb Eliot Ave
Site offices
Amenities
Site offices
Station Box
Clean & Scrap
Offices
Figtree Dr
PHILIPS
Blaxland
Riverside Park
Wentworth
Point
Holker St
Sydney
Olympic Park
IKEA
Newington
Concord We
Accor Stadium
DFO Homebush
Sydney Markets
Homebush
Rookwood
al Cemetery
Concord Rd
John St
Bombay St
Armitt St


Sydney Metro West-
Sydney Olympic Park
TBM Retrieval
Activity 4a(i)
Daytime noise contours
Receiver types
Commercial/Business
Commercial/Residential
Hotel
Residential
Predicted Noise Level, dBA
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
0 10 20 30 40 m
Herb Eliot Ave
Figtree Dr
Figtree Dr
Offices
Clean & Scrap
Sydney Olympic Park
Qudos Bank Arena
Sydney Olympic Park Aquatic Centre
DFO Homebush
Rookwood General Cemetery

Appendix E. **Detailed noise predictions for individual receivers**

E.1 Phases 4 to 6 Demobilisation

Supplied as Excel spreadsheets