

## ACOUSTICS ADVISOR ENDORSEMENT SYDNEY METRO WEST (SSI 10038)

Review of	Central Tunnelling Package: DNVIS for Five Dock	Reviewed document reference:	21028-NV-RP-3-15
Prepared by:	[REDACTED]		Revision 15
Date of issue:	19 November 2024		Dated: 12 November 2024

I endorsed Revision 12 of this Detailed Noise and Vibration Impact Statement (DNVIS) for the Five Dock (FDK) Station site in November 2023.

Revisions 13 and 14 were updates detailing demobilisation, which is the final phase of these works, and addressing comments from Sydney Metro, the Environmental Representative (ER) and me.

I am satisfied that Revision 15 adequately addresses our comments and as an approved alternate Acoustics Advisor (AA) for the Sydney Metro West project, I endorse Revision 15 of the DNVIS for Five Dock Station site for implementation, in accordance with Condition of Approval A36(e).

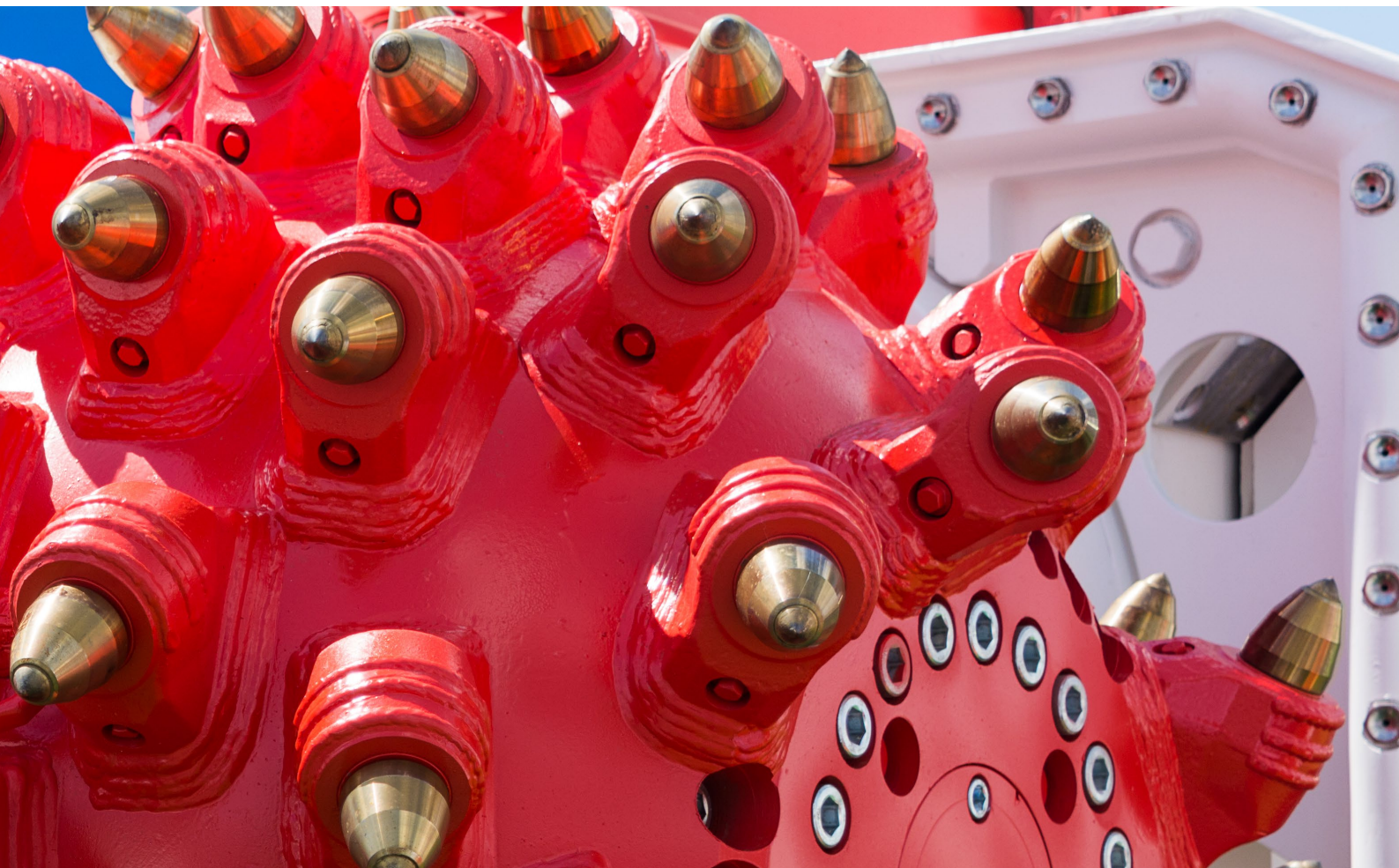
[REDACTED]

[REDACTED] Metro West Alternate Acoustics Advisor

**Acciona Ferrovia Joint Venture  
Sydney Metro West Central Tunnelling Package  
Five Dock**

**Detailed noise and vibration impact statement  
November 2024**

**Doc no. 21028-NV-RP-3-15**





## Detailed noise and vibration impact statement

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Project	Sydney Metro West Central Tunnelling Package
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### Revision history

0	2 November 2021	Draft report to client
1	5 November 2021	Revised report following client review
2	7 December 2021	Revised report following AA review
3	3 March 2022	Revised report minor edits
4	21 April 2022	Additional AA and ER comments
5	28 June 2022	Hoarding updated to reflect plan during shed construction
6	23 March 2023	Report updated to include changes to FDK west acoustic shed and hoarding plan
7	11 May 2023	Updated with AA/ER and client comments
8	2 June 2023	Updated with AA/ER comments
9	28 June 2023	Updated with AA/ER comments
10	13 October 2023	Updated with AA/ER comments
11	9 November 2023	Updated with TBM traverse details
12	20 November 2023	Updated with Sydney Metro comments
13	13 September 2024	Updated with demobilisation plan
14	11 October 2024	Updated with AA/ER comments
15	12 November 2024	Updated with AA comments



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### Definition of acoustic terms and acronyms

<b>AA</b>	Acoustic Advisor
<b>AMM</b>	Additional mitigation measures – applicable where standard measures have been implemented and NML is still expected to be exceeded.
<b>Approved hours</b>	Construction hours approved in the Project Conditions of Approval D35. These differ from “standard” hours defined in the ICNG. Work outside the approved hours does not imply the works have not been otherwise approved through the procedures outlined in the NVMP.
<b>Assessment period</b>	The period in a day over which assessments are made.
<b>Background noise</b>	The underlying level of noise present in the ambient noise, excluding the noise source under investigation.
<b>CSSI</b>	Critical State Significant Infrastructure
<b>Decibel (dB)</b>	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.
<b>dB(A)</b>	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.
<b>dB(C)</b>	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.
<b>DPIE</b>	NSW Department of Planning, Industry and Environment
<b>EIS</b>	Environmental Impact Statement
<b>Extraneous noise</b>	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.
<b>Highly affected receivers</b>	Residential receivers are considered to be highly noise affected where construction activities are determined to have an LAeq, 15 minute noise level of 75 dB(A) or higher.
<b>Highly noise intensive works</b>	Construction activities which are defined as annoying under the ICNG. See Section 2.1.2.
<b>ICNG</b>	Interim Construction Noise Guideline (Department of Environment and Climate Change 2009)
<b>Noise assessment criteria</b>	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.
<b>NCA</b>	Noise Catchment Area



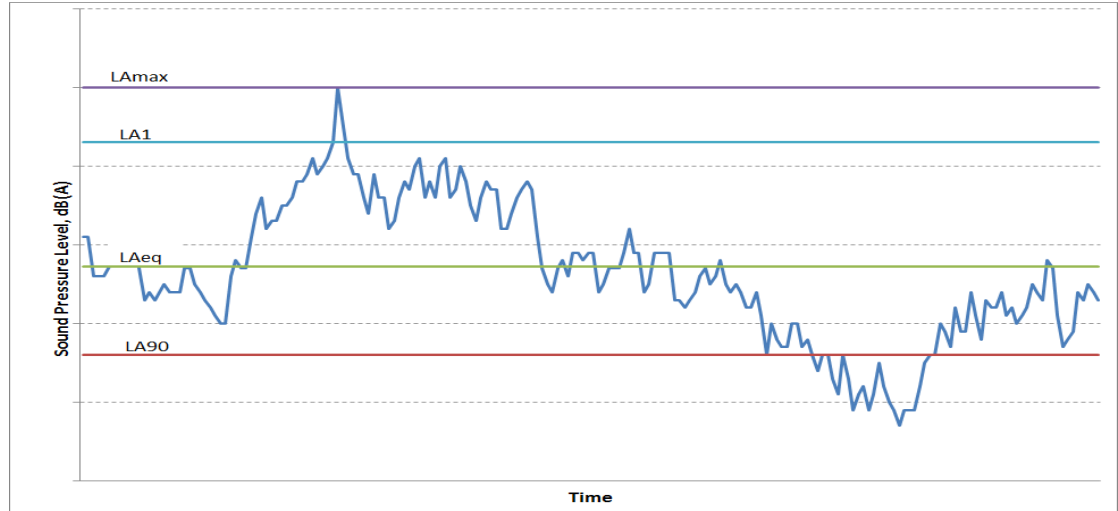
**Noise level statistics**

$L_{A90}$  - 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.



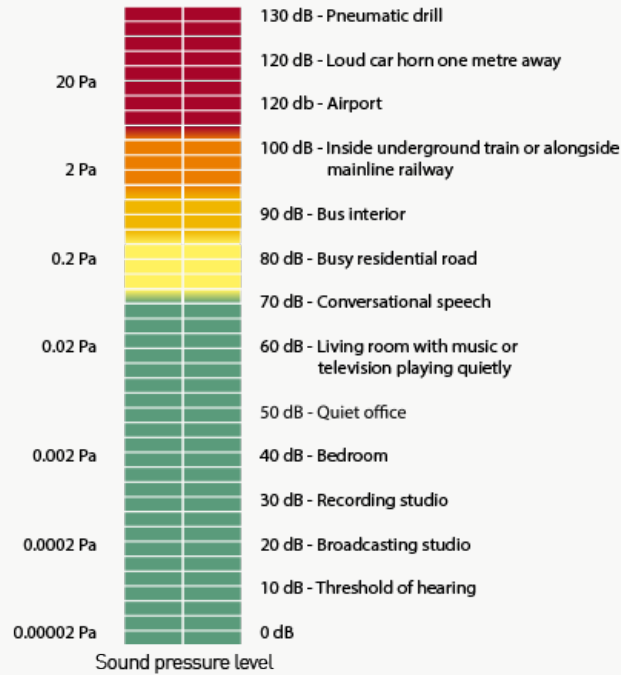
<b>NML</b>	Noise Management Level
<b>NVMP</b>	Noise and Vibration Management Plan
<b>PPV</b>	Peak Particle Velocity – Measurement of ground-borne vibration in units of mm/s
<b>RBL</b>	Rating Background Level - a single figure that represents the background noise level for assessment purposes
<b>ROL</b>	Road Occupancy Licence – granted by Transport for NSW and required for any activity likely to impact on traffic flow.
<b>Sound Power Level (SWL)</b>	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.

Threshold of pain



Source: [https://www.osha.gov/dts/osta/otm/noise/health\\_effects/soundpropagation.html](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





## 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 several 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 Ferroviaria Joint Venture (ACJV) was commissioned to deliver the Central Tunnel Package of Stage 1, comprising excavation of five shafts and around 11.5 kilometres of twin-bore tunnel between The Bays and Sydney Olympic Park (the Project). An overview of the Project alignment is presented in Figure 1-1, which includes the tunnel alignment and location of the future stations at:

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

This report covers activities for construction of Five Dock east and west shafts located in the heart of the Five dock village. This DNVIS has comprised several phases from site establishment through to tunnelling support. The final phase of these works is the demobilisation of the site which is detailed in this version of the DNVIS.

An overview of the site layout of Five Dock is presented in Figure 1-2.

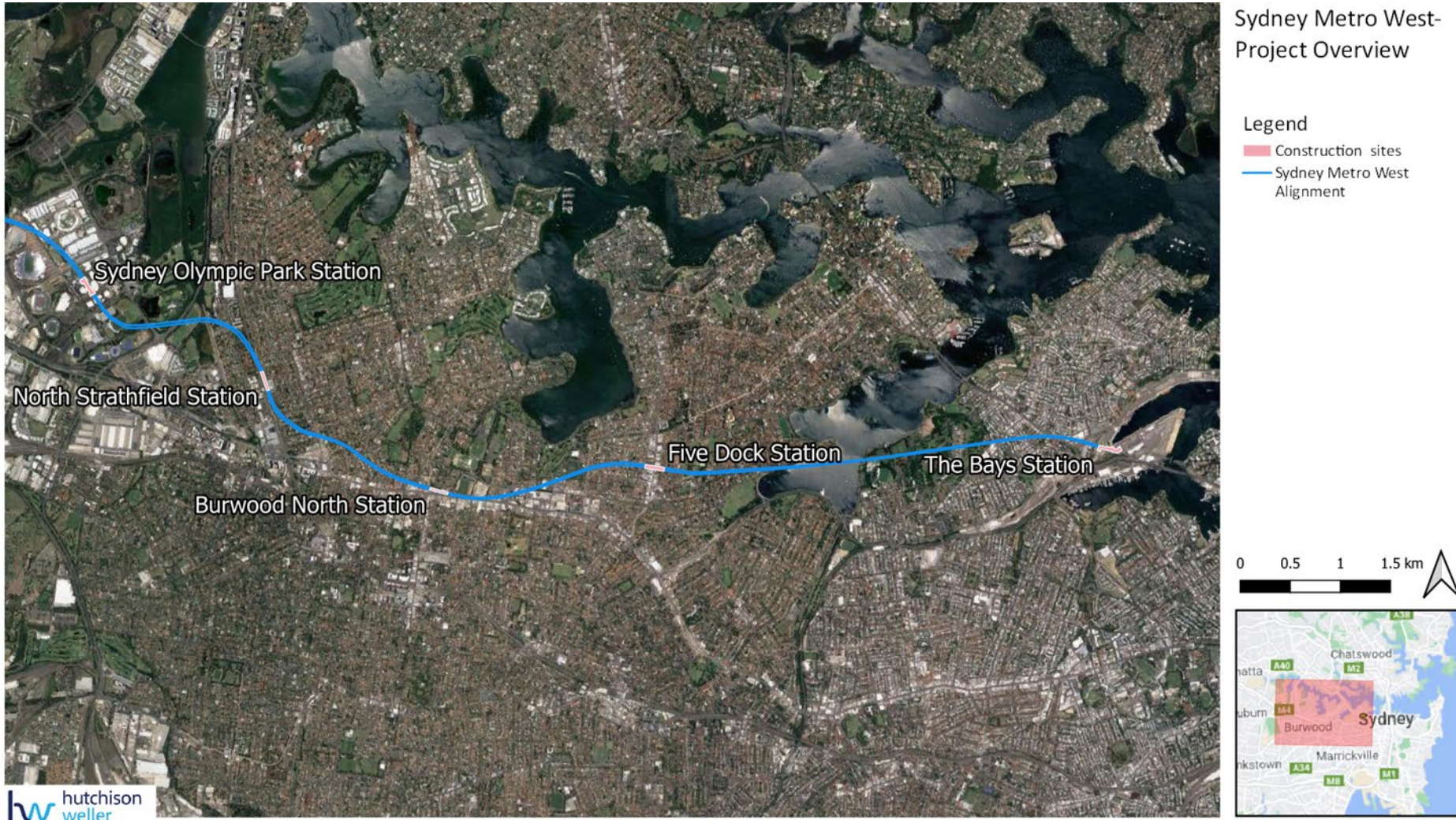


Figure 1-1 Overview of the CTP of Stage 1 of the Sydney Metro West Project.



Figure 1-2 Five Dock construction 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

### 2.1.1 Planned works

Activities associated with Five Dock east and west sites are summarised in Table 2-1 and Table 2-2, which are completed in 4 main phases for each site generally following establishment, excavation, tunnelling support and demobilisation.

Low impact works mainly comprising of geotechnical and utilities investigations in and around the Five Dock sites commenced in October 2021. Site establishment works commenced in early January 2022 with shaft construction completed in late 2023. All works up to tunnelling support have now been completed for the Five Dock Site. Once tunnelling is finalised, the project site will be demobilised in preparation for the next stage of the project, which will include civil construction works.

The anticipated program to completion for this site is illustrated in Table 2-5 and shows the duration of each work phase. The current program has the site demobilisation commencing about October 2024 and finishing around April 2025. Only tunnel finishing activities and handover works, including concreting works within the caverns, will take place alongside the demobilisation activities.

#### **Five Dock east**

In approximately October 2024, demobilisation of the eastern site would commence with the dismantling of the acoustic shed including removal of ventilation structure, tipping frame, and gantry crane. Within the station box, conveyors and conveyor boosters will be removed along with ventilation ducting.

Additional activities also include

- Dismantling the water treatment plant
- Demolition of the spoil bin wall inside the shed – Prior to acoustic shed removal
- Demolition of the concrete hobs around shed – Post acoustic shed removal
- Decommissioning of services
- Demobilisation of the site offices at 21 Waterview Street

At the eastern site, finishing works within the eastern cavern would continue once the acoustic shed has been removed. These activities would be on a 24 hour basis required to maintain consistency with concrete pours and setting times. Note that concrete pours will be conducted from within the acoustic shed while it remains erected and then only during standard construction hours when the shed has been removed. Additionally, intermittent NML compliant works will be carried out at night within the eastern shaft and central cavern.

#### **Five Dock west**

At Five Dock west, demobilisation activities will be limited to decommissioning the site offices, services and facilities on the surface. Within the station box, conveyors will be removed along with ventilation ducting.

Similar to the eastern site, concrete finishing works within the central cavern would continue on a 24 hour basis to maintain consistency with concrete pours and setting times. Note that concrete pours will be conducted from within the acoustic shed while it remains erected and then only during standard construction hours when the shed has been removed. Additionally, intermittent NML compliant works will be carried out at night within the western shaft and central cavern.



Table 2-1 to Table 2-4 presents a summary of the completed activities for each of the Five Dock sites as well as current and future activities for the demobilisation works.

Table 2-1 Summary of proposed activities at Five Dock west

Construction phase	Activity		Outside approved hours?	
<b>1. Site Establishment Completed</b>	1a	Routine activities	No	
	1b	Construction utilities and facilities	No	
	1c	Temporary fencing/ hoardings	No	
	1d	Utilities disconnection/relocation	No	
	1e	Demolition and clearing site	No	
	1f	Site Concrete Works	No	
<b>2. Shaft Excavation Completed</b>	2a	Piling	No	
	2b	Site structures	No	
	2c	Capping beams	Detailed excavation, break back & capping beam	No
	2d	Active anchors	Ground stabilisation	No
	2e	Excavation & Retention	Other Than Rock (OTR) - Dozer (No ripping)	No
	2f		Rippable - Dozer (ripping)	No
	2g		Non-rippable - Excavators with hammers or eccentric rippers	No
	2h		Road header/Surface miner	No
	2i		Retention - Ground Anchors, Shotcrete	No
<b>3 Mucking out Completed</b>	3a/3b	Spoil handling	Clearing during OTR – Excavator surface	No
		Shaft clearing – Gantry, kibble & excavator	No	
<b>4.1 Station cavern excavation</b>	4a	Excavations	Cavern excavation (within cavern)	Evening and night*
	4b	Tunnel Lining	Concrete lining	Evening and night*

Table 2-2 Summary of proposed activities at Five Dock east

Construction phase	Activity		Outside approved hours?	
<b>5. Site Establishment Completed</b>	5a	Temporary fencing/ hoardings	No	
	5b	Utilities disconnection/relocation	No	
	5c	Demolition and clearing site	No	
	5d	Site Concrete Works	No	
<b>6. Shaft Excavation Completed</b>	6a	Piling	No	
	6b	Site structures including acoustic shed	No	
	6c	Capping beams	No	No
	6d	Active anchors	No	No
	6e	Excavation & Retention	Other Than Rock (OTR) - Dozer (No ripping)	Evening
	6f		Rippable - Dozer (Ripping)	Evening
	6g		Non-rippable - Excavators with hammers or eccentric rippers	Evening
6h	Retention - Ground Anchors		Evening	
<b>7 Mucking out Completed</b>	7a	Spoil handling	Clearing during OTR – No Kibble	Evening
	7b		Spoil Handling all shaft clearing with kibble	Evening
	8a	Excavations	Cavern excavation (within cavern)	Evening and night
	8b	Tunnel Lining	Concrete lining	Evening and night

Construction phase	Activity			Outside approved hours?
<b>8. Station cavern excavation</b>	8c		Concrete lining finishing works	Evening and night*

**Table 2-3 Summary of tunnelling and support activities at Five Dock**

Construction phase	Activity			Outside approved hours?
<b>9 Tunnelling</b>	9a	TBM traverse	TBM is moved from east to west of the station cavern	Evening and night
	9b	TBM relaunch	TBM recommences tunnelling after	Evening and night
	9c	Tunnelling support	Segment deliveries to, and spoil transport from TBM	Evening and night

**Table 2-4 Summary of demobilisation activities at Five Dock**

Construction phase	Activity			Outside approved hours?
<b>10. Five Dock East Demobilisation</b>	10a	WTP & Services (EAST) Soft demo		No
	10b	Demo concrete hobs (EAST) Demo with hammer		No
	10c	Spoil Bin Wall Demo (EAST) Demo with hammer		No
	10d	Gantry Crane Demob (EAST) Soft demo		No
	10e	Demolition acoustic shed (EAST) Soft demo		No
	10f	Site Offices/ Crib Shed Demobilisation (EAST) Soft demo		No
<b>11. Five Dock West Demobilisation</b>	11a	Decommission site services and facilities (WEST) Soft demo		No
	11b	Site Offices/ Hoarding (WEST) Soft demo		No
	11c	Pile Cap Demo (WEST) Demo with hammer		No





Table 2-5 Current support and demobilisation construction program for Five Dock

Phase	Activity	2024												2025											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TBM Tunnelling	TBM Traverse																								
	TBM Support																								
Demobilisation	Site demobilisation																								
Station Cavern	Cavern Lining																								

### 2.1.2 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2-6. 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 2-6 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 or EPL)
D36	Highly noise intensive works	8:00 am to 6:00 pm <sup>1</sup>	8:00 am to 1:00 pm <sup>1</sup>	No work (unless approved under out-of-hours work protocol or EPL)

Notes:

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

### 2.1.3 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  $L_{Aeq}$  (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  $L_{AFmax}$  (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 Five Dock construction scenarios:
  - i. tunnelling (excluding cut and cover tunnelling and surface works) which is permitted 24 hours a day, seven days a week; or
  - iii. delivery of material that is required to be delivered outside of standard construction hours in Condition D35 of this schedule to directly support tunnelling activities
  - v. work within an acoustic shed where there is no exceedance of noise levels under Low impact circumstances identified in (b) above, unless otherwise agreed by the Planning Secretary.



Where out-of-hours work is necessary, appropriate respite would be identified in consultation with the affected community, in line with the NVMP. As per CoA D51, consultation would include providing:

- a) a progressive schedule for periods no less than three (3) months, of likely out-of-hours work;
- b) a description of the potential work, location and duration of the out-of-hours work;
- c) the noise characteristics and likely noise levels of the work; and
- d) likely mitigation and management measures which aim to achieve the relevant NMLs (See Section 4) including circumstances of when respite or relocation offers would be available and details about how the affected community can access these offers.

### 3. Existing environment

#### 3.1 Existing environment

The Five Dock construction zones cover two separate locations within the Five Dock village precinct, namely Five Dock East (FDE) and Five Dock West (FDW) as illustrated in Figure 1-2.

The FDW site is located west of the Great North Road near the intersection of Second Avenue and covers an area of around 3600m<sup>2</sup>. Adjacent land uses to this site, fronting the Great North Road, are mostly commercial businesses with some mixed-use commercial/ residential buildings.

West of FDW, the closest residences are located on East Street with the Sunshine childcare facility at the end of the row of residences. To the north of the site is St Albans Church, which is heritage listed, whilst to the south is a Coles supermarket complex which also has some multi storey residences on the upper floors.

The FDE site is located to the east of Great North Road, bounded by Second Avenue and Waterview Street and has a footprint of around 1900m<sup>2</sup>. This site has residences on all four facades with a three-storey mixed use occupancy to the west having commercial premises on the ground floor and residences on the upper two floors.

The acoustic environment in all areas is described in the EIS as dominated by road traffic noise on the major transport corridors such as Great North Road, Ramsey Road and First Avenue. Contributions from aircraft are also noted.

#### 3.2 Sensitive receivers

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 are provided graphically in the Construction Noise and Vibration Management Plan (CNVMP) and relevant land uses to Five Dock are presented in Appendix A of this DNVIS.

In summary, a number of residential and non residential receivers have been identified and include:

- Residential receivers immediately adjacent to FDE in Waterview Street including directly abutting
- Residential receivers on Great North Road including 110 Great North Road which is between FDE and FDW
- Residential receivers in East Street and over looking FDW from apartments above Coles
- Non-residential receivers including:
  - St Albans Church directly abutting FDW (heritage site)
  - Five Dock public school to the west of FDW
  - GGC Church in Great North Road
  - Commercial office space on great North Road including medical and dental rooms
  - Cafes and restaurants adjacent to FDE on Great North Road
  - Childcare centres in East Street, Garfield Street and Henry Street
  - Police Station at Corner West and Garfield Streets.

Consultation with sensitive receivers is underway and feedback to date is summarised in Section 7.1.5.

### 3.3 Heritage items

There are several items of heritage value area were identified in the EIS, which include the following. These items have been considered for impacts of vibration-intensive activities in Section 6.3.

- St Albans Church and associated buildings
- Canada Bay Police Station

### 3.4 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 Five Docks sites have been divided into Noise Catchment Areas (NCAs).

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

NCAs were 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
14	West of Great Northern Road	High component of commercial and mixed-use receivers at the eastern boundary of the NCA, adjacent to the Great North Road. Mainly residential one block west from the main road. 'Other sensitive' receivers include the St Albans Anglican Church, Sunshine Early Learning Centres x 2, Garfield Street Child Centre, Five Dock Police station, Five Dock Public School, and several local practices.	Road traffic on the Great North Road, Barnstaple Road and Ramsay Road.
15	East of Great Northern Road.	Commercial and mixed-use receivers at the western boundary of the NCA, adjacent to the Great North Road. Mainly residential one block to the east from the main road. 'Other sensitive' receivers include the St Albans Anglican Church, Kiddies on First Early Learning Centre, Domremy Catholic College, and a local medical practice.	Road traffic on the Great North Road, Barnstaple Road and Ramsay Road.



### 3.5 Background noise survey

Background noise monitoring was undertaken as part of the wider 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.

The Five dock Area 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**

NCA	Noise level (dBA) <sup>1</sup>		
	Day <sup>2</sup>	Evening <sup>2</sup>	Night <sup>2</sup>
NCA14	42	41	33
NCA15	43	43	38

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.
3. During the EIS noise assessment, the monitoring level was found to be higher than the daytime. In this situation, the NPfl requires that the evening level be reduced to match the daytime

## 4. Noise and vibration assessment criteria

### 4.1 Overview

Project CoA D43 requires planned works to be assessed within this DNVIS where any planned works 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 at the establishment phase. Subsequent revisions of this DNVIS are provided for review and approval as appropriate.

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  $L_{Aeq, 15 \text{ minute}}$  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, $L_{Aeq, 15 min}$
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:

- $L_{Aeq, 15 minute}$  40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and the
- $L_{Amax}$  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 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  $L_{Aeq}$  (15hour) day and 55 dB  $L_{Aeq}$  (9hour) night for existing freeway/ arterial/ sub-arterial roads.
- 55 dB  $L_{Aeq}$  (1hour) day and 50 dB  $L_{Aeq}$  (1hour) night for existing local roads.

#### 4.2.4 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 4-3.

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

Construction hours	dB above NML	Additional management measures
<b>Approved hours</b> 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
<b>Evening</b> 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
<b>Night</b> 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: PC = Phone Calls and emails      SN = Specific notification  
M = Monitoring      LB = Letterbox drops  
IB = Individual briefings      RO = Project specific respite offer  
AA = Alternative accommodation

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

Construction hours	dB above NML	Additional management measures
<b>Approved hours</b> Monday – Friday: 7am – 6pm Saturday: 8am to 6pm	No NML for ground-borne noise during standard hours (refer to Table 4-7)	
<b>Evening</b> 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, PC, RO
<b>Night</b> 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, $L_{Aeq, 15 \text{ minute}}$							
	Approved hours		Outside approved hours				Sleep disturbance (CNVS)	
	Noise affected	Highly noise affected	Day	Evening	Night	$L_{Aeq, 15 \text{ minute}}$	$L_{Amax}$	
14	52	75	47	46	38	40	52	
15	53	75	48	48	43	43	53	

### 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 <sup>1.75</sup> )	Adverse comment possible (m/s <sup>1.75</sup> )	Adverse comment probable (m/s <sup>1.75</sup> )
Residential buildings – 16 hour day (7am to 11pm) <sup>1</sup>	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings – 8 hour night (11pm to 7am) <sup>1</sup>	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
<b>Approved hours</b> Monday – Friday: 7am – 6pm, Saturday: 8am to 6pm	LB, M, RO
<b>Evening</b> Monday – Friday: 6pm – 10pm; Saturday: 7am – 8am, 6pm – 10pm; Sunday / PH: 8am – 6pm	LB, M, IB, PC, RO, SN
<b>Night</b> 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 Five Dock was provided in Table 2-1. Nominal equipment and estimated sound power levels of each item and activity are presented in Appendix B.

At both Five Dock east and west sites, demobilisation during standard hours would require the adoption of respite during extended periods of noisy works.

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).

Figure 5-1 and Figure 5-2 present an overview of the location and layout of construction sites at Five Dock east and west.



Figure 5-1 Five Dock west and acoustic shed east

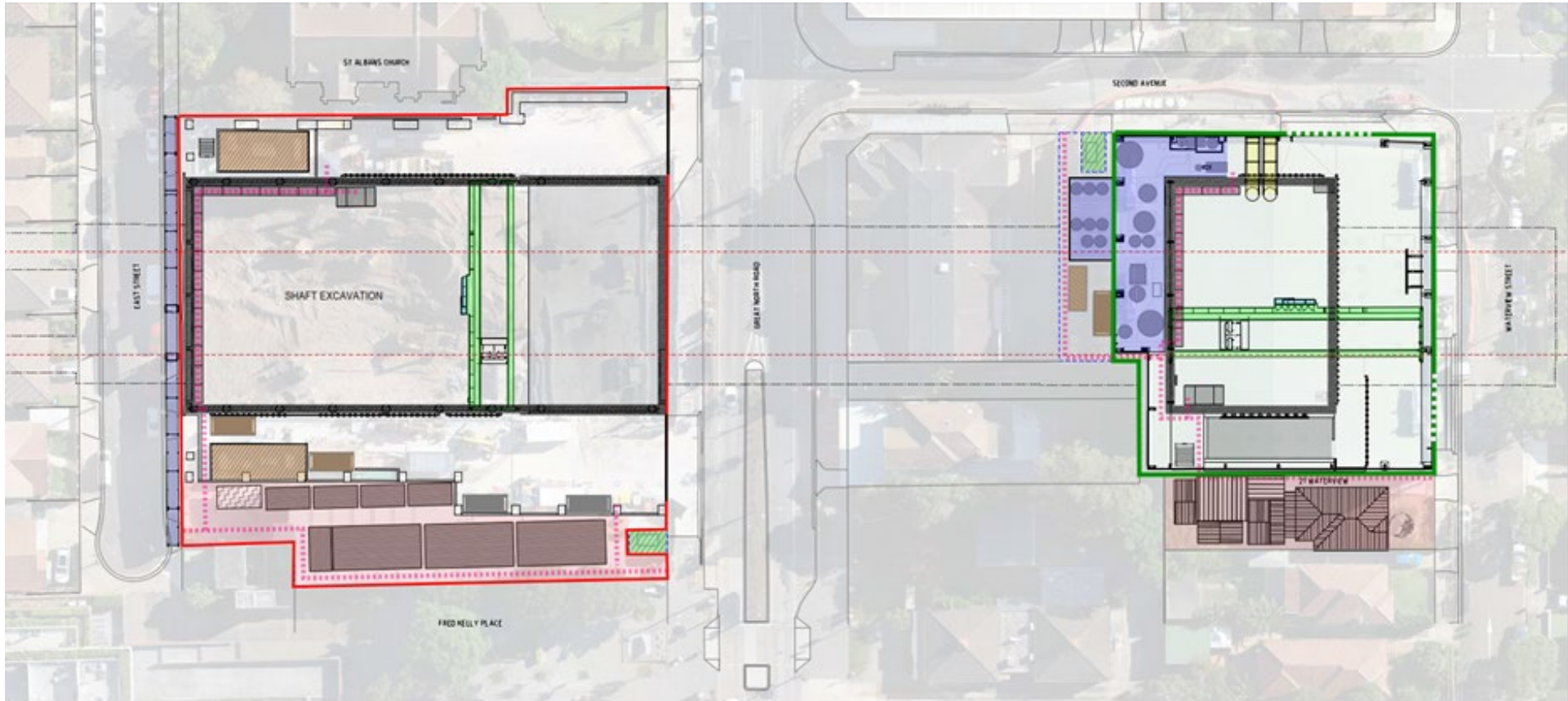


Figure 5-2 Five Dock east and west site layouts with acoustic shed shown in green.

## 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 B. Source is modelled at 1.5 metres above ground.
- Shaft excavation depth was accounted for in the modelling, with calculation of shaft noise entering the shed from the ground then passing through the shed walls and roof (see acoustic shed design below).
- Each phase of work was modelled to account for the benefit from site hoarding during the establishment phase. Activities are enclosed early in the process by the acoustic shed, which demonstrates benefit from increasing depth of activity.
- Meteorology –worst-case conditions: gentle breeze (3-5 m/s) source to receiver and stable conditions (conducive of temperature inversion).

Aerial photographs of the east and west sites showing the Five Dock east shed are presented in and Figure 5-4 showing the scale of the building in situ.



Figure 5-3 Five Dock east acoustic shed (background) and Five Dock west site (foreground).



Figure 5-4 Five Dock east acoustic shed and surrounding buildings.



## 6. Predicted noise levels

### 6.1.1 Overview

A summary of predicted noise levels for work during approved hours and outside approved hours is provided in the following sections for each construction phase. Detailed results for all sensitive receivers are provided in Appendix D, which represent the highest impact for all floors for each building.

Noise contours for key activities are presented in Appendix C. The contours demonstrate the extent of the worst-case cumulative impacts and illustrate buildings around the work sites generally providing good noise screening. Contours models included in Appendix C include impacts for the first floor which allows all buildings to be assessed at an equal height (not all buildings have 2 or more floors)

### 6.1.2 Site establishment works (Phases 1 & 5)

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

### 6.1.3 Shaft works (Phases 2-4 & 6-8)

All shaft excavation and station box works have been completed with the exception of concrete lining of the caverns and any required defect works. The concrete lining work would take place inside the eastern and western caverns.

Works in the eastern cavern would be completed with the acoustic shed still in place. After the shed has been removed, additional tunnel fit-out and finishing work may be required within the eastern cavern and tunnels. Estimated worst case levels are assumed for this activity, with a reduced equipment list for evening and night works. In practice this work would be wholly within the tunnel and therefore inaudible but would be monitored for compliance with the Project NML prior to night works commencing.

See earlier revisions of this document for detail of completed activities.

### 6.1.4 TBM tunnelling and support (Phase 9)

TBM tunnelling activities for the project will be completed by early October. Tunnelling support activities will continue until breakthrough at Sydney Olympic Park is achieved. See earlier revisions of this document for detail of these activities.

### 6.1.5 Site demobilisation (Phases 10 & 11)

The assessed activities are identified as either soft removal or hard demolition depending on the required equipment for the task. Soft removal includes dismantling the site facilities using hand tools and non-noise intrusive equipment. Hard demolition will require the use of rock hammers to remove some concreted areas.

The highest impact during soft removal would be associated with the dismantling cladding/walls on the acoustic shed. During the course of this activity, up to 160 receiver locations would be impacted in the 0-10 dB range, 38 in the 10-20 dB range and a total of 10 receivers in the +20 dB range. About 9 receiver location are expected to be highly impacted during this period of work. However, work around the shed would be progressive with any standing facades providing shielding of varying degrees until work is complete.



At the east site, the number of noise impacts increases significantly with demolition of the concrete hobs around the acoustic shed when rock hammers are in use, generating the highest noise impacts. Over the course of these works, around 225 receiver locations are predicted for the 0-10 dB range, 90 in the 10-20 dB range and a total of 37 receivers in the +20 dB range. About up to 29 receiver locations would be highly impacted when works are at the closest point.

At the west site, the number of noise impacts during the pile cap demolition works would be around 229 receiver locations in the 0-10 dB range, 58 in the 10-20 dB range and a total of 18 receivers in the +20 dB range with 9 receiver locations predicted to be highly impacted when works are at the closest point.

These impacts are predicted worst case and are generally not concurrent but represent the total number of impacted receivers for each activity. Variation in the work locations and local shielding are expected to provide reduced noise impacts or respite during a given activity. In addition, noisy works are programmed for approved hours only minimising the impact of the demobilisation works. Highly noise intensive activities works as defined in the ICNG, such as concrete cutting and hammering, will be undertaken on a 3 hours on, 1 hour off basis to provide respite to the community, unless otherwise approved. Table 6-1 presents a summary of the predicted noise levels for each activity.

**Table 6-1 Summary of predicted NML exceedances for Phase 10& 11 –Demobilisation activities**

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 - 30	30+	0-10	10- 20	20- 30	30+	0-10	10- 20	20- 30	30+	0-10	10- 20	20- 30	30+
4b	Concrete lining west*	49	49	0	0	0	0	0	Approved hours only				Approved hours only				Approved hours only			
8b	Concrete lining east*	43	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8c	Finishing work east*	45	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10a	WTP & Services (East)	88	79	3	35	4	2	1	Approved hours only				Approved hours only				Approved hours only			
10b	Hobs demo (East)	108	88	29	225	90	22	15												
10c	Spoil wall demo (Shed)	55	43	0	1	0	0	0												
10d	Gantry crane demob (East)	55	43	0	1	0	0	0												
10e	Acoustic shed Cladding (East)	98	75	9	160	37	10	1												
10e	Acoustic shed Structure (East)	95	75	10	75	13	9	1												
10f	Site office demob (East)	85	62	1	4	1	0	1												
11a	Services (West)	65	80	0	21	3	0	0												
11b	Site Offices (West)	69	81	0	36	7	0	0												
11c	Pile cap demo (West)	83	93	9	229	58	16	2												

\*Activities may be undertaken outside approved hours where they are within the acoustic shed or verified to be below airborne NML.

### 6.1.6 Sleep disturbance

For activities outside approved hours any work within the east and west sites would be compliant with CoA D37 or the project the EPL. Activities external to these sites undertaken outside of approved hours is covered separately under the project OOHW protocol.

The demobilisation of the Five Dock east and west sites will be limited to noisy activities such as rock hammering, during approved hours only and therefore are not anticipated to exceed the sleep disturbance criteria. If any works are to be completed outside standard hours for the Five Dock sites they would aim to be NML compliant using reasonable and feasible mitigation measures.

Other out of hours work such as utility relocations and oversized plant, may be undertaken where they comply with CoA D37 and EPL 21610 and these works would be assessed through the out of hours works process.

## 6.2 Ground-borne noise

Ground-borne noise criteria apply only to residential receivers during the evening and night periods. For the demobilisation program at Five Dock, there are no works outside of approved hours unless compliant with D37 and the project EPL.

## 6.3 Vibration impact assessment

### 6.3.1 Assessment method and reference data

Vibration-intensive surface works will form part of the site establishment and ongoing excavation works for the duration of the Project. Potential items of plant that can generate vibration impacts are:

- Rock Hammers
- Vibratory rollers

To assess the likelihood of impacts on human comfort and structures, reference vibration levels are summarised in Table 6-2 and curves of vibration with distance are presented in Figure 6-1. Reference vibration levels are based on previously measured levels.

**Table 6-2 Summary of vibration-intensive activities**

Activity	Typical equipment	Typical PPV vibration emission levels	Source
Demolition/Rock breaking	35 t Excavator with hammer	1.3 mm/s at 10 m	Site measurement
Site compaction	Vibratory roller	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), predicted levels of vibration with distance can be established.

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

Where:

PPV – Peak Particle Velocity at the source (PPV<sub>1</sub>) and Receiver (PPV<sub>2</sub>)

R – distance from source of reference level (R<sub>1</sub>) and distance from source of receiver (R<sub>2</sub>)

n – ground factor assumed as 1.7 for body waves near the ground surface

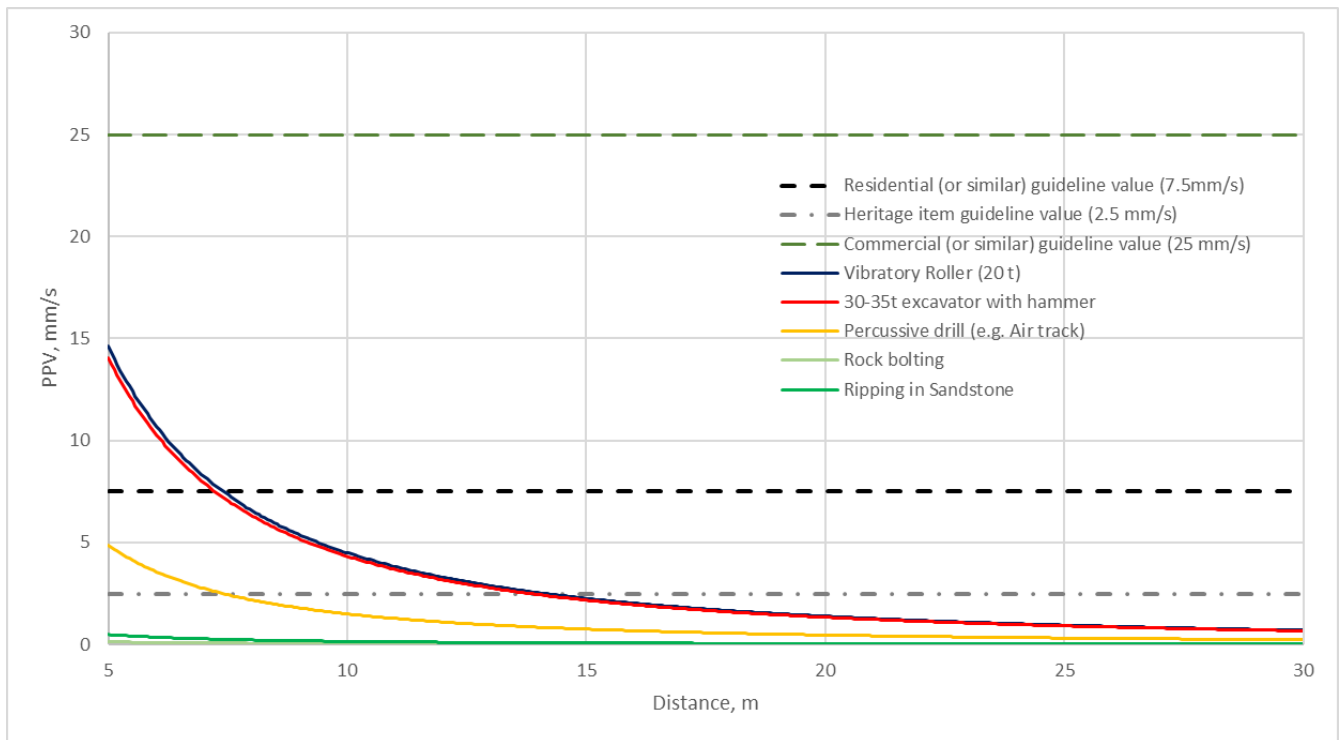
Predicted levels of vibration over distance are summarized in Table 6-3.

**Table 6-3 Predicted level of vibration with distance from the source**

Typical equipment	Distance from source, m				
	PPV, mm/s				
	5	10	15	20	25
32 t Excavator with hammer	9.6	2.9	1.5	0.9	0.6
20t Vibratory roller	14.6	4.5	2.3	1.4	0.9
Drill rig	4.9	1.5	0.8	0.5	0.3

### 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, with residential dwellings at 7.5 mm/s, the risk of cosmetic damage is low for equipment outside 8-10 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 C. Where sensitive structures are within the buffer distance, trial monitoring should be undertaken prior to any works commencing to determine actual vibration levels.

St Albans Church was assessed to be structurally sound by an appropriately qualified person during the initial stages of the project, therefore a criterion of 7.5mm/s would be applicable for construction activity in the vicinity of the Five Dock west shaft.

The number of sensitive receivers within the minimum distance to meet the applicable vibration guidelines can be inferred from the maps in Appendix C and are listed in Table 6-4. Monitoring for sensitive receivers is outlined in (Section 7.1.4) and consultation (Section 7.1.5) provides information on addressing impacts at these locations.

**Table 6-4 Properties identified within safe working distance cosmetic damage**

Activity	Activity Location	Address	Distance to works (m)
Demolition	East Shaft	110 Great North Rd, Five Dock	6
	East Shaft	21 Waterview St, Five Dock	6
	West Shaft	171 Great North Rd, Five Dock - St Albans Church	3
Excavation	East Shaft	21 Waterview St, Five Dock	15
	West Shaft	171 Great North Rd, Five Dock - St Albans Church	15

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

- Employ non-vibratory (static) rolling methods for compaction on the 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.

Compaction is not anticipated for shaft excavation and tunnelling activities.

The location of sensitive receivers surrounding each site means that the potential for adverse comment is high and the perceived impact to property will be elevated given the presence of construction activities adjacent to residences.

To minimise the potential for recourse of vibration type impacts including ground settling, a thorough investigation and survey of all adjacent properties will be necessary. Vibration monitoring for the most affected buildings including the heritage listed St Albans Church will be required to confirm actual vibration levels against cosmetic damage criteria (see Section 7.1.4).

### 6.3.3 Human exposure

Excavation rock hammering activities would generate high levels of vibration and over short periods of time. Based on the distance to the nearest residences, It is unlikely the vibration level and duration of operation would result in vibration dose values exceeding the criteria.

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<sup>2</sup> 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 compacting 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 13-15 metres from the source for a total of up to 2 hours of work. For durations over 2 hours, the human comfort impact zone would extend to around 20 metres.

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 homes that may fall within the 15 metre contours for possible adverse comment during daytime hours.

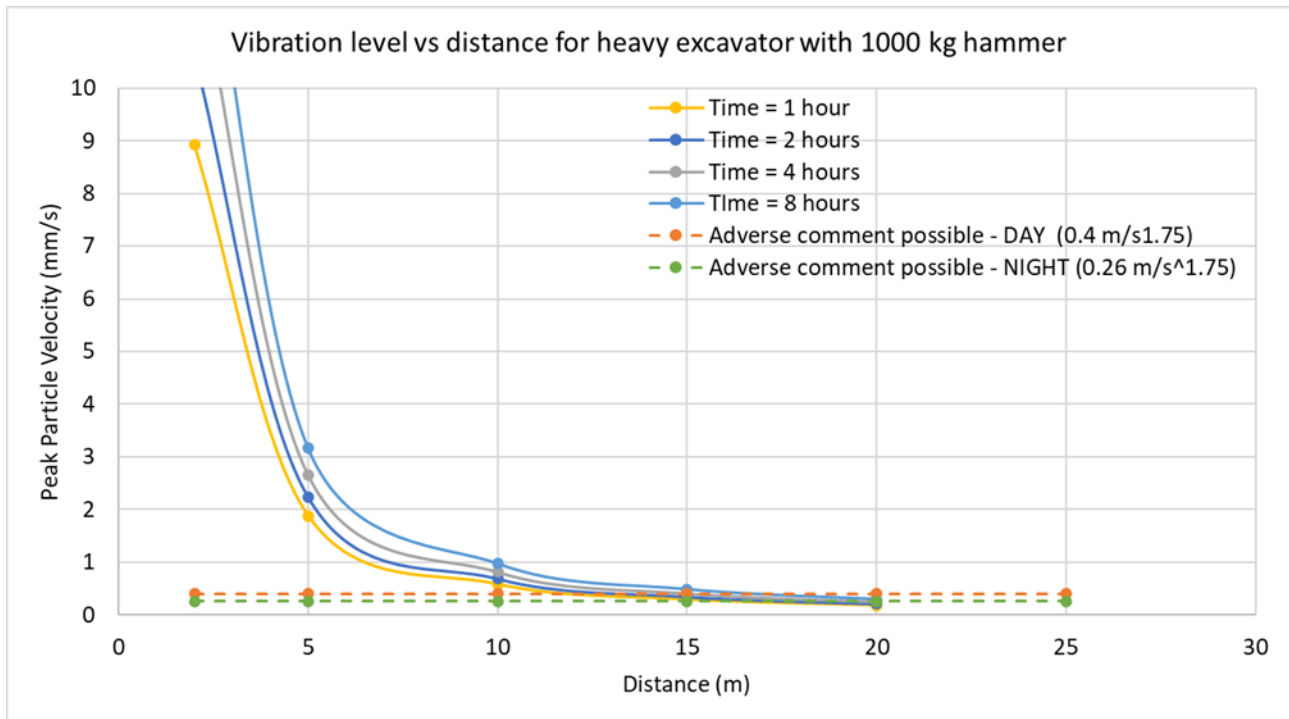


Figure 6-2 VDV curves for excavator and hammer

There are two scenarios assessed for human comfort vibration level: surface vibration works that would occur during site establishment and rock hammering within the tunnel support shaft.

Vibratory works such as rock hammering undertaken during site establishment will generally be of short duration and can be managed using recommendations in Section 6.3.2 combined with respite periods.

When hammering activities move to the tunnel shafts, longer duration impacts are likely and residences within about 20 metres of the work could experience vibration impacts. Prior to the beginning of hammering, a trial run to measure actual vibration impacts at each shaft will be conducted at representative receiver locations where access is available.

Receivers to be monitored for human comfort vibration impacts from surface and tunnel shaft works are shown in Appendix C.

#### 6.4 Construction traffic

Heavy vehicle movements related to the Five Dock demobilisation activities will comprise of removal of materials, demountable offices and equipment for the final phase of works. Truck movements for the Five Dock sites would only occur during the  $L_{Aeq\ 15\ hour}$  (TfNSW NCG daytime period) hours of operation.

During this period the Five Dock West site would have around 1 trucks accessing and leaving per hour over the demobilisation period (outside traffic peak-hour). The Five Dock East site is expected to have around 4 trucks entering and leaving the site during the peak of demolition activities, providing the scenario for the worst case 1 hour  $L_{Aeq}$  noise level.

Trucks would enter the Five Dock West site from the north bound lane of Great North Road (FD Gate 1) and exit into the same lane (FD Gate 2). At the Five Dock East site, vehicles enter from Waterview Street (FD Gate 4) and exit west bound on the Second Avenue (FD Gate 3), as shown in Figure 6-3.

Public roads around the site, including Waterview Street and Second Avenue are expected to have lower volumes of existing traffic and the EIS indicated a 2 dB increase above existing traffic noise on these roads was likely.

Considering this, an assessment against the RNP criteria for arterial and local roads has been undertaken using the *Calculation of Road Traffic Noise* (CoRTN) methodology. Five Dock West has the existing traffic profile of an arterial road and with a RNP criteria for daytime road traffic of 60 dB  $L_{Aeq\ 15hr}$ . Five Dock East is classified as a local road with a 55 dB  $L_{Aeq\ 1\ hr}$  traffic noise criteria.

Based on a speed limit of 40-50km/h for vehicles entering and exiting the east and west site, predicted noise levels at 7 metres for the peak number of construction-related heavy vehicles would be 64 dB  $L_{Aeq\ 1hr}$  and 63  $L_{Aeq\ 15hr}$  respectively, indicating an exceedance of the RNP traffic noise criteria for both sites at the closest residences.

In addition to demobilisation movements, a street sweeper is also being used as a mitigation measure for tracking and dust management onsite, at access points and along the haul routes around Five Dock eastern and western sites.

Onsite mitigation measures such as working on hardstand areas and manual cleaning where reasonable and feasible will be implemented to reduce frequency of street sweeper use. The street sweeper will be fitted with a non-tonal reverse alarm. If required the street sweeper will be in regular use during standard construction hours. Infrequent use of the street sweeper at the eastern site from 6pm to 10pm and on weekends during hauling may be required but will be minimised where possible. The street sweeper will be included in the traffic noise monitoring survey.

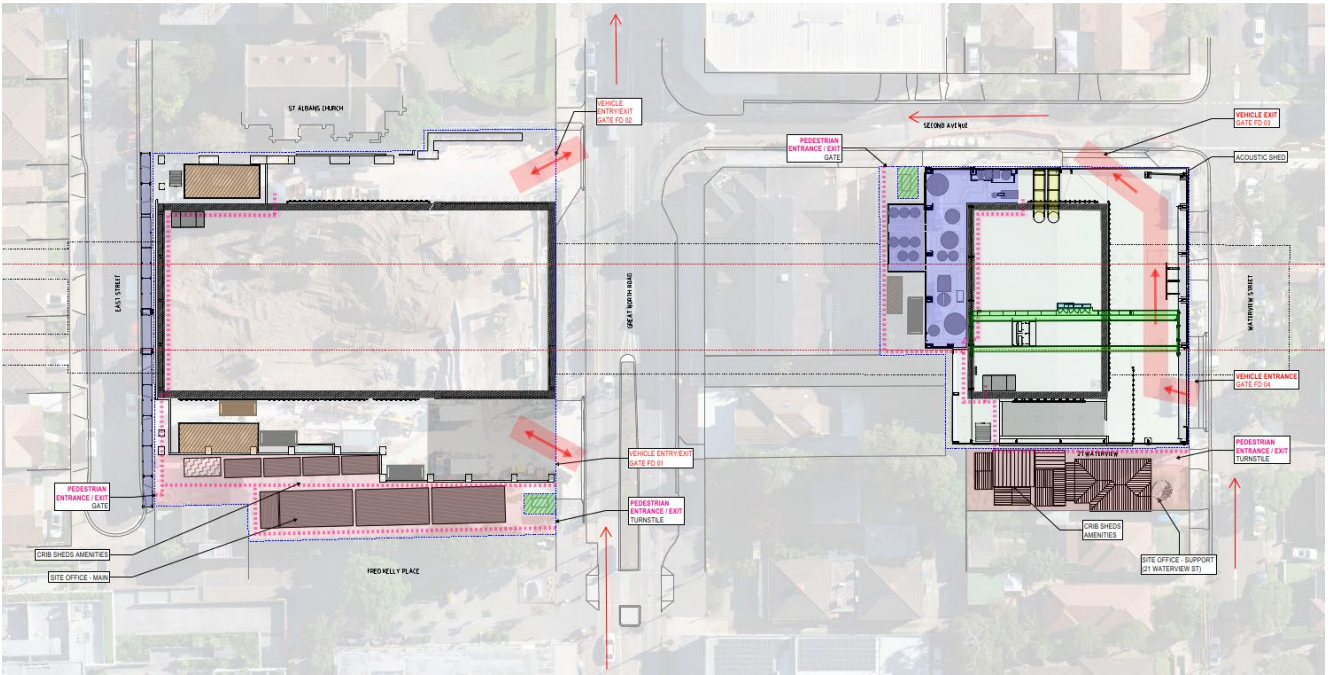


Figure 6-3 Five Dock construction traffic movements



## 7. Summary and recommendations

### 7.1.1 Impact summary

This DNVIS established that demobilisation works will result in adverse impacts on the local community, with residents directly adjacent to the works experiencing the greatest level of impact.

To minimise the risk of impacts for the Five Dock community, only works during approved hours are planned for demobilisation activities. There are no activities planned for night-time at either site however, out of hours work will be required for works outside the scope of this DNVIS such as out of hours utility relocations and oversized plant transport, which will be assessed through the out of hours work process. These activities may cause impacts above NML and sleep disturbance levels and mitigation measures such as offering alternative accommodation will be implemented as required.

As there are no noisy works programmed during the evening or night, there are no sleep disturbance impacts expected for the duration of the Project.

Construction traffic for the Five Dock sites is managed in accordance with the requirements of the project approval limiting vehicle movements to the 7am to 10 pm daytime period as detailed in the Road Noise Policy. Traffic noise impacts on local roads are considered against the requirements of the Revised Environmental Management Measures for these sites.

### 7.1.2 Standard mitigation

Standard noise mitigation measures described in Table 7-1 should be implemented at all phases 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 specific alternative construction techniques such as:
  - Minimising use of rock hammers during demolition phase of the work by using shear and jaw attachments for excavators
  - Avoid hammering foundations during demolition where practicable by saw cutting and lifting slabs with the excavator bucket
  - Minimising use of rock hammers using rippers and road headers for spoil removal where practicable
  - Completing pile cap breaking using non percussive equipment such as pile croppers

All activities that can be completed before the east acoustic shed is removed will be carried out. The spoil bin wall will be taken down prior to the demolition of the spoil shed. Once the shed is removed, the only components that will be hammered will be the concrete hobs, which will stay in place to prevent any potential runoff from the site.

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

As required by CoA D37(a), any emergency works predicted to exceed the NML would be undertaken in accordance with Section 6.6 of the out-of-hours works protocol (SMWSTCTP-AFJ-1NL-PE-PLN-000005 Revision 02). 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.

**Table 7-1 Standard mitigation measures**

Measure	Description
<b>Administrative</b>	
Construction hours	<ul style="list-style-type: none"> <li>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.</li> </ul>
	<ul style="list-style-type: none"> <li>When working outside schools, medical facilities and child care centres, excessively noisy activities will be completed outside normal working hours where practicable.</li> </ul>
	<ul style="list-style-type: none"> <li>When working outside churches, particularly noisy activities will be undertaken outside scheduled service times where reasonable and feasible.</li> </ul>
	<ul style="list-style-type: none"> <li>Highly noise intensive works as defined in the ICNG, such as concrete cutting and hammering, will be undertaken on a 3 hours on, 1 hour off basis to provide respite to the community, unless otherwise approved.</li> </ul>
Implementation	<ul style="list-style-type: none"> <li>Where mitigation measures include physical controls such as noise barriers and enclosures, long-term monitoring locations, specific mitigation measures for receivers, these will be included in an Environmental Control Map (ECM) for easy reference.</li> </ul>
Community consultation	<ul style="list-style-type: none"> <li>In line with the CNVMP, nearby receivers will be notified of the upcoming works in advance of the works starting and ongoing consultation during the works, including the duration and predicted level of impact.</li> </ul>
	<ul style="list-style-type: none"> <li>In line with the CNVS, ongoing community consultation will be undertaken regarding the DNVIS and proposed mitigation such as respite offers.</li> </ul>
Site induction	<ul style="list-style-type: none"> <li>Site Environmental Induction should be delivered to the team and should include consideration and awareness of noise impacts.</li> </ul>
Cumulative impacts	<ul style="list-style-type: none"> <li>Programming for works undertaken outside approved hours will also consider works being undertaken by third parties</li> </ul>
Behaviour	<ul style="list-style-type: none"> <li>Avoid yelling and swearing near sensitive receivers.</li> </ul>
<b>Noise control</b>	
Equipment selection	<ul style="list-style-type: none"> <li>Priority will be given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable.</li> </ul>
	<ul style="list-style-type: none"> <li>All equipment shall be well maintained, including mufflers and any noise suppression</li> </ul>
	<ul style="list-style-type: none"> <li>All equipment will meet the maximum sound power requirements of Table 13 of the CNVS.</li> </ul>
	<ul style="list-style-type: none"> <li>Trucks approaching construction sites will avoid the use of compression braking, especially in the night period</li> </ul>
	<ul style="list-style-type: none"> <li>Traffic management signage vehicles shall be padded to reduce rattling as much as possible.</li> </ul>
Noise barriers	<ul style="list-style-type: none"> <li>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 Echobarrier) should be placed between source and receivers, be continuous (without gaps) and installed according to manufacturer directions.</li> </ul>
Use and siting of plant	<ul style="list-style-type: none"> <li>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)</li> <li>Noise-emitting plant to be directed away from sensitive receivers where possible.</li> <li>Stationary plant should be located behind a structure or enclosed if practicable.</li> <li>Avoid compression braking on approach to the site.</li> </ul>

Measure	Description
Non-tonal reversing alarms.	<ul style="list-style-type: none"> <li>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.</li> </ul>
<b>Monitoring</b>	
Noise monitoring	<ul style="list-style-type: none"> <li>Noise monitoring shall be completed to:               <ul style="list-style-type: none"> <li>verify assumptions of this DNVIS regarding estimated equipment noise emissions,</li> <li>ensure noise levels remain within the NMLs,</li> <li>as required by the AMM for each assessed activity and</li> <li>as required by the NVMP and associated monitoring program.</li> </ul> </li> </ul>
Vibration monitoring	<ul style="list-style-type: none"> <li>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.</li> </ul>

### 7.1.3 Additional mitigation measures

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

AMMM would be largely limited to notifications and monitoring. Where works are undertaken outside approved hours, additional notification would likely be required as well as ensuring appropriate respite is provided. Alternative Accommodation is not likely to be needed for works assessed in this DNVIS; however this will be reviewed on a case-by-case basis. Alternative accommodation is likely to be offered for work outside the scope of this DNVIS such as out of hours utility relocations and this will be assessed through the out of hours work process.

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

Several assumptions have been made in this assessment to provide representative predictions, such as work location, equipment types, numbers, intensity of operation and noise screening options and these will be verified once works commence and regularly throughout the program.

Noise and vibration monitoring will be undertaken in line with the Noise and Vibration Monitoring Program.

### 7.1.5 Consultation

AFJV continues to consult with the community about planned work by providing regular updates about upcoming activities, associated noise and vibration impacts and mitigation measures being implemented as well as seeking ongoing feedback to be provided via email, 24-hour phone line or in person meetings.

Extensive community consultation has occurred since before construction commenced at Five Dock and community engagement will continue throughout demobilisation of the eastern and western construction sites towards the end of 2024. AFJV understands the concerns and sensitivities of the local community in Five Dock and will be undertaking considerable consultation prior to and during site demobilisation with the stakeholders and businesses within close proximity to the sites. Extra consideration has been given to the



demobilisation program, especially around noisy and high impact works such as hammering, saw cutting and steel works. Additional consultation and respite will be offered during these works.

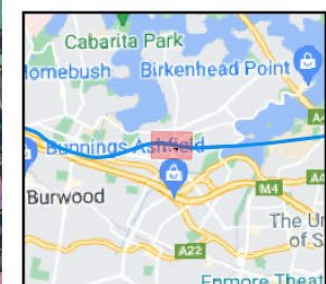
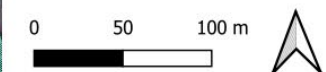


## Appendix A. Land use survey and NCA maps



Sydney Metro West  
Central Tunneling Package  
Land Use Survey

-  Five Dock east
-  Five Dock west
- Receiver Type
-  Childcare
-  Commercial/Business
-  Commercial/Residential
-  Community Use
-  Community/Residential
-  Education
-  Hotel
-  Industrial/Utilities
-  Recreational/Open Space
-  Residential
-  Medical
-  Place of Worship
-  Recreational Passive
-  Aged Care
-  Transport/Infrastructure





## Appendix B. Proposed equipment and sound power levels

### B.1 Site demobilisation

Phase	Description	Aspect	Activity		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	Adj equipment SWL, LAeq,15 minute				Active LAeq, 15 min SWL				
			ID	Description		7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night		
4	Concrete Lining West shaft	Station Caverns (West)	4b	Concrete Lining (Inside cavern)	3 x 6m3 agi truck	3			103	0.3		0	108	103	0	0	110	0	0		
					Concrete Line Pumps	1			108	0.3		0	113	103	0	0					
					Telehandlers	2			100	0.4		0	105	99	0	0					
					E.W.Ps	4			89	0.3		0	94	90	0	0					
					Scissor Lift	2			93	0.4		0	98	92	0	0					
					40T Volvo Loader	1			110	0.4		0	115	106	0	0					
					Bobcat	1			107	0.3		0	112	102	0	0					
	8	Concrete Lining East shaft	Mined Caverns East	8b	Concrete Lining (Inside Cavern with shed in place)	6m3 agi truck	3	3	3	103	0.3		0	108	103	103	103	110	110	110	
						Concrete Line Pumps	1	1	1	108	0.3		0	113	103	103	103				
						Telehandlers	2	2	2	100	0.4		0	105	99	99	99				
						E.W.Ps	4	4	4	89	0.3		0	94	90	90	90				
						Scissor Lift	2	2	2	93	0.4		0	98	92	92	92				
						40T Volvo Loader	1	1	1	110	0.4		0	115	106	106	106				
						Bobcat	1	1	1	107	0.3		0	112	102	102	102				
10	Demobilisation	Five Dock East	8c	Concrete Lining finishing works (Inside the cavern)	Telehandlers	1	1	1	100	0.4		0	105	96	0	0	103	97	97		
					Scissor Lift	1	1	1	93	0.4		0	98	89	0	0					
					Bobcat	1	0	0	107	0.3		0	112	102	0	0					
					E.W.Ps	1	1	1	89	0.3		0	94	87	0	0					
			10a	WTP & Services (EAST) Soft demo	150t Crane	1			98	0.4		0	103	94	0	0	113	0	0		
					Flat bed truck	3			93	0.3		0	98	93	0	0					
					Hand tools (grinder/ Rattle gun)	4			101	0.2		5	109	105	0	0					
					EWP	2			89	0.3		0	94	87	0	0					
					Vac Truck	2			109	1		0	114	112	0	0					
					Sweeper	1			104	0.2		0	109	97	0	0					
			10b	Demo concrete hobs (EAST) Demo with hammer	Concrete Saw	1			114	0.2		5	122	112	0	0	122	0	0		
					35tExcavator + Hammer +Pulveriser	1			122	0.3		5	128	120	0	0					
Compressor	1					93	0.5		0	98	90	0	0								
Bogies	2					108	0.2		0	113	104	0	0								
Street Sweeper	1					104	0.2		0	109	97	0	0								
10c	Spoil Bin Wall Demo (EAST) Demo with hammer	Watercart	1			103	0.4		0	108	99	0	0								
		24t Excavator + Hammer +Pulveriser	1			120	0.3		5	128	120	0	0	120	0	0					
		Demo Saw	1			105	0.5		5	113	107	0	0								
		Bogies	2			108	0.2		0	113	104	0	0								
10d	Gantry Crane Demob (EAST) Soft demo	Street Sweeper	1			104	0.2		0	109	97	0	0								
		300t Crane	1			108	0.4		0	113	104	0	0	111	0	0					
		EWP	2			89	0.3		0	94	87	0	0								
		35t Excavator	1			109	0.2		0	114	105	0	0								
		14t Excavator	1			107	0.2		0	112	103	0	0								
		Flat bed truck	2			93	0.3		0	98	91	0	0								
		Bogies	2			98	0.4		0	103	97	0	0								
		Hand tools (grinder/ Rattle gun)	4			101	0.2		5	109	105	0	0								
10e	Cladding removal acoustic shed (EAST) Soft demo	Bin truck	4			98	0.4		0	103	100	0	0								
		300t Crane	1			108	0.2		0	113	104	0	0	107	0	0					
		EWP	3			89	0.3		0	94	89	0	0								
		Flatbed truck	1			93	0.3		0	98	88	0	0								
10ei	Structure removal acoustic shed (EAST)	Hand tools (grinder/ Rattle gun)	4			101	0.5		5	109	105	0	0								
		300t Crane	1			108	0.2		0	113	101	0	0	108	0	0					
		35T Excavator	1			109	0.2		0	114	102	0	0								
				14T Excavator	1			107	0.2		0	112	100	0	0						



Phase	Description	Aspect	Activity		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	Adj equipment SWL, LAeq,15 minute			Activity LAeq, 15 min SWL						
			ID	Description		7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night			
11		Five Dock West	10f	Site Offices/ Crib Shed Demobilisation (EAST) Soft demo	Flat Bed Truck	2			93	0.3		0	98	91	0	0						
					Bogies	4			98	0.2		0	103	97	0	0						
					Bin truck	2			98	0.2		0	103	94	0	0						
					Hand Tools (grinder/ rattle gun)	8			100	0.3		0	105	101	0	0						
			80t Crane	1			98	0.4		0	103	94	0	0	94	0	0					
			Drop Deck Truck	4			0	0		0	0	0	0	0								
			11a	Decommission site services and facilities (WEST) Soft demo	Sweeper	1			104	0.2		0	109	97	0	0	106	0	0			
					EWP	1			89	0.3		0	94	84	0	0						
					150t Crane	1			105	0.4		0	110	101	0	0						
					Tilt Tray	1			100	0.3		0	105	95	0	0						
					90t Crane	1			98	0.4		0	103	94	0	0						
					Drop Deck Truck	4			101	0.3		0	106	96	0	0						
		Hand Tools (grinder/ rattle gun)			4			101	0.2		5	109	99	0	0							
		Semi			3			100	0.3		0	105	95	0	0							
		11b	Site Offices/ Hoarding (WEST) Soft demo	Sweeper	1			104	0.2		0	109	97	0	0	107	0	0				
				EWP	1			89	0.3		0	94	84	0	0							
				150t Crane	1			105	0.4		0	110	101	0	0							
				Tilt Tray	1			100	0.3		0	105	95	0	0							
				90t Crane	1			98	0.4		0	103	94	0	0							
				Drop Deck Truck	4			101	0.3		0	106	96	0	0							
				Hand Tools (grinder/ rattle gun)	4			101	0.2		5	109	99	0	0							
				Bin Trucks	4			101	0.2		5	109	99	0	0							
		Semi	3			100	0.3		0	105	95	0	0									
		11c	Pile Cap Demo (WEST) Demo with hammer	Concrete Saw	1			114	0.2		5	122	112	0	0	122	0	0				
				35t Excavator + Hammer	1			122	0.3		5	130	122	0	0							
				Compressor	1			93	0.5		0	98	90	0	0							
				Bogies	2			108	0.2		0	113	104	0	0							
				Street Sweeper	1			104	0.2		0	109	97	0	0							
Bin trucks	1					101	0.3		0	106	96	0	0									
Watercart	2					103	0.4		0	108	99	0	0									



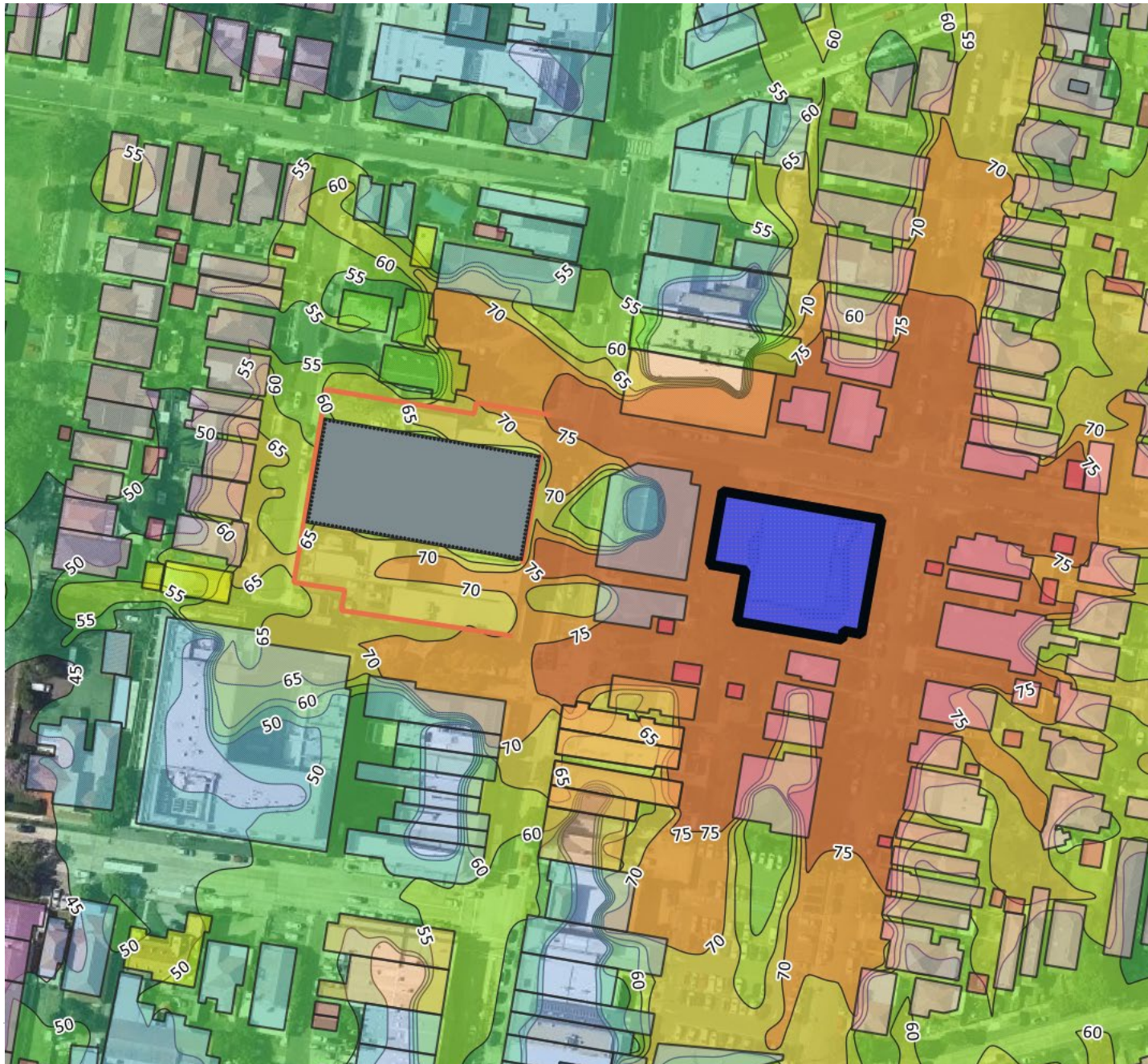


## Appendix C. Construction noise and vibration contours



### C.1 Construction noise contours













## Detailed noise and vibration impact statement

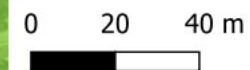


Five Dock Demobilisation  
Daytime noise contours  
East - Concrete Hob Demo

-  East Acoustic Shed
-  West Hoarding (3.0m)

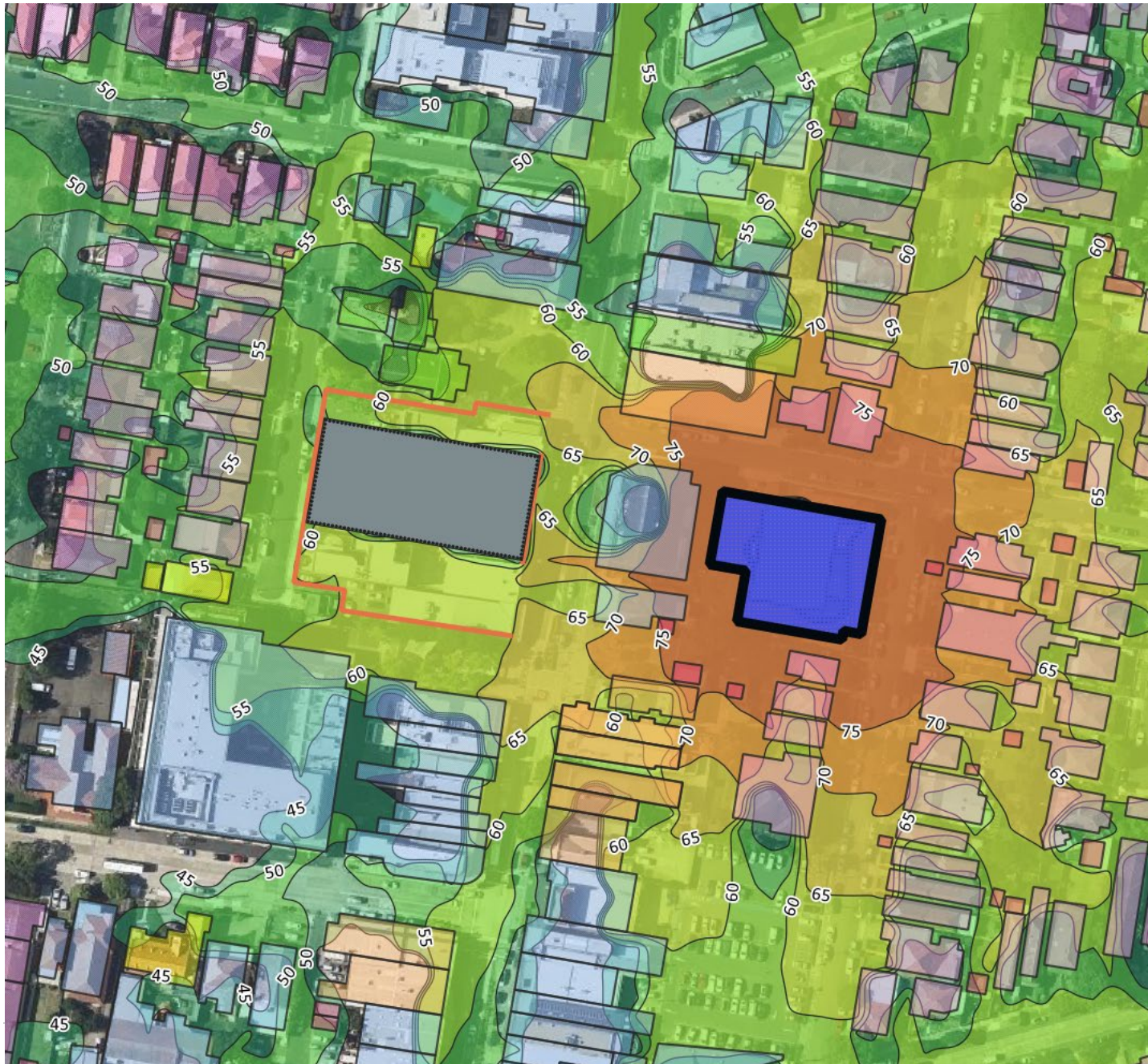
- Receiver types
-  Childcare
  -  Commercial/Business
  -  Commercial/Residential
  -  Community Use
  -  Community/Residential
  -  Education
  -  Industrial/Utilities
  -  Residential
  -  Medical
  -  Place of Worship

- Predicted noise level, dBA
-  45.00
  -  50.00
  -  55.00
  -  60.00
  -  65.00
  -  70.00
  -  75.00





## Detailed noise and vibration impact statement



Five Dock Demobilisation  
Daytime noise contours  
East - Acoustic Shed Demo

East Acoustic Shed  
 West Hoarding (3.0m)

Receiver types

- Childcare
- Commercial/Business
- Commercial/Residential
- Community Use
- Community/Residential
- Education
- Industrial/Utilities
- Residential
- Medical
- Place of Worship

Predicted noise level, dBA

- 45.00
- 50.00
- 55.00
- 60.00
- 65.00
- 70.00
- 75.00







## Detailed noise and vibration impact statement



## Detailed noise and vibration impact statement











Five Dock Demobilisation  
Daytime noise contours  
West Services Removal


 East Acoustic Shed  
 West Hoarding (3.0m)

### Receiver types

 Childcare  
 Commercial/Business  
 Commercial/Residential  
 Community Use  
 Community/Residential  
 Education  
 Industrial/Utilities  
 Residential  
 Medical  
 Place of Worship

### Predicted noise level, dBA

 40.00  
 45.00  
 50.00  
 55.00  
 60.00  
 65.00  
 70.00  
 75.00

0 20 40 m  






## Detailed noise and vibration impact statement





## Appendix D. Detailed noise predictions for individual receivers

### D.1 Phase 10 and 11 - Site demobilisation

Supplied as Excel spreadsheets