Integrated Management System

Planning Approval Consistency Assessment Form

SM ES-FT-414

Sydney Metro Integrated Management System (IMS)

Assessment Name:	Sydney Olympic Park and Burwood North noise mitigation
Prepared by:	Sydney Metro
Prepared for:	Sydney Metro and AFJV
Assessment number:	SMW CA 10
Type of assessment:	Assessment under EP&A Act 1979, Division 5.2
Version:	Final
Planning approval No. (where relevant):	CSSI 10038 Sydney Metro West Concept and Stage 1
Date required:	August 2023
iCentral number	SM-23-00816207

Form information – do not alter

Form number	SM ES-FT-414
Applicable to:	Sydney Metro
Document Owner:	Associate Director, Planning Approvals
System Owner:	Executive Director, Environment, Sustainability & Planning
Status:	Final
Version:	3.0
Date of issue:	AUGUST 2022
Review date:	As required

Table of Contents

1. Existing Approved Project 3
2. Description of proposed change which is the subject of this assessment 7
3. Timeframe 16
4. Site description 17
5. Site Environmental Characteristics 18
6. Justification for the proposed change 19
7. Environmental Benefit 25
8. Control Measures 25
9. Conditions of approval 25
10. Impact Assessment – Construction 28
11. Impact Assessment – Operation 47
12. Consistency with the Approved Project 49
13. Other Environmental Approvals 50
14. Recommendation 50
Author certification 51

1. Existing Approved Project

Planning approval reference details (Application/Document No. (including modifications)):			
• CSSI 10038 Sydney Metro West Concept and Stage 1 (11 March 2021) • Administrative Modification 1 (28 July 2021) • Modification 2 Clyde stabling and maintenance facility (3 June 2022) • Administrative Modification 3 (4 July 2022) • Administrative Modification 4 (22 December 2022)			
Date of determination:	Determination: 11 March 2021 Date of modifications: • Modification 1: 28 July 2021 • Modification 2: 3 June 2022 • Modification 3: 4 July 2022 • Modification 4: 22 December 2022	Type of planning approval:	Critical State Significant Infrastructure (CSSI) (EP&A Act Division 5.2)
Relevant background information (including EA, REF, Submissions Report, Director General's Report, MCoA):			
• Sydney Metro West Concept and Stage 1, Environment Impact Statement, April 2020 • Sydney Metro West Concept and Stage 1, Amendment Report, November 2020 • Sydney Metro West Concept and Stage 1, Submissions Report, November 2020 • Sydney Metro West Concept and Stage 1 - Assessment Report (SSI 10038), March 2021 • Sydney Metro West Concept and Stage 1, Conditions of Approval (CoA), released on 11 March 2021 and updated on 28 July 2021 (Modification 1), 3 June 2022 (Modification 2), 4 July 2022 (Modification 3) and 22 December 2022 (Modification 4).			
Description of existing Approved Project you are assessing for consistency:			
Sydney Metro West (the Concept) Sydney Metro West (the Concept) would involve the construction and operation of a metro rail line around 24 kilometres long between Westmead and Hunter Street in the Sydney CBD. The key components are expected to include (as described in Chapter 6 of the Environmental Impact Statement (EIS)):			

- construction and operation of new passenger rail infrastructure between Westmead and the central business district of Sydney, including:
  - tunnels, stations (including surrounding areas) and associated rail facilities
  - stabling and maintenance facilities (including associated underground and overground connections to tunnels)
- modification of existing rail infrastructure (including stations and surrounding areas)
- ancillary development.

Sydney Metro West - all major civil construction works between Westmead and The Bays (the Approved Project)

The Sydney Metro West Project Concept; and all major civil construction works between Westmead and The Bays, including station excavation and tunnelling was determined on 11 March 2021. Stage 1 of the planning approval process for Sydney Metro West (the Approved Project) is described in Chapter 9 of the EIS, with the key features including:

- tunnel excavation including tunnel support activities between Westmead and The Bays
- station excavation for new metro stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock and The Bays
- shaft excavation for services facilities
- civil work for the stabling and maintenance facility at Clyde.

To construct the above, Sydney Metro West Stage 1 is divided into multiple packages, each with their own design and construction scope. The package relevant to this Consistency Assessment is the Central Tunnelling Package (CTP) which involves the design and construction of 11km of twin tunnels and underground station excavations from The Bays to Sydney Olympic Park. The overall design and construction timeframe is approximately 3.5 years from July 2021.

This Consistency Assessment is relevant to the construction sites for Sydney Olympic Park and Burwood North metro stations. The Sydney Olympic Park construction site and Burwood North construction sites are described in Chapter 9 of the EIS as follows:

- Sydney Olympic Park construction site would be used to excavate the Sydney Olympic Park metro station using a cut-and-cover technique (refer to Figure 1-1 for extent of excavation within the construction site)
- Burwood North Station would require two construction sites, a western construction site and an eastern construction site (refer to Figure 1-2). At the northern site, the station box is being excavated through a cut-and-cover construction technique. An acoustic shed sits over the western portion of the station box to enable out of hours work in this area. A shaft would be excavated at the southern construction site for the southern station entrance, and would be connected to the station box via a pedestrian tunnel. The pedestrian adit would be a mined tunnel using roadheader from the northern station box connecting to the southern shaft.

The construction sites would be used to excavate the station boxes and shafts. The construction sites include spoil storage and removal, water supply, water treatment and disposal, material storage and office facilities and worker amenities.

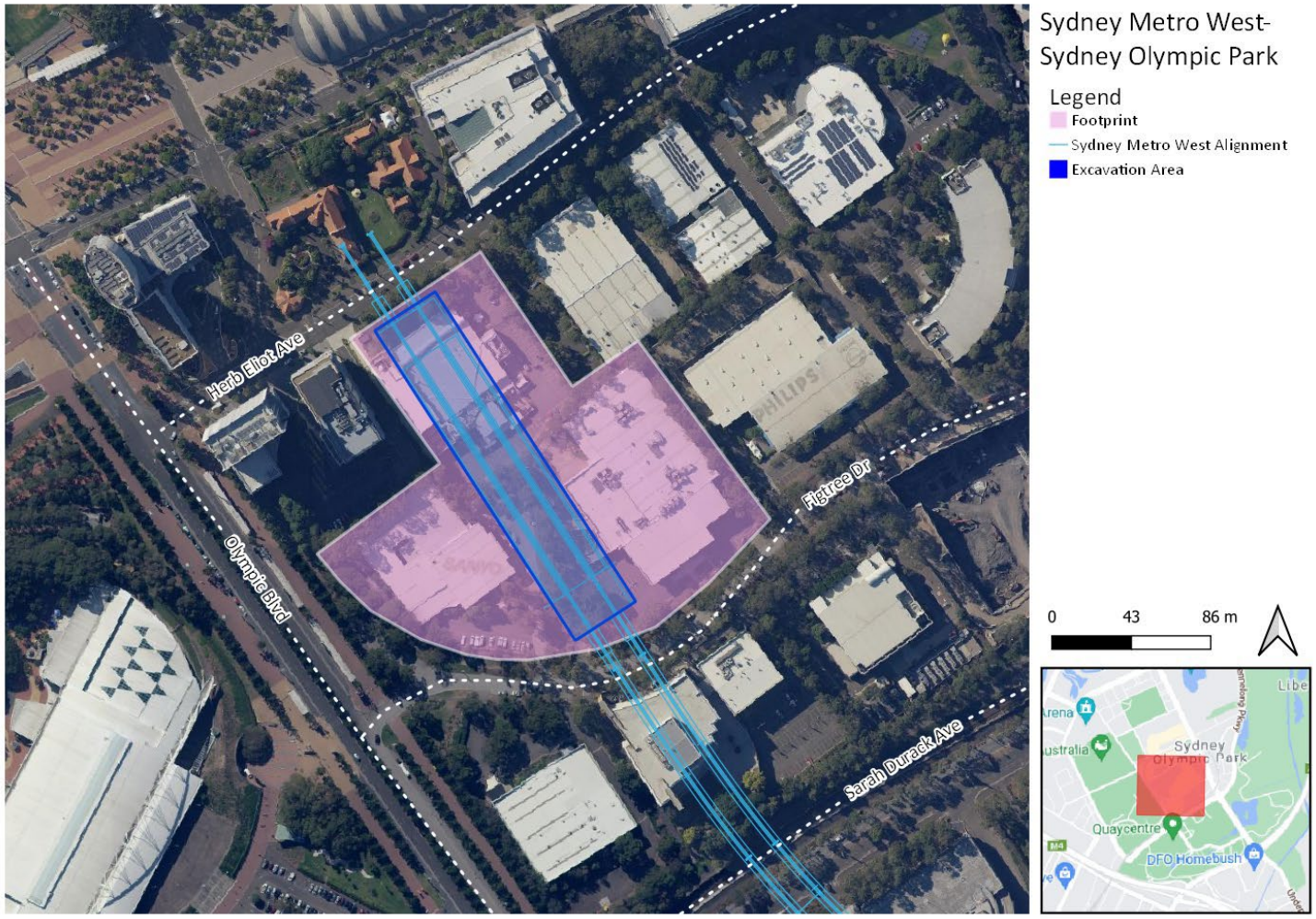


Figure 1-1: Sydney Olympic Park construction site location

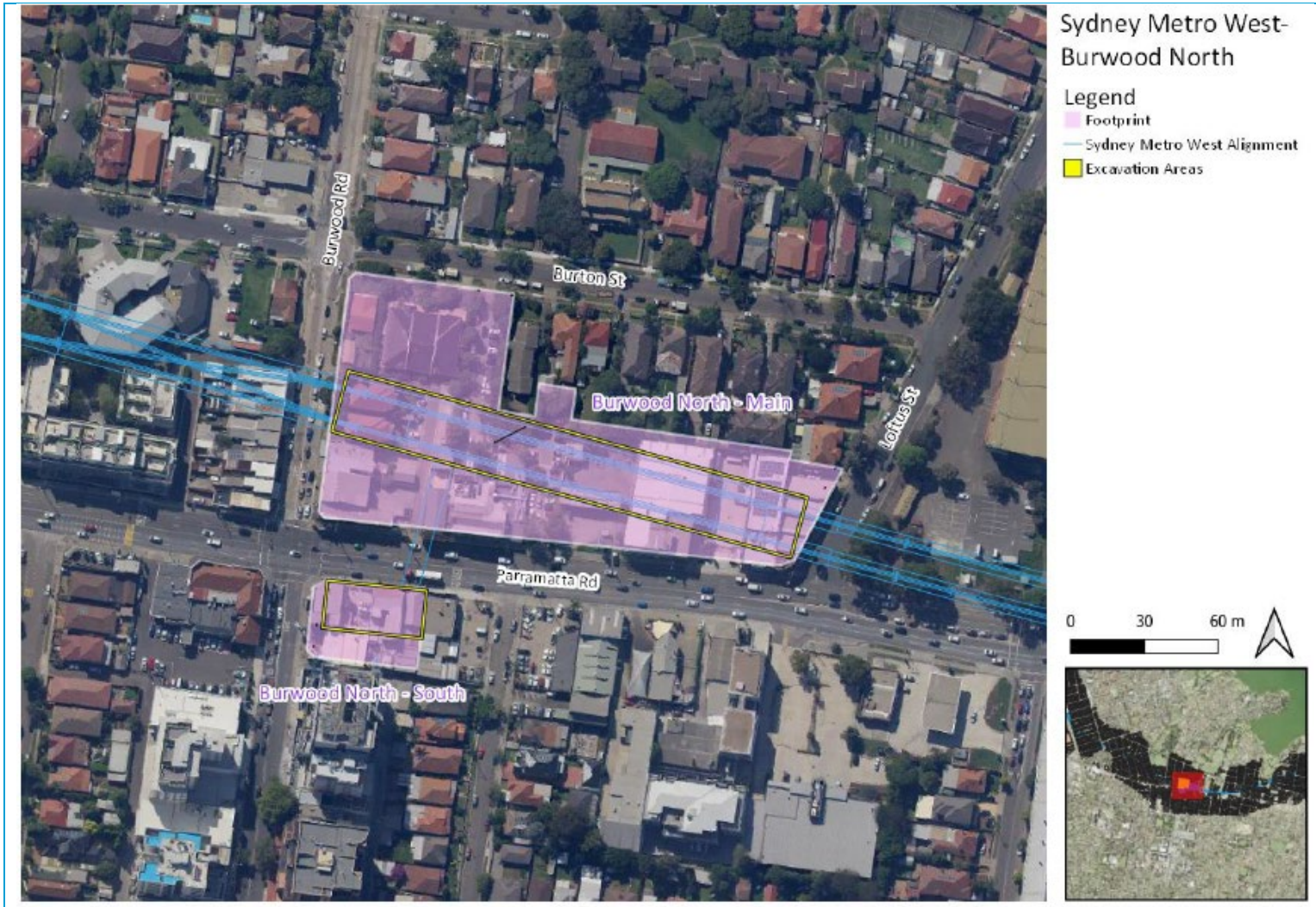


Figure 1-2: Burwood North construction site location

2. Description of proposed change which is the subject of this assessment

Overview

For the construction of the Approved Project, stations as well as services facility shafts, tunnel dives and TBM launch shafts would need to be excavated from the surface down. The EIS for the Approved Project considered that excavation would be completed within acoustic sheds or below acoustic panels (or other acoustic measures) at sites where 24/7 excavation works are proposed. At sites without acoustic sheds or panels, noisy excavation works would typically be restricted to the daytime.

During the preparation of the EIS, it was assumed that excavation at Sydney Olympic Park and Burwood North would be required to occur 24 hours a day, seven days a week. Table 21 of the Environmental Impact Statement - Noise and Vibration Technical Paper states:

> *Main excavation (referred to as 'excavation' hereon) involves excavation to a depth where blasting can be performed, if it is suitable for that site. Excavation would be completed within acoustic sheds or below acoustic panels (or other acoustic measures) at sites where 24/7 excavation works are proposed including Westmead metro station, Olympic Park metro station, Burwood North Station, Five Dock Station and The Bays Station construction sites.*
>
> *At sites without acoustic sheds or panels, noisy excavation works would typically be restricted to the daytime.*

Excavation in the EIS for the Approved Project and this Consistency Assessment is assumed to include the use of support equipment for spoil handling and 'mucking out' (the transfer of loose spoil to heavy vehicles).

Sydney Olympic Park

Noise mitigation modelled in the EIS
The EIS anticipated that to mitigate noise impact from 24/7 excavation at Sydney Olympic Park:

- an acoustic shed would be placed over the northern portion of the station box excavation
- an acoustic shed would be placed over the southern portion of the station box excavation
- in between the acoustic sheds, acoustic protection such as acoustic panels would be provided over the excavation.

Change in construction planning at Sydney Olympic Park

During detailed construction planning, it has been identified that 24/7 works for the excavation of the station box at Sydney Olympic Park is not required. Given the production rate of excavation has been greater than that identified during the preparation of the EIS, there has been an opportunity to eliminate the requirement for general out of hours station box excavation whilst still meeting the program. The construction contractor has identified that all works can be completed within the program timeframe within the approved construction hours as outlined in Condition of Approval D35, and therefore main excavation for the site does not need to occur 24/7. This would also minimise disruption to the local community. The excavation of the station box would be completed by Q4 2023 with TBM retrieval expected to be Q2, Q3 and Q4 2024.

In summary, station box excavations and associated spoil management at Sydney Olympic Park will continue to only be required to be undertaken during approved construction hours specified in condition of approval D35, whilst meeting the required program timeframes.

Change in noise mitigation strategy at Sydney Olympic Park

During detailed construction planning for the Sydney Olympic Park construction site, taking into consideration the construction program, working hours and traffic management; it was determined that station box excavation work is only required during approved construction hours. As a result, acoustic sheds are no longer justified as the preferred noise mitigation strategy (refer to Section 6 - Justification). This is consistent with the approach taken for the excavations of Parramatta and North Strathfield metro stations as stated in the EIS, which are being excavated within the approved construction hours. This approach is also consistent with the approach taken at the Five Dock western construction site (subject of Consistency Assessment AFJV20 – Five Dock Western Construction Site Noise Mitigation (Sydney Metro, 2023)).

Burwood North

Noise mitigation modelled in the EIS

The EIS anticipated that to mitigate noise impact from 24/7 excavation of the station box and southern shaft at Burwood North:

- an acoustic shed would be placed over the western side of the station box excavation (northern construction site - which has now been constructed as shown in Figure 2-1)
- acoustic protection such as acoustic panels (which are covers placed over the top of the excavation pit to minimise noise emissions) would be provided over the eastern side of the station box excavation (northern construction site)
- an acoustic shed would be placed over the shaft to be constructed on the southern construction site where the adit connecting the southern construction site underneath Parramatta Road to the station box would be tunnelled.

Change in construction planning at Burwood North

During detailed construction planning, it has been identified that 24/7 works for the excavation of the station box, southern shaft and pedestrian adit at Burwood North is not required. There has been an opportunity to improve the sequence of work at these sites to eliminate the requirement for general out of hours excavation. Details of the change in construction planning include:

- the construction methodology anticipated a duration of one year of excavation would be required for the excavation of the station box. During detailed construction planning, the required production rate for the station box has been achievable working approved construction hours only as outlined in condition of approval D35 to minimise disruption to the local community. The station box excavation is expected to be completed in Q4 this year continuing with approved construction hours only.
- due to a change in methodology during detailed construction planning, the entire construction of the pedestrian adit from the station box to the southern shaft was taken off the critical path and work could be completed only during approved construction hours from the northern construction site.
- the excavation for the southern shaft is expected to be completed in Q4 2023 continuing with approved construction hours only. The breakthrough into the completed pedestrian adit at the southern site will occur using excavators from the southern shaft during approved construction hours, expected to be in Q4 2023.

As a result of the change in methodology during detailed construction planning, station box excavation, shaft excavation, and tunnelling of the pedestrian adit will now only be required to be undertaken during approved construction hours specified in condition of approval D35. No roadheader tunnelling for the breakthrough from the southern shaft into the pedestrian adit would be undertaken outside of approved construction hours.

Change in noise mitigation strategy at Burwood North

During detailed construction planning for Burwood North, taking into consideration the construction program, working hours and traffic management; it was determined that excavation work for the station box, shaft and adit is now only required during approved construction hours. As a result, an acoustic shed is no longer required to mitigate out of hours noise impacts for the southern construction site, and acoustic panels are no longer justified for the eastern part of the station box (refer to Section 6 - Justification). This is consistent with the approach taken for the excavations of Parramatta and North Strathfield metro stations as stated in the EIS, and Five Dock as per Consistency Assessment AFJV20 which are primarily being excavated within approved construction hours.

An acoustic shed has been constructed at the western side of the Burwood North northern construction site where tunnelling of the crossover cavern, tunnel support activities and spoil management are required to occur outside the approved construction hours in line with the conditions of approval. This was considered an appropriate control in consideration of the construction program and tunnelling of the crossover cavern to the west, and therefore extended periods of out of hours works are required to be mitigated.

Figure 2-1: Burwood North construction site showing the existing acoustic shed

Proposed change

The proposed change, subject of this Consistency Assessment, is to alter the proposed noise mitigation strategy to respond to the change in construction methodology at both sites:

- acoustic sheds and panels at the Sydney Olympic Park construction site are no longer proposed due to station box excavation occurring during approved construction hours only
- an acoustic shed at Burwood North southern construction site is no longer proposed due to shaft excavations and mining of the adit occurring during approved construction hours only
- acoustic panels at Burwood North northern construction site are no longer proposed due to excavation of the station box in the area outside the acoustic shed occurring during approved construction hours only.

Alternate feasible and reasonable noise mitigation in accordance with condition of approval D39 to minimise exceedances of the noise management levels to nearby receivers during the approved construction hours is required.

Table 2-1 provides a comparison between the Approved Project and proposed change.

Table 2-1 - Comparison of the proposal with relevant elements of the Approved Project

Relevant elements of the Approved Project	Proposed change
Hours of work The construction hours identified in Condition of Approval D35 for the Approved Project are: • 7:00am to 6:00pm Mondays to Fridays, inclusive; • 8:00am to 6:00pm Saturdays; and • at no time on Sundays or public holidays. Exceptions to this in accordance with Condition of Approval D37 generally include: • work required for safety reasons and emergencies • construction work that is deemed to meet 'Low Noise Impact Work' criteria are permitted out of standard construction hours • tunnelling (excluding cut and cover tunnelling and surface works) are permitted 24 hours a day, seven days a week • any changes to construction working hours approved by the NSW Environment Protection Authority (EPA) under an EPL.	No changes to the construction hours identified in Condition of Approval D35 and D37 for the Approved Project are required as a result of the proposed change. Details on the proposed working hours for excavation and tunnelling are included below.
Excavation work at the Sydney Olympic Park construction site Section 9.5.5 of the EIS for the Approved Project discussed the activities for excavation and identified the indicative location of the construction site at Sydney Olympic Park (Figure 9-22 of the EIS). The EIS for the Approved Project also identified that initial excavation without acoustic sheds was identified as being required at Sydney Olympic Park for around two months. The EIS identified that this excavation without acoustic sheds would be generally limited to approved construction hours only. Section 11-3 of the EIS described that once acoustic sheds (or other acoustic measures) are in place, excavation works would	This Consistency Assessment does not change the extent or location of station box excavation at Sydney Olympic Park. This Consistency Assessment does not change the methodology of the station box excavation required, and the plant and equipment required would also remain unchanged. During detailed construction planning, it was identified that works can be completed within the program timeframe within the approved constructions hours, and that 24/7 excavation and associated spoil management would not be required. This Consistency Assessment therefore proposes reduced daily working hours at Sydney Olympic Park for station box excavation and spoil management compared to the hours assessed in the EIS. Excavation and spoil management will only be required to be undertaken during the approved construction hours listed in condition of approval D35. Highly noise intensive work would only be able to be undertaken during approved construction hours in accordance with condition of approval D36, which also requires respite periods during extended durations of noisy works.

occur 24 hours per day, seven days a week. The EIS anticipated that to mitigate noise impact from 24/7 excavation: • an acoustic shed would be placed over the northern and southern portions of the station box excavation • in between the acoustic sheds, acoustic protection such as acoustic panels would be provided over the excavation. Condition of approval D37 specifies that work within an acoustic shed may be undertaken outside standard construction hours where there is no exceedance of noise levels under Low Noise Impact Work circumstances, unless otherwise agreed by the Planning Secretary.	If work is deemed to meet the low noise impact criteria, this may be undertaken outside of approved construction hours in accordance with condition of approval D37. As 24/7 excavation work is not proposed at Sydney Olympic Park, acoustic sheds and acoustic panels are not required to mitigate out of hours noise impacts. Alternate reasonable and feasible noise mitigation would be implemented to manage noise impacts from excavation during the approved construction hours.
Excavation and tunnelling works at the Burwood North construction sites Section 9.5.7 of the EIS for the Approved Project discussed the activities for excavation and identified the indicative location of the construction site at Burwood North (Figure 9-26 of the EIS). This included: • the excavation of a station box at the northern construction site • a shaft at the southern construction site which would be used to construct a southern entrance • tunnelling of an adit underneath Parramatta Road between the southern shaft and the station box to create access from the southern station entrance to the station • tunnelling of a crossover cavern to the west of the station box. The EIS for the Approved Project identified that initial excavation of the station box and shaft without an acoustic shed was identified as being required at Burwood North northern and southern construction sites for around 18 weeks. The EIS identified that this excavation without an acoustic shed would be generally limited to standard construction hours only. Section 11-3 of the EIS described that once acoustic sheds (or other acoustic measures) are in place, excavation works for the	This Consistency Assessment does not change the extent or location of excavation required at the Burwood North northern and southern construction sites. This Consistency Assessment does not change the methodology of the excavation and adit tunnelling at the northern and southern sites, and the plant and equipment required would also remain unchanged. An acoustic shed has been constructed over the western portion of the station box excavation where 24/7 tunnelling of the crossover cavern to the west, and support activities, would be required (refer to Figure 2-1). During detailed construction planning, it was identified that the following excavation activities can be completed within the program timeframe within the approved constructions hours, and that 24/7 excavation and associated spoil management would not be required: • excavation of the eastern side of the station box • excavation of the southern shaft • tunnelling of the adit connecting the station box to the southern shaft. This Consistency Assessment proposes reduced daily working hours at Burwood North compared to the hours assessed in the EIS for all excavation outside the acoustic shed, including for the eastern side of the station box and shaft excavation at the southern construction site. 24/7 tunnelling would still be required for the crossover cavern to the west of the station box. Excavation and spoil management at Burwood North outside of the acoustic shed at both sites will only be required to be undertaken during the approved construction hours listed in condition of approval D35. Highly noise intensive work would only be able to be undertaken during approved construction hours in accordance with condition of approval D36, which also requires respite periods during extended durations of noisy works.

station box and shaft would occur 24 hours per day, seven days a week. Section 9.4 of the EIS for the Approved Project discussed the activities for the construction of the tunnels including the use of roadheaders to excavate irregular shaped tunnels including the cavern required between the two construction sites at Burwood (connecting underneath Parramatta Road). The EIS identified that once the shaft at the southern construction site has been excavated, areas of the underground adit (cavern) would be mined using road headers (24 hours per day, seven days a week). These tunnelling works would be required to connect the southern station entrance to the station box at the northern construction site, with tunnelling required under Parramatta Road. The EIS anticipated that to mitigate noise impact from 24/7 excavation and tunnelling: • an acoustic shed would be placed over the western side of the station box excavation (northern construction site) • acoustic protection such as acoustic panels (which are covers placed over the top of the excavation pit to minimise noise emissions) would be provided over the eastern side of the station box excavation (northern construction site) • an acoustic shed would be placed over the shaft to be constructed on the southern construction site where the adit connecting the southern construction site underneath Parramatta Road to the station box would be tunnelled. Condition of approval D37 specifies that work within an acoustic shed may be undertaken outside approved construction hours where there is no exceedance of noise levels under Low Noise Impact Work circumstances, unless otherwise agreed by the Planning Secretary.	If excavation work is deemed to meet the low noise impact criteria, this may be undertaken outside of approved construction hours in accordance with condition of approval D37. As 24/7 excavation work is no longer proposed at the eastern side of the station box, acoustic panels are not required to mitigate out of hours noise impacts. As 24/7 excavation work is no longer proposed at the southern construction site, an acoustic shed at the southern construction site is not required to mitigate out of hours noise impacts. Roadheaders for tunnelling of the crossover cavern to the west, and support activities, would be required to be undertaken outside of approved construction hours in accordance with the conditions of approval, with noise of the support activities managed from within the acoustic shed. Roadheaders for the adit which connects the southern station entrance to the station box will now be launched from the northern site within the existing acoustic shed and would only be required to be undertaken during approved construction hours. No tunnelling works are required from the southern site. The breakthrough into the adit from the southern shaft would be excavated during approved construction hours only. Ventilation for tunnelling will also be serviced from the northern site within the acoustic shed. Feasible and reasonable mitigation measures will be implemented, as required, during the course of these activities. Alternate reasonable and feasible noise mitigation would be implemented to manage noise impacts from excavation during the approved construction hours.
Tunnelling of the mainline tunnels and supporting activities The EIS for the Approved Project identifies the following methodology for excavation of the tunnels, primarily using tunnel boring machines. Tunnel boring machines would be used to excavate twin tunnels about 21 kilometres long. The two bored	This Consistency Assessment does not change the scope of tunnelling or supporting activity for the Approved Project. The depth of the mainline tunnels is consistent with the assessment

tunnels would have a circular cross-section with an internal lined diameter of about six metres and an excavated diameter of about seven metres. Roadheaders would be used to excavate irregular shaped tunnels such as stub tunnels, cross passages, crossover and turnback caverns and niches. Roadheaders would also be used to excavate mined station caverns, underground pedestrian connections, shafts and the connecting tunnels between the Rosehill dive structure and the mainline tunnels. Condition of approval D37 specifies that tunnelling can occur outside of approved construction hours. As assessed in Consistency Assessment SMW01 for the Approved Project, tunnel boring machines would be launched from Clyde and The Bays, where they would be retrieved at both Westmead and Sydney Olympic Park construction sites.	in the EIS for the Approved Project. Tunnelling would continue to be undertaken out of hours in accordance with the conditions of approval. No change to the methodology of the tunnel boring machine work is required as a result of the proposed change. As identified in Consistency Assessment SMW01 for the Approved Project, four of the tunnel boring machines would be retrieved at the Sydney Olympic Park construction site. This work would be undertaken during the approved construction hours however some oversize deliveries or other low noise impact work may be required out of hours in accordance with condition of approval D37.
Timing for the Sydney Olympic Park construction activities An indicative program for construction activities at Sydney Olympic Park is shown in Figure 9-23 of the EIS for the Approved Project. The EIS and Technical Paper 2 – Noise and Vibration for the Approved Project identified that for Sydney Olympic Park: • excavation of the station box would be completed over a period of about one year (around 8 weeks of excavation required before the construction of the proposed acoustic sheds was identified in the EIS).	Station box excavation without acoustic sheds was identified as being required for the Approved Project, and would be limited to being undertaken within approved construction hours only. As such, excavation commenced in October 2022 and would be expected to continue until Q4 2023. The tunnel boring machines are expected to be retrieved from Sydney Olympic Park in approximately Q4 2024 for the tunnel boring machines from the east and Q2 2024 for the tunnel boring machines from the west. The retrieval of these tunnel boring machines would occur during approved construction hours. Overall, this Consistency Assessment does not change the overall duration of the construction work of the Approved Project. Refer to Section 3 – Timeframe for more details.
Timing for the Burwood North construction activities An indicative program for construction activities at Burwood North is shown in Figure 9-27 of the EIS for the Approved Project. The EIS and Technical Paper 2 – Noise and Vibration for the Approved Project identified that for both construction sites at Burwood North: • station excavation including the southern shaft would be completed over a period of approximately one year	An acoustic shed has been established over the western portion of the station box to support the activities that require work to be undertaken 24/7, including the tunnelling of the crossover cavern to the west. A construction scenario for excavation without acoustic sheds was identified in the Environmental Impact Statement as being required for the Approved Project for station box construction and would be limited to being undertaken within approved construction hours only.

(around 18 weeks of excavation would be required before construction of the proposed acoustic shed) • Cavern and adit excavation from within the proposed acoustic shed to the west would be completed over a period of approximately one year.	Excavation of the station box commenced in Q3 2022 and would be expected to continue until Q4 2023. Tunnelling for the crossover cavern and adit commenced in Q4 2022 and will be expected to be completed by Q3 2023. Tunnelling for the crossover cavern would be required to be undertaken out of hours in accordance with the conditions of approval, however tunnelling of the pedestrian adit would only be undertaken during approved construction hours. The tunnel boring machine is expected to pass through Burwood North in approximately Q2 2024. Overall, this Consistency Assessment does not change the overall duration of the construction work of the Approved Project. Refer to Section 3 – Timeframe for more details.
Heavy vehicles In accordance with condition of approval D85 for the Approved Project, Construction Traffic Management Plans (CTMP) have been prepared in accordance with the Sydney Metro Construction Traffic Management Framework (CTMF) to assess and manage impacts on the surrounding road network. In accordance with condition of approval D37 of the Approved Project, no delivery of materials or spoil haulage would be undertaken from the Burwood North construction sites using any roads / streets other than directly from Parramatta Road between the hours of 10pm and 7am, unless required for safety reasons.	Construction traffic volumes at both the Sydney Olympic Park and Burwood North construction sites are not expected to increase as a result of this proposal. No change to the peak daily traffic movement volumes or the hourly movement volumes during the peak period would be required as a result of this proposal. No change to the haul routes would be required as a result of the proposed change. Construction traffic will be managed as per the approved Construction Traffic Management Plan (CTMP), prepared in accordance with condition of approval D85. In accordance with the conditions of approval, no delivery of materials or spoil haulage between the hours of 10pm and 7am would occur from the Burwood North using any roads / streets other than directly from Parramatta Road, unless required for safety reasons.
Noise and vibration mitigation measures During the preparation of the EIS, it was assumed that excavation work at the Sydney Olympic Park and Burwood North construction sites would be required to occur 24/7. The EIS for the Approved Project considered that excavation would be completed within acoustic sheds or below acoustic panels (or other acoustic measures) at sites where 24/7 excavation works are proposed including at Sydney Olympic Park and Burwood North. The EIS identified that at sites where no regular out of hours works were proposed and excavation works were proposed to be undertaken during the daytime only (such as North Strathfield and Parramatta), acoustic sheds or panels were not identified as a feasible or reasonable mitigation measure.	Due to excavations of the station boxes and shafts, including the associated spoil management and mucking out at Sydney Olympic Park and Burwood North being required to occur during approved construction hours only: • acoustic sheds and acoustic panels (or other acoustic measures) over the station box at the Sydney Olympic Park construction site are no longer proposed • an acoustic shed (or other acoustic measures) over the shaft at the southern construction site at Burwood North is no longer proposed • acoustic panels (or other acoustic measures) over the eastern portion of the station box at the Burwood North construction site are no longer proposed (noting the existing acoustic shed would remain over the western portion of the station box to support 24/7 crossover cavern tunnelling to the west).

Condition of approval D39 stipulates the need to implement feasible and reasonable mitigation measures with the aim of achieving construction noise management levels and vibration criteria in accordance with the relevant guidelines.	Alternate feasible and reasonable noise mitigation in accordance with condition of approval D39 to minimise exceedances of the noise management levels to nearby receivers during the approved construction hours is required. Noise mitigation measures have been determined by taking into account construction program, construction working hours and construction traffic management in accordance with the Sydney Metro Construction Noise and Vibration Standard (CNVS). The standard mitigation measures in the CNVS will be applied as well as the additional mitigation measures, as required. These measures are also included in the Noise and Vibration Management Plans prepared for the Approved Project. In accordance with condition of approval D44, a Detailed Noise and Vibration Impact Statement (DNVIS) must be prepared for each construction site and include specific mitigation measures identified through consultation with affected sensitive land users. Extensive community engagement has occurred since before construction commenced and will continue throughout construction. The concerns and sensitivities of the local communities for each site are well understood and have been considered in determining feasible and reasonable mitigation measures, appropriate to the context of east site. Examples of the site specific noise mitigation measures to be implemented at Sydney Olympic Park as identified through the DNVIS include: • elimination of general out of hours work for station box excavations and spoil management at the Sydney Olympic Park construction site • residential grade mufflers are to be fitted to all mobile plant, with equipment maintained and operated effectively • ‘damped’ rock hammers would be used which have reductions of around 10 dB in comparison to similar sized ‘un-damped’ rock hammers • plant would be placed behind larger objects or as far from receivers as possible • moveable hoarding of around 2.4 metres in height is proposed, however no hoarding has been considered in the modelling of noise and therefore the DNVIS considers a worst-case assessment. The location of adjacent multi-story buildings reduces the effectiveness of hoarding around the boundary, which in some instances are over 100 metres from the noise source in the direction of the receivers. • avoidance of high noise impact works when reasonably practicable, with respite provided as per condition of approval D36 • community notifications and engagement including community information sessions and individual meetings with owners/tenants of neighbouring properties

	• verification of the noise model by undertaking noise monitoring. If noise monitoring is higher than predicted, then the works will be reviewed and additional feasible and reasonable measures will be implemented. Site specific noise mitigation measures to be implemented at Burwood North as identified through the DNVIS include: • the existing acoustic shed (approximately 20 metres in height) would remain over the western portion of the station box where 24/7 tunnelling and spoil management is required • elimination of general out of hours work for excavation of the eastern side of the station box and associated spoil management • elimination of general out of hours work for the excavation and associated spoil management of the southern shaft, and tunnelling of the pedestrian adit • various forms of hoarding are proposed, with a mix of 2.4 metre high hoarding and retention of existing building facades at the site boundary (noting vehicle access points would be required for site entry and egress) • rock hammers will be used where required when breaking up building slabs, with alternative methods proposed in “no hammer” zones. If using hammers is unavoidable, noise mats or suitable noise screens around the activity would be investigated where practicable. • avoidance of high noise impact works when reasonably practicable, with respite provided as per condition of approval D36 • community notifications and engagement including community information sessions and individual meetings with owners/tenants of neighbouring properties • verification of the noise model by undertaking noise monitoring. If noise monitoring is higher than predicted then the works will be reviewed and additional feasible and reasonable measures will be implemented. Further discussion of mitigation measures including alternatives considered is provided in Section 6 – Justification.

3. Timeframe

An indicative construction program for the major civil construction work between Westmead and The Bays is shown in Figure 9-29 of the EIS. Section 9.3 of the EIS notes that the actual program and commencement of the civil work at each construction site may vary and is subject to the final delivery strategy and actual construction program to be agreed with the successful contractor for each work package. An overview of the works schedule for Sydney Olympic Park is provided in Table 3-1. An overview of the works schedule for Burwood North is provided in Table 3-2. These dates are indicative and may change depending on ground conditions, weather and other factors. The programs presented are generally consistent with the indicative programs in the EIS.

Table 3-1: Sydney Olympic Park construction site indicative construction program

Sydney Olympic Park	2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site establishment												
Station box excavation												
Tunnel boring machine retrieval												
Demobilisation												

Table 3-2: Burwood North construction site indicative construction program

Burwood North	2022				2023				2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site establishment												
Station box excavation												
Shaft excavation (southern site)												
TBM pass through												
Crossover cavern + adit excavation												
Demobilisation												

4. Site description

Sydney Olympic Park

The Sydney Olympic Park metro station construction site is located south of the existing Olympic Park Station, within the current mixed use area of Sydney Olympic Park. Prior to the property acquisition and demolition work undertaken for the Approved Project, the construction site mostly contained existing commercial and industrial land uses.

Burwood North

Burwood North Station construction works would involve two construction sites. The northern construction site occupies part of the block bounded by Burwood Road, Parramatta Road, Loftus Street and Burton Street. Prior to the property acquisition and demolition work undertaken for the Approved Project, this area comprised shops, residential apartments, a pub/hotel, a hostel, and part of Neichs Lane. The southern construction site is located south of Parramatta Road, within the block bounded by Burwood Road, Parramatta Road, and Esther Street occupying space previously used for shops, commercial services and an educational facility.

5. Site Environmental Characteristics

Land uses surrounding the Sydney Olympic Park metro station construction site include the following:

- north of the site is the former State Abattoirs (heritage listed) and then the existing Olympic Park Station, beyond which are a number of major sporting and events facilities
- there are additionally three hotels located directly adjacent to the site to the north west
- east of the site are a number of commercial buildings, beyond which are newly completed mixed use high density buildings. Further east is Bicentennial Park, a key area of regional open space in Greater Sydney
- south of the site are a range of commercial uses, an educational facility and a number of sporting facilities, including the Sydney Olympic Park Tennis Centre and the Hockey Centre
- west of the site are visitor accommodation facilities, and the Sydney Olympic Park Aquatic and Athletic Centres
- the closest residences are located along Figtree Drive and Australia Avenue (high rise apartments).

Land uses surrounding the Burwood North Station construction sites include the following:

- north and north-west of the site are the residential areas of Concord. Immediately north of Burton Street is St Lukes Anglican Church. Further north across Gipps Street are a range of recreational and sporting facilities such as St Lukes Park and Cintra Park
- east of the site is Concord Oval
- south of the site along the southern side of Parramatta Road land use generally comprises retail, commercial services and commercial premises, including several motor vehicle related premises. South along Burwood Road is a continuation of the commercial and retail uses, often comprising mixed use developments with multi-storey residential buildings above. Further south is Burwood Park, Westfield Burwood and the existing Burwood Station
- south-west of the site is a mix of low density residential housing, and MLC School Burwood. Other the land uses south of the site include commercial and retail premises along Parramatta Road and low density residential dwellings
- west of the site is a mix of uses including residential apartments, student accommodation and retail uses.

The sites have been cleared and established for the construction of Sydney Metro West as part of the Approved Project. They do not contain any sensitive environmental features.

6. Justification for the proposed change

Acoustic sheds and acoustic panels (or other acoustic measures) at the Sydney Olympic Park and Burwood North construction sites were contemplated in the EIS for the Approved Project on the basis that excavation (for station boxes and shafts) at the sites would be required to be undertaken 24/7. During detailed construction planning it was determined that the construction program timeframes can be met with excavation of the station boxes and the shaft only required to be undertaken during approved construction hours, minimising impact to the nearby communities. At Burwood North, some tunnelling for a crossover cavern from the western portion of the site is required to be undertaken outside of approved construction hours and an acoustic shed has been installed over this portion of the site to mitigate noise impacts during out of hours work to support these tunnelling activities. As work at the Sydney Olympic Park construction site and the eastern and southern parts of the Burwood North construction site would only be required to be undertaken during approved construction hours:

- acoustic sheds and acoustic panels (or other acoustic measures) over the station box at the Sydney Olympic Park construction site are no longer proposed
- an acoustic shed (or other acoustic measures) over the shaft at the southern construction site at Burwood North is no longer proposed
- acoustic panels (or other acoustic measures) over the eastern portion of the station box at the Burwood North construction site is no longer proposed (noting the existing acoustic shed would remain over the western portion of the station box where 24/7 tunnelling support is required).

Using acoustic sheds at Sydney Olympic Park and the Burwood North southern construction site would prolong the excavation process to allow for installation of the acoustic sheds, and would result in noise impacts associated with constructing and dismantling the acoustic shed. Using acoustic panels over the station box excavations is also not feasible because of the impact it would have had on the construction duration of the project during installation and dismantling and the difficulties associated with the ventilation of the station box during the excavation.

Given the proximity of sensitive receivers at Sydney Olympic Park, and the limited excavation required at the Burwood North southern construction site, appropriate feasible and reasonable noise mitigation in accordance with condition of approval D39 to minimise exceedance of the noise management levels to nearby receivers during the approved construction hours is required. Appropriate mitigations are able to be implemented to manage impacts associated with the construction activities required at each site. This section provides a justification of the proposed change including:

- justification of feasible and reasonable mitigation appropriate for excavation work being primarily undertaken during approved construction hours including:
    - an assessment of different physical acoustic barriers and acoustic panels against a number of criteria including noise mitigation effectiveness, constructability and design
- construction implications of installing acoustic sheds and the project benefits associated with alternate feasible and reasonable noise mitigation
- excavation of the station boxes and shaft at the sites has commenced without an acoustic shed or acoustic panels in place and the excavation works have been restricted to approved construction hours only, which is consistent with the scenario identified in the EIS for the Approved Project.

Mitigation measures

Condition D39 states that all feasible and reasonable mitigation measures must be implemented with the aim of achieving the construction noise management levels and vibration criteria listed in various standards and guidelines.

Chapter 11 Noise and Vibration of the EIS for the Approved Project states:

Acoustic shed(s) (or other acoustic measures) would be constructed over excavation and spoil handling areas as early as possible for sites where excavation and tunnelling works are proposed 24 hours per day seven days a week.

At sites without acoustic sheds (or other acoustic measures), excavation works would be restricted to standard construction hours. Once acoustic sheds (or other acoustic measures) are in place, excavation works would occur 24 hours per day, seven days a week.

Where 24 hours per day, seven day a week tunnelling or excavation works are required near sensitive receivers, an acoustic shed (or other acoustic measures) would be erected to mitigate the noise emissions.

Additionally, section 11.3.4 of the EIS for the Approved Project states:

Acoustic sheds (or other acoustic measures) would be constructed prior to commencing evening and night time works at all sites where works outside of standard construction hours could have the potential to impact nearby receivers.

These statements from the EIS for the Approved Project suggest that an acoustic shed (or other acoustic measures) was considered an appropriate measure to mitigate airborne noise impacts during 24 hour excavation proposed at Sydney Olympic Park and Burwood North.

Given the change in construction methodology as identified in Section 2 above, the need for station box excavation and shaft excavation at Sydney Olympic Park and Burwood North would be limited to approved construction hours only, and 24/7 excavation is no longer required. Therefore, reassessment of the need for an acoustic shed and panels as the feasible and reasonable mitigation to manage day time noise impacts is justified. It is acknowledged that an acoustic shed may have benefits for managing noise during approved construction hours, however these impacts can be managed through feasible and reasonable mitigation measures as required by condition of approval D39. An acoustic shed would remain installed over the western portion of the Burwood North northern site which requires 24/7 tunnelling support to be undertaken outside of approved construction hours (refer to Figure 2-1).

Detailed Noise and Vibration Impact Statements (DNVIS) for both Sydney Olympic Park and Burwood North have been prepared in accordance with conditions of approval D43 and D44. These DNVIS's include mitigation measures identified through consultation and refer to compliance with the standards listed in condition of approval D39. All work at the construction sites must be carried out in accordance with the approved DNVIS, to be endorsed by the Acoustics Advisor. The proposed feasible and reasonable mitigation which includes site specific acoustic measures have been provided in Section 2 – Description Table 2-1 of this Consistency Assessment.

Proposed hoarding and alternatives considered

Sydney Olympic Park

Installation of acoustic sheds approximately 20 metres high, and acoustic panels, is no longer considered feasible or reasonable as the excavation productivity rate required to meet the construction program can be achieved through excavation during approved construction hours only, with out of hours work no longer required. Analysis of the alternate options of noise mitigation include:

- installation of acoustic sheds: installation of acoustic sheds would extend the overall duration of surface construction works. Noisy work associated with the installation of acoustic sheds includes out of hours deliveries and the use of rattle guns to fasten the steel structure. This would be required for a period of around 4-6 months and would require a large amount of resources. Installation of the sheds would be for a limited period of time because it is a temporary works item and would need to be partially removed in 2023 with full removal by the end of 2024. The sheds would not be handed over to the station contractor because it interferes with the station construction scope. Any benefits of the completed acoustic sheds would therefore be short-medium term
- installation of acoustic panels: acoustic panels present constructability and safety constraints. Acoustic panels would restrict access to the shaft from the surface which is necessary for spoil load-out during construction within the approved construction hours. Large louvred attenuation steel panels would

attenuate noise but they have to be designed to provide sufficient ventilation requirements whilst working in the excavated box. The panels would need to be robust enough to be lifted in place before and removed when spoil needs to be shifted, and a sizeable crane will therefore be required on a fulltime basis. In addition:

  - panels would potentially slow the progress onsite as different construction methodologies would need to be implemented causing a need to work out of approved hours to meet program
  - panels would enclose the excavation and therefore increase the levels of silica present requiring additional ventilation set ups and more onsite water use to control the dust
  - ventilation would need to be added to minimise the impact of the panels which requires additional energy consumption
  - panels would block out the sun and cause the need to use additional lighting, which requires additional energy consumption. This would increase the project's environmental impact.

- installation of acoustic hoarding: the DNVIS for Sydney Olympic Park states that "*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. Moveable hoarding of 2.4 metres in height is proposed for the site but has not been included in the noise model for the assessment of impacts since its configuration and application is not known at this time.*" Whilst hoarding around the construction site may not be required to mitigate noise impact given the distance of nearby sensitive receivers, hoarding would provide a visual screen between receivers and the construction site. Also, as the excavation becomes deeper the predicted noise levels decrease at nearby receivers. Construction of hoarding around this height provides visual benefits; easy procurement of available materials and resources, and simplicity of design; as opposed to more substantial higher hoarding of up to 6 metres, which requires the drilling of posts for additional structural support, more resources, however negligible additional noise benefits given the depth of the excavation and location of receivers. The hoarding structure proposed in the DNVIS and installed at the site is considered feasible from a design perspective, with a style are similar to other hoarding on other Sydney Metro West Project sites such as North Strathfield.

Burwood North

Northern construction site

An acoustic shed has been constructed at the western side of the Burwood North northern construction site where tunnelling of the crossover cavern, tunnel support activities and spoil management are required to occur outside approved construction hours in line with the conditions of approval. This was considered an appropriate control in consideration of the construction program and additional activities to be undertaken (such as tunnelling of the crossover cavern to the west), and therefore extended periods of out of hours works are required. During the crossover cavern excavation, noise from the tunnel portal, the scrubber/ventilation fan and spoil haulage and kibble loading would be the only sources of noise from site. Other surface activities within the acoustic shed would include the gantry crane stockpiling the spoil, spoil haulage trucks removing the spoil and deliveries of concrete and other materials.

Installation of acoustic panels over the eastern side of the station box excavation is no longer considered to be the feasible or reasonable mitigation as the excavation productivity rate required to meet the construction program for the station box can be achieved through excavation during approved construction hours only, with out of hours work no longer required. Analysis of the alternate options of noise mitigation include:

- whilst tunnelling of the crossover cavern to the west can occur 24/7 in accordance with the conditions of approval, the DNVIS indicates that there are no predicted exceedances of the NML for the tunnelling within the mined cavern and tunnelling support inside the acoustic shed during day, evening and night

time periods (this has been modelled with the acoustic shed installed but without any additional acoustic panels). Therefore, installation of acoustic panels would not be required to mitigate out of hours noise impact associated with 24/7 tunnelling

- assessment of excavation depth of the station box allows a comparison of the attenuation that is provided from the sides of the excavation as the depth of the excavation increases. As the excavation becomes deeper the predicted noise levels decrease at nearby receivers. This is confirmed in the Burwood North DNVIS Rev 8 Addendum which compared excavation of material other than rock (OTR) at 0-3 metre depth without acoustic measures (i.e. an acoustic shed or acoustic panels), against excavating material at 12 metres where the excavation requires hammer attachments and dozer which are louder than required for OTR. This confirmed the additional depth of the excavation activities provides significant shielding which largely offsets the higher sound levels produced by excavator with hammers required at the deeper levels of excavation. The predicted noise range at the three closest and most affected receivers is the same for the excavation activities at 0-3 metre and 12 metre depth without a shed or acoustic roof, and no additional receivers are predicted to be impacted. This assessment did not include attenuation provided by the acoustic shed over the main shaft excavation, which was completed in April 2023, which further reduces noise impact at the western receivers
- installation of acoustic panels: works in the station box would have had to be put on hold due to required safety exclusion zones during the installation of the acoustic panels, and this would result in a program risk. Acoustic panels also present constructability and safety constraints. Large louvred attenuation steel panels would attenuate noise but they have to be designed to provide sufficient ventilation requirements whilst working in the excavated box. The panels would need to be robust enough to be lifted in place before and removed when spoil needs to be shifted, and a sizeable crane will therefore be required on a fulltime basis. In addition:
    - panels would potentially slow the progress onsite as different construction methodologies would need to be implemented causing a need to work out of approved hours to meet program
    - panels would enclose the excavation and therefore increase the levels of silica present requiring additional ventilation set ups and more onsite water use to control the dust
    - ventilation would need to be added to minimise the impact of the panels which requires additional energy consumption
    - panels would block out the sun and cause the need to use additional lighting, which requires additional energy consumption. This would increase the projects environmental impact.
- installation of acoustic hoarding: the DNVIS for Burwood North states that various forms of hoarding are proposed, with a mix of 2.4 metre high hoarding and retention of existing building facades at the site boundary. Construction of the hoarding of this height provides visual benefits; easy procurement of available materials and resources, and simplicity of design; as opposed to more substantial higher hoarding of up to 6 metres, which requires the drilling of posts for additional structural support, more resources, however negligible additional noise benefits given the depth of the excavation and location of receivers. The hoarding structure proposed in the DNVIS is considered feasible from a design perspective, with a style are similar to other hoarding on other Sydney Metro West Project sites such as North Strathfield.

Hoarding at the northern construction site (around the eastern part of the station box where there is no acoustic shed) is considered the most feasible and reasonable acoustic measure. In summary, the combination of the acoustic shed to support 24/7 tunnel works and the hoarding proposed around the remainder of the station box is considered the most feasible and reasonable mitigation measure due to reduced noise benefits of higher hoarding as the excavation deepens, timeliness of installation, the feasibility of design, simplified construction method and minimal visual impact (noting vehicle access points would be required for site entry and egress).

Southern construction site

At the southern construction site required for the excavation of the southern station entry, the need for shaft excavations and surface works would now be limited to approved construction hours only and 24/7 excavation is no longer required. Therefore, reassessment of the need for an acoustic shed as the feasible and reasonable mitigation to manage day time noise impacts is justified. It is acknowledged that an acoustic shed may have benefits for managing noise during standard construction hours, however these impacts can be managed through feasible and reasonable mitigation measures as required by condition of approval D39. Analysis of the alternate options of noise mitigation include:

- installation of an acoustic shed: installation of an acoustic shed at the southern construction site would extend the overall duration of surface construction works. Noisy work associated with the installation of acoustic sheds includes out of hours deliveries and the use of rattle guns to fasten the steel structure. This would be required for a period of around 4-6 months based on the installation of other acoustic sheds along the Sydney Metro West alignment and would require a large amount of resources. Installation of an acoustic shed at the southern site would also have constructability constraints given the size of the construction site and limited access, which may require out of hours work and road closures for installation. The construction and demobilisation of the shed would involve cranes lifting steel components and personnel working from elevated work platforms with pneumatic rattle guns to tension the fasteners between structural members. These activities would occur in close proximity of residential receivers and would potentially require road and footpath closures for safety of the public. Installation of the shed would be for a limited period of time because it is a temporary works item and would need to be removed by the end of 2024. The shed would not be handed over to the station contractor because it interferes with the station construction scope. Any benefits of the completed acoustic shed would therefore be short-medium term.
- installation of acoustic panels: acoustic panels present constructability and safety constraints. Acoustic panels are not feasible or reasonable because the structure would restrict access to the shaft from the surface which is necessary for spoil load-out during construction within the approved construction hours. Refer to justification above regarding use of acoustic panels and potential worker safety and environmental impact
- installation of acoustic hoarding: the DNVIS for Burwood North states that various forms of hoarding are proposed, with a mix of 2.4 metre high hoarding and retention of existing building facades at the site boundary. Construction of the hoarding of this height provides some visual screening ground level; easy procurement of available materials and resources, and simplicity of design; as opposed to more substantial higher hoarding of up to 6 metres, which requires the drilling of posts for additional structural support, more resources, however negligible additional noise benefits given the depth of the excavation and location of receivers. The hoarding structure proposed in the DNVIS is considered feasible from a design perspective, with a style similar to other hoarding on other Sydney Metro West Project sites such as North Strathfield
- tunnelling of the pedestrian adit has been undertaken from the northern construction site during approved construction hours. The breakthrough into the completed pedestrian adit at the southern site will occur using excavators from the southern shaft, during approved construction hours only, as specified in the DNVIS. Out of hours tunnelling for this activity is not required or assessed under the DNVIS.

Implications of installing an acoustic shed at Sydney Olympic Park and the southern construction site at Burwood North

Installation and removal of an acoustic shed could increase surface works construction. On-site duration of shed construction could be around 4-6 months based on experiences at the other Sydney Metro West construction sites, given the difficulties encountered with installing the large sections of panelling, which are highly

sensitive to wind events. During this period, excavations would not be able to occur. Demobilisation of the shed after shaft excavation would take approximately 2 months, and this would have to occur prior to the handover of the sites to the station contractors.

The construction and demobilisation of the shed would involve cranes lifting steel components and personnel working from elevated work platforms with pneumatic rattle guns to tension the fasteners between structural members. These activities will occur in close proximity of receivers at Burwood North and Sydney Olympic Park, and the pedestrian footpaths may require closures for safety of the public.

Installation and demobilisation of an acoustic shed would require significant heavy vehicle movements for delivering and removing materials. Deliveries of shed materials and elements of shed construction may need to be undertaken at night, considering road closures for cranage and oversized deliveries being only permitted outside approved construction hours.

The indicative noise and vibration impacts associated with shed construction and demobilisation have been predicted and modelled using a project-specific noise prediction tool, KNOWnoise, which indicates that installation and removal of an acoustic shed could result in a sound power level of up to 86dBA (refer to Consistency Assessment AFJV20 – Five Dock Western Construction Site Noise Mitigation (Sydney Metro, 2023)) which is around 38dB above the background noise level. .

Installation of the shed would be for a limited period of time because it is a temporary works item. The Sydney Olympic Park sheds would have been required to be partially removed in 2023 with full removal by the end of 2024, and the Burwood North southern shed by the end of 2024, to hand over the sites to the stations contractors.

Overview of justification

In summary, given 24/7 excavation of the station boxes and shaft is no longer required at Sydney Olympic Park and Burwood North:

- acoustic sheds and acoustic panels (or other acoustic measures) over the station box at the Sydney Olympic Park construction site are no longer proposed
- an acoustic shed (or other acoustic measures) over the shaft at the southern construction site at Burwood North is no longer proposed
- acoustic panels (or other acoustic measures) over the eastern portion of the station box at the Burwood North construction site is no longer proposed (noting the existing acoustic shed would remain over the western portion of the station box where 24/7 tunnelling support is required).

An assessment of alternate noise mitigation options to reduce daytime noise impacts has been undertaken, considering acoustic mitigation, duration of acoustic mitigation associated with an increasing excavation depth, and constructability. Hoarding is considered the most feasible and reasonable mitigation for these sites to manage noise impacts, and DNVIS have been prepared for each site to justify the feasible and reasonable mitigation in accordance with the conditions of approval and the Sydney Metro Construction Noise and Vibration Standard. In addition, the installation of acoustic sheds would result in additional noise and vibration impacts including an approximate six months of surface works required at each site with disruptions to the local community associated with footpath and road closures, and out of hours work required to install the large structure. Installation of acoustic panels may result in a program risk as different construction methodologies would need to be implemented causing a need to work out of approved hours to meet program. Acoustic panels may also have additional worker safety and environmental impact associated with ventilation and energy consumption.

No additional visual or air quality impacts are anticipated as a result of the proposed change and any impacts can be managed through standard mitigation for the Approved Project.

7. Environmental Benefit

Elimination of out of hours excavation work will benefit the local community by reduced noise, vibration, construction vehicles and light spill impact at night and on Sundays.

Not constructing the acoustic sheds and acoustic panels results in less resource consumption and waste being generated during construction and demobilisation. This will also reduce truck movements associated with shed construction and demobilisation.

8. Control Measures

Will a project and site specific EMP be prepared?	☐ Yes ☒ No	Are appropriate control measures already identified in an existing EMP?	☒ Yes ☐ No

9. Conditions of approval

Will the proposal be consistent with the conditions of approval?	☒ Yes ☐ No

The most relevant conditions of approval to this proposed change are provided in the following table. No changes to the conditions of approval are required as a result of the proposed change.

Ref. no.	Condition description
D35	Work must only be undertaken during the following hours: (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; (b) 8:00am to 6:00pm Saturdays; and (c) at no time on Sundays or public holidays.
D36	Except as permitted by an EPL, highly noise intensive work that results in an exceedance of the applicable NML at the same receiver must only be undertaken: (a) between the hours of 8:00 am to 6:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) if continuously, then not exceeding three (3) hours, with a minimum cessation of work of not less than one (1) hour. For the purposes of this condition, 'continuously' includes any period during which there is less than one (1) hour between ceasing and recommencing any of the work.
D37	Notwithstanding Conditions D35 and D36 of this schedule work may be undertaken outside the hours specified in the following circumstances: (a) Safety and Emergencies, including: (i) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or (ii) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm. On becoming aware of the need for emergency work in accordance with (a)(ii) above, the AA, the ER, the Planning Secretary and the EPA must be notified of the reasons for such work. The Proponent must use best endeavours to notify as soon as practicable all noise and/or vibration affected sensitive land user(s) of the likely impact and duration of those work. (b) Low Noise Impact Work, 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). (c) By Approval, including: (i) where different construction hours are permitted or required under an EPL in force in respect of the CSSI; or (ii) works which are not subject to an EPL that are approved under an Out-of-Hours Work Protocol as required by Condition D38 of this schedule; or (iii) negotiated agreements with directly affected residents and sensitive land user(s). (d) By Prescribed Activity, including: (i) tunnelling (excluding cut and cover tunnelling and surface works) are permitted 24 hours a day, seven days a week; or (ii) concrete batching at the Clyde construction site 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, except between the hours 10:00 pm and 7:00 am to / from the Five Dock and Westmead construction sites and to / from Burwood North construction site using any roads / streets other than directly from Parramatta Road; or (iv) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from the Five Dock and Westmead construction sites and to / from Burwood North construction site using any roads / streets other than directly from Parramatta Road; or (v) work within an acoustic shed where there is no exceedance of noise levels under Low Noise Impact Work, circumstances identified in (b) above, unless otherwise agreed by the Planning Secretary. Note: Tunnelling does not include station box excavation.
D39	All reasonable and feasible mitigation measures must be implemented with the aim of achieving the following construction noise management levels and vibration criteria: (a) construction 'Noise affected' noise management levels established using the Interim Construction Noise Guideline (DECC, 2009); (b) vibration criteria established using the Assessing vibration: a technical guideline (DEC, 2006) (for human exposure); (c) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives" (for human exposure); (d) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions"; and (e) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration- effects of vibration on structures (for structural damage for structurally unsound heritage items). Any work identified as exceeding the noise management levels and / or vibration criteria must be managed in accordance with the Noise and Vibration CEMP Sub-plan. Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5 dB(A) to the predicted level before comparing to the construction Noise Management Level.

10. Impact Assessment – Construction

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Flora and fauna	No change from Approved Project	No additional measures	Y	Y	
Water	No change from Approved Project. Surface water runoff will be managed as per the erosion and sediment control plans prepared for the construction sites.	No additional measures	Y	Y	
Soils and contamination	No change from Approved Project	No additional measures	Y	Y	
Air quality	Unmitigated dust impacts for Sydney Olympic Park were assessed in Table 23-7 of EIS Chapter 23 Air Quality. The EIS determined that the mixed-use nature of Sydney Olympic Park and large extent of excavation would result in a 'medium risk' rating (unmitigated) during earthworks activities. Due to the distance of the construction site to sensitive ecological receivers, potential ecological impacts are negligible. Unmitigated dust impacts for Burwood North were assessed in Table 23-7 of EIS Chapter 23 Air Quality. The EIS determined that the large extent of excavation and earthworks combined with the close proximity of sensitive receivers results in Burwood North Station construction site being assessed as having a 'high risk' rating (unmitigated) for earthworks activities. There are no nearby ecologically sensitive areas and	Dust impacts will be managed as per the Air Quality Management Plan including dust suppression such as sprinklers. No additional measures are required.	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	therefore potential ecological impacts are negligible. The EIS assessed that potential dust impact would be temporary in nature and would be substantially reduced with the implementation of standard mitigation measures identified in Section 23.7 of the EIS, which would be implemented for the duration of works. Omission of the acoustic shed is not expected to change the nature and extent of air quality impact as assessed in the EIS when air quality mitigation measures are implemented. Potential additional dust impacts will be effectively managed through mitigation measures outlined in the EIS and Air Quality Management Plan. These measures are currently being implemented, for example, a water sprinkler/spray system used during excavations to suppress dust.				
Noise and vibration	**Sydney Olympic Park** **Sensitive receivers** 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. The closest receivers are commercial operations at 6 Herb Elliott Drive, 10 Herb Elliott Drive, and 3 Figtree Drive. The buildings at 6 Herb Elliott Drive and 3 Figtree Drive have limited window area facing the site which minimises noise transmission, however at 10 Herb Elliott Drive the	**Sydney Olympic Park** A DNVIS for Sydney Olympic Park has been prepared to assess the noise and vibration impacts using the preferred feasible and reasonable noise mitigation for the proposed change. The DNVIS is subject to endorsement by the Acoustics Advisor, and includes: • elimination of general out of hours work for station box excavations and spoil management at the Sydney	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	upper floors are fully glazed, which will limit the amount of noise reduction across the facade. The Pullman and Ibis hotels located within 65 -100 metres of the station box excavation have some shielding from direct impacts depending on the location of the work but are likely to experience high noise levels. Residential receivers are generally located further from the site, reducing the direct noise impacts from daily activities. **Detailed noise and vibration impact statement** A DNVIS has been prepared for Sydney Olympic Park as required by condition of approval D43 (Hutchison Weller, August 2023). The DNVIS is prepared in accordance with Sydney Metro Construction Noise and Vibration Standard (CNVS) and the Noise and Vibration Management Plan (NVMP), and is subject to endorsement by the Acoustics Advisor. The DNVIS includes an assessment of the proposed activities at Sydney Olympic Park without acoustic sheds or other acoustic measures installed over the station box excavation. **Excavations during approved construction hours** During the site establishment and initial excavation phases, the work undertaken at Sydney Olympic Park was consistent with EIS and was only undertaken during approved construction hours. As discussed in Section 2 - Description, given the production rate of excavation has been greater than that predicted during the preparation of the	Olympic Park construction site • residential grade mufflers are to be fitted to all mobile plant, with equipment maintained and operated effectively • 'damped' rock hammers would be used which have reductions of around 10 dB in comparison to similar sized 'un-damped' rock hammers • plant would be placed behind larger objects or as far from receivers as possible • hoarding of around 2.4 metres in height has been installed • avoidance of high noise impact works when reasonably practicable, with respite provided as per condition of approval D36 • community notifications and engagement including community information sessions and individual meetings with			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	EIS, there has been an opportunity to eliminate the requirement for general out of hours station box excavation whilst still meeting the program. Excavating the station box during approved construction hours will eliminate impact from this activity during the evening and night periods. As no regular out of hours excavation works are proposed, acoustic sheds or panels are no longer identified as a feasible and reasonable mitigation measure. Feasible and reasonable mitigation measures will be implemented for excavations during approved construction hours (refer to Section 6 and the proposed control measures). This DNVIS contains a more refined assessment of the predicted noise and vibration levels when compared to the more conservative assumptions in the EIS and Amendment Report (refer to DNVIS in Appendix A for the assessment). The Amendment Report for the Approved Project predicted the following daytime noise impacts for use of rockbreaker which was considered the worst-case noise impact scenario (Technical Paper 2 Table 73). The DNVIS assessed the daytime noise impacts without an acoustic shed but with alternate feasible and reasonable mitigation during approved construction hours. An assessment of the worst-case noise impacts during the daytime has been completed, comparing the predicted impacts from the DNVIS to the Amendment Report from the Approved Project. **Highly noise affected receivers:** the Amendment Report for the Approved Project predicted that no	owners/tenants of neighbouring properties • verification of the noise model by undertaking noise monitoring. If noise monitoring is higher than predicted, then the works will be reviewed and additional feasible and reasonable measures will be implemented. **Burwood North** A DNVIS for Burwood North has been prepared to assess the noise and vibration impacts using the preferred feasible and reasonable noise mitigation for the proposed change. The DNVIS is subject to endorsement by the Acoustics Advisor, and includes: • the existing acoustic shed (approximately 20 metres in height) would remain over the western portion of the station box where 24/7 tunnelling and spoil management is required • elimination of general out of hours work for excavation of the eastern side of the station box and associated spoil management			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	residential receivers would be highly noise affected (>75 dB(A)) during excavation, and this is consistent with the results of the DNVIS. The DNVIS however indicates that during the noisiest excavation work, up to 5 commercial receivers may experience levels of more than 75 dB(A) at various times with noise impacts reducing as the depth of activity, and therefore the available shielding, increases. **Exceedances of the noise management level (NMLs):** As identified in the DNVIS, approximately 25 receivers would experience an exceedance of the NML by 1-10dB and 2 receivers would experience an exceedance of the NML by 10-20dB during the noisiest excavation work (rippable materials at 6-19 metres without acoustic sheds or panels). This impact would reduce as the excavation deepens. In comparison, the Amendment Report for the Approved Project predicted: • approximately 21 receivers would experience an exceedance of the NML by 1-10dB, 6 receivers would experience an exceedance of the NML by 10-20dB, and 2 receivers would experience an exceedance of the NML by >20dB during initial excavations using a rockbreaker (without acoustics shed in place) • approximately 6 receivers would experience an exceedance of the daytime NML by 1-10dB during main excavations using a rockbreaker which was modelled with acoustic sheds in place. During out of hours work this could impact up to 8 receivers with acoustic sheds in	• elimination of general out of hours work for the excavation and associated spoil management of the southern shaft • tunnelling of the pedestrian adit will occur using excavators during approved construction hours only, as specified in the DNVIS • various forms of hoarding being installed, with a mix of 2.4 metre high hoarding and retention of existing building facades at the site boundary • rock hammers will be used where required when breaking up building slabs, with alternative methods proposed in “no hammer” zones. If using hammers is unavoidable, noise mats or suitable noise screens around the activity would be investigated where practicable. • avoidance of high noise impact works when reasonably practicable, with respite provided as per condition of approval D36			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	place (however this is no longer required as out of hours work is no longer proposed). The total number of impacted receivers is less than predicted in the Amendment Report for work without an acoustic shed, however, is greater than the scenario with acoustic sheds in place. Impacts associated with noisy excavation work would decrease as the excavations deepen, however may be experienced for a longer duration than anticipated in the Amendment Report for the Approved Project. In summary, the DNVIS assessment is generally consistent with predicted noise impacts for affected receivers associated with excavation works without acoustic sheds identified in the Amendment Report. The number of impacted receivers during excavations would decrease if the construction methodology was to progress with the installation of acoustic sheds and panels. With the omission of acoustic measures, sensitive receivers would be exposed to higher noise levels for a longer period of time, however, the installation and removal of a shed would prolong other surface work noise impacts by up to approximately 6 months as discussed in Section 6. Further, acoustic panels are not justified given potential construction program risk associated with changes to the construction methodology, potential worker safety risks and additional energy and resource consumption required. Given the extended duration of worst-case day time noise impacts, additional feasible and reasonable mitigation would be required to manage this	• community notifications and engagement including community information sessions and individual meetings with owners/tenants of neighbouring properties • verification of the noise model by undertaking noise monitoring. If noise monitoring is higher than predicted then the works will be reviewed and additional feasible and reasonable measures will be implemented.			

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	impact (refer Section 6). These activities represent worst case scenario and appropriate respite, as per condition of approval D36, will be implemented during these activities. **Burwood North** **Sensitive receivers** The main northern construction site is located north of Parramatta Road, near the intersection of Parramatta Road and Burwood Road. Adjacent land uses to this site, fronting Parramatta Road, are mostly commercial businesses with some mixed-use commercial/ residential buildings. North of the northern construction site, residential receivers are on Burton Street, with the nearest backing directly onto the boundary of the construction site. To the north of the site is also St Luke's Church, which is heritage listed. The southern construction site is located to the south of Parramatta Road, also bounded by Burwood Road and Esher Street and Esher Lane. This site has commercial premises located to the east and mixed commercial and residential 10 storey residences to the south. The heritage listed Bath Arms Hotel is located 20 metres west of the site. The acoustic environment in all areas is dominated by road traffic noise on the major transport corridors such as Parramatta Road and Burwood Road. **Detailed noise and vibration impact statement**				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	A DNVIS has been prepared for Burwood North as required by condition of approval D43 (Hutchison Weller, August 2023). The DNVIS is prepared in accordance with Sydney Metro CNVS and the Noise and Vibration Management Plan, and is subject to endorsement by the Acoustics Advisor. The DNVIS includes an assessment of the proposed activities at Burwood North with an acoustic shed over the western portion of the northern construction site. **Night work assessment in the EIS** The EIS for the Approved Project considered that excavation would be completed within acoustic sheds or below acoustic panels (or other acoustic measures) at sites where 24/7 excavation works are proposed, including at Burwood North. The EIS identified that at sites where no regular out of hours works were proposed and excavation works were proposed to be undertaken during the daytime only, acoustic sheds or panels were not identified as a feasible or reasonable mitigation measure. Table 67 of the EIS – Technical Paper 2 – Noise and Vibration shows that at Burwood North which was predicted to require 24/7 excavation of the station box and southern shaft, noise levels at night during excavation at both northern and southern construction sites with acoustic sheds installed were predicted to impact up to 171 receivers (between 1 to 20+ dBA above NML). Therefore, for the EIS scenario, acoustic sheds were considered appropriate mitigation measure to manage noise impacts of work outside standard				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	construction hours, however, noise impacts were still anticipated with an acoustic shed, particularly with the doors open. Condition of approval D37 has placed restrictions on excavation work within an acoustic shed and outside the approved construction hours to limit these to those that meet the low noise impact criteria or tunnelling work. The proposed change subject of this Consistency Assessment includes that excavation of the station box and shaft would no longer be required outside of approved construction hours. **Excavations during approved construction hours** During the site establishment and initial excavation phases, the work undertaken at Burwood North was consistent with EIS and was only undertaken during approved construction hours. As discussed in Section 2 - Description, given the production rate of excavation has been greater than that predicted during the preparation of the EIS, there has been an opportunity to eliminate the requirement for general out of hours station box excavation whilst still meeting the program. Excavating the station box during approved construction hours will eliminate impact from this activity during the evening and night periods. As no regular out of hours excavation works are proposed, acoustic panels are no longer identified as a feasible and reasonable mitigation measure at the northern construction site. Feasible and reasonable mitigation measures will be implemented for excavations during approved				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	construction hours (refer to Section 6 and the proposed control measures). This DNVIS contains a more refined assessment of the predicted noise and vibration levels when compared to the more conservative assumptions in the EIS (refer to DNVIS in Appendix B for the assessment). The EIS for the Approved Project predicted the daytime noise impacts for use of rockbreaker which was considered the worst-case noise impact scenario (Technical Paper 2 - Table 67). The DNVIS assessed the daytime noise impacts with an acoustic shed (with no acoustic panels) during approved construction hours for the northern site, and no acoustic shed for the southern site where work would be during approved construction hours only. An assessment of the worst-case noise impacts during the daytime has been completed, comparing the predicted impacts from the DNVIS to the EIS from the Approved Project. **Highly noise affected receivers:** the EIS predicted that around 24 receivers would be highly noise affected (>75 dB(A)) during excavation at both construction sites with no acoustic sheds. The DNVIS indicates that during the noisiest excavation work, at the northern construction site, up to 10 receivers at the northern site and 14 at the southern site may experience levels of more than 75 dB(A), with noise impacts reducing as the depth of activity, and therefore the available shielding, increases. The noise impacts would reduce with installation of an acoustic shed at the				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	southern site and acoustic panels at the northern construction site, however given out of hours work is not required, an acoustic shed at the southern site and acoustic panels at the northern site is not deemed to be feasible and reasonable noise mitigation. **Exceedances of the noise management level (NMLs):** As identified in the DNVIS, for the northern construction site, approximately 96 receivers would experience an exceedance of the NML by 1-10dB, 20 receivers would experience an exceedance of the NML by 10-20dB, and 13 receivers would experience an exceedance of the NML by >20dB during the noisiest excavation work (excavation other than rock). In the DNVIS for the excavation activities at the southern construction site, approximately 161 receivers would experience an exceedance of the NML by 1-10dB, 33 receivers would experience an exceedance of the NML by 10-20dB, and 12 receivers would experience an exceedance of the NML by >20dB during the noisiest excavation work (excavation rippable). In comparison, the EIS predicted the following for both the northern and southern construction sites combined: • approximately 487 receivers would experience an exceedance of the NML by 1-10dB, 65 receivers would experience an exceedance of the NML by 10-20dB, and 21 receivers would experience an exceedance of the NML by >20dB during initial excavations (without acoustic sheds in place)				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	• approximately 61 receivers would experience an exceedance of the NML by 1-10dB, 13 receivers would experience an exceedance of the NML by 10-20dB, and 2 receivers would experience an exceedance of the NML by >20dB during main excavations which was modelled with acoustic sheds in place. During out of hours work this could impact up to 171 receivers with acoustic sheds in place (however out of hours work is no longer required). The total number of impacted receivers is less than predicted in the EIS for initial excavation work modelled without acoustic sheds, however, is greater than the scenario with an acoustic shed in place at the northern and southern construction sites. An acoustic shed has been installed at the northern site to mitigate some of the noise impact from the western side of the station box. Impacts associated with noisy excavation work would decrease as the excavations deepen, however may be experienced for a longer duration than anticipated in the EIS for the Approved Project. In summary, the DNVIS assessment shows fewer predicted noise impacts for affected receivers associated with excavation works without acoustic sheds, compared to those identified in the EIS. The number of impacted receivers during excavations would decrease if the construction methodology was to progress with the installation of a shed at the southern site and acoustic panels at the northern construction site. With the omission of these additional acoustic measures, sensitive receivers would be exposed to higher				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	noise levels for a longer period of time, however, the installation and removal of a shed at the southern site would prolong other surface work noise impacts by up to approximately 6 months as discussed in Section 6. Further, acoustic panels are not justified given potential construction program risk associated with changes to the construction methodology, potential worker safety risks and additional energy and resource consumption required. Given the extended duration of worst-case day time noise impacts, additional feasible and reasonable mitigation would be required to manage this impact (refer Section 6). These activities represent worst case scenario and appropriate respite, as per condition of approval D36, will be implemented during these activities. **Tunnelling including crossover cavern excavation** This consistency assessment applies to: • tunnelling (including crossover cavern excavation) from the northern construction site • tunnelling from the northern construction site from within the acoustic shed to the southern construction site to create the mined pedestrian adit Out of hours tunnelling would be required to be undertaken from the within the acoustic shed for the crossover cavern excavation, and this has been assessed in the DNVIS. Tunnelling of the pedestrian adit will occur using excavators during				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	approved construction hours only, as specified in the DNVIS. The DNVIS has predicted that crossover cavern excavation is not predicted to result in any exceedance of the NML without acoustic panels in place (but with the acoustic shed in place) during approved construction hours as a result of the proposed change. Noise monitoring of the tunnelling and support activities would be completed to confirm compliance with the predicted noise levels for the revised scenario for tunnelling and support within the acoustic shed, without acoustic panels. **Summary** Overall, reducing the requirement for out of hours work for station box, shaft excavation, and excavation of the pedestrian adit would reduce noise and vibration impacts outside of approved construction hours. Whilst noise impacts during the day would be greater for a longer duration than if an acoustic shed or acoustic panels were in place, noise impacts can be managed with the implementation of feasible and reasonable mitigation. Not installing a shed also reduces additional surface construction work required which is anticipated could take up to six months. As a result of the proposed change, station box and shaft excavation, and pedestrian adit tunnelling would only be required to be undertaken during approved construction hours.				
Aboriginal heritage	No change from Approved Project	No additional measures	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Non-Aboriginal heritage	No change from Approved Project	No additional measures	Y	Y	
Community and socio-economic	Local stakeholders may be concerned about potential increased noise and dust impacts without acoustic sheds or acoustic panels in place. Refer to the noise and vibration and air quality aspects of this table for details and proposed mitigation. It should be noted there will be some benefits associated with the change of approach. These benefits include: • tunnel support works would be limited to within the existing acoustic shed at Burwood North • no excavation work for the station boxes or shafts (including the associated spoil management) after 6pm unless the work meets the low noise impact work criteria • reduced visual impacts without additional approximately 20 metre tall sheds installed • no construction impacts, including night works, associated with installation and removal of the shed which could extend surface works by approximately six months. The revised construction program, potential impacts and mitigation measures will be clearly communicated to local residents and businesses through written information and in person during briefings and information sessions. Potential impacts associated with noise and air quality will be addressed with feasible and reasonable mitigation measures as per the Noise	Ongoing community engagement would be undertaken in accordance with the Sydney Metro Overarching Community Communications Strategy, and site specific Community Communications Strategies to manage any potential impacts associated with the proposed change. No additional measures	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	and Vibration Management Plan and Air Quality Management Plan. Access to properties will not be altered. Overall, the impact to community and stakeholders is considered to be broadly consistent with that assessed in the EIS for the Approved Project.				
Traffic and transport	In accordance with condition of approval D85 for the Approved Project, Construction Traffic Management Plans (CTMP) have been prepared in accordance with the Sydney Metro Construction Traffic Management Framework (CTMF) to assess and manage impacts on the surrounding road network. Construction traffic volumes at both the Sydney Olympic Park and Burwood North construction sites are not expected to increase as a result of this proposal. In accordance with condition of approval D37 of the Approved Project, no delivery of materials or spoil haulage would be undertaken from the Burwood North construction sites using any roads / streets other than directly from Parramatta Road between the hours of 10pm and 7am, unless required for safety reasons. No change to the peak daily traffic movement volumes or the hourly movement volumes during the peak period would be required as a result of this proposed change. No change to the haul routes would be required as a result of the proposed change. Construction traffic will be managed as per the approved CTMPs.	No additional measures	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	No changes to light vehicle volumes are proposed. No additional impacts are anticipated for the active transport network or public transport services.				
Waste and resource management	The proposed change would result in less waste being generated by eliminating the construction and demobilisation of additional acoustic sheds and acoustic panels.	No additional measures	Y	Y	
Visual	Landscape character and visual amenity impacts were assessed in Chapter 15 of the EIS. The EIS states: *Where acoustic measures are proposed at construction sites, the assessment has assumed the presence of an acoustic shed to assess the likely worse case visual impact. However, other acoustic measures (of a similar or smaller scale) could be implemented instead of acoustic sheds.* **Sydney Olympic Park** Work at Sydney Olympic Park was assessed as having a negligible to moderate adverse impacts to landscape character and visual amenity. The EIS acknowledged that temporary construction vehicles and access points, as well as acoustic sheds (or other acoustic measures) and barriers in the construction area would substantially change the character of the area within the site, with up to moderate adverse impacts from some viewpoints. Given the viewpoints would still have some shielding from hoarding, without the bulk of acoustic sheds, the impacts are anticipated to be consistent with that of the Approved Project.	No additional measures	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
	Burwood North Work at Burwood North was assessed as having a minor to moderate adverse impacts to landscape character and visual amenity. The EIS acknowledged that acoustic sheds (about 15 metres high) (or other acoustic measures) and noise barriers and hoardings surrounding the construction site about three metres high would contribute to the key components that would be seen at the northern and southern construction site. As the acoustic shed has been installed at the northern construction site, no changes to the visual amenity impacts at this site are anticipated. At the southern construction site, with the omission of an acoustic shed, the impacts associated with temporary overshadowing of the existing medium density residential property located directly to the south of the construction site would not be experienced. Given the viewpoints would still have some shielding from hoarding, without the bulk of acoustic sheds, the impacts are anticipated to be consistent with that of the Approved Project. **Summary** Overall, the landscape character and visual impacts as a result of the proposed changes at Sydney Olympic Park and Burwood North are considered to be broadly consistent with that assessed in the EIS.				

Aspect	Nature and extent of impacts (negative and positive) during construction (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project CoA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Land use and property	No change from Approved Project	No additional measures	Y	Y	
Hazard and risk	No change from Approved Project	No additional measures	Y	Y	
Other	No change from Approved Project	No additional measures	Y	Y	

11. Impact Assessment – Operation

Stage 1 of the planning application for Sydney Metro West (subject of this Consistency Assessment) is for major civil construction work for Sydney Metro West between Westmead and The Bays. Measures to avoid or minimise impacts have been developed only for major civil construction work for Sydney Metro West between Westmead and The Bays – which involves construction only. Impacts applicable to the operational aspects of Sydney Metro West including operation stage environmental mitigation measures are subject to the Sydney Metro West - Rail infrastructure, stations, precincts and operations (Stage 3) planning approval. As the proposed change relates to a change in construction methodology only, operational impacts associated with the proposed change are not anticipated.

Aspect	Nature and extent of impacts (negative and positive) during operation (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Flora and fauna	No change from the Approved Project.	No additional measures	Y	Y	
Water	No change from the Approved Project.	No additional measures	Y	Y	
Soils and contamination	No change from the Approved Project.	No additional measures	Y	Y	
Air quality	No change from the Approved Project.	No additional measures	Y	Y	
Noise and vibration	No change from the Approved Project.	No additional measures	Y	Y	
Aboriginal heritage	No change from the Approved Project.	No additional measures	Y	Y	
Non-Aboriginal heritage	No change from the Approved Project.	No additional measures	Y	Y	
Community and socio-economic	No change from the Approved Project.	No additional measures	Y	Y	
Traffic and transport	No change from the Approved Project.	No additional measures	Y	Y	

Aspect	Nature and extent of impacts (negative and positive) during operation (if control measures implemented) of the proposed change, relative to the relevant impact in the Approved Project	Proposed Control Measures in addition to project COA and REMMs	Minimal Impact Y/N	Endorsed	
				Y/N	Comments
Waste and resource management	No change from the Approved Project.	No additional measures	Y	Y	
Visual and urban design	No change from the Approved Project.	No additional measures	Y	Y	
Land use and property	No change from the Approved Project.	No additional measures	Y	Y	
Hazard and risk	No change from the Approved Project.	No additional measures	Y	Y	
Other	No change from the Approved Project.	No additional measures	Y	Y	

12. Consistency with the Approved Project

Question	Consider the following:
Is the project (including the proposed changes) consistent with the conditions of approval?	Yes. The proposed works would be consistent with the conditions of approval.
Is the project (including the proposed changes) consistent with the objectives and functions of elements of the Approved Project?	Yes. The changes identified in this assessment are consistent with the objectives and functions of the elements of the Approved Project.
Are the environmental impacts of the proposed change consistent with the impacts of the Approved Project?	Yes. The proposed works would result in some minor changes to the impacts as assessed in the EIS and Amendment Report for the Approved Project, however, the level of impact would remain consistent. Potential impacts to receivers would be adequately addressed through the application of the mitigation measures provided in the EIS, Submissions Report and conditions of approval. The proposed change includes that no station box, shaft, or pedestrian adit excavation would be undertaken outside of approved construction hours at Sydney Olympic Park and Burwood North. As such, alternate feasible and reasonable mitigation to an acoustic shed (or acoustic panels) has been selected to mitigate the day time noise impacts.
Are there any new environmental impacts as a result of the proposed works/project changes?	The proposed works would not result in any new environmental impacts beyond those considered in the Approved Project. The proposed changes would be negligible or minor environmental impacts relative to the impact of the Approved Project. All impacts identified for the proposed change would be adequately mitigated through the application of the mitigation measures provided in the EIS, Submissions Report and conditions of approval.
Are the impacts of the proposed activity/works known and understood?	Yes. The impacts of the proposed works are understood and will be accounted for by implementing the control measures within the CEMP and sub-plans.
Are the impacts of the proposed activity/works able to be managed so as not to have an adverse impact?	Yes. The impacts of the proposed works can be managed so as to avoid an adverse impact. This includes routine monitoring and ongoing community engagement in accordance with the Sydney Metro Overarching Community Communications Strategy to manage any potential noise impacts.
Is the proposed change/s consistent with the approval (having regard to the above assessment)?	☒ Yes ☐ No

13. Other Environmental Approvals

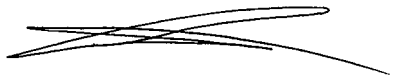
Identify all other approvals required for the proposed works:	Nil. No additional environmental approvals are required.

14. Recommendation

Based on the above impact assessment, and with reference to the Sydney Metro West – Concept and Stage 1 (major civil construction between Westmead and The Bays) Environmental Impact Statement, including the conditions of approval, it is recommended that:

	Tick relevant box
The proposed change has negligible or more than negligible impacts on the environment or community however is consistent with the Approval, including the conditions of approval. The proposed impacts are consistent with those assessed for the Approved Project (i.e., does not trigger a change to the conditions of approval).	✓
The proposed change is not consistent with the Approved Project including the conditions of approval and would be subject to a separate modification application.	
The proposed change is not substantially the same as the Approved Project and is considered a radical transformation. A new planning pathway should be considered.	

Author certification

I certify that to the best of my knowledge this Consistency Checklist: • Examines and takes into account the fullest extent possible all matters affecting or likely to affect the environment as a result of activities associated with the proposed change; and • Examines the consistency of the proposed change with the Approved Project; is accurate in all material respects and does not omit any material information.			
Name:	Jessie Strange	Signature:	
Title:	Manager Planning Approvals		
Company:	Sydney Metro	Date:	21 August 2023

Assessment Supporting Signature

Application supported and submitted by			
Name:	Yvette Buchli	Date:	22/08/2023
Title:	Director Planning Approvals	Comments:	
Signature:			

Assessment Endorsement

Based on the above assessment, are the impacts and scope of the proposed change consistent with the existing Approved Project?

Yes ☒ The proposed change is consistent with the Approved Project and no further assessment is required.

No ☐ The proposed change is not consistent with the Approved Project.

A modification or a new activity approval/ consent is required. Advise Senior Project Manager of appropriate alternative planning approvals pathway to be undertaken.

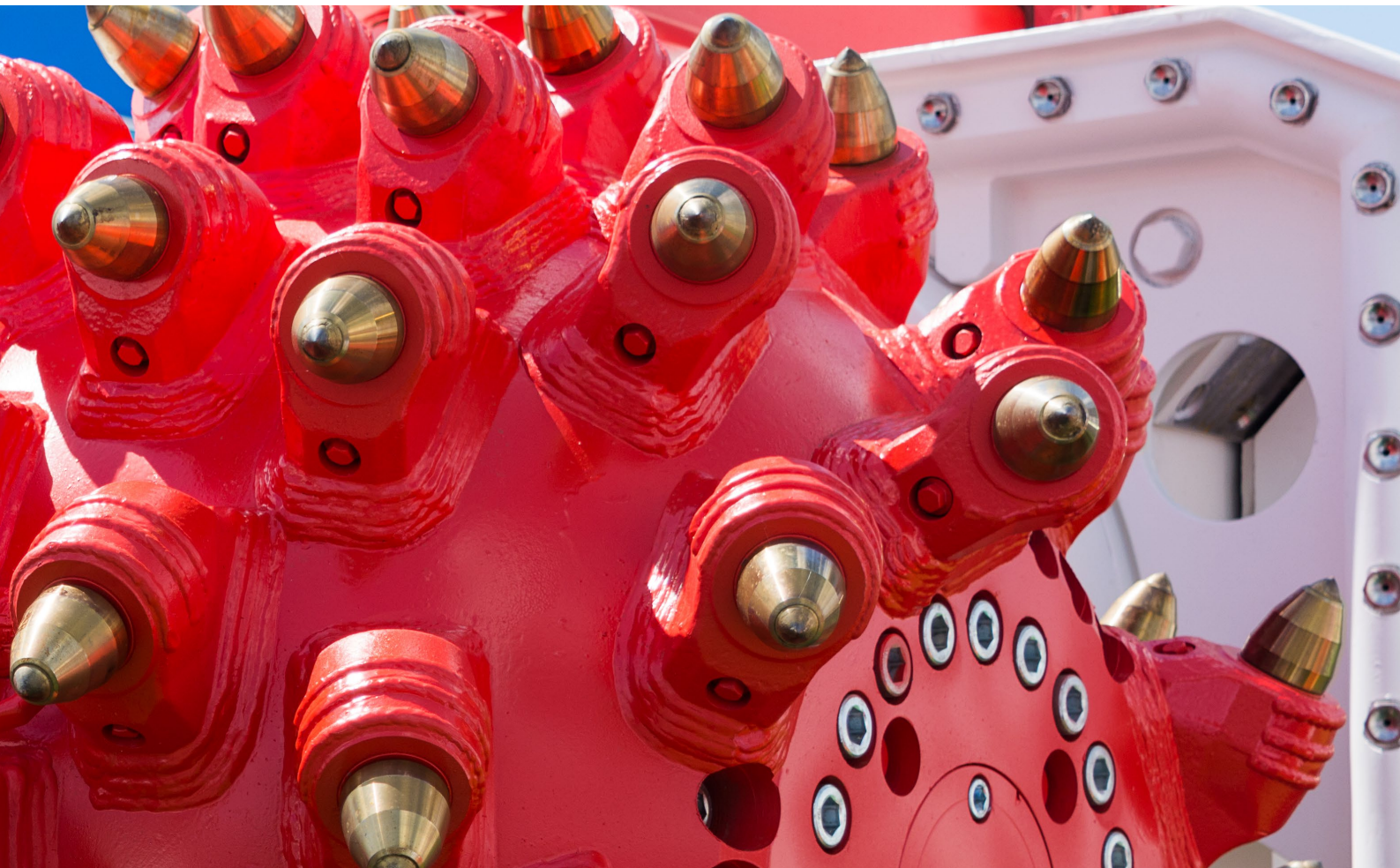
Endorsed by			
Name:	Ben Hodgson-Armstrong	Date:	22 August 2023
Title:	Director, Project Environment, Sustainability & Planning, West	Comments:	
Signature:			

hutchison weller

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

Detailed noise and vibration impact statement
August 2023

Doc no. 21028-NV-RP-6-8



Detailed noise and vibration impact statement

Client	Acciona Ferrovial Joint Venture
Project	Sydney Metro West Central Tunnelling Package
Document no.	21028-NV-RP-6-8
Revision	Rev 8
Date	14 August 2023
Author	John Hutchison
Reviewer	Scott Hughes
Doc Number	21028-NV-RP-6-8 SMW CTP SOP DNVIS.docx

Hutchison Weller Pty Ltd
ABN 37 001 024 095
Lvl 1, 357 Military Road Mosman NSW 2008

www.hutchisonweller.com

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

Contents

Definition of acoustic terms and acronyms ..... **v**

1. Introduction **1**

1.1 Project overview 1

1.2 Detailed noise and vibration impact statement 4

2. Construction works and hours **5**

2.1 Planned works 5

2.1.1 Approved construction hours 7

2.1.2 Variations to work hours 7

3. Existing environment **8**

3.1 Existing environment 8

3.2 Heritage items 8

3.3 Noise catchment areas 8

3.4 Background noise survey 9

4. Noise and vibration assessment criteria **10**

4.1 Overview 10

4.2 Noise 10

4.2.1 ICNG 10

4.2.2 Sleep disturbance 11

4.2.3 Ground-borne noise 11

4.2.4 Construction traffic 12

4.2.5 Additional mitigation measures 12

4.3 Project-specific construction noise management levels 13

4.4 Vibration management 14

4.4.1 Human comfort 14

4.4.2 Buildings 14

4.4.3 Heritage 14

4.4.4 Additional mitigation measures 15

5. Impact assessment **16**

5.1 Plant and equipment 16

5.2 Noise modelling 16

5.3 Mitigation measures included in the modelling 16

6. Predicted noise levels **18**

6.1.1 Overview 18

6.1.2 Phase 1 - Site establishment 18
6.1.3 Phase 2 – Station box construction 19
6.1.4 Sleep disturbance 19
6.2 Ground-borne noise 21
6.3 Vibration impact assessment 21
6.3.1 Assessment method and reference data 21
6.3.2 Risk of cosmetic damage 22
6.3.3 Human exposure 23
6.4 Construction traffic 24
7. Summary and recommendations 27
7.1.1 Impact summary 27
7.1.2 Standard mitigation 28
7.1.3 Additional mitigation measures 29
7.1.4 Monitoring 29
7.1.5 Consultation 30

Appendix A. Land use survey and NCA maps

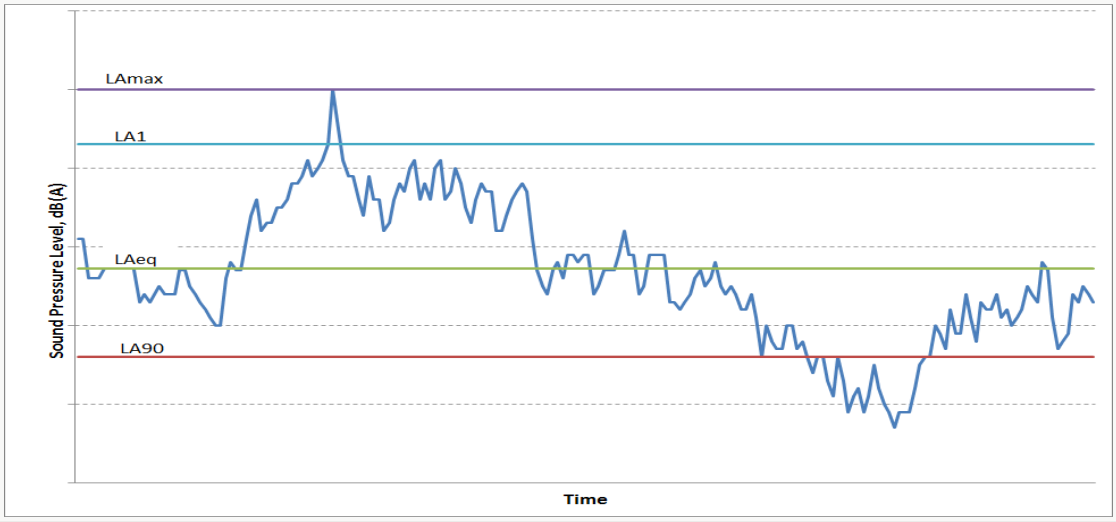
Appendix B. Proposed equipment and sound power levels

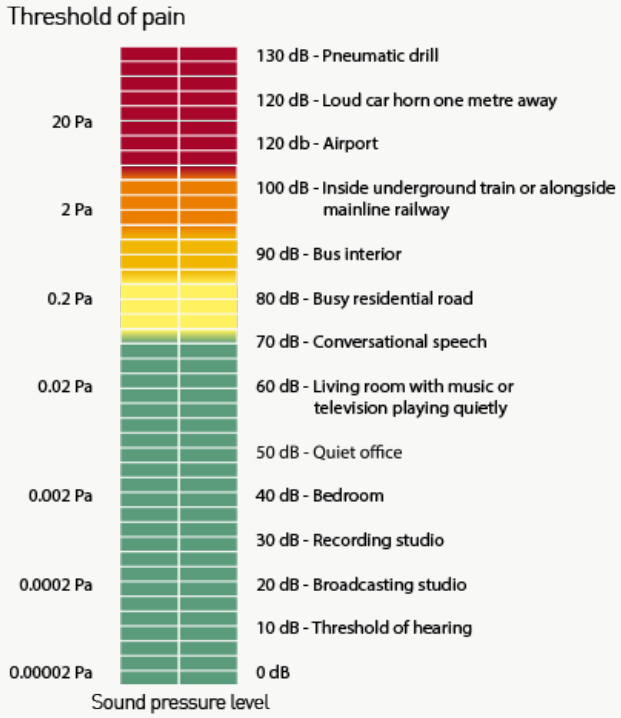
Appendix C. Construction noise and vibration contours

Appendix D. Detailed noise predictions for individual receivers

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
- Demobilisation

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

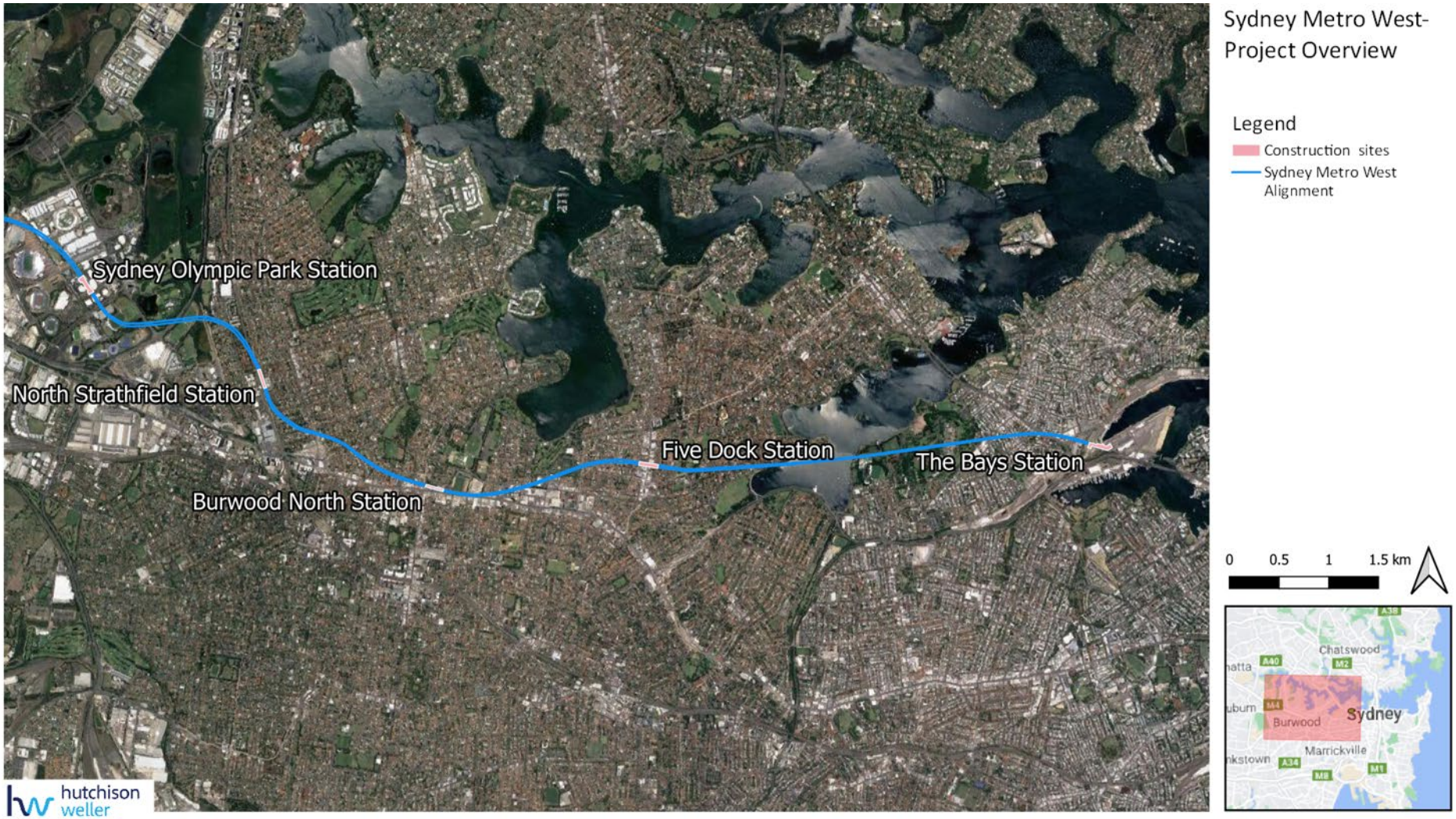


Figure 1-1 Overview of the CTP of Stage 1 of the Sydney Metro West Project.

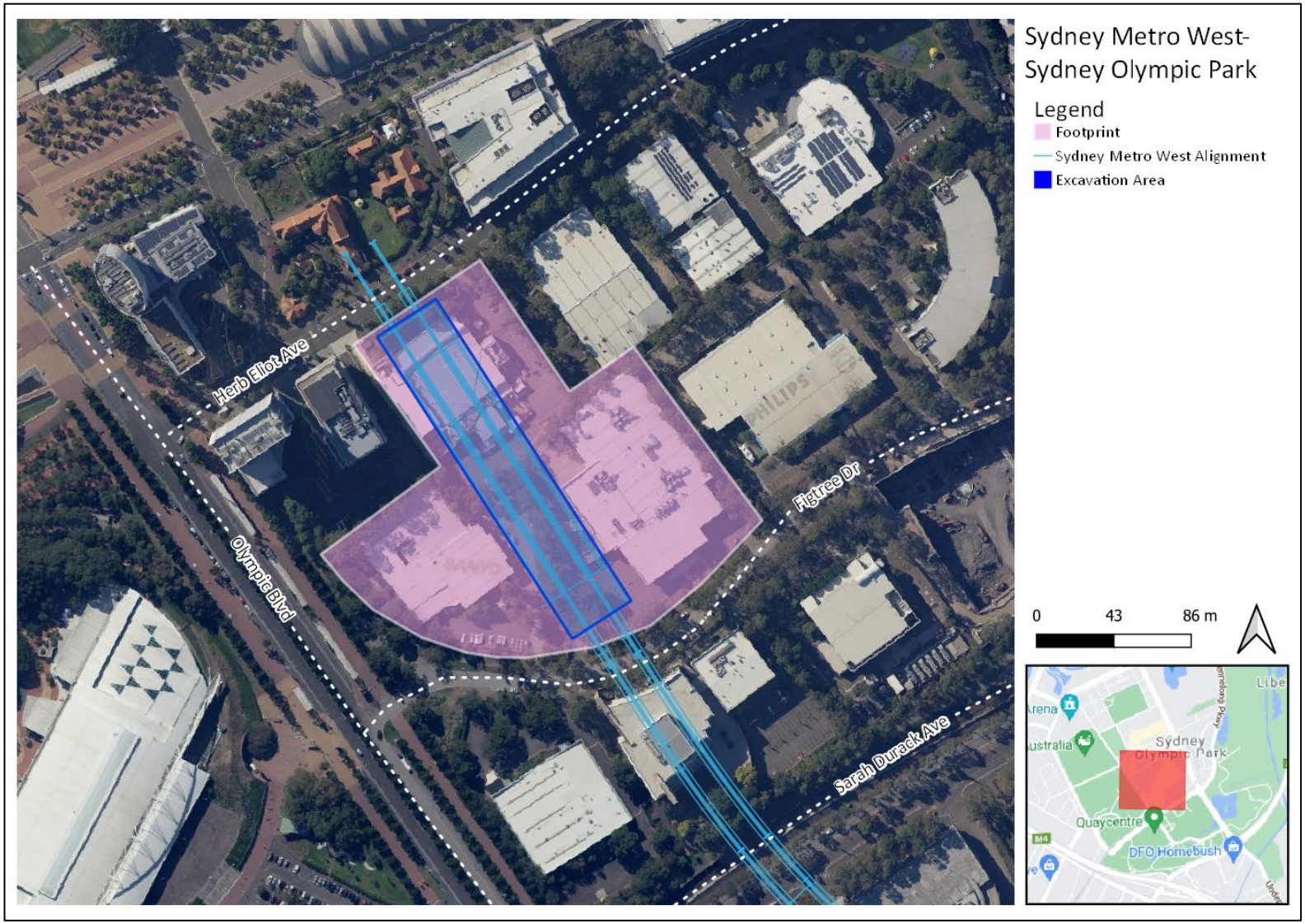


Figure 1-2 Sydney Olympic Park construction site

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 Planned works

Activities associated with construction of the Sydney Olympic Park station box are summarised in Table 2-1, which will be completed in three main phases for each site generally including establishment, excavation and tunnelling support.

Works commenced in November 2021 and will continue for around 3 years. The current program is illustrated in Table 2-2 and shows the duration of each phase. All construction works would occur during standard hours of operation.

Currently the site is excavated to around 20 metres below surface level with piling and ripping excavation completed. Nozzle excavation work at the northern end of the station box has commenced with loading out of spoil via a telescopic excavator during approved of operation.

The updated nozzle activity assessed for this DNVIS includes the addition of concrete pumping equipment at the surface of the site surface and the telescopic excavator.

This DNVIS addresses the activities and impacts from the construction work phases as detailed in Table 2-1 .

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

Construction phase	Activity			Outside approved hours?
1. Site Establishment	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	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	Tunnel Nozzle Concrete Lining		No
4. TBM Retrieval	4a	Retrieval		No

Table 2-2 Anticipated program for Sydney Olympic Park

	Sydney Olympic Park	2023							2024											
Phase	**Activity**	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Station Box	1. Site Establishment/Demob																			
	2. Station Box Excavation																			
	3. Mucking out & Tunnel Nozzles																			
	4. TBM Retrieval																			

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. 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.

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
M = monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
DR = Duration reduction
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 was provided in Table 2-1. Nominal equipment and estimated sound power levels of each item and activity are presented in Appendix B. No work is proposed outside the approved construction hours.

During site establishment, several activities were undertaken concurrently so cumulative impacts were assessed as part of this DNVIS.

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 B. 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 as standard practice throughout the works. 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 Table 13 of the CNVS.
    - 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.
  - Moveable hoarding of 2.4 metres in height is proposed for the site but has not been included in the noise model for the assessment of impacts since its configuration and application is not known at this time.

- Acoustic sheds
  - The Sydney Olympic Park site was assessed for 24 hour operations for the Environmental Impact Statement. AFJV have determined that works can be completed within the program time frame within standard constructions hours. As works are to be wholly undertaken during standard construction hours there is no acoustic shed proposed for the site.

6. Predicted noise levels

6.1.1 Overview

Construction work at Sydney Olympic Park is to be undertaken during standard operating hours for all activities. 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 D.

Noise contours for typical noisy 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.

6.1.2 Phase 1 - Site establishment

Site establishment was undertaken across the whole site with noisy activities such as demolition and utilities relocation occurring within about 10-15 metres of the nearest commercial receivers. During the initial demolition phase of the works, use of excavator mounted hammers was minimised in favour of demolition jaws and Erkat head. Rock hammers however, were used break up the foundation slabs during the final stages of the site clearing.

Site establishment was completed during standard hours with respite periods incorporated into the construction program. During the establishment works, exceedances in NML were predicted for some impact classes however, as the site is around three hectares in area, these higher noise levels are only apparent when the work is closest to the affected receiver locations.

The closest receivers are commercial operations at 6 Herb Elliot Drive, 10 Herb Elliot Drive, and 3 Figtree Drive which have a higher threshold for noise impacts than residential receivers. The buildings at 6 Herb Elliott Drive and 3 Figtree Drive have limited window area facing the site, which will minimise noise transmission into workspaces adjacent to the site.

At 10 Herb Elliot Drive the upper floors are fully glazed, which will limit the amount of noise reduction across the facade. These facades also overlook the northern half of the site and would not gain any benefit from local hoarding around the excavation area.

The Pullman and Ibis hotels have some shielding from direct impacts depending on the location of the work but are likely to experience high noise levels at various times during the establishment phase. Residential receivers are generally located further from the site, reducing the direct noise impacts from daily activities.

The highest impacts occur during demolition works using rock hammers where around 18 commercial receivers would experience noise levels >75 dB(A). The noise impact class for the 0-10 dB above daytime NML range would be exceeded for about 19 receiver locations and a further 8 receivers may experience exceedances of up to 20 dB above NML.

During the demolition phase, the Ibis and Pullman hotels would each experience noise levels of up to 68 and 70 dB(A) respectively on the most affected facades during some portions of the work. As the demolition proceeds, these levels would decrease due to distance and shielding from neighbouring buildings.

Highly noise intensive work is undertaken in accordance with COA D36 and are reflected in Table 7-1 detailing standard mitigation measures relating to construction hours.

A summary of maximum predicted noise levels at residential and non-residential land uses and predicted exceedances of the NMLs are presented in Table 6-1.

6.1.3 Phase 2 – Station box construction

At Sydney Olympic Park the initial station box construction activities are primarily surface works in the excavation zone shown in Figure 1-2. These works include the piling, pouring and breaking of capping beams and installation of active ground anchors. The highest impact during these works will be from the installation of active anchors with a maximum expected noise level of around 79 dB(A) at the closest commercial receiver. Residential receivers would experience a maximum noise level of around 60 dB(A). Where a non-percussive drill rig is used for this work, predicted noise impacts will be minimised and the maximum noise levels reduced accordingly.

The highest impacts for the station box construction are expected to occur during the rippable phase of the work at around 6 metres below ground level. Noise impacts during this times are higher due to the use of rock breakers and percussive drill rigs respectively.

The noise impacts from ripping and other noisy work are largely mitigated by the depth of the station box, which provides significant shielding for most nearby receivers. Being multi storey buildings, the closest receivers at 10 Herb Elliot Avenue and 6 Figtree Drive would experience the highest noise levels with the upper floors overlooking the works. The Pullman Hotel would also have a line of sight to sections of the work area during ripping of the station box, with this activity indicating the highest noise level for the hotel of around 74 dB(A) during the noisiest part of the excavation.

When ripping work commences at around 6 metres depth, 23 receiver locations are expected to exceed the NML in the 0-10 dB(A) range and about 2 receivers would exceed in the 10-20 dB(A) range. During ripping, up to 5 commercial receivers experiencing levels of more than 75 dB(A) at various times with noise impacts reducing across the board as the depth of activity, and therefore the available shielding, increases.

Once at the station box floor, excavation work continues to the tunnel nozzles located at the northern end of the site. Initially, equipment would be located within the station box where shielding form the station box walls would provide some noise reduction during the noisiest activities. As work progresses into the nozzles, this shielding will increase.

Noise impact during the nozzle excavation would be minimal due to the depth of the station box below the natural surface and the location of the bulk of the equipment inside the tunnel portal. Noise contours showing the extent of the predicted impacts are presented in Appendix C.

As there are no evening or night works planned for the Sydney Olympic Park station box site, noise impacts are managed in accordance with the project CNVMP that includes mitigation and management measures outlined in Section 7.1.2 of this report.

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

6.1.4 Sleep disturbance

There are no activities proposed outside approved hours and sleep disturbance has not been assessed in this DNVIS. Should work outside approved hours be proposed later, impacts will be assessed and managed in accordance with the Project's out-of-hours works protocol and CNVMP.

Table 6-1 Summary of predicted NML exceedances for Phase 1 – Site establishment

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+
1a	Daily activities	57	68	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
1b	Demolition (no hammer)	68	86	10	22	2	-	-	-	-	-	-	-	-	-	-	-	-	-
1c	Demolition (with hammer)	74	90	18	19	8	-	-	-	-	-	-	-	-	-	-	-	-	-
1d	Fencing & hoarding	59	80	2	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-
1e	Utilities Connections	63	81	4	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-
1ff	Hardstand/Concrete	62	80	4	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-2 Summary of predicted NML exceedances for Phase 2–Excavation 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+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+
2a	Piling	64	80	4	8	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2b	Capping Beams	60	77	1	7	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2c	Active Anchors	62	79	3	17	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2d	OTR 0m-6m	64	80	5	22	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2e	Rippable 6m-19m	68	84	13	25	2	0	-	-	-	-	-	-	-	-	-	-	-	-
2f	Retention 3m-20m	65	78	3	16	0	0	-	-	-	-	-	-	-	-	-	-	-	-
3a	Stockpile	63	73	0	9	0	0	-	-	-	-	-	-	-	-	-	-	-	-
3b	Nozzle Excavation	63	74	0	12	0	0	-	-	-	-	-	-	-	-	-	-	-	-
3c	Concrete Lining	52	65	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
4a	TBM Walkthrough	55	67	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-

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

- Rock Hammers
- Percussive drills
- Vibratory rollers

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
Percussive drilling	Airtrack drill or similar	1.5 mm/s at 10 m	Site measurement
Rock bolting	Jumbo bolter	0.4 mm/s at 2.5 m	Site measurement
Ripping	Dozer in Sydney Sandstone	0.15 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.

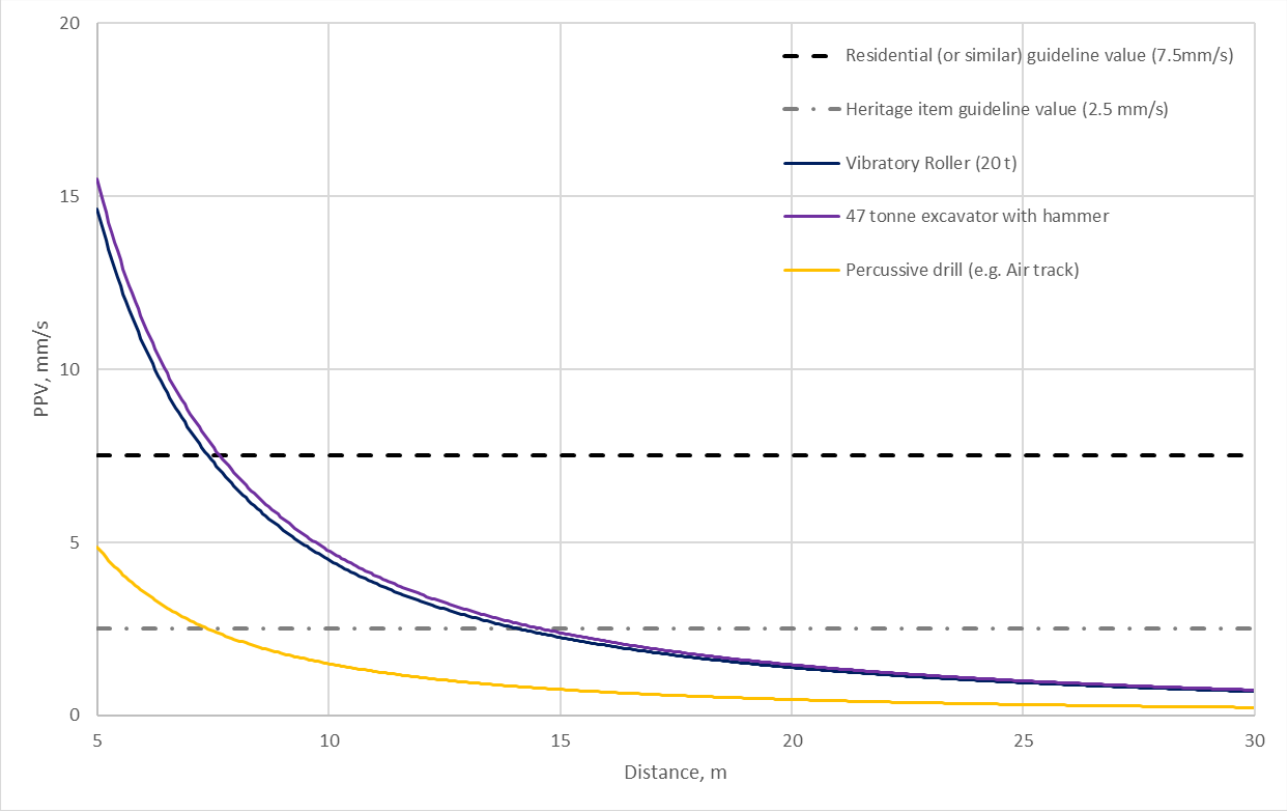


Figure 6-1 Curves of vibration with distance from the source

Contours representing the distance at which the vibration guideline values for each item are predicted to be achieved are presented in Appendix C. 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.

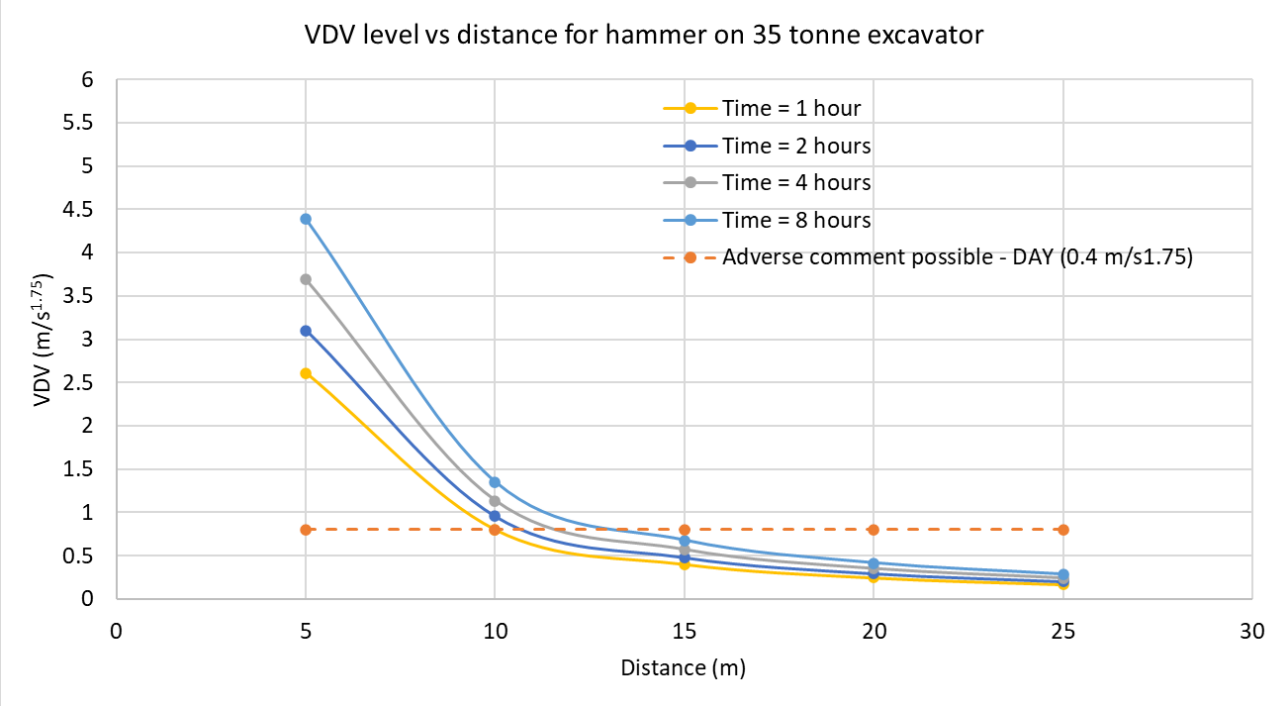


Figure 6-2 VDV curves for excavator and hammer

6.4 Construction traffic

Heavy vehicle movements related to Sydney Olympic Park construction activities will comprise of deliveries of materials and equipment as well as spoil haulage during excavation. 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.

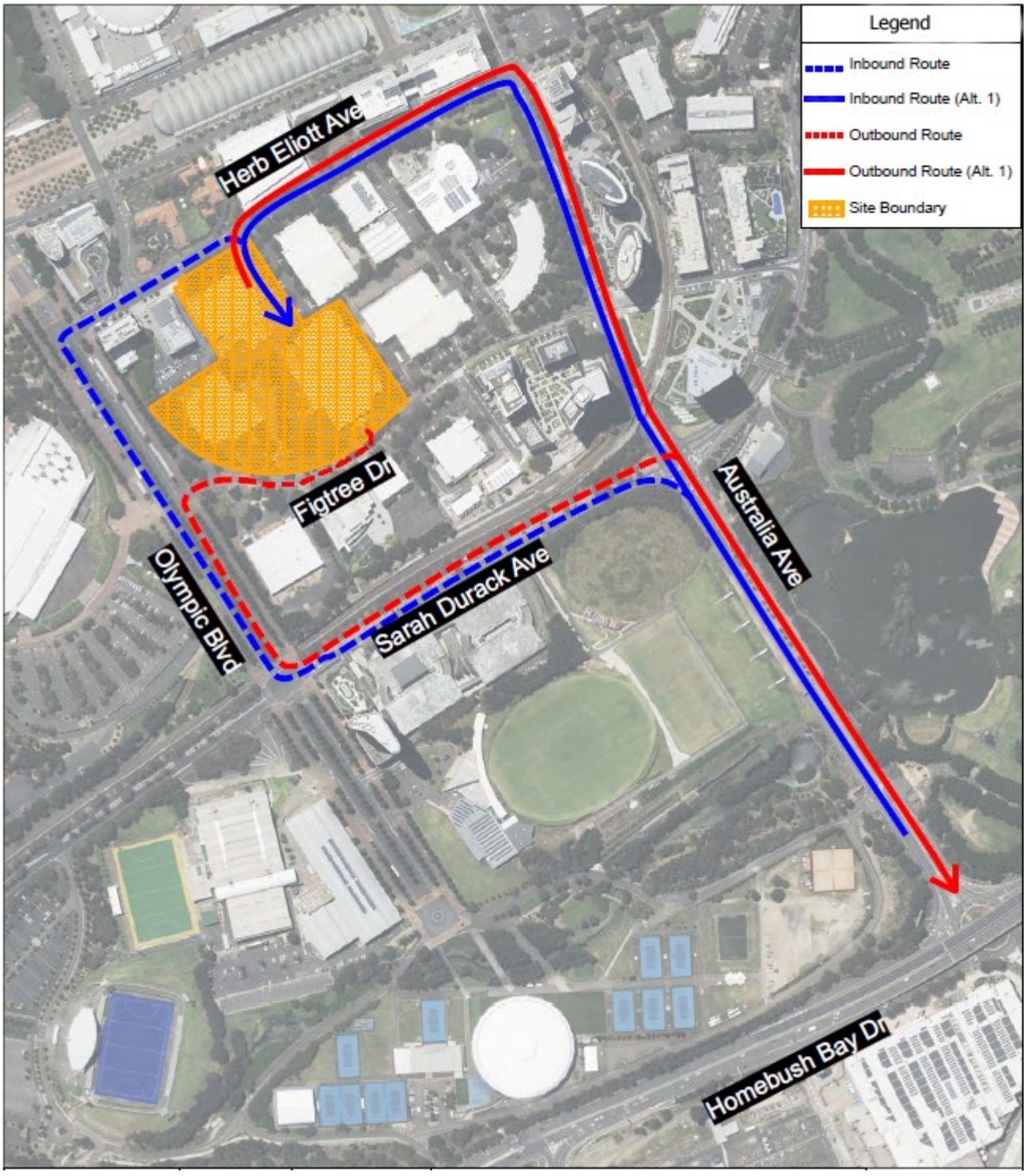


Figure 6-3 Sydney Olympic Park construction traffic movement

7. Summary and recommendations

7.1.1 Impact summary

This DNVIS has established that during some early construction activities, noise and vibration is likely to result in adverse impacts on the closest receiver locations. To provide a balanced assessment the DNVIS does not assume a worst-case scenario where all equipment is operational adjacent to the nearest receiver. Predicted noise levels can only represent a static case; however, in practice, noise levels will vary thorough the course of the project, often quieter than the levels represented for the assessment of impacts.

Predicted noise levels for this assessment identify likely equipment combinations from the overall equipment list, working near the most affected location for each receiver. This provides a typical '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 excavations, although being multi storey residential, the receivers 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 further from these hotels and will have some shielding benefit offered by the adjacent commercial buildings that will reduce the overall levels of the predicted noise impacts.

The works are programmed for daytime activities only and therefore, no impacts outside approved hours for residential receivers or the nearby hotels are predicted. Commercial buildings directly adjacent to the works will experience the greatest level of impact; however, the location of equipment will vary over the duration of the works as will the depth of excavation providing increased shielding as the project progresses.

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 will be required for works outside the scope of this DNVIS such as out of hours utility relocations and oversized plant deliveries undertaken where they comply with CoA D37 and EPL 21610, and this 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.

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

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 and out-of-hours protocol as appropriate, with the following monitoring to be completed as a minimum.

- Sound power level verification to ensure equipment meets the requirements of the CNVS
- Compliance monitoring at nearby sensitive receivers to verify predictions at various stages of construction.

- Ground-borne noise and vibration monitoring to verify predicted levels and maintain compliance with objectives.
- Vibration monitoring at heritage items while any vibratory work is underway within safe working distances.
- To meet the requirements of CoA D63, fixed monitoring locations have been identified for this site and are detailed in the CNVMP. Long-term noise and vibration monitoring data at these locations will be readily available as required in the CNVMP and Monitoring Program.

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.

All mitigation measures developed as part of this DNVIS have been formed around community needs and concerns established through the community consultation process, as required by CoA D43.

AFJV place manager has been on site since November 2021. Various communication materials and face to face meetings have resulted in the identification of several stakeholders that require individual consultation on upcoming activities to manage their operations, such as the General Managers of Pullman, Novotel and Ibis Hotels have requested early dialogue regarding any out of hours work to enable staff to manage customer expectations.

The adjacent NSW Institute of Sport has not raised any concerns around noise or vibration impacts. This building is a commercial-style facility, with fixed windows, so would be less susceptible to impacts than a traditional educational receiver. Buildings either side of the NSWIS site have been engaged with and have no issues or concerns regarding the project to date.

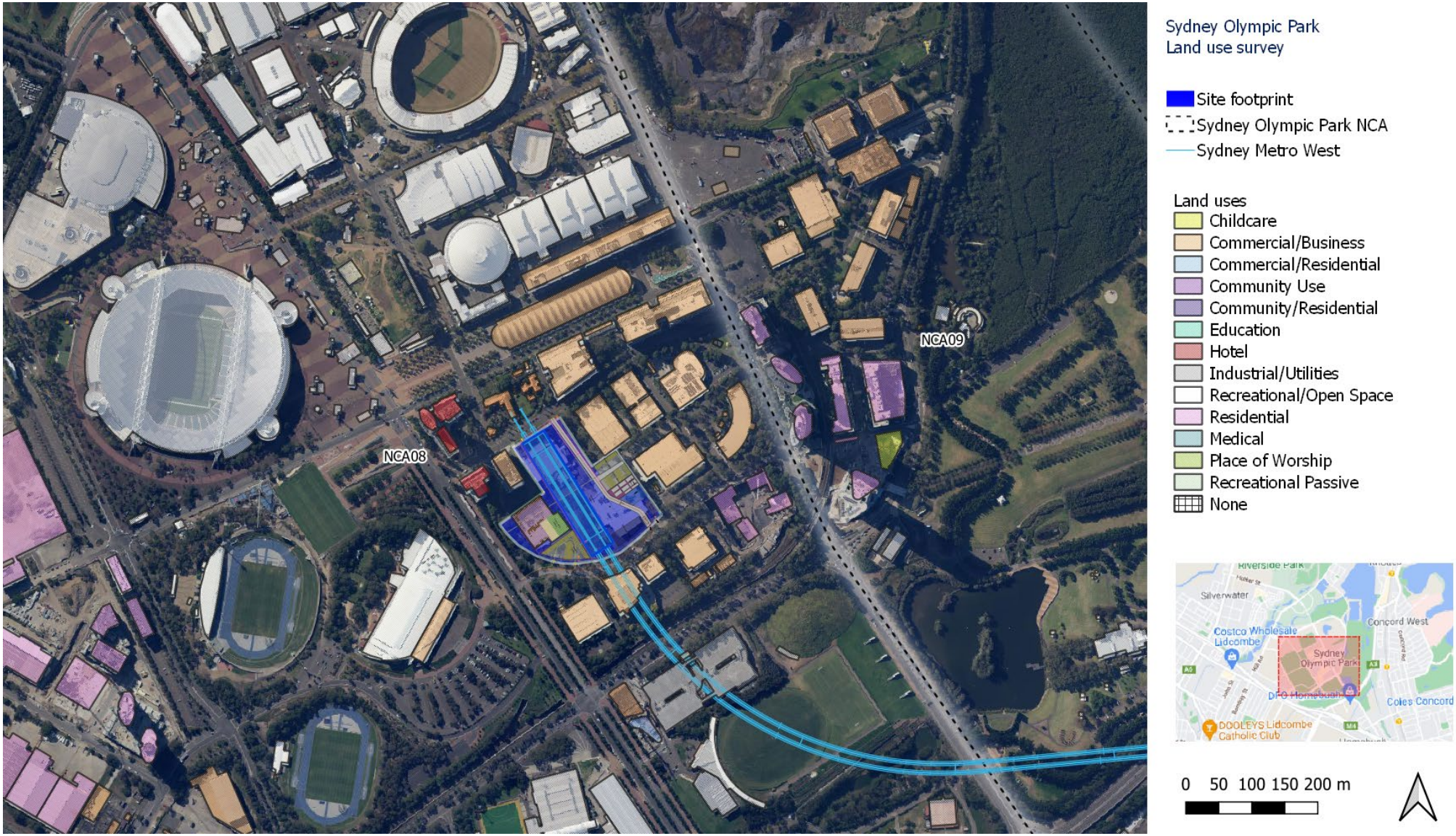
AFJV has regular dialogue with the building manager of 10 Herb Elliott Avenue, which houses several businesses and many with different day / night operating conditions. Additional tailored communications will continue with this sensitive receiver to ensure all disruptive activity is communicated clearly in advance to minimise impact on the day to day operations. We have on various occasions adjusted our daytime site activity on certain days and times to accommodate events taking place within the building.

AFJV has also met with local food outlets in the area to ascertain their specific needs and concerns and ensure the construction team are fully informed regarding various requirements.

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. A drop-in-session was host in November 2022 and are looking to host a site open day in September 2023, to invite the community into the site to ask any questions and provide any feedback they may have.

AFJV have issued 2 Sydney Olympic Park site-specific newsletters 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 A. Land use survey and NCA maps


NCA08
NCA09
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
Silverwater
Costco Wholesale Lidcombe
Concord West
Sydney Olympic Park
Coles Concord
DOOLEYS Lidcombe Catholic Club
0 50 100 150 200 m

Appendix B. Proposed equipment and sound power levels

B.1 Site establishment

Phase		Activity/Work Area	Aspect		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		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night
1	Site Establishment	Construction Compound	1a	Daily activities	Light vehicle (8/hr)	2			85	0.6		0	90	86	0	0	106	0	0
					Road trucks (deliveries to site)	2			102	0.6		0	107	103	0	0			
					Wheel wash unit	1			93	0.3		0	98	88	0	0			
					Telehandler	1			100	0.4		0	105	96	0	0			
					Water treatment plant pump	1			92	1		0	95	92	0	0			
					Watercart/Sweeper	1			103	0.4		0	108	99	0	0			
					Generator 450KVa (CAT)	1			98	1		0	99	98	0	0			
		Demolition	1b	Demolition (no hammer)	3x40t Excavator + Bucket+ Jaw+ Erkat	2			112	0.5		0	117	112	0	0	114	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Bobcat	1			107	0.3		0	112	102	0	0			
					Pad foot roller*	1			105	0.5		5	113	107	0	0			
					Smooth drum roller*	1			105	0.5		5	113	107	0	0			
					Grader	1			108	0.5		0	113	105	0	0			
					Franna	1			98	0.5		0	103	95	0	0			
					Watercart/Sweeper	1			103	0.5		0	108	100	0	0			
					100T Mobile Crane	1			98	0.5		0	103	95	0	0			
			1c	Demolition (with hammer)	49t Excavator + Hammer	1			122	0.3		5	130	122	0	0	122	0	0
					14t Excavator	1			107	0.4		0	112	103	0	0			
					Truck and Dog	1			108	0.2		0	113	101	0	0			
		Temporary fencing/ hoardings	1d	Fencing & hoarding	Bobcat	1			107	0.3		0	112	102	0	0	107	0	0
					Tracked excavator w bucket	1			107	0.4		0	112	103	0	0			
					Flat bed truck	1			93	0.3		0	98	88	0	0			
					Hiab	1			101	0.3		0	106	96	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Concrete agitator trucks	1			103	0.3		0	108	98	0	0			
		Utilities (Power/Water)	1e	Utilities Connections	15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0	110	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Bogie trucks	1			93	1		0	98	93	0	0			
					Compressor	1			93	0.5		0	98	90	0	0			
					Jackhammer*	1			111	0.2		5	119	109	0	0			
		Concrete Works	1f	Hardstand/Concrete	15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0	110	0	0
					Franna crane	1			98	0.4		0	103	94	0	0			
					Concrete agitator trucks	1			103	0.3		0	108	98	0	0			
					Concrete Pump	1			108	0.3		0	113	103	0	0			
					Generator	1			106	1		0	107	106	0	0			
					vibrator	1			100	0.2		0	105	93	0	0			

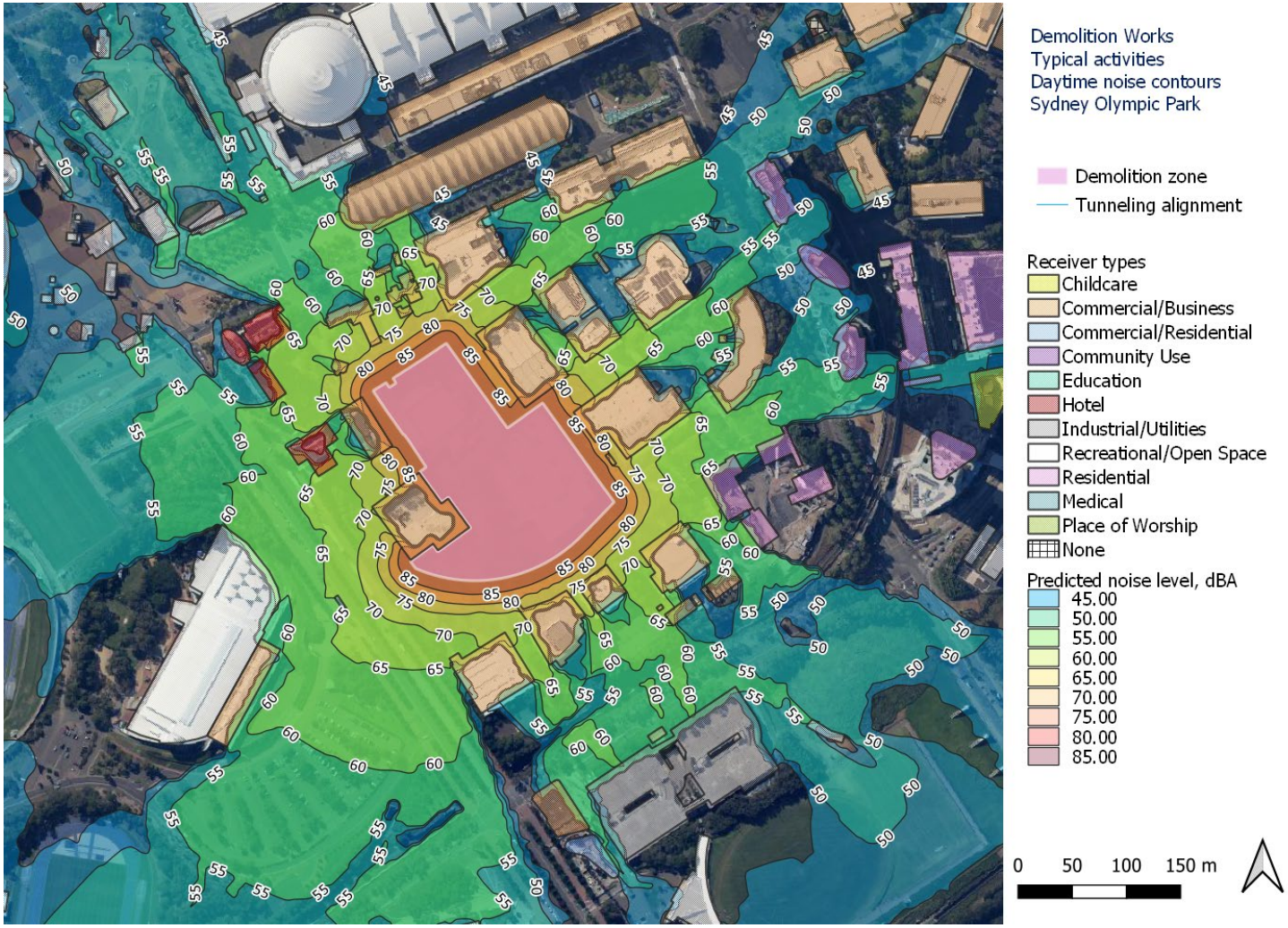
B.2 Station box excavation

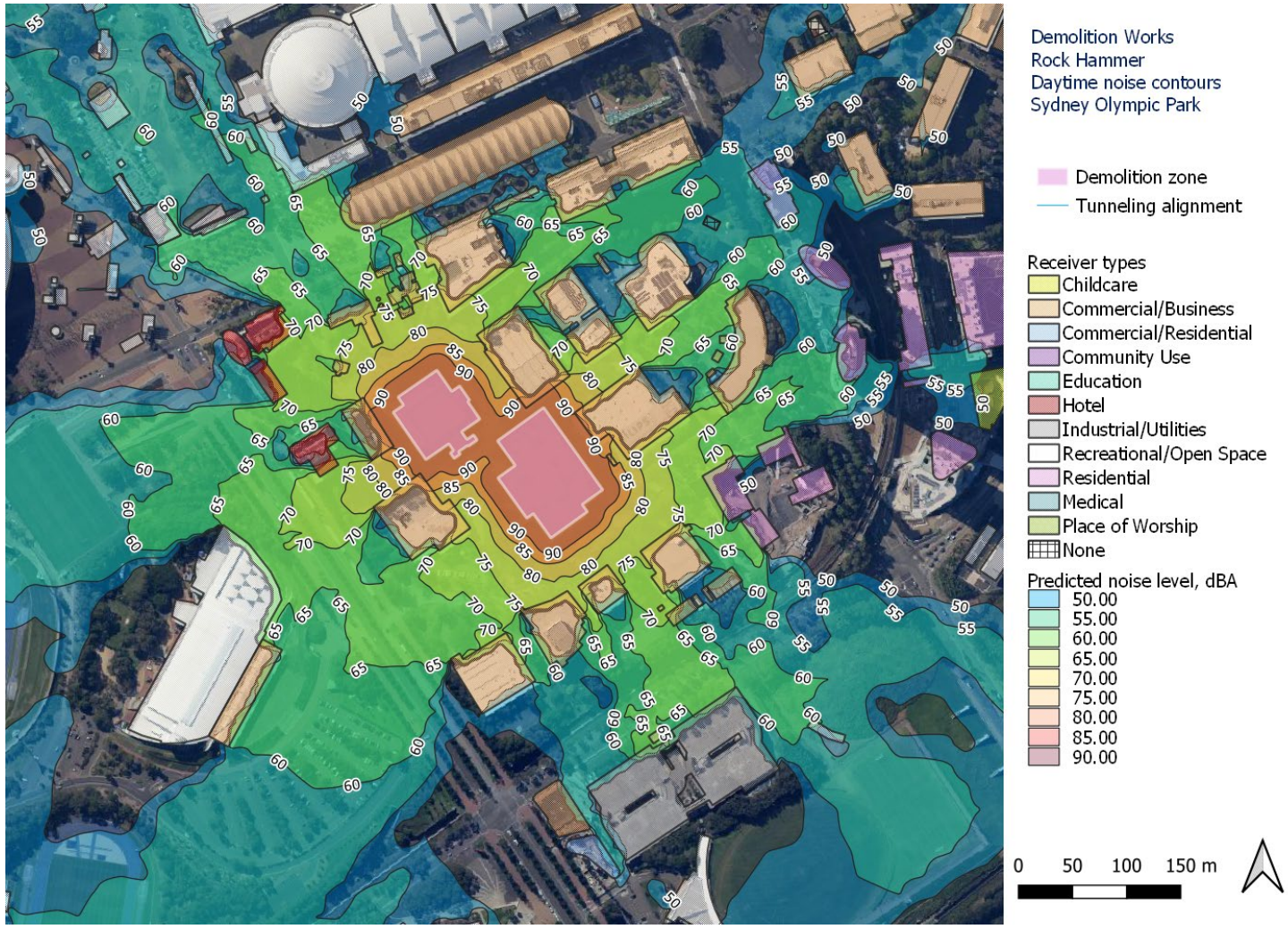
Phase		Activity/Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	Adj equipment SWL, LAeq,15 minute				Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night
2	Surface Works	Piling	2a	Piling	3 x Piling Rig (Liebherr LB 20)	1			113	0.4		0	118	109	0	0	111	0	0
					2x100t Crane	1			98	0.4		0	103	94	0	0			
					Concrete agitator trucks	1			103	0.3		0	108	98	0	0			
					Concrete Pump	1			108	0.3		0	113	103	0	0			
					20T excavator	1			105	0.4		0	110	101	0	0			
					15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0			
		Capping Beams	2b	Capping Beams	Franna	1			98	0.4		0	103	94	0	0	113	0	0
					5T Excavator	1			94	0.4		0	99	90	0	0			
					Concrete Trucks	1			103	0.3		0	108	98	0	0			
					Concrete pump	1			108	0.3		0	113	103	0	0			
					Vibrator	1			100	0.4		0	105	96	0	0			
					2 x Jack Hammers (Break Back Piles)*	2			111	0.2		5	119	112	0	0			
		Active Anchors	2c	Active Anchors	Drill rig	1			114	0.4		5	119	115	0	0	115	0	0
					Shotcrete rig	1			106	0.4		0	111	102	0	0			
					Franna	1			98	0.4		0	103	94	0	0			
	Excavation Works	Excavation- OTR	2d	OTR 0m-6m	2 x D10 Dozer	1			118	0.4		0	123	114	0	0	117	0	0
					2 x 50T Excavator + Bucket	1			112	0.4		0	117	108	0	0			
					2 x 30T Excavator + Bucket	1			109	0.4		0	114	105	0	0			
					4 x 40t ADT (haul to surface)	4			107	0.3		0	112	108	0	0			
					2 x CAT 980 Loader	1			112	0.4		0	117	108	0	0			
		Excavation Rippable	2e	Rip 6m-19m	2xD10 Dozer	1			118	0.3		0	123	113	0	0	121	0	0
					4 x30T Excavator + Bucket + Hammer*	1			120	0.3		5	128	120	0	0			
					2 x50t Excavator + Bucket (Load ADT)	1			112	0.4		0	117	108	0	0			
					3 x 40t ADT (haul to surface)	4			107	0.3		0	112	108	0	0			
					2 x Loader CAT 980 (Surface/Stockpile)	1			112	0.4		0	117	108	0	0			
					2x50t Telescopic Excavator (surface)	1			108	0.8		0	113	107	0	0			
		Retention- Anchors & Rockbolts	2f	Retention 3m-20m	2-4xDrill Rig (eg Casagrande C6xp-2)	1			120	0.2		5	128	118	0	0	118	0	0
					Shotcrete rig	1			106	0.4		0	111	102	0	0			
					telehandler	1			100	0.4		0	105	96	0	0			
					EWP x 2	1			89	0.3		0	94	84	0	0			
					Franna	1			98	0.4		0	103	94	0	0			
3	Stockpile	Loading - Excavator	3a	Stockpile	50t telescopic excavator +bucket	1			112	0.6		0	117	110	0	0	112	0	0
					35t excavator and bucket	1			109	0.6		0	114	107	0	0			
					Street Sweeper	1			109	0.3		0	114	104	0	0			
	Tunnel Nozzles	Tunnel nozzle excavation	3b	Nozzle Excavation	14t Excavator + Hammer + Erkat	1			118	0.4		5	126	119	0	0	125	0	0
					35t Excavator + Hammer	1			120	0.3		5	128	120	0	0			
					150 m^3/h Scrubber	1			104	1		0	106	104	0	0			
					Concrete agi + pump (surface)	1			113	1		0	118	113	0	0			

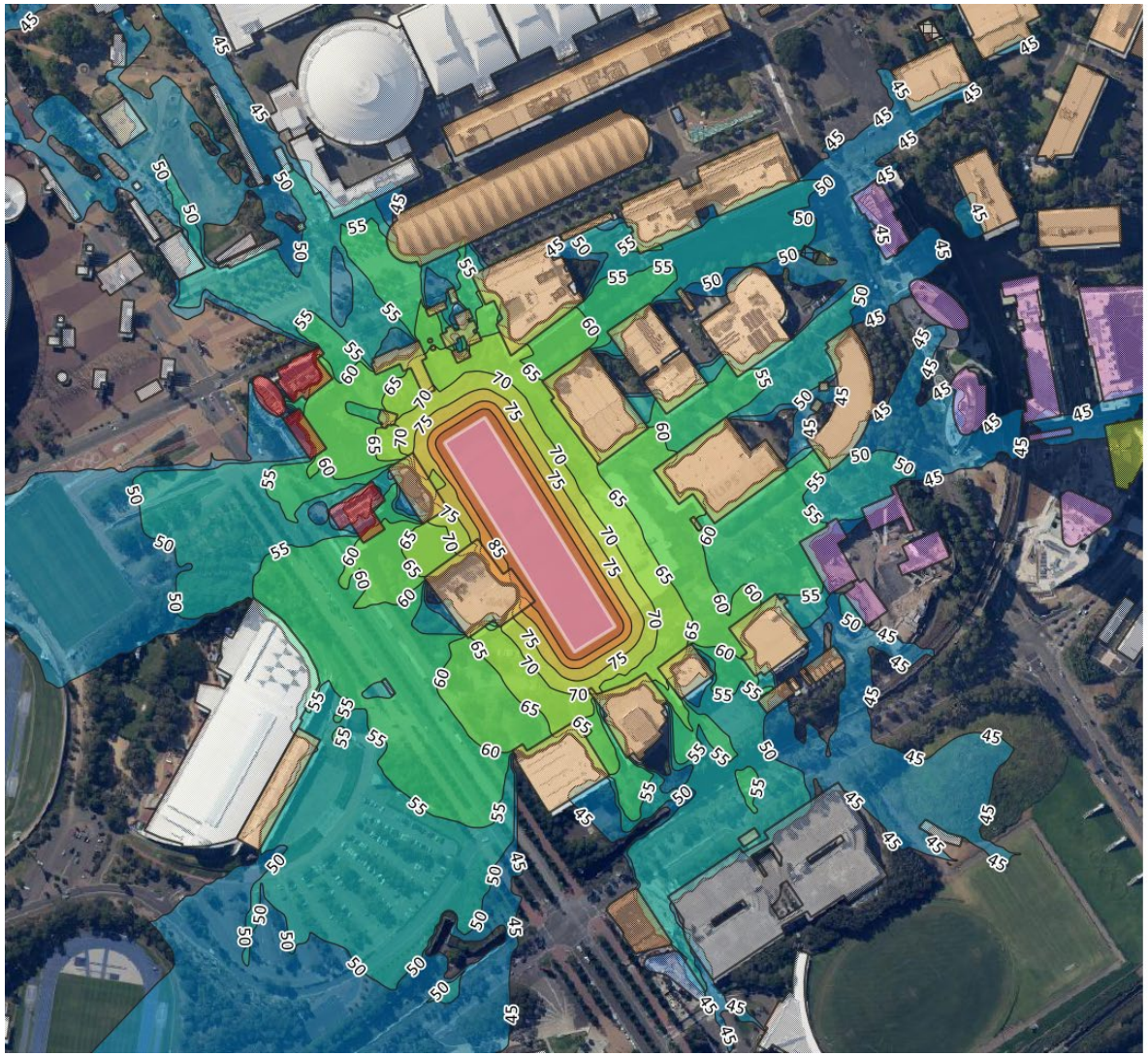
Phase		Activity/Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	Adj equipment SWL, LAeq,15 minute				Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night
					JCB dumper	1			100	0.4		0	105	96	0	0			
					1x Shotcrete Rig	1			106	0.4		0	111	102	0	0			
					1x Drilling Rig	1			120	0.4		5	128	121	0	0			
					Generator (surface)	2			98	1		0	99	101	0	0			
		Concrete Lining	3c	Concrete Lining	1x Telehandler	1			100	0.4		0	105	96	0	0			
					4x E.W.P	4			89	0.3		0	94	0	0	0			
					1x Diesel Concrete Line Pump	1			108	0.3		0	113	103	0	0	105	0	0
					2x Concrete agitator trucks (at Surface level)	2			103	0.3		0	108	101	0	0			
4	TBM Retrieval	TBM Retrieval	4a	TBM walkthrough	2x Telehandlers	2			100	0.4		0	105	99	0	0			
					2x E.W.Ps	2			89	0.3		0	94	87	0	0			
					1x Bobcat	1			107	0.3		0	112	102	0	0	108	0	0
					1x 40T Volvo Loader	1			110	0.4		0	115	106	0	0			

Appendix C. Construction noise and vibration contours

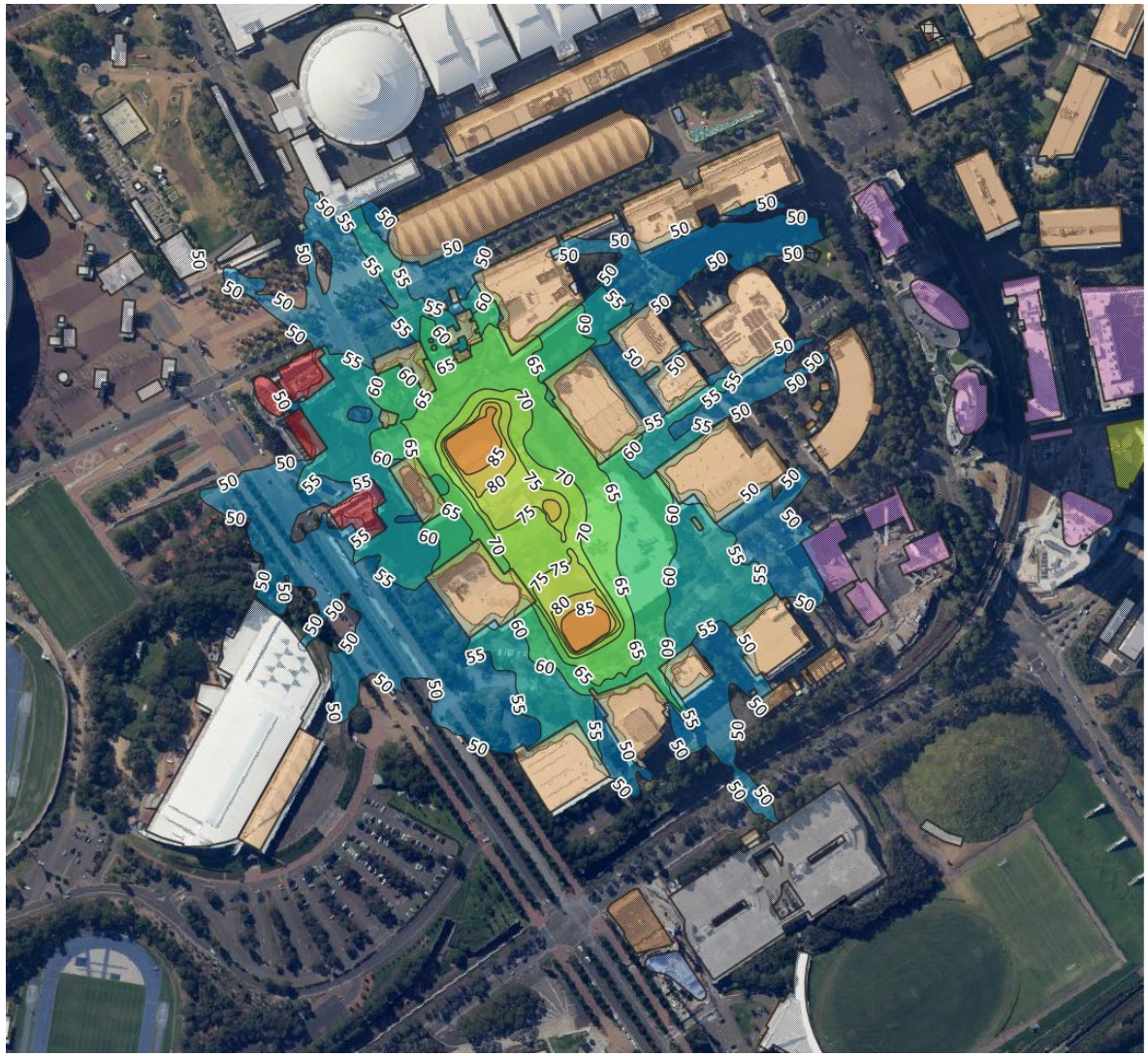
C.1 Construction noise contours



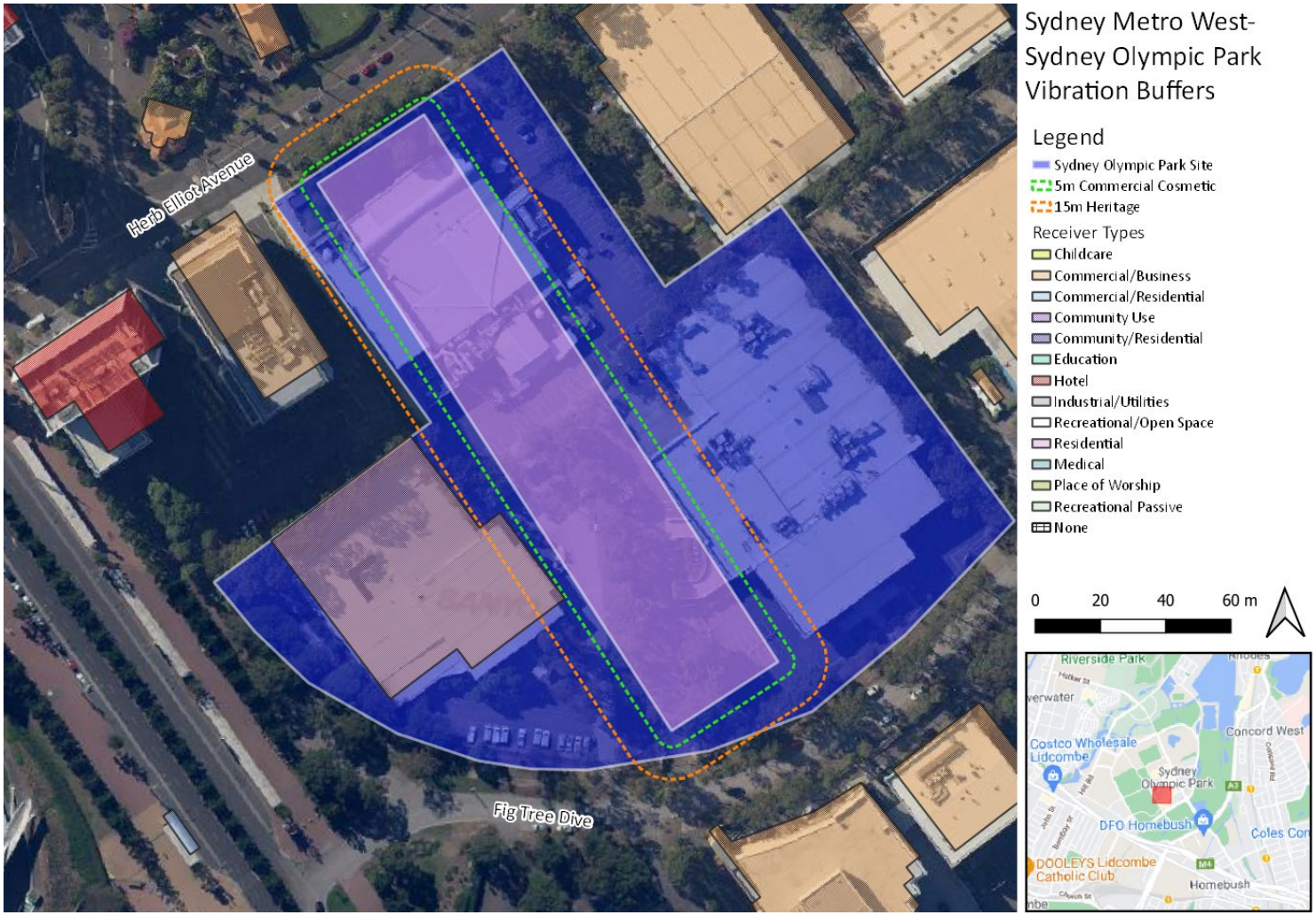

Demolition Works
Rock Hammer
Daytime noise contours
Sydney Olympic Park
Demolition zone
Tunneling alignment
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Hotel
Industrial/Utilities
Recreational/Open Space
Residential
Medical
Place of Worship
None
Predicted noise level, dBA
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
0 50 100 150 m


Piling Works
Typical activities
Daytime noise contours
Sydney Olympic Park
Piling zone
Tunneling alignment
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Hotel
Industrial/Utilities
Recreational/Open Space
Residential
Medical
Place of Worship
None
Predicted noise level, dBA
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
0
50
100
150 m


Ripping Works
Typical activities
Daytime noise contours
Sydney Olympic Park
Ripping zone
Tunneling alignment
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Hotel
Industrial/Utilities
Recreational/Open Space
Residential
Medical
Place of Worship
None
Predicted noise level, dBA
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
0 50 100 150 m


Excavation
Nozzle caverns
Daytime noise contours
Sydney Olympic Park
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Hotel
Industrial/Utilities
Recreational/Open Space
Residential
Medical
Place of Worship
None
Predicted noise level, dBA
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
0 50 100 150 m

C.2 Construction vibration contours



Sydney Metro West-
Sydney Olympic Park
Vibration Buffers

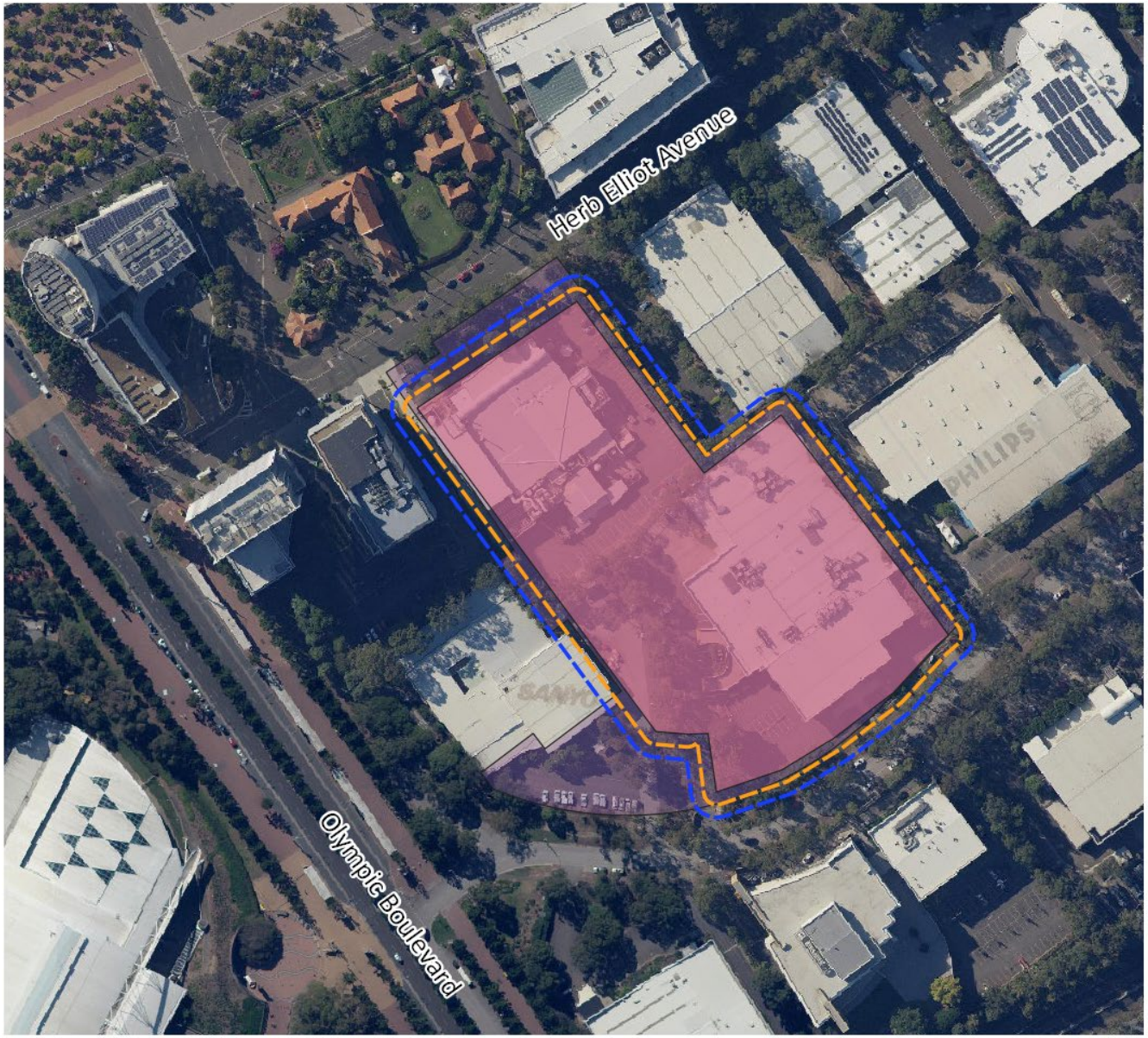
Legend

- Sydney Olympic Park Site
- 5m Commercial Cosmetic
- 15m Heritage

Receiver Types

- 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 20 40 60 m



Vibration Safe Working Distances-
SOP Project Sources

Legend
- Demolition Boundary
- SOP Site Boundary
- Cosmetic Damage (5m)
- Human Comfort (10m - 1 Hour)

0 25 50 m

Appendix D. Detailed noise predictions for individual receivers

D.1 Phase 1 Site Establishment

D.2 Phase 2 Piling and Excavation

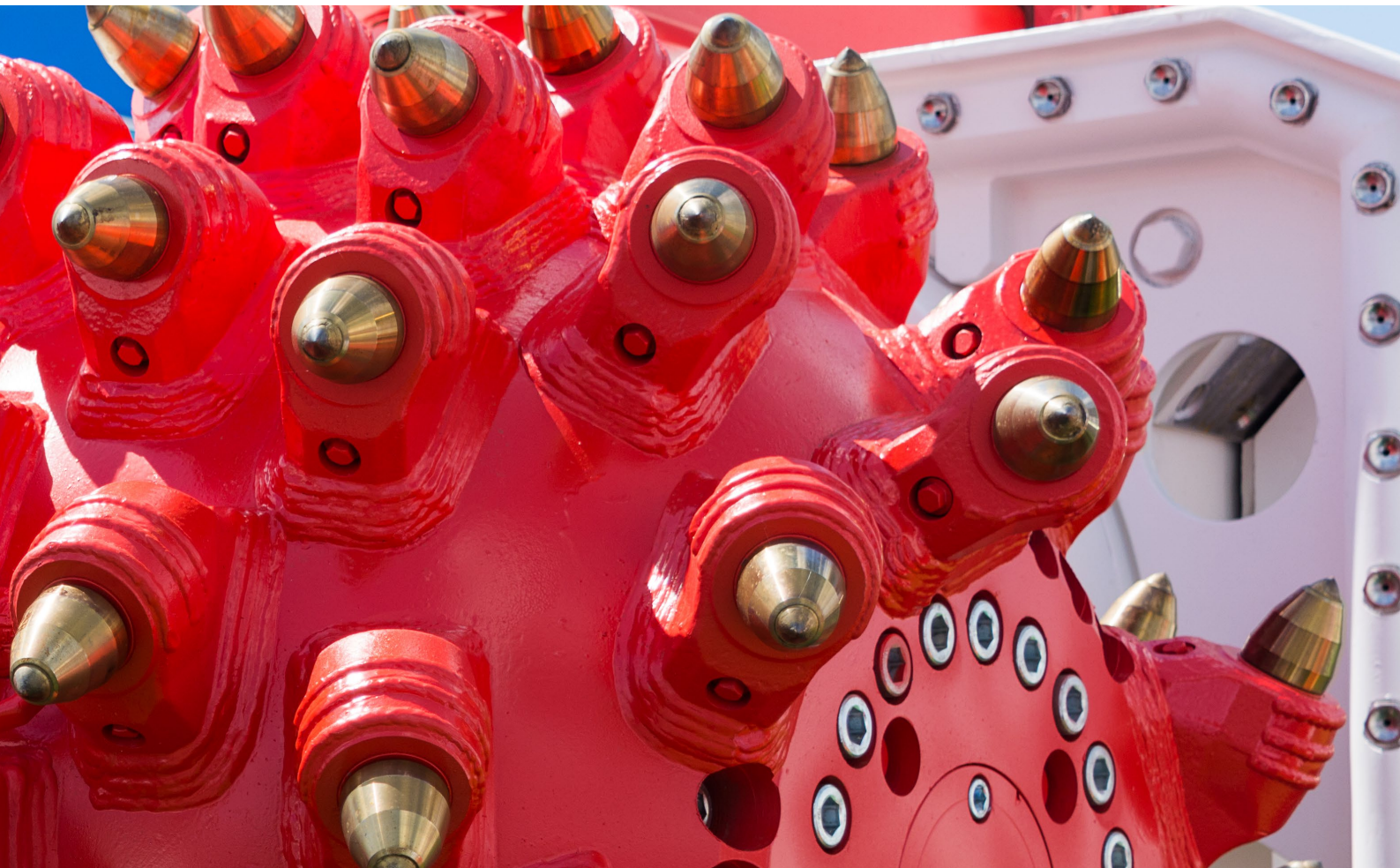
Supplied as Excel spreadsheets

hutchison weller

Acciona Ferrovial Joint Venture
Sydney Metro West Central Tunnelling Package
Burwood North

Detailed noise and vibration impact statement
August 2022

Doc no. 21028-NV-RP-4-11



Detailed noise and vibration impact statement

Client	Acciona Ferrovial Joint Venture
Project	Sydney Metro West Central Tunnelling Package
Document no.	21028-NV-RP-4-11
Revision	Rev 11
Date	15 August 2023
Author	John Hutchison
Reviewer	Scott Hughes
Doc Number	21028-NV-RP-4-11 SMW CTP Burwood North DNVIS.docx

Hutchison Weller Pty Ltd
ABN 37 001 024 095
Lvl 1, 357 Military Road Mosman NSW 2008

www.hutchisonweller.com

Revision history

0	11 November 2021	Draft report to client
1	12 November 2021	Amended following client comments
2	10 December 2021	Amended following AA & ER comments
3	25 February 2022	Updated demolition plan and equipment list
4	18 March 2022	Updated to include AA comments 18/03/2022
5	30 June 2022	Updated to reflect minor change to hoarding
6	8 July 2022	Updated to include capping beam, ground anchor works and acoustic shed references
7	8 August 2022	Updated DNVIS to include acoustic shed and excavation scenarios
8	8 September 2022	Updated with AA comments
9	23 May 2023	Updated acoustic shed design
10	11 July 2023	Updated with AA/ER comments
11	15 August 2023	Additional detail in Section 2.1.1 and 5.3

Contents

Definition of acoustic terms and acronyms ..... **v**

1. Introduction **1**

1.1 Project overview 1

1.2 Detailed noise and vibration impact statement 4

2. Construction works and hours **5**

2.1.1 Planned works 5

2.1.2 Approved construction hours 9

2.1.3 Variations to work hours 9

3. Existing environment **11**

3.1 Existing environment 11

3.2 Heritage items 11

3.3 Noise catchment areas 11

3.4 Background noise survey 12

4. Noise and vibration assessment criteria **13**

4.1 Overview 13

4.2 Noise 13

4.2.1 ICNG 13

4.2.2 Sleep disturbance 14

4.2.3 Ground-borne noise 14

4.2.4 Construction traffic 15

4.2.5 Additional mitigation measures 15

4.3 Project-specific construction noise management levels 16

4.4 Vibration management 17

4.4.1 Human comfort 17

4.4.2 Buildings 17

4.4.3 Heritage 17

4.4.4 Additional mitigation measures 18

5. Impact assessment **19**

5.1 Plant and equipment 19

5.2 Noise modelling 19

5.3 Mitigation measures included in the modelling 19

6. Predicted noise levels **23**

6.1.1 Overview 23

6.1.2 Site establishment works (Phases 1 & 5) 23
6.1.3 Construction within shed (Phases 2 - 4 & 6 – 8) 23
6.1.4 Cumulative impacts 27
6.1.5 Sleep disturbance 27
6.2 Ground-borne noise 27
6.3 Vibration impact assessment 30
6.3.1 Assessment method and reference data 30
6.3.2 Risk of cosmetic damage 30
6.3.3 Human exposure 33
6.4 Construction traffic 35
Summary and recommendations 38
6.4.1 Impact summary 38
6.4.2 Standard mitigation 38
6.4.3 Additional mitigation measures 40
6.4.4 Monitoring 40
6.4.5 Consultation 41

Appendix A. Land use survey and NCA maps

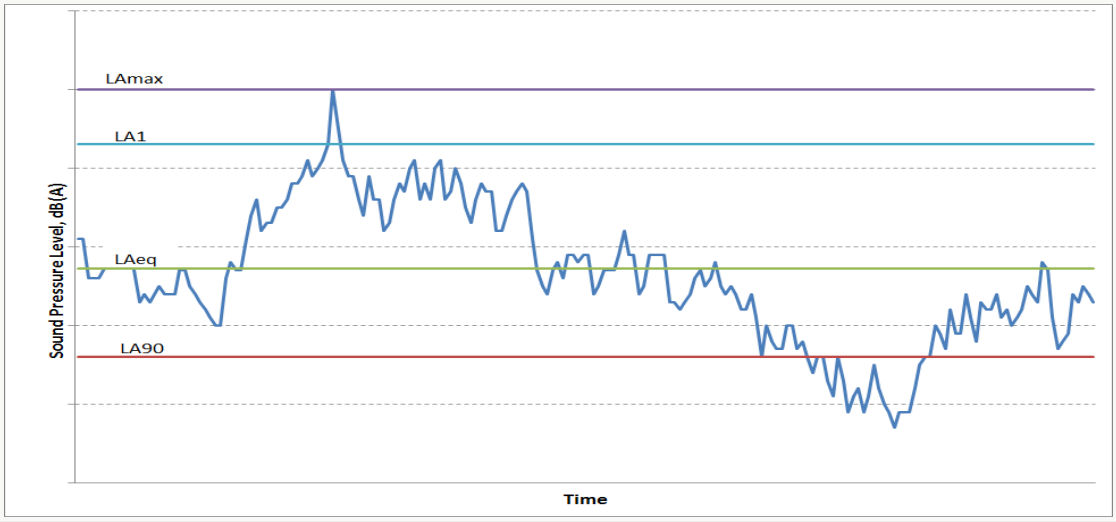
Appendix B. Proposed equipment and sound power levels

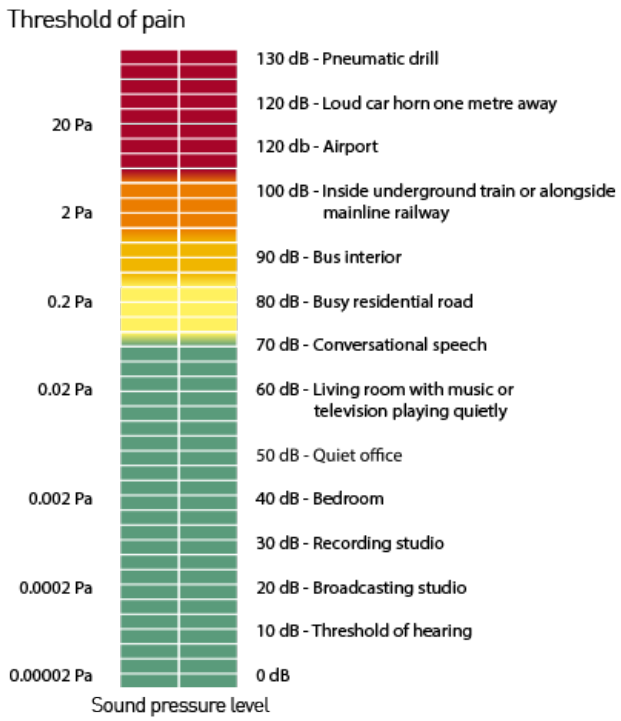
Appendix C. Construction noise and vibration contours

Appendix D. Detailed noise predictions for individual receivers

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.
Approved hours	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.
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.
CoA	Sydney Metro West – Concept and Stage 1 Conditions of Approval. Table 1 of the CoA also contains definitions related to the approval.
CSSI	Critical State Significant Infrastructure
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 LAeq, 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
NVMP	Noise and Vibration Management Plan
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

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 sites 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
- Strathfield
- Burwood North
- Sydney Olympic Park

This report covers activities for construction of Burwood North Station box and south shaft located near Burwood's shopping district and directly adjacent to Parramatta Road. The project comprises several phases including:

- Site establishment
- Excavation of the station box
- Tunnelling
- Demobilisation

An overview of the site layout of Burwood North is presented in Figure 1-2.

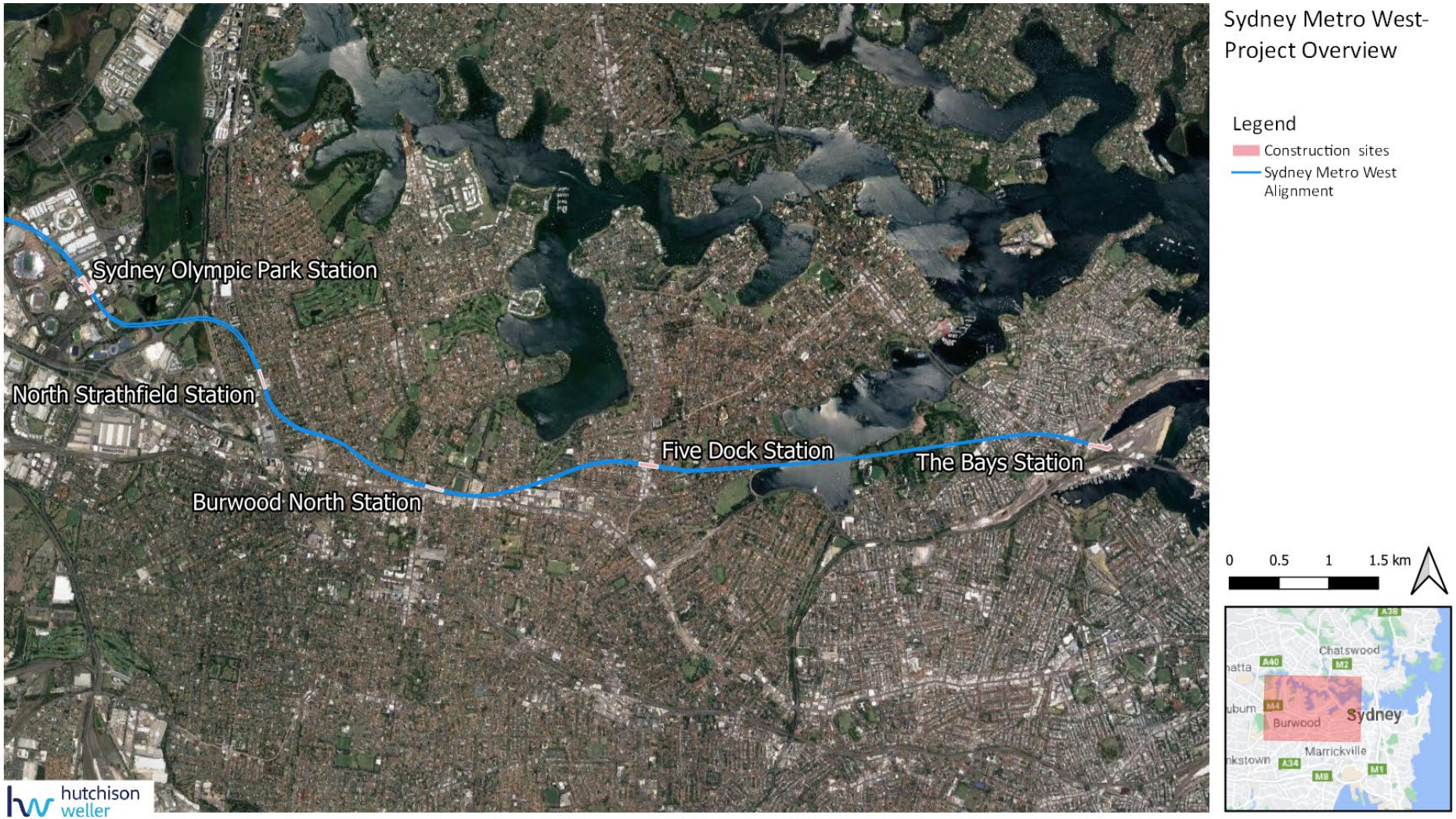


Figure 1-1 Overview of the CTP of Stage 1 of the Sydney Metro West Project.

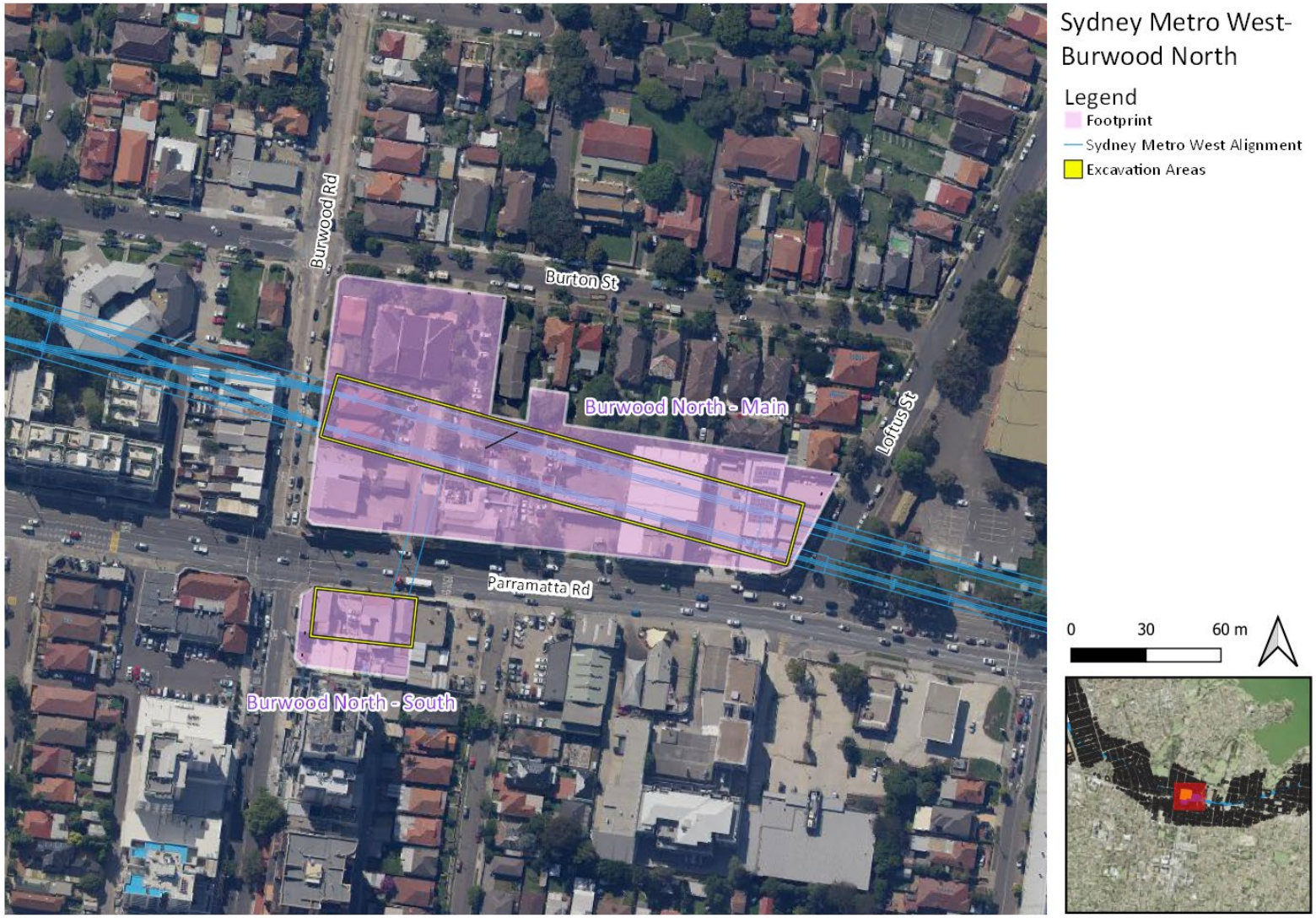


Figure 1-2 Burwood North construction site

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 appropriate mitigation measures identified through consultation with affected sensitive land users.

The structure of this DNVIS addresses 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 Burwood North are separated into two areas, the Main Site (including Station Box) and the South Site, a support shaft). Construction work outside these sites is covered under the CNVMP and the out of hours work protocol where activities are completed outside approved hours.

Construction phases for each of these sites broadly include site establishment, excavation and then tunnelling support.

The anticipated program is illustrated in Table 2-3 and shows the duration of each phase. Establishment for the site commenced in November 2021 and continue for around 7 months. Excavation commenced in July 2022 and at the South site in January 2023. In total, the project is expected to take around 2 years to complete in Burwood North.

This update to the DNVIS provides additional assessment of changes to the acoustic shed arrangements for the main north site. Work at the southern shaft is being completed during approved hours and there are no changes to this scenario.

At the main station box, site establishment is complete and station box excavation under the acoustic shed has reached operational levels. The eastern section of the station box and tunnel nozzles are yet to be completed. Previous assessment of these activities is not impacted by the proposed changes to site operations which were completed during approved hours.

As per the initial assessment of acoustic sheds for the project, the main site station box is covered with an acoustic shed to the west while the eastern portion of the station box was to be covered with an ‘acoustic roof'. Design of the acoustic shed over the western section of the station box was finalised in September 2022. The construction of the western shed is expected to be completed in May 2023.

Installing a roof enclosure over the Burwood North station box would prolong the excavation process. Program delays at Burwood North could have implications for TBM progress which would have flow-on effects for other sites.

Without the roof, spoil can be handled from the surface adjacent to Parramatta Road and provide an alternative spoil handling location outside the acoustic shed. This enables spoil load out to occur during standard construction hours at two points thus alleviating congestion and eliminating the need for continuous out of hours spoil haulage.

An assessment of the changes to the eastern site acoustic roof and associated noise impacts for approved and OOH works based on the current program, has been completed in this update to the DNVIS.

Construction within the cavern at the western end of the station box is currently underway and operational on a 24 hour basis. These works were initially assessed for the Burwood DNVIS where construction was still within the station box and align with the activities described in Phase 4 for mined excavations at the main northern site.

Once tunnelling is underway, all excavation equipment is located within the cavern and ground borne noise and vibration impacts from this aspect of the works is assessed separately in the Tunnelling DNVIS.

For the Burwood site, tunnelling support activities are assessable against the project NML and will occur within the acoustic shed during the cavern excavation prior to the TBM arrival.

Support activities/equipment within the acoustic shed include gantry and kibble for spoil stockpiling, concrete deliveries and spoil haulage via Parramatta Road. At the station box floor around 30 metres from the surface, excavation within the cavern is underway supported by tunnel ventilation and spoil removal in the station box.

After the caverns and station box are excavated cavern lining and some additional excavation would continue until the TBM walk through around February 2024.

During the cavern excavation, noise from the tunnel portal, the scrubber/ventilation fan and spoil haulage and kibble loading would be the only sources from the station box floor. Other surface activities within the acoustic shed would include the gantry crane stockpiling the spoil, spoil haulage trucks removing the spoil and deliveries of concrete and other materials. These activities have been assessed in this DNVIS for OOHW noise impacts with no eastern acoustic roof in place.

In the eastern section of the station box where the acoustic roof has not been constructed, excavation to the station box floor is being completed in preparation for mining of the eastern tunnel nozzles as described in Phase 3 activities at the main northern site. Without the acoustic roof, these works will be limited to daytime operations only.

Table 2-1 and Table 2-2 present a summary the activities for each of the Burwood construction sites.

Table 2-1 Summary of proposed activities at the Main site

Construction phase	Activity			Outside approved hours?
1. Site Establishment	1a	General activities		No
	1b	Construction utilities and facilities		No
	1c	Temporary fencing/ hoardings		No
	1d	Utilities disconnection/relocation		No
	1e	Demolition and clearing site (No hammer)		No
	1f	Demolition and clearing site (With hammer)		No
	1g	Site Concrete Works		No
2. Station Box Excavation	2a	Piling		No
	2b	Site structures including acoustic enclosures		No
	2c	Capping beams	Detailed excavation, break back & capping beam	No
	2d	Active anchors	Ground stabilisation	No
	2e	Excavation & Retention	Whaler beam installation	No
	2f		Other Than Rock (OTR) – Dozer (No ripping)	No
	2g		Rippable – Dozer (Ripping)	No
	2h		Non-rippable – Excavators with hammers or eccentric rippers	No
	2i		Retention – Ground Anchors	No
3 Tunnel Nozzles	3a	Excavation & Lining	Excavation	No
	3b		Nozzle bolting	No
4. Mined excavations	4a	Excavations	Tunnelling (cavern excavation)	Within the underground cavern Evening and night
		Rock bolting	Cavern rock bolting	
		Shotcrete	Cavern roof shotcrete	
		Spoil muck out	Haulage/stockpile (station box/ acoustic shed)	Evening and night
	4b	Tunnel Lining	Concrete lining	Evening and night
	4c	Tunnelling	TBM Walkthrough	TBA

Table 2-2 Summary of proposed activities at the South site

Construction phase	Activity			Outside approved hours?
5. Site Establishment	5a	Temporary fencing/ hoardings		No
	5b	Utilities disconnection/relocation		No
	5c	Demolition and clearing site		No
	5d	Site Concrete Works		No
6. Excavation	6a	Piling		No
	6b	Capping beams	Detailed excavation, break back & capping beam	No
	6c	Active anchors	Ground stabilisation	No
	6d	Excavation & Retention	Other Than Rock (OTR) – Dozer (No ripping)	No
	6e		Rippable – Excavator (Ripping and Hammer)	No
	6f		Retention – Ground Anchors	No
7 Mucking out	7a	Spoil handling	Excavator load out	No
8. Pedestrian adit	8a	Excavation	Clearing station entry	No
	8b	Tunnel Lining	Concrete lining	No

Table 2-3 Current shaft and cavern construction program for Burwood North

	Burwood North	2023							2024											
Site	**Phase**	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Main site (incl. station box)	1. Site Establishment – Completed																			
	2. Station Box Excavation																			
	3. Nozzle excavation																			
	4. Mined Cavern & Adit excavation																			
	Cavern and adit lining																			
	TBM arrival – Preparatory works																			
South Site	5.Soth shaft Site Establishment Completed																			
	6. South Shaft Excavation																			
	7. Mucking Out																			
All sites	Demobilisation																			

2.1.2 Approved construction hours

Working hours are set by CoA D35 to D36 as summarised in Table 2-4. 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 2-4 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.

2.1.3 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 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 Burwood North 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, except between the hours 10:00 pm and 7:00 am to / from the Five Dock and Westmead construction sites and to / from Burwood North construction site using any roads / streets other than directly from Parramatta Road; or
  - iv. haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from the Five Dock and Westmead construction sites and to / from Burwood North construction site using any roads / streets other than directly from Parramatta Road;

v. work within an acoustic shed where there is no exceedance of noise levels under Low impact circumstances identified in (37b), unless otherwise agreed by the Planning Secretary.

Note: Tunnelling does not include station box excavation

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 progressive schedule for periods no less than three (3) months, of likely out-of-hours work;
- a description of the potential work, location and duration of the out-of-hours work;
- the noise characteristics and likely noise levels of the work; and
- 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 Burwood North construction zone covers two separate locations, namely Burwood North – Main (Main site), which includes the station box, and Burwood North – South (South site), as illustrated in Figure 1-2.

The Main site is located north of Parramatta Road, near the intersection of Parramatta Road and Burwood Road and covers an area of around 1.3 hectares. Adjacent land uses to this site, fronting Parramatta Road, are mostly commercial businesses with some mixed-use commercial/ residential buildings.

North of the Main site, residential receivers are on Burton Street, with the nearest backing directly onto the project boundary. To the north of the site is also St Luke's Church, which is heritage listed.

The South site is located to the south of Parramatta Road, also bounded by Burwood Road and Esher Street and Esher Lane with a footprint of around 1480 m^2. This site has commercial premises located to the east and mixed commercial and residential 10 storey residences to the south. The heritage listed Bath Arms Hotel is located 20 metres west of the South site.

The acoustic environment in all areas is described in the EIS as dominated by road traffic noise on the major transport corridors such as Parramatta Road and Burwood Road.

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 Burwood North are presented in Appendix A of this DNVIS.

3.2 Heritage items

There are several items of heritage value identified in the EIS, which include the following. These items will be considered for impacts of vibration-intensive activities.

- St Luke's Anglican Church
- Bath Arms Hotel
- Semi-detached houses along Burwood Rd

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 Burwood 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
NCA12	Burwood, North of Parramatta Road	Mainly residential, with some commercial areas along Parramatta Road. 'Other sensitive' receivers include Concord High School, St Mary's Catholic Primary School, St Marys Catholic Church and St Luke's Anglican Church	Existing noise is controlled by road traffic. The area surrounding the construction site is mostly residential and the nearest receivers are near the northern boundary of the northern construction site and the southern boundary of the southern Construction Site. Commercial receivers are also adjacent to the site, along Parramatta Road, and are of general retail use
NCA13	Burwood, South of Parramatta Road	Mainly residential, with commercial areas along Parramatta Road and Burwood Road. 'Other sensitive' receivers include Sydney Central ENT, Bath Arms Hotel, Southern Cross Catholic College and Methodist Ladies College.	

3.4 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 Burwood 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

	Noise level (dBA)[1]		
NCA	Day[2]	Evening[2]	Night[2]
NCA12	43	43 (47)[3]	42
NCA13	48	48	44

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 NPfI 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 the early works investigations.

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.

Actual noise levels associated with construction traffic will be monitored and compared to the following road traffic noise criteria in the RNP.

- 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.

Where exceedances of the RNP are attributed to construction traffic, consideration for mitigation would be made in accordance with the project CoA and the Revised Environmental Mitigation Measures (REMM).

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 4-3.

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:
PC = Phone call/Email
M = monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
DR = Duration reduction
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, PC, 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:
PC = Phone call/Email
M = monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
DR = Duration reduction
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}
NCA12	53	75	48	48	47	47	57
NCA13	58	75	53	53	49	49	59

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

Notes:
PC = Phone call/Email
M = monitoring
IB = Individual briefings
AA = Alternative accommodation
SN = Specific notification
LB = Letterbox drops
DR = Duration reduction
RO = Project specific respite offer

5. Impact assessment

5.1 Plant and equipment

A summary of proposed activities at the Burwood sites was provided in Table 2-1. Nominal equipment and estimated sound power levels of each item and activity are presented in Appendix B. All activities are proposed during approved hours only until the acoustic shed is completed.

During site establishment, it is likely several activities would be undertaken concurrently so cumulative impacts have been assessed as part of this DNVIS. Similarly, concurrent excavation of the main station box and southern shaft has been considered (see Section 6).

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 B. Source is modelled at 1.5 metres above ground.
- 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 are to be implemented to ameliorate noise impacts as standard practice throughout the duration of the works. 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 Table 13 of the CNVS.
    - 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
- Site layout planned to allow noisy stationary plant to be 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 and all equipment outside approved hours.

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

- Noise control strategies:
  - Various forms of hoarding are proposed, with a mix of 2.4m high Class A hoarding direct to slab, 2.4m high Class A hoarding on concrete barriers and retention of existing building facades at the site boundary. These are summarised in Figure 5-1 and were included in modelling for all site establishment activities.
  - Rock hammers were used where required when breaking up building slabs, with alternative methods used in "no hammer" zones within the SWD detailed in Section 6.3. where use of hammers was unavoidable, noise mats or suitable noise screens around the activity were implemented where practicable.
  - During the piling and capping beam phase, work on the site structures including the acoustic shed began. The final layout for the station box will be a combination of acoustic shed over the western end of the station box and hoarding around the eastern excavation area.

To provide safe access around the boundary, an interim hoarding configuration will be used after the demolition phase, during the construction of the acoustic shed. Following shed construction, the final hoarding design will be implemented. The planned hoarding arrangement pre and post shed construction is presented in Figure 5-1 and Figure 5-2.

- Acoustic shed:
  - The 20 metre tall acoustic shed over the main shaft excavation has been modelled with a weighted noise reduction, Rw of 35 with transmission loss equivalent or better than values in Table 5-1. Modelling assumes roller doors are closed during OOHW periods. Closing of shed doors will be managed through on-site practices, inspections and monitoring.

Table 5-1: Acoustic shed transmission loss at frequencies (Hz)

63	125	250	500	1000	2000	4000
19.7	18.8	24.7	31.1	39.5	45.8	52.5

Intake and exhaust noise from the Acoustic shed has been accounted for in the model based on the preliminary shed design with the vent openings in the roof. Intake and exhaust fans have silenced, ducted inlets and exhausts on the roof.

Figure 5-3 presents an artist impression of the location and scale of the main acoustic shed

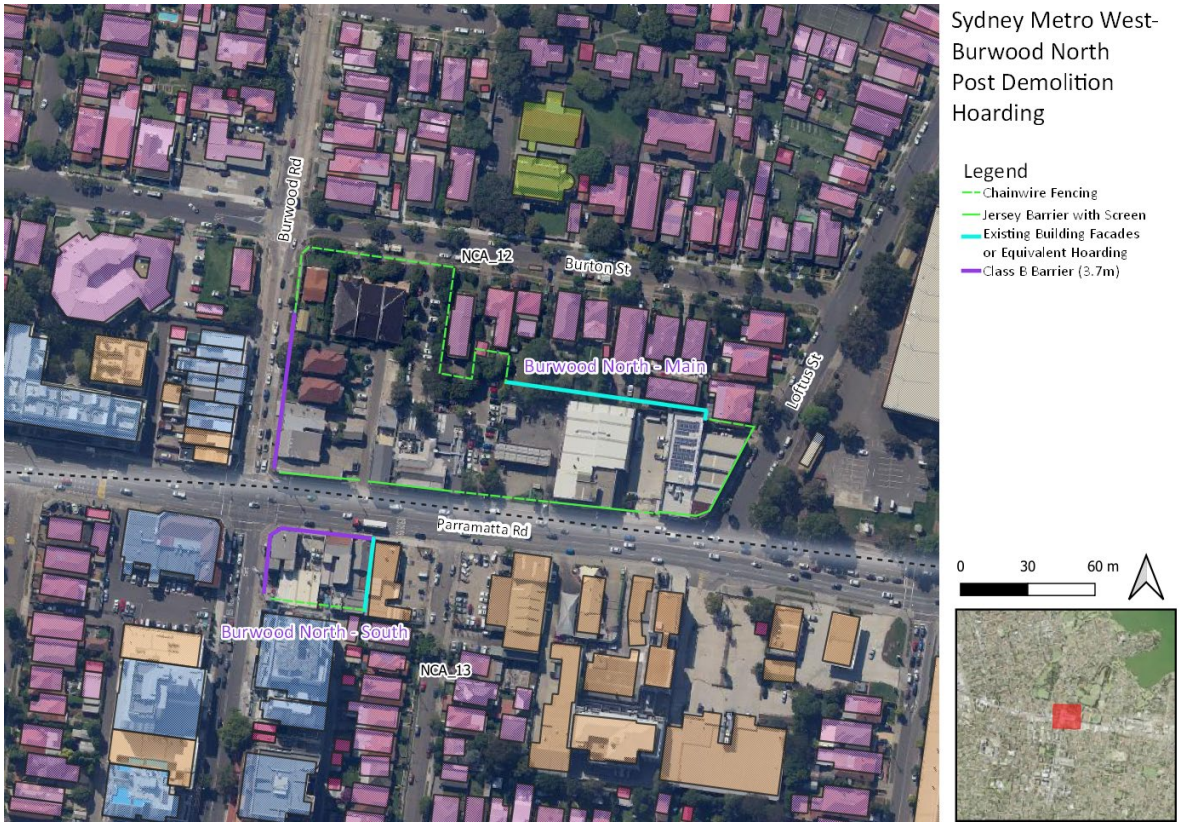


Figure 5-1 Hoarding layout – Post demolition, pre acoustic shed

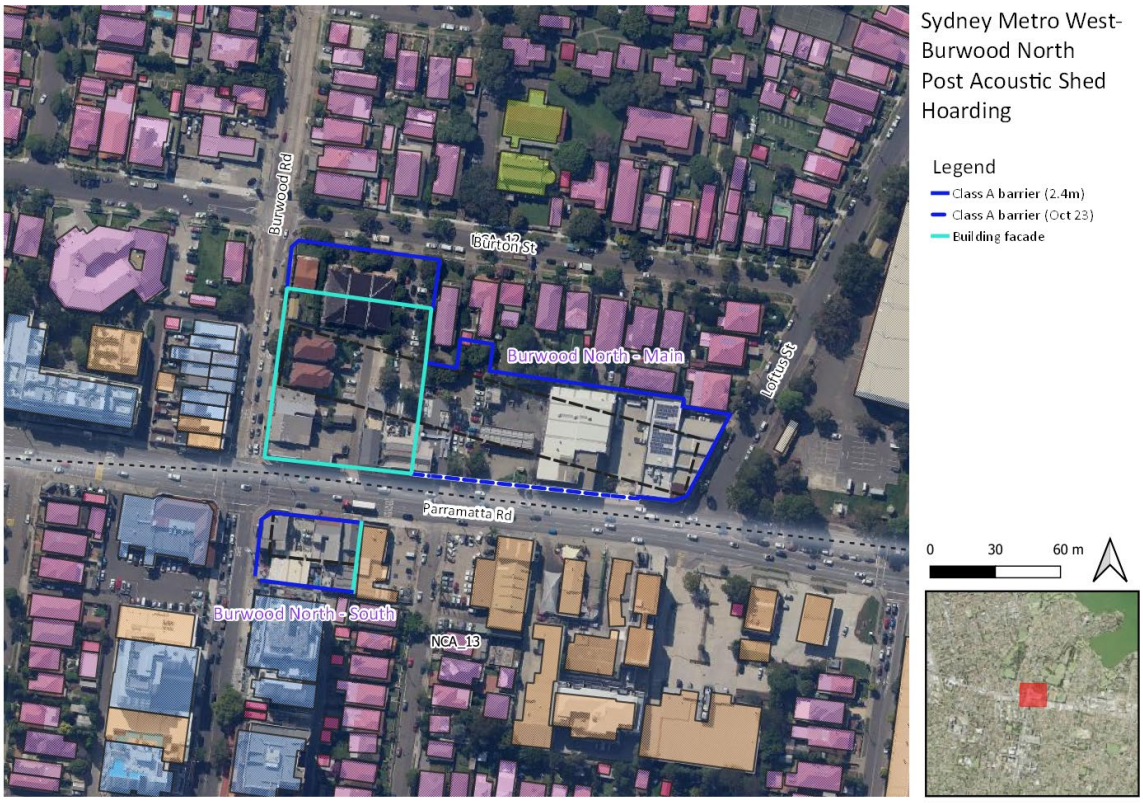


Figure 5-2 Hoarding layout – Final layout

Figure 5-3 Burwood Acoustic shed and open station box excavation (looking west along Parramatta Road)

6. Predicted noise levels

6.1.1 Overview

A summary of predicted noise levels for works during approved hours is provided in the following sections for each construction phase. For site establishment and initial shaft construction, there would be no OOHW undertaken. Detailed results for all sensitive receivers are provided in Appendix D.

Noise contours for selected activities are presented in Appendix C showing the extent of the impacts with the greatest impacts predicted at receivers immediately adjacent to the works. Contours illustrate that existing buildings around the work sites generally provide good noise screening to houses situated further back from the construction sites.

6.1.2 Site establishment works (Phases 1 & 5)

A summary of predicted noise levels at residential and non-residential land uses and predicted exceedances of the NMLs are presented in Table 6-1.

Site establishment have been completed during approved hours. At that time, exceedances of the NML were likely, with most being minor (1 – 10 dB). However, 4 – 6 receivers may have experienced highly intrusive noise levels during activities like concrete pours, utilities relocations and general construction works.

Where hammering was required at the main site to excavate existing building foundations the noise impacts were predicted to be high with up to 17 residential receivers likely to be highly noise affected (>75 dBA) when works are in close proximity. Any highly noise intensive work was undertaken in accordance with COA D36 and are reflected in Table 7-1 detailing standard mitigation measures relating to construction hours.

At the South site, exceedances of impact classes were lower given the higher NML and the greater number of commercial receivers in the area. During demolition at the south site, the highest impact was predicted for demolition where 163 receivers may have experienced exceedances of the daytime NML of up to 10 dB, with 38 receivers experiencing impacts in the 10-20 dB range and up to 10 receivers in the greater than 20 dB range.

6.1.3 Construction within shed (Phases 2 - 4 & 6 – 8)

At the Main and South sites work of the initial shaft construction included piling and break-back (by cropping where possible), pouring of capping beams and installation of active ground anchors, and construction of the acoustic shed.

The western end of the station box is covered with an acoustic shed while the eastern section is an open excavation. Construction of the acoustic shed west began after piling and capping beams within the footprint of the shed were completed. Erection of the shed followed the footing foundations, spoil structure, and slab pours.

The acoustic shed construction is now complete and this update to the DNVIS covers activities inside the station box area below the shed during tunnelling for all assessment periods for the main site. Work within the station box has progressed out of sequence for some of the assessed activities and with the eastern end of the station box uncovered, some activities are restricted to daytime only operations.

Work within the western end of the station box has progressed to the cavern excavation stage where all activities are associated with tunnelling operations. Excavation using road headers, drill rigs and shotcrete rig is wholly within the cavern, while tunnelling support for spoil removal and ventilation facilities are operational within the station box.

Currently spoil stockpiling from tunnelling is confined to the middle section of the station box during the day. This location is also used for stockpiling to facilitate the remaining excavation around the tunnel nozzles at the eastern portal.

During OOH periods, stockpiling will be confined to the western end of the station box below the acoustic shed and all stockpiling and spoil handling activities will be handled within the acoustic shed by the end of April 2023.

Activities within the acoustic shed and the station box directly below will be limited to spoil removal and tunnelling support during OOH periods. Noisy activities such as hammering and nozzle construction in the station box east would be undertaken during approved hours only. Other construction activities within the station box and adit may be undertaken during OOH periods where the works are NML compliant at the nearest residences.

There are no predicted exceedances of the NML for the tunnelling within the mined cavern and tunnelling support inside the acoustic shed during the OOH periods.

As there are no excavation activities within the station box area during the evening and night, and noisy activities are scheduled for approved hours only, the deletion of the acoustic roof over the eastern section of the station box is not expected to impact nearby residential receiver locations during the cavern excavation. During standard construction hours, noise levels will be higher during shaft excavations in the absence of an acoustic roof, however, the noise levels will decrease as the excavation deepens.

A noise monitoring survey of the tunnelling and support activities would be completed to confirm compliance with the predicted noise levels for the revised OOHW scenario for tunnelling and support. Without the eastern acoustic roof, general excavation within the station box including the nozzle excavation work at the eastern portal would have an increased noise impact at the nearest residences. Predicted exceedances of up to 10 dB above the daytime NML for 21 receiver locations and 3 receivers would experience noise impacts in the 10-20 dB range.

The predicted noise impacts for the cavern and nozzle excavations are presented in Table 6-2 and the modelled noise contours are shown in Appendix C.

Table 6-1 Summary of predicted NML exceedances for Site establishment

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+
Main site																			
1a	General activities	88	71	3	48	18	6	-	-	-	-	-	-	-	-	-	-	-	-
1b	Construction facilities	90	72	4	57	21	8	-	-	-	-	-	-	-	-	-	-	-	-
1c	Fencing & hoarding	90	70	4	32	22	7	-	-	-	-	-	-	-	-	-	-	-	-
1d	Utilities disconnection	91	73	5	60	22	8	-	-	-	-	-	-	-	-	-	-	-	-
1e	Demolition (no hammer)	89	71	3	49	18	6	-	-	-	-	-	-	-	-	-	-	-	-
1f	Demolition (with hammer)	109	78	17	136	54	26	-	-	-	-	-	-	-	-	-	-	-	-
1g	Site Concreting	90	72	4	56	20	8	-	-	-	-	-	-	-	-	-	-	-	-
South site																			
5a	General activities	78	74	1	21	9	0	-	-	-	-	-	-	-	-	-	-	-	-
5b	Construction facilities	77	72	1	20	6	0	-	-	-	-	-	-	-	-	-	-	-	-
5c	Fencing & hoarding	77	73	1	18	6	0	-	-	-	-	-	-	-	-	-	-	-	-
5d	Utilities disconnection	81	76	3	37	11	1	-	-	-	-	-	-	-	-	-	-	-	-
5e	Demolition (no hammer)	79	75	2	27	10	1	-	-	-	-	-	-	-	-	-	-	-	-
5f	Demolition (with hammer)	88	83	14	163	38	11	-	-	-	-	-	-	-	-	-	-	-	-
5g	Site concreting	80	75	3	26	11	1	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-2 Summary of predicted NML exceedances for excavation 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+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+	0-10	10-20	20-30	30+
2a	Piling	80	71	3	54	17	3	-	-	-	-	-	-	-	-	-	-	-	-
2b	Acoustic shed construction	93	66	1	18	6	2	-	-	-	-	-	-	-	-	-	-	-	-
2c	Capping Beams	76	66	1	26	6	2	-	-	-	-	-	-	-	-	-	-	-	-
2d	Active Anchors	85	75	8	105	21	9	-	-	-	-	-	-	-	-	-	-	-	-
2e	Whaler beams	74	65		21	6	1	-	-	-	-	-	-	-	-	-	-	-	-
2f	Excavation OTR	84	75	10	96	20	13	-	-	-	-	-	-	-	-	-	-	-	-
2g	Excavation Rippable	54	48		1			-	-	-	-	-	-	-	-	-	-	-	-
2h	Excavation Non-Rippable	57	53		2			-	-	-	-	-	-	-	-	-	-	-	-
2i	Rock bolting	51	42					-	-	-	-	-	-	-	-	-	-	-	-
3a	Nozzle excavation	72	65		21	3		-	-	-	-	-	-	-	-	-	-	-	-
3b	Concrete lining	47	40					-	-	-	-	-	-	-	-	-	-	-	-
4a	Cavern excavation	47	37					-	-	-	-	-	-	-	-	-	-	-	-
4b	Cavern lining	47	37					-	-	-	-	-	-	-	-	-	-	-	-
4c	TBM walkthrough	51	39					-	-	-	-	-	-	-	-	-	-	-	-
6a	Piling	77	97	2	40	12	1	-	-	-	-	-	-	-	-	-	-	-	-
6b	Caping Beams	74	94	1	18	8	1	-	-	-	-	-	-	-	-	-	-	-	-
6c	Active Anchors	81	101	6	71	16	6	-	-	-	-	-	-	-	-	-	-	-	-
6d	Excavation OTR	75	95	1	26	9	1	-	-	-	-	-	-	-	-	-	-	-	-
6e	Excavation Rippable	86	106	14	161	33	12	-	-	-	-	-	-	-	-	-	-	-	-
6f	Retention ground anchors - rock bolts	78	98	2	49	13	2	-	-	-	-	-	-	-	-	-	-	-	-
7a	Mucking out - Shaft	74	94	1	20	8	1	-	-	-	-	-	-	-	-	-	-	-	-
8a	Pedestrian Adit	82	101	6	76	17	6	-	-	-	-	-	-	-	-	-	-	-	-
8b	Segment lining	75	95	1	26	9	1	-	-	-	-	-	-	-	-	-	-	-	-

6.1.4 Cumulative impacts

Works in the Main and South sites may occur concurrently. Considering the placement of sensitive receivers relative to each site, cumulative impacts would be minimal, with the nearest site to each residence being the dominant influence on construction noise levels.

When multiple activities are underway on the Main or South sites, predicted levels at any receiver would be influenced primarily by the closest activity. As a worst case, if two similarly noisy activities were underway equidistant from a single receiver, the noise level would increase by 3 dB.

6.1.5 Sleep disturbance

For activities outside approved hours any work within the main station box would be compliant with CoA D37 or the project the EPL. Activities external to the site undertaken outside of approved hours is covered separately under the project OOHW protocol.

Activities to be completed outside standard hours would be wholly within the cavern or within the footprint of the acoustic shed. These works have been assessed to be NML compliant, therefore would not exceed the sleep disturbance criteria.

At the southern shaft site, there are no planned excavation works outside approved hours and therefore sleep disturbance impacts are not applicable.

Other out of hours work not associated with site activities 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 impacts are associated with tunnelling or other subterranean works, which have the potential to generate vibration in the ground which translates into noise as it radiates to internal living spaces. These impacts are considered where noise within a building envelope caused by ground transmission is greater than airborne noise from the construction project.

During site establishment, no substantial vibration-intensive activities are proposed that would create indoor noise levels greater than airborne noise from construction activity. Further, no works are proposed below ground. Therefore, ground-borne noise does not require further assessment or consideration of mitigation measures.

The requirement to consider ground-borne noise is applicable to tunnelling or other subterranean works which have the potential to generate airborne noise impacts at the same receiver. During excavation of the tunnel support shafts, vibration-intensive equipment such as rock hammers and rock bolters would be used. Road headers would also be employed to excavate the mined cavern at the western end of the station box.

A range of ground-borne noise monitoring has been completed over the last few years in Sydney, which provides an indication of the level of ground-borne noise to be experienced by sensitive receivers for work at various 3-dimensional slant distances from the vibration sources. A sample of measured ground-borne noise data for road headers, rock breaking and rock bolting is provided in Figure 6-1 to Figure 6-3.

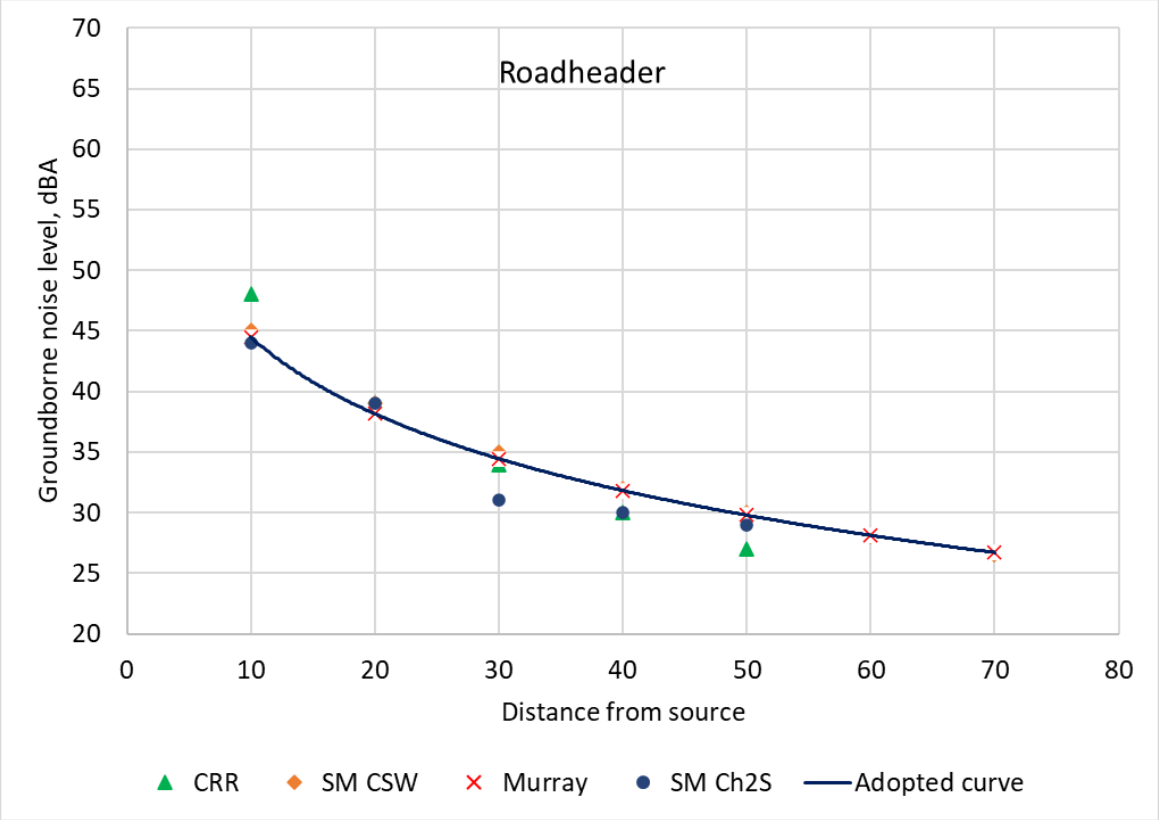


Figure 6-1 Ground-borne noise for road header at various slant distances[1]

[1] CRR (2011) Cross River Rail EIS Construction noise and vibration, SM CSW (2019) Sydney Metro City and Southwest EIS construction noise and vibration, Murray (2003) Tunnelling noise and vibration management, Technical Review, SM Ch2S (2016) Sydney Metro Chatswood to Sydenham Technical Paper.

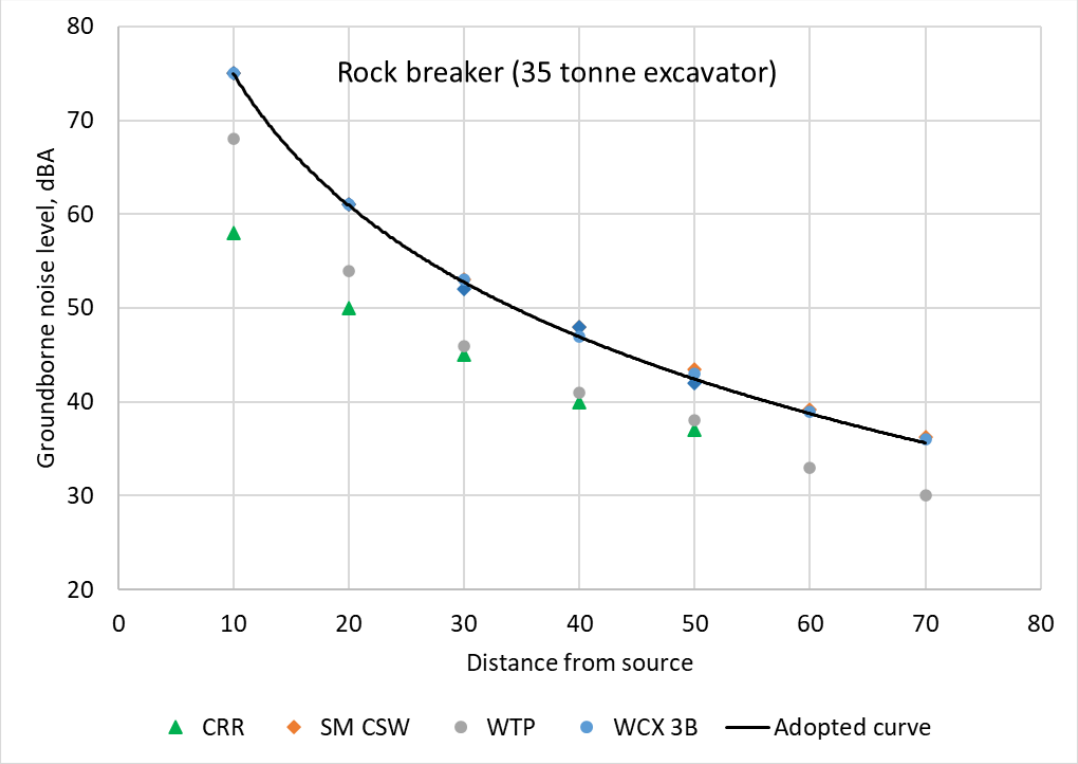


Figure 6-2 Ground-borne noise for 32 tonne excavator with rock breaker at various slant distances[2]

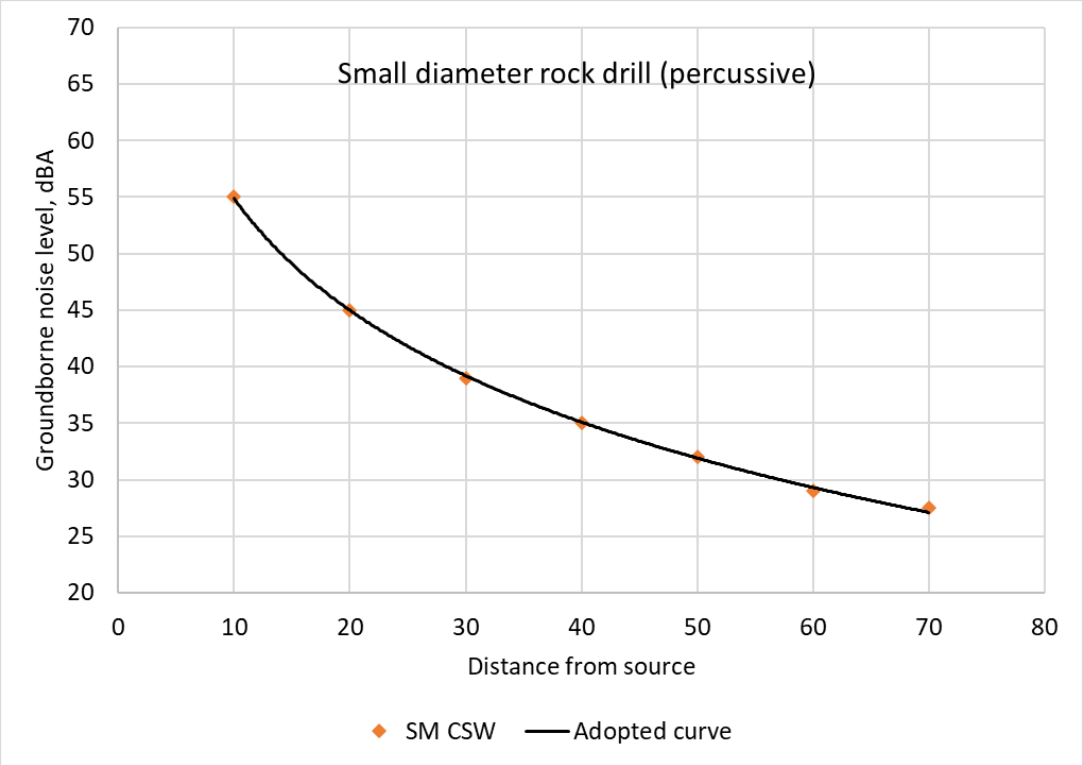


Figure 6-3 Ground-borne noise for road bolter at various slant distances

[2] WTP(2020) Sydney Metro West Stage 1 EIS Technical Paper on Noise and Vibration, WCX 3B (2020) M4-M5 Link Rozelle Interchange Construction Noise and Vibration Impact Statement

Ground-borne noise criteria are not applicable while airborne noise remains the dominant influence on amenity at a sensitive receiver. With the removal of the eastern acoustic roof, night works within the station box that generate ground borne noise are no longer applicable to this DNVIS. Where vibration generating activities occur outside approved hours within the western cavern, the GBN impacts are assessed separately in the tunnelling DNVIS.

6.3 Vibration impact assessment

6.3.1 Assessment method and reference data

There are two stages of works where vibration-intensive works are required. The first during site establishment, which would be limited to some compaction by vibratory rollers and some hammering if necessary during demolition of existing buildings. The second, is where non-rippable excavation occurs within the station box area.

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 6-3 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 hammer	20 t Excavator with hammer	2.9 mm/s at 10 m	Site measurement
	47 t Excavator with hammer	4.8 mm/s at 10 m	Site measurement
Site compaction	Vibratory roller 11 tonne	3.6 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_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

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 around 8 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 13 metres.

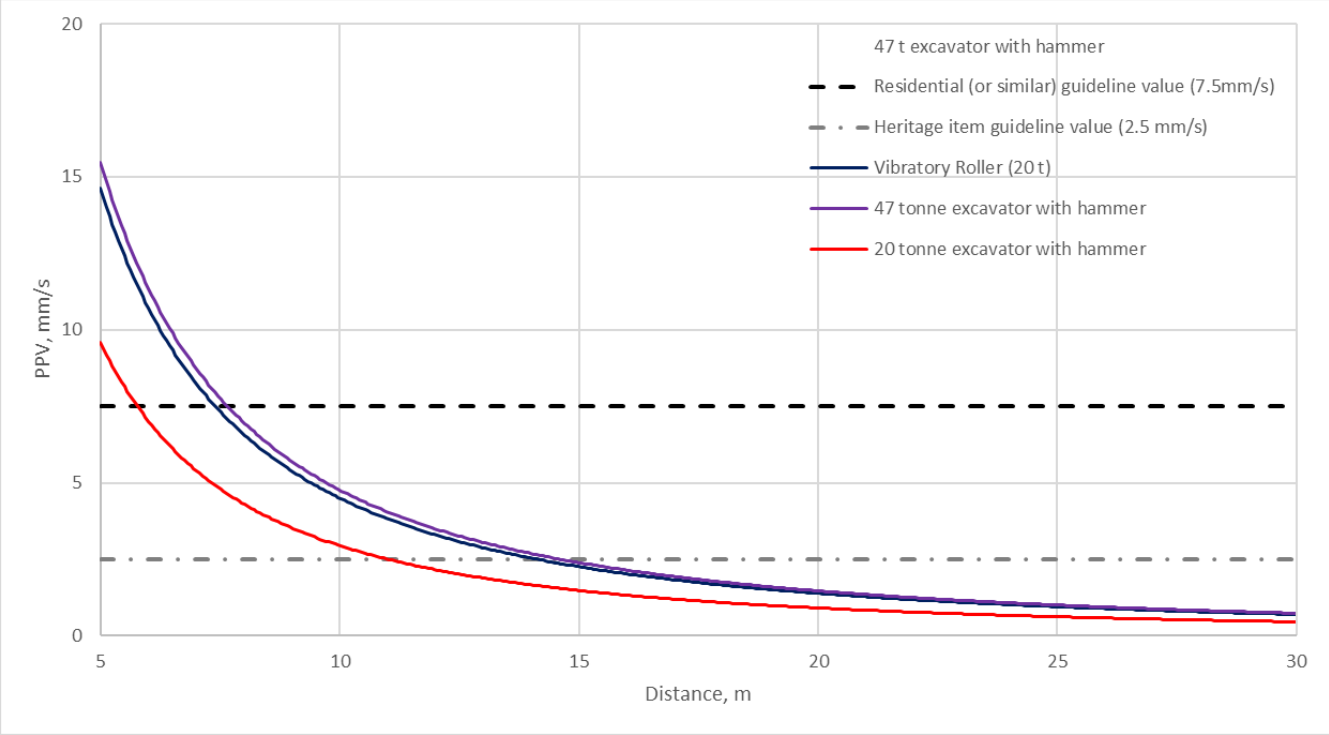


Figure 6-4 Curves of vibration with distance from the source

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 distances identified for each site, trial monitoring should be undertaken prior to any works commencing to determine actual vibration levels.

The AFJV will require the use of vibratory demolition equipment such as rock hammers during some portions of the site establishment works. Rock hammers are needed to remove thick sections of foundation slab that cannot be cut or broken efficiently in other ways.

Several homes along Burton Street and Esher Street as well as a commercial premises on Parramatta Road are within the 7.5 mm/s contour for cosmetic damage and care will be needed to protect their property when working close to the site boundary by following recommendations in Section 7.1.2. No heritage structures are identified within the 2.5 mm/s contour.

Sensitive receivers identified within the minimum distance to meet the applicable vibration guidelines are listed in Table 6-4. Monitoring (Section 7.1.4) and consultation (Section 7.1.5) would focus on these locations.

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

Activity	Activity Location	Address	Distance to works (m)
Demolition	Station box	1 Loftus Street, Burwood	5
	Station box	2-4 Burton Street, Burwood	5
	Station box	8 Burwood Rd, Burwood	5
	South Shaft	1 Esher Street, Burwood	7
	South Shaft	336 Parramatta Road, Burwood	1

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.

Where vibratory demolition works are undertaken within the safe working distances(SWD) for cosmetic and human comfort impacts, non-hammering methods will be employed. When working within these zones, vibration monitoring will be used to confirm the vibration levels at the nearest dwellings.

General consideration of vibration generating activities will include alternative methods where possible to minimise vibration risk, such as:

- Employ smaller rollers or 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.

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 items will be required to confirm actual vibration levels against cosmetic damage criteria (see Section 7.1.4).

Following demolition, the station box and shaft excavations will commence initially with spoil removal via excavator and dozer down to a level of around three metres. Excavation using rock hammers within the station box and the southern shaft would continue to be used to remove non-rippable material as the excavation depth increases.

Vibration from rock hammering at these locations will be less than the predicted levels from demolition due to the distance from the excavations to the residences. As the depth of hammering increases, the slant distance to buildings and structures would also increase.

Based on the vibration curves in Figure 6-4, no residential dwellings would be within the 6 metre SWD buffer for a 20 tonne hammer. At the southern shaft, the Eagle Riders Motorcycle shop, which is adjacent to the excavation shaft, would be within the SWD at the shallower depths.

This location has previously been identified as a potential risk for cosmetic damage to a non-residential building and has a 24 hour vibration monitoring system installed to alert the Project team of any potential exceedances of the vibration criteria.

Where larger equipment such as a 47-50 tonne hammer is used for the station box site, the 10 metre SWD may not be met for one residential dwelling in Burton Street, adjacent to the station box. It is important to consider that distances representing the SWD are at the closest boundary points of the station box excavation and the residences. As hammering work moves away from these areas or where smaller hammers are used, there would be no expected exceedance of the predicted SWD for the station box.

The closest receiver locations to the station box and southern shaft are listed in Table 6-5. Monitoring (Section 7.1.4) and consultation (Section 7.1.5) would focus on these locations.

Table 6-5 Properties identified within safe working distance cosmetic damage - Excavation

Activity	Activity Location	Address	Distance to works (m)
Excavation	Station box	1 Loftus Street, Burwood	13
	Station box	2-4 Burton Street, Burwood	15
	Station box	16 Burton Street, Burwood	10
	South Shaft	14 Burwood Rd, Burwood	18
	South Shaft	1 Esher Street, Burwood	17
	South Shaft	336 Parramatta Road, Burwood	1

6.3.3 Human exposure

During site establishment, rock hammering is not likely to extend over substantial periods of time, so human exposure to vibration would be limited. Rolling also, is likely to be of limited duration in any single location. 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^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 3.5 for rolling and 5 for hammering. The dominant frequency of compacting is taken as 40 Hz and hammering 80 Hz.

eVDVs for durations of rolling and hammering of between 1 hour and 8 hours, are presented in Figure 6-2 and Figure 6-3 respectively, which show the eVDV at various distances from the source for a range of exposure durations.

From the graph, rolling in the daytime would result in possible adverse comment within 20 to 25 metres from the source for a total of up to 8 hours of work. Hammering is likely to result in adverse comment when works are closer than 15 metres for 8 hours a day or about 10 metres for short durations such as 1 – 2 hours.

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

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 25 metres for possible adverse comment during daytime hours. Several homes on Burton Street fall within this category.

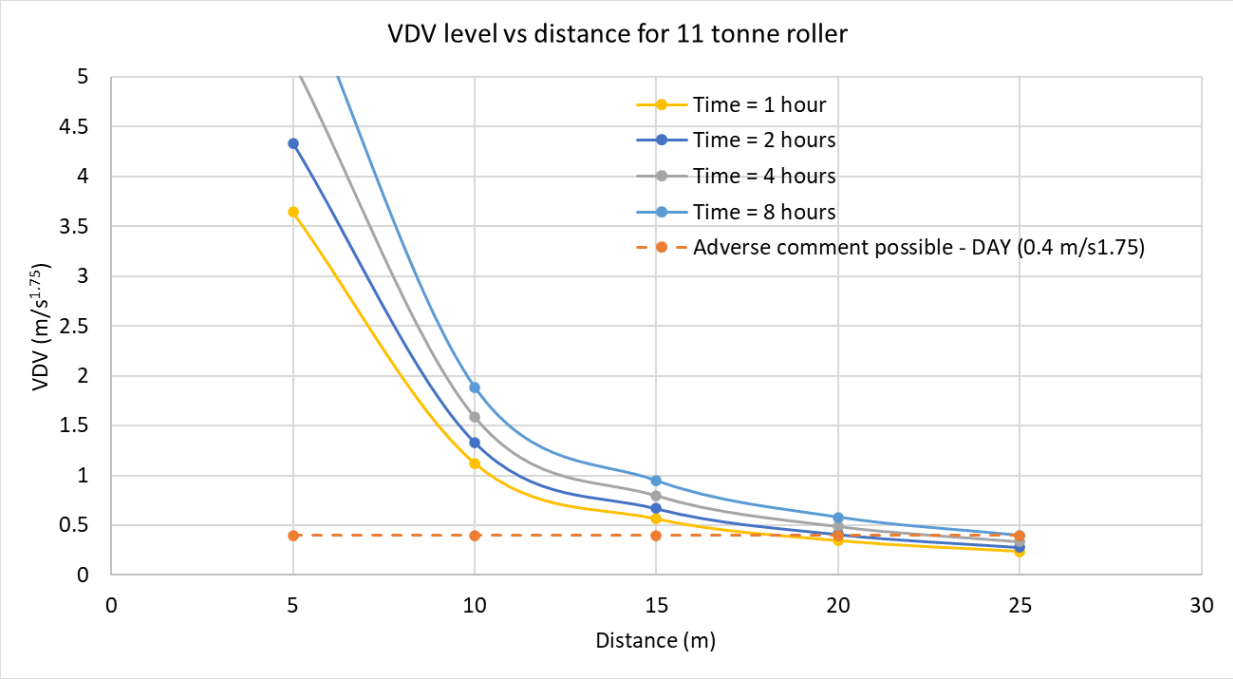


Figure 6-5 VDV curves for vibratory roller

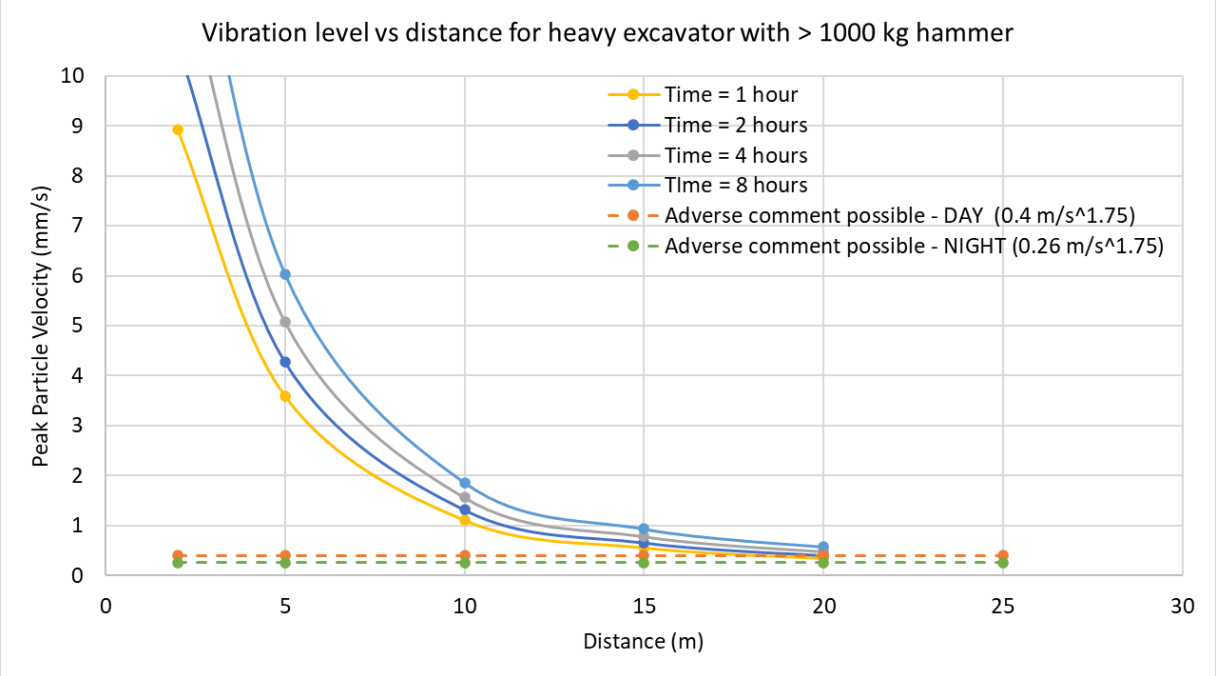


Figure 6-6 VDV curves for 47 tonne excavator with hammer

6.4 Construction traffic

The Burwood north main station box site is bounded by 2 arterial roads, Parramatta Road and Burwood Road, and two local roads, Burton Street and Loftus Street. The southern site is bounded by Parramatta Road and Burwood Road and a laneway access from Esher Lane at the rear of the site.

Figure 6-7 presents the traffic access points for the main and southern sites. Spoil removal from the site will be ongoing up to the completion of the station box and cavern excavation at the western end of the station box until late 2023. Additional deliveries of materials and equipment will continue as necessary during this time.

Based on the nominal activities during site establishment, up to 2 heavy vehicles are expected to access and exit the site each hour during the establishment phase and 8 to 12 heavy vehicles per hour during excavation of the station box and the southern station entry. Condition D37, limits truck movements from the Burwood site to daytime traffic hours from 7am to 10pm for local roads while outside approved hours truck movements must access and exit site via Parramatta Road.

Currently, there is no access to Burton Street therefore all spoil truck movements enter and exit the site via Parramatta Road during the day. Other irregular deliveries of equipment and concrete may use Burton Street during the day. From about mid May 2023 spoil movements of around 120 vehicles per day would use the Parramatta Road exits and an additional 80 spoil/delivery trucks would exit via Burton Street.

Public roads such as Burton Street have low volumes of existing traffic and the EIS indicated a 2 dB increase above existing traffic noise on these roads was likely. For the main site the Burton Street exit is expected to be impacted by daytime traffic defined in the RNP as 7am to 10pm and have been assessed against the RNP criteria for local roads. Local roads have an RNP assessment criteria of L_{Aeq} 1hour 55 dBA for daytime.

To determine potential impacts, an estimate of expected traffic noise using the *Calculation of Road Traffic Noise* (CoRTN) methodology has been completed for the local roads. Based on a speed limit of 40 km/h for vehicles entering and exiting the site, predicted noise levels for the average peak periods of 5-6 vph for Burton Street. An assessment of the construction-related heavy vehicle noise impacts are estimated to be 57 dB L_{Aeq} 1hr for local roads.

For Burton Street the predicted noise levels indicate an exceedance of 2 dBA for the $L_{Aeq\ 1hr}$ daytime period. Where the predicted exceedance of the daytime traffic is no greater than 2dB(A), traffic noise impacts would be managed in accordance with the NVMP.

The southern site construction traffic will use Parramatta Road and Burwood Road which have the noise profile of an arterial road. The additional construction traffic on these roads is only a minor increase in percentage heavy vehicle terms and the predicted traffic noise for 6 hvph is 58 dB(A). The additional traffic on Burwood and Parramatta Roads would therefore be below RNP criteria for daytime road traffic of 60 dB L_{Aeq} 15hr with no substantial increase in traffic volume.

Considering the estimated traffic noise impacts on local roads, the project noise and vibration sub plan provides for the management of construction traffic related noise impacts as follows:

Where road traffic noise levels increase by more than 2 dBA because of construction traffic, consideration will be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity. Consideration will also be given to the actual noise levels associated with construction traffic and whether these levels comply with the following road traffic noise criteria in the RNP:

An important consideration of potential mitigation will include the limited duration of construction noise impact during standard construction hours only and the predicted exceedance of less than 2 dBA above the RNP traffic noise criteria.

A review of the predicted impacts from construction traffic for the nearest receivers indicates that there were no viable options for traffic noise mitigation detailed in the EIS. Heavy vehicle traffic would begin to access Burton Street around mid May 2023, after which time a traffic noise monitoring survey and report would be completed to determine the actual noise levels from the main site prior to the consideration of any mitigation options in accordance with the project Revised Environmental Mitigation Measure (REMM) NV14.

In addition to spoil and delivery 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 the Burwood Main and southern sites.

Onsite mitigation measures such as working on hardstand areas and use of a wheel wash 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. On local roads infrequent use of the street sweeper between 6pm and 10pm during hauling may be required but will be minimised where possible. On Parramatta Road, the street sweep will operate as required. The street sweeper will be included in the traffic noise monitoring survey.

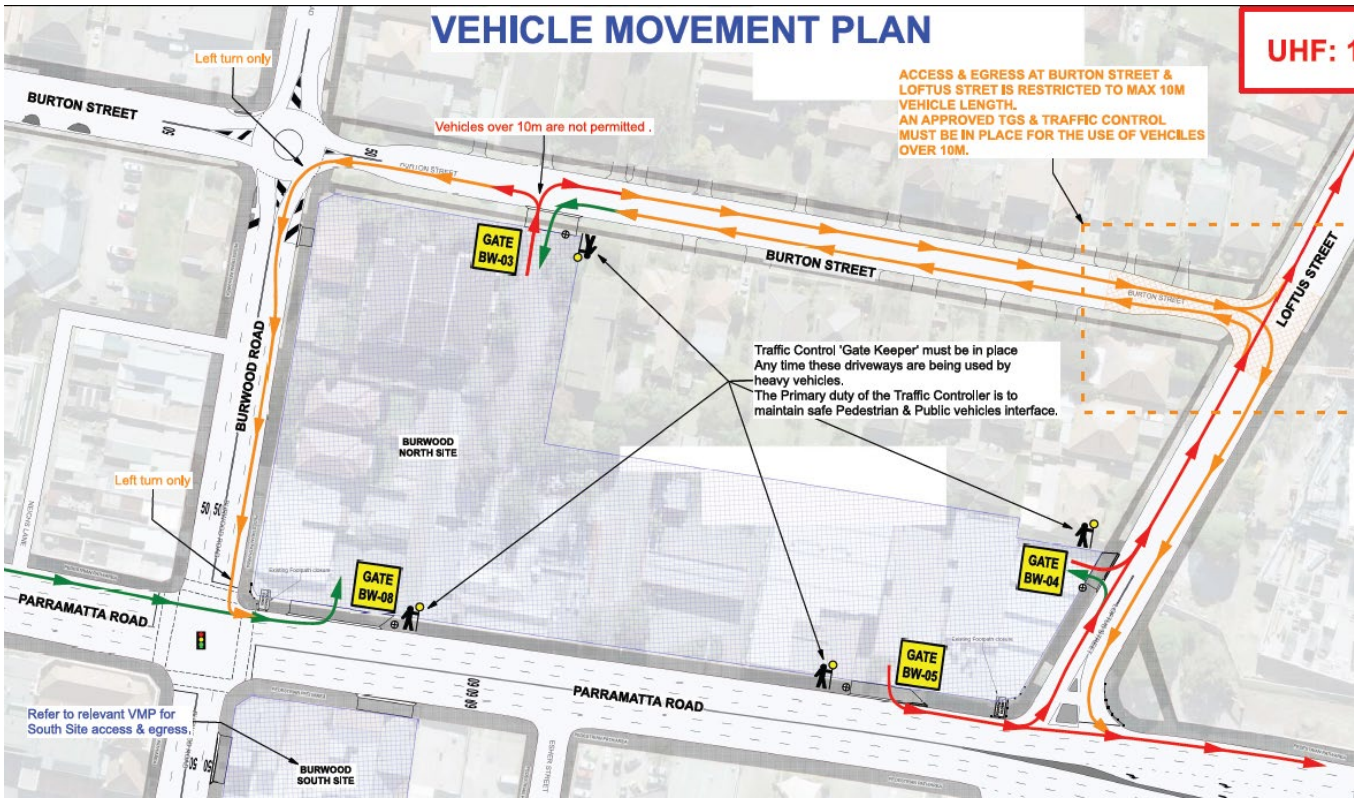


Figure 6-7a Burwood North construction traffic movements – Main site

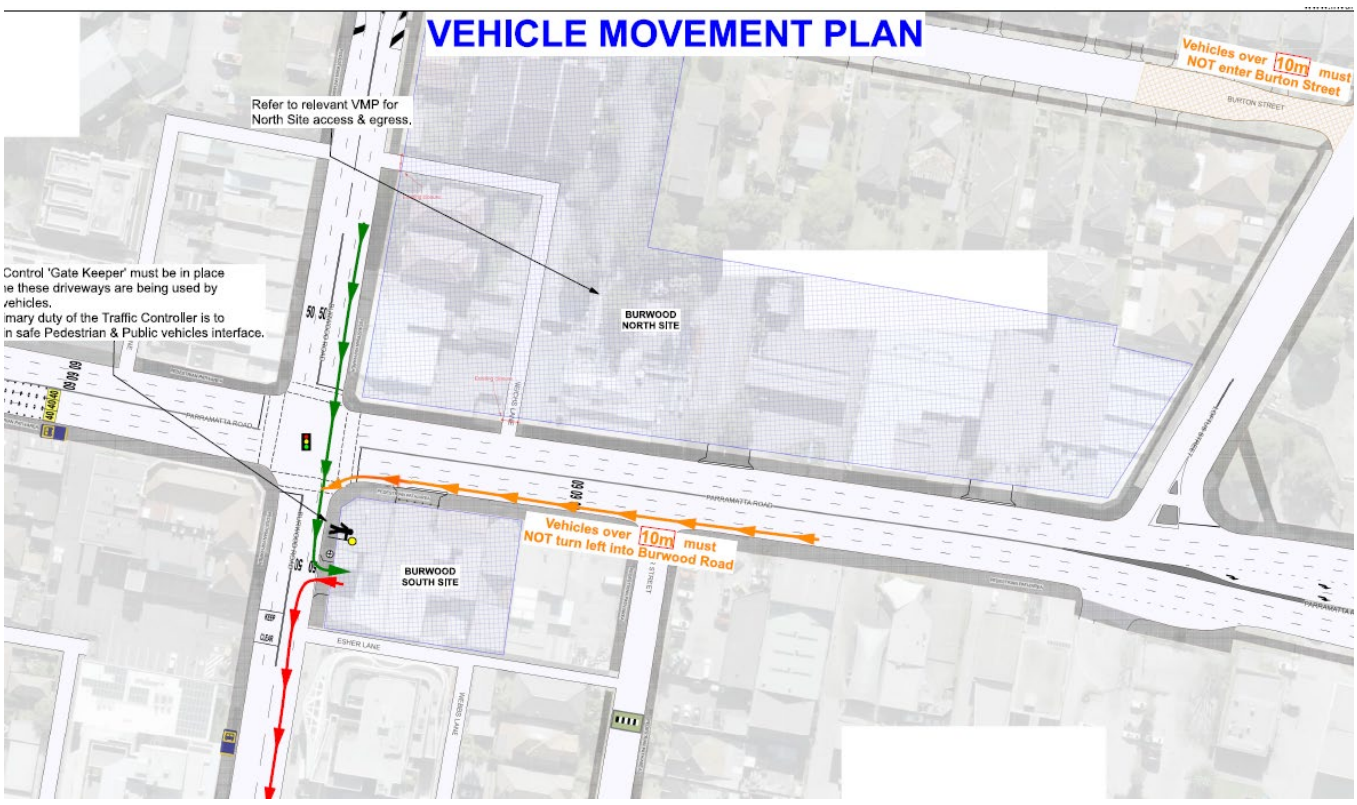


Figure 6-8 Burwood North construction traffic movements – South site

Summary and recommendations

6.4.1 Impact summary

Predicted noise levels indicate some construction activities will result in adverse impacts on the local community, with residents directly adjacent to the works to experience the greatest level of impact.

As there are no noisy works programmed during the evening or night, there are no sleep disturbance expected at this stage.

Where out of hours work are required outside the scope of this DNVIS such as out of hours utility relocations and oversized plant deliveries and this 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.

Hoarding was included as a safety and noise mitigation measure for early works based on the review of mitigation requirements from Sydney Metro West. Some of these areas have existing barriers at the boundary or will be retained as facades of several of the demolished buildings or an equivalent noise wall. Predicted noise levels at receiver locations reflect this level of mitigation.

Despite noisy activities in the eastern end of the station box being approved hours only, predicted noise levels and sensitivity of the community to noise and vibration, results in a moderate level of risk. Mitigation measures in line with this classification are proposed.

Vibration impacts from surface works may be perceptible where vibration generating equipment such as rock hammering or vibratory rolling is undertaken. These impacts need to be managed where vibratory work is required at the closest boundary locations adjacent to sensitive receivers.

With respite, the level of impact on residents is not likely to exceed any vibration management levels outside of the 25 metre buffer zone around these activities. However, within this buffer several homes on Burton Street, Burwood Road and Esher Street may experience vibration above the human comfort thresholds. Cosmetic damage risk is relatively high where vibratory activities are close to the boundary, particularly adjacent to receivers on Burton Street.

6.4.2 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 alternative construction techniques to minimise noise and vibration will be adopted including:
  - 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
  - Completing pile cap breaking using non percussive equipment such as pile croppers

The acoustic shed will be designed and constructed with the aim of meeting the NMLs for evening and night periods for the activities proposed during these times. Shed walls will be erected as early as possible, with walls protecting the nearest residential receivers to be scheduled as a priority.

Where external noise sources are identified outside of this DNVIS, use of noise mats and timber hoarding will provide both an acoustic benefit and a visual indicator to the public that all reasonable and feasible measures are being undertaken.

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 6-7 Properties 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.
	• When working outside schools, medical facilities and child care centres, excessively noisy activities will be completed outside normal working hours where practicable.
	• When working outside churches, particularly noisy activities will be undertaken outside scheduled service times where reasonable and feasible.
	• In accordance with CoA D36 noisy activities as defined in the ICNG, such as concrete cutting, will be undertaken on a, 3 hours on, 1 hour off, basis 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.
	• Trucks shall enter and exit the sites via Parramatta and Burwood Roads during establishment.
Noise control	
Equipment selection	• Priority will be given to the use of quieter and less vibration emitting construction methods and plant alternatives where feasible and reasonable.
	• All equipment shall be well maintained, including mufflers and any noise suppression
	• Use shears to break up building slabs where possible. If unavoidable, use of hammers would be of short duration, during standard hours, follow 3 hours on 1 hour off and be surrounded by noise mats.
	• All equipment will meet the maximum sound power requirements of Table 13 of the CNVS.

Measure	Description
	• 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 Echobarrier) should be placed between source and receivers, be continuous (without gaps) and installed according to manufacturer directions.
	• During demolition, existing buildings will be removed with consideration of retaining noise barriers for as long as possible. Work should generally progress in an anticlockwise direction starting at Burton Road then moving south to Parramatta Road towards Loftus Street with the general aim of providing maximum duration of shielding from the existing buildings and infrastructure.
	• Erection of hoarding will be considered along boundaries with noise affected residents.
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 noise levels below 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.

6.4.3 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.

6.4.4 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 and out-of-hours protocol as appropriate, with the following monitoring to be completed as a minimum.

Noise

- Sound power level verification (on-site) to ensure equipment meets the requirements of the CNVS
- Monitoring at representative nearby sensitive receivers to verify predictions at various phases of construction.
- Evaluation of the acoustic shed for Burwood north to establish that it meets the design requirements described in this DNVIS.
- Ground-borne noise monitoring would be conducted within the centre of habitable rooms at locations identified to exceed the ground-borne noise NMLs or in the event of a complaint if monitoring is identified as an appropriate response.

Vibration

- To verify predicted levels and assist in meeting objectives. This will be done as new vibration intensive activities commence such as ground compaction, percussive drilling, non-rippable excavation with hammers. Monitoring locations will be at the nearest sensitive receiver or at the closest boundary if private property access is unavailable.

- The closest heritage item for the Burwood north and south shafts is the Bath Arms Hotel. This location is expected to fall outside the safe working distance for heritage vibration impacts during demolition and shaft excavation but may experience some low levels of vibration in the range of human comfort levels. while any vibratory work is underway within safe working distances. Consultation prior to potential vibration generating works would be necessary for this site.

Continuous monitoring

- To meet the requirements of CoA D63, fixed monitoring locations have been identified for this site and are detailed in the CNVMP. Long-term noise and vibration monitoring data at these locations will be readily available as required in the CNVMP and Monitoring Program.

6.4.5 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. All mitigation measures developed as part of this DNVIS have been formed around community needs and concerns established through the community consultation process, as required by CoA D43. This process will continue for further phases of work.

In reviewing sensitive land uses near the Burwood North sites, specific receivers requiring consultation has included nearby receivers on Burton Street, Loftus Street, Esher Lane, Parramatta Road and Burwood Road, as well as businesses, schools and places of worship, which may be sensitive to noise.

AFJV's Place Manager presence on site since 20 October 2021 has been instrumental in identifying the needs of local residents, businesses and community organisations. Regular standardised and tailored communication material has been provided to stakeholders at each stage of site development, including targeted doorknocks and communication material at key construction milestones such as installation of the water treatment plant, excavation progress, Tasman tank and acoustic shed construction.

In addition, many properties around Loftus and Burton Street are suffering construction fatigue resulting from the recently completed Concord Oval redevelopment. AFJV worked closely with ADCO Construction Australia (Concord Oval construction contractor) and the Concord Oval Redevelopment to ensure a consistent interface, plan works to avoid cumulative impacts to nearby receivers and to communicate and advocate any concerns of residents.

AFJV has continued to utilise the mitigation measure of relocation (alternative accommodation) for residents impacted by OOHW, complementing this with additional respite offers such as noise cancelling headphones and movie vouchers for stakeholders with specific and/or unique circumstances. These offers are extended for both airborne and groundborne noise impacts where appropriate.

AFJV continues to work closely with St Luke's Anglican Church in Burton Street during construction with open dialogue on the construction timeline, precondition property inspections for the heritage site and specific requirements for the additional activities held at the Church grounds (such as playgroups and classes). Tailored communication has been very effective with this sensitive receiver to ensure all disruptive activity is communicated clearly in advance to minimise any impact on the day to day running of the Church and the wider congregation. To date the Church has expressed great satisfaction with the operation of the site and communications regarding impacts on Burton Street and continues to be an advocate of Sydney Metro as a result. In particular, the Church expressed gratitude for the detailed attention to the needs of the Church such as ensuring VMS signs are in place advising the community the Church access was open when Burton Street was closed. The Church continues to work closely with the Place Manager and participate in significant events on site such as the blessing of the St Barbara statue prior to tunnelling commencement.

AFJV has also commenced discussions with St Marys Church, Catholic Primary School and Residential Retirement Villas, all located on the block from Parramatta Road, Broughton Street and Burton Street. Whilst these stakeholders are located some 300m from site, they will be affected by tunnelling activity. After close consultation with the primary school and Parish Priest, AFJV adjusted the program of geotechnical investigation work that was set to occur in front of the school building to undertake this activity during the school holidays to minimise disruption. This willingness to adjust set programs to consider the needs of the school has been well received by these important stakeholders. AFJV has also commenced engagement activities with the school to ensure the wider school community is aware and informed of the activities occurring at the Burwood North construction site.

AFJV has also commenced discussions with local businesses in the area to ascertain their specific needs and concerns and ensure the construction team are fully aware of these, such as the Royal Enfield Motorcycle shop that shares a wall with the South site. The Royal Enfield has been appreciative of the collegiate relationship with AFJV and assistance with modifying disruptive work when major promotions or filming us underway. AFJV continues to ensure construction methodology and sequencing is sensitive to the impact of the Royal Enfield and the program planning is reflective of this with all attempts to undertake disruptive work such as pile trimming and shotcrete adjacent to the wall undertaken on the day the business is not operational wherever possible.

Businesses and residents on Burton Street and Burwood Road have been kept well informed of the updates to the sewer relocation package to ensure they understood their access to alternative accommodation and to minimise impacts of work on shop trading.

AFJV will continue to consult with the community about planned works, including regular updates 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.

An out of hours work lookahead of no less than 3 months is provided to the community on a quarterly basis while monthly site-based notifications are distributed and emailed as well as sent via Sydney Metro Connect App and weekly email updates provide regular updates on progress of current out of hours work as well as upcoming work. A recent Community information drop-in session was held on 4 May 2023. 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 A. Land use survey and NCA maps


Sydney Metro West
Central Tunneling Package
Land Use Survey
Project Footprint
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
None
0
50
100 m
Gipps Street
Burwood Road
Burton Street
Parramatta Road
Parramatta Road
Burwood Road
Shaftsbury Road
hutchison
weller

Appendix B. Proposed equipment and sound power levels

B.1 Site establishment

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
1	Site Establishment- North shaft	Construction Compound	1a	Daily activities	Power Generator	1			106	1	5	0	107	101	0	0	108	0	0
					Road truck (d per 15 minutes)	2			107	0.4		0	112	106	0	0			
					Light vehicle / 15 min	4			93	0.3		0	98	93	0	0			
					Compressor	1			101	0.3		0	106	95	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Franna Crane	1			98	0.4		0	103	94	0	0			
		Construction facilities	1b	Construction facilities	Excavator w bucket	2			107	0.6		0	112	108	0	0	111	0	0
					Franna Crane	1			98	0.6		0	103	96	0	0			
					Small Truck / 15 min	1			93	0.3		0	98	88	0	0			
					Concrete Agi / 15 min	2			103	0.3		0	108	101	0	0			
					Pneumatic vibrator	1			95	1		0	100	95	0	0			
					Compressor trailer mount	1			94	0.4		0	99	90	0	0			
					Concrete pump	1			108	0.3		0	113	103	0	0			
					Mobile crane	1			104	1.4		0	109	105	0	0			
					Hand tools	2			94	0.2		0	99	90	0	0			
					Elevated work platform	2			89	2.4		0	94	96	0	0			
		Temporary fencing/ hoardings	1c	Fencing & hoarding	Bobcat	1			107	0.3		0	112	102	0	0	107	0	0
					Tracked excavator w bucket	1			107	0.4		0	112	103	0	0			
					Flat bed truck	1			93	0.3		0	98	88	0	0			
					Hiab	1			101	0.3		0	106	96	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Concrete agitator trucks	1			103	0.3		0	108	98	0	0			
		Utilities Disconnection	1d	Utilities disconnection	15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0	110	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Bogie trucks	1			93	1		0	98	93	0	0			
					Compressor	1			93	0.5		0	98	90	0	0			
					Jackhammer*	1			111	0.2		5	119	109	0	0			
		Demolition	1e	Demolition (no hammer)	47t Excavator bucket/shears	3			112	0.4		0	117	108	0	0	113	0	0
					Tipper trucks	2			98	0.4		0	103	97	0	0			
					Watercart	1			103	0.4		0	108	99	0	0			
					Possi Track bobcat	1			107	0.3		0	112	102	0	0			
			1f	Demolition (with hammer)	47t Excavator + hammer	1			122	0.3		5	128	122	0	0	122	0	0
					10t Excavator	1			99	0.4		0	109	100	0	0			
					Tipper trucks	1			98	0.4		0	103	94	0	0			
		Site Concrete Works	1g	Site Concreting	15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0	109	0	0
					Franna	1			98	0.4		0	103	94	0	0			
					Concrete agitator	1			103	0.3		0	108	98	0	0			
					Compressor, trailer mounted	1			94	0.5		0	99	91	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
					Generator	1			106	1		0	107	106	0	0			
					Concrete Pump	1			108	0.3		0	113	103	0	0			
5	Site Establishment- South Shaft	Construction Compound	5a	Daily activities	Power Generator	1			106	1	5	0	107	101	0	0	108	0	0
					Road truck (deliveries per 15 minutes)	2			107	0.4		0	112	106	0	0			
					Light vehicle / 15 min	4			93	0.3		0	98	93	0	0			
					Compressor	1			101	0.3		0	106	95	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Franna Crane	1			98	0.4		0	103	94	0	0			
		Construction Compound	5b	Construction facilities	Excavator w bucket	1			107	0.6		0	112	105	0	0	107	0	0
					Franna Crane	1			98	0.6		0	103	96	0	0			
					Small Truck / 15 min	1			93	0.3		0	98	88	0	0			
					Concrete Agi / 15 min	1			103	0.3		0	108	98	0	0			
					Pneumatic vibrator	1			95	1		0	100	95	0	0			
					Compressor trailer mounted diesel	1			94	0.4		0	99	90	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Elevated work platform	1			89	2.4		0	94	93	0	0			
		Temporary fencing/ hoardings	5c	Fencing & hoarding	Bobcat	1			107	0.3		0	112	102	0	0	107	0	0
					15t Tracked excavator w bucket	1			107	0.4		0	112	103	0	0			
					Flat bed truck	1			93	0.3		0	98	88	0	0			
					Hiab	1			101	0.3		0	106	96	0	0			
					Hand tools	1			94	0.2		0	99	87	0	0			
					Concrete agitator trucks	1			103	0.3		0	108	98	0	0			
		Utilities Disconnection	5d	Utilities disconnection	15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0	110	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Bogie trucks	1			105	0.2		0	110	98	0	0			
					Compressor	1			93	0.5		0	98	90	0	0			
					Jackhammer*	1			111	0.2		5	119	109	0	0			
		Demolition	5e	Demolition (no hammer)	20t Excavator bucket/shears	1			109	0.4		0	117	108	0	0	111	0	0
					15t Excavator	1			107	0.4		0	112	103	0	0			
					Franna	1			98	0.4		0	103	94	0	0			
					Saw cutter	1			100	0.2		5	108	98	0	0			
					1x Watercart	1			103	0.4		0	108	99	0	0			
					60T Mobile Crane	1			109	0.4		0	114	105	0	0			
			5f	Demolition (with hammer)	20t Excavator + Hammer	1			120	0.3		5	128	120	0	0	120	0	0
					14t Excavator	1			104	0.4		0	109	100	0	0			
					Tipper trucks	1			98	0.4		0	103	94	0	0			
		Temporary construction and concrete slabs	5g	Site concreting	15t excavator + Bucket	1			107	0.4		0	112	103	0	0	109	0	0
					Franna	1			98	0.4		0	103	94	0	0			
					Concrete Agi	1			103	0.3		0	108	98	0	0			
					Compressor (Diesel)	1			93	0.5		0	98	90	0	0			
					Concrete Pump	1			108	0.3		0	113	103	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
			Generator	1			106	1		0	107	106	0	0			

B.2 Burwood North Station Box Excavation (Main)\ Shaft excavation (South)

Phase		Activity/ Work Area	Aspect		Plant/Equipment	Day	Evening	Night	SWL, dBA	Usage	Temp. barrier reduction, dB	Penalty, dB	SWL	Adj equipment SWL, LAeq,15 minute			Activity LAeq, 15 min SWL		
						7am - 6pm	6pm - 10pm	10pm - 7am					Lmax	Day	Evening	Night	Day	Evening	Night
2	Station Box Surface Works	Piling	2a	Piling	Piling Rig (Bauer BG50)	1			113	0.4		0	118	109	0	0	111	0	0
					Franna x2	1			98	0.4		0	103	94	0	0			
					Concrete Pump	1			108	0.3		0	113	103	0	0			
					15t tracked excavator + bucket	1			107	0.4		0	112	103	0	0			
		Acoustic Shed	2b	Acoustic shed construction	400t mobile crane	1			98	0.4		0	103	94	0	0	103	0	0
					EWP	1			89	0.3		0	94	84	0	0			
					Delivery truck	1			93	1		0	98	93	0	0			
					Table saw*	1			100	0.2		5	108	98	0	0			
					Rattle gun*	1			105	0.2		0	110	98	0	0			
					5" grinder *	1			93	0.2		5	101	91	0	0			
					25T Mobile pick and carry crane (franna)	1			98	0.4		0	103	94	0	0			
		Caping Beams	2c	Caping Beams	Franna	1			98	0.4		0	103	94	0	0	106	0	0
					5t Excavator + Pile Cropper	1			94	0.4		0	99	90	0	0			
					20t Excavator	1			105	0.4		0	110	101	0	0			
					Concrete Pump	1			108	0.3		0	113	103	0	0			
					Concrete vibrator	1			100	0.4		0	105	99	0	0			
		Active Anchors	2d	Active Anchors	Drill rig*	1			114	0.4		5	119	115	0	0	115	0	0
					Shotcrete rig	1			106	0.4		0	111	102	0	0			
					Franna	1			98	0.4		0	103	94	0	0			
	Station Box Excavation	Retention - Whaler Beam	2e	Whaler Beams	60t mobile crane	1			109	0.4		0	114	105	0	0	105	-	-
					EWP x2	2			89	0.3		0	94	87	0	0			
		Excavation- OTR	2f	OTR 0m-3m	D10 Dozer	1	1		118	0.4		0	123	114	114	0	117	0	0
					50t Excavator + Bucket (Bulk)	2	2		112	0.4		0	117	111	111	0			
					35t Excavator + Bucket	1	1		109	0.4		0	114	105	105	0			
					20t Excavator + Bucket	2	2		105	0.4		0	110	104	104	0			
					14t Excavator + Bucket	1	1		107	0.4		0	112	103	103	0			

					30T Articulated Dump Trucks	2	2	107	0.3	0	112	105	105	0			
		Excavation Rippable	2g	Rip 3m-18m	D10 Dozer	1	1	118	0.4	0	123	114	114	0	125	116	0
					50t Excavator + Hammer	2	0	122	0.3	5	130	125	0	0			
					Gantry Cranes (electric) within acoustic shed	1	1	99	0.6	0	100	97	97	0			
					35texcavator	1	1	109	0.4	0	114	105	105	0			
					35t telescopic excavator	1	1	109	0.4	0	114	105	105	0			
					20t Excavator	2	1	105	0.6	0	110	106	103	0			
					14t Excavator	1	1	112	0.4	0	117	108	108	0			
		Excavation Non-Rippable	2h	Non_Rip 18m-31m	70t Excavator + Bucket + Hammer (Bulk)	2		122	0.4	5	130	126			131	123	0
					50t Excavator + Bucket + Hammer (Bulk)	3		122	0.4	5	130	128					
					35t Excavator + Bucket + Hammer (Bulk)	1	1	122	0.4	5	130	123	123				
					35t telescopic excavator at surface for muck out	2	1	109	0.4	0	114	108	105				
					20t Excavator	2	1	105	0.4	0	110	104	101				
					14t Excavator + Trimming	1	1	104	0.4	0	109	100	100				
		Retention-Rockbolts	2i	Rock Bolting	Drill Rig (ECM 660IV)	2	1	1	118	0.5	5	126	123	120	120	123	120	120
					Shotcrete rig	1	1	1	106	0.4	0	111	102	102	102			
					telehandler	1	1	1	89	0.3	0	94	84	84	84			
					EWP x 2	2	1	1	100	0.4	0	105	99	96	96			
					Franna	1	1	1	98	0.4	0	103	94	94	94			
3	Tunnel Nozzles	Tunnel nozzle excavation	3a	Nozzle Excavation (east)	20t Excavator + hammer	1			120	0.3	5	128	120	0	0	121	0	0
					Roadheader Mitsui S300	1			100	1	0	108	100	0	0			
					14T Excavator + Bucket + Ripper	1			107	0.4	0	112	103	0	0			
					Shotcrete Rig 8100 Spraymec	1			106	0.4	0	111	102	0	0			
					Drill Rig - Robodrill - Electric	1			114	0.4	0	119	110	0	0			
					50m3 scrubber	1			104	1	0	106	104	0	0			
					30t Dump truck	1			107	0.3	0	112	102	0	0			
		Concrete Lining	3b	Concrete lining	Telehandler	1	1	1	100	0.4	0	105	96	96	96	107	107	107
					E.W.P	4	4	4	89	0.5	0	94	90	87	87			
					1x Diesel Concrete Line Pump	1	1	1	108		0	113	105	105	105			
					2x Concrete Trucks (at Surface level)	2	2	2	103	0.5	0	108	103	103	103			

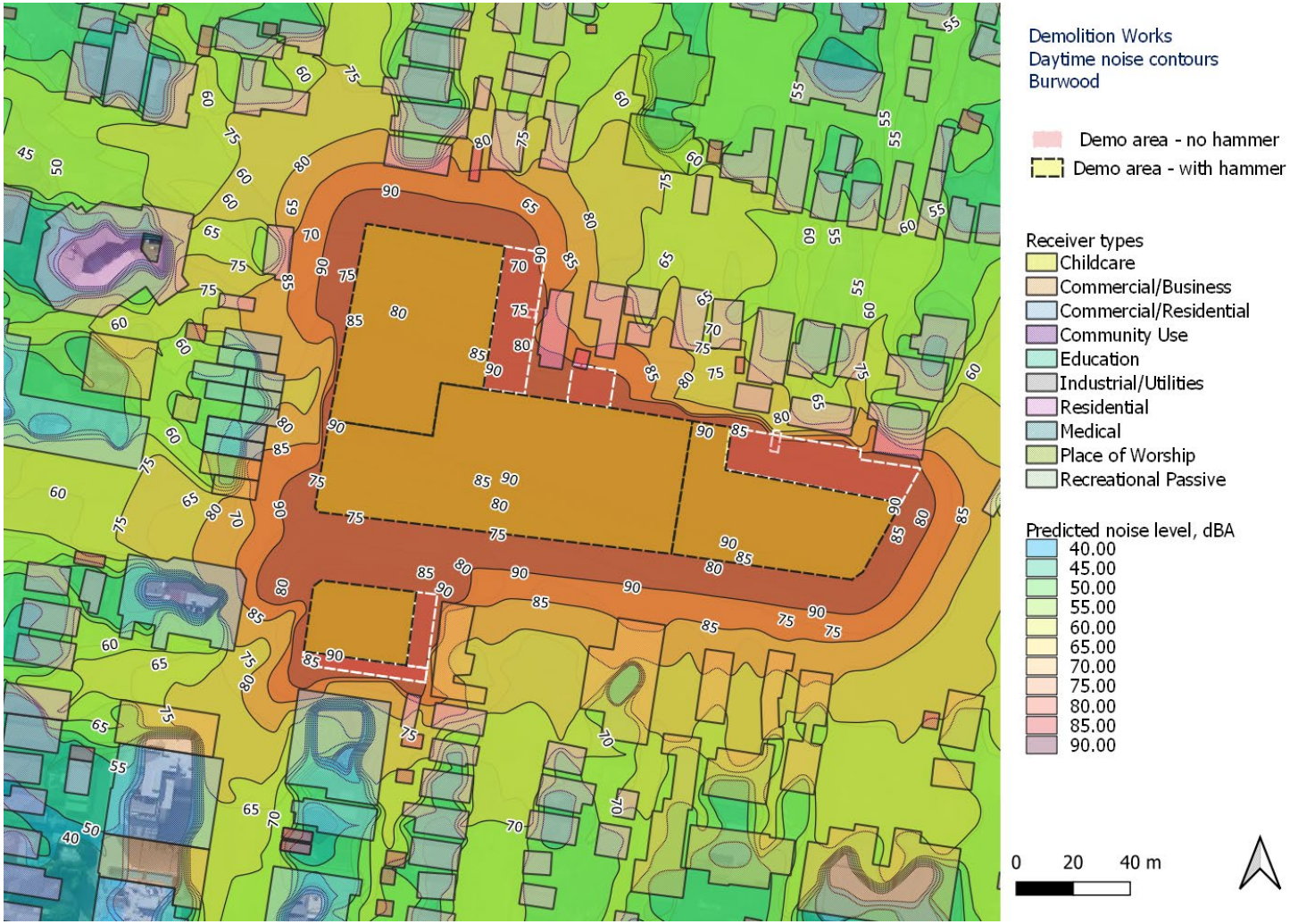
4	Mined Caverns	Cavern excavation	4a	Cavern Excavation* (Tunnelling)	300kW Road header (Mitsui S300)	2	2	2	100	1	0	108	103	103	103	122	122	122
					Twin Boom Jumbo Drill Rig	1	1	1	120	0.4	5	128	121	121	121			
					Normet 8100 Shotcrete rig	2	2	2	106	0.4	0	111	105	105	105			
					CAR325 Dump Trucks	2	2	2	107	1	0	112	110	110	110			
					14t Excavator	1	1	1	107	0.6	0	112	105	105	105			
					50m3 scrubber	2	2	2	104	1	0	106	107	107	107			
				Shed activities	Spoil Truck	1	1	1	100	0.6	0	105	98	98	98	107	106	106
					Gantry crane (Kibble)	1	1	1	99	0.2	0	100	92	92	92			
					8m3 Agi Truck	2	1	1	103	0.3	0	108	98	98	98			
					14t Excavator + Bucket	1	1	1	107	0.6	0	112	105	105	105			
		Concrete Lining	4b	Cavern lining	6m3 agi truck	4	3	3	103	0.3	0	108	104	103	103	108	107	107
					Concrete Line Pumps	2	1	1	108	0.3	0	113	106	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			
	TBM Launch	TBM Walkthrough	4c	TBM walkthrough	2x Telehandlers	2	2	2	100	0.5	0	105	100	100	100	109	109	109
					2x E.W.Ps	2	2	2	89	0.5	0	94	89	89	89			
					1x Bobcat	1	1	1	107	0.5	0	112	104	104	104			
					1x 40T Volvo Loader	1	1	1	110	0.5	0	115	107	107	107			
6	Southern Shaft Surface works	Piling	6a	Piling	750 dia piling rig	1			113	0.4	0	118	109	0	0	111	0	0
					40t crawler crane	1			109	0.4	0	114	105	0	0			
					15t excavator + Bucket	1			107	0.4	0	112	103	0	0			
		Caping Beams	6b	Caping Beams	Franna	1			98	0.4	0	103	94	0	0	107	0	0
					14T Excavator + Pile Cropper	1			107	0.4	0	112	103	0	0			
					Concrete Pump	1			108	0.3	0	113	103	0	0			
					Concrete vibrator	1			100	0.4	0	105	96	0	0			
		Active Anchors	6c	Active Anchors	Drill rig (Percussion)	1			114	0.4	5	119	115	0	0	115	0	0
					Shotcrete rig	1			106	0.4	0	111	102	0	0			
					Franna	1			98	0.4	0	103	94	0	0			
	Southern Shaft Excavation & Retention	Excavation OTR	6d	Excavation OTR	2x 50T Excavator + Bucket (Bulk)	2			112	0.4	0	117	111	0	0	112	0	0
					1x 30T Excavator + Bucket (Trim)	1			109	0.4	0	114	105	0	0			
		Excavation Rippable	6e	Excavation Rippable 3m - 17m	2x 50T Excavator + Bucket + Ripper + Hammer (Bulk)	2			122	0.3	5	130	125	0	0	125	0	0
					1x 30T Excavator + Bucket + Ripper (Trim Walls)	1			109	0.4	0	114	105	0	0			
					1x 30T Excavator + Bucket +	1			110	0.4	5	118	111	0	0			

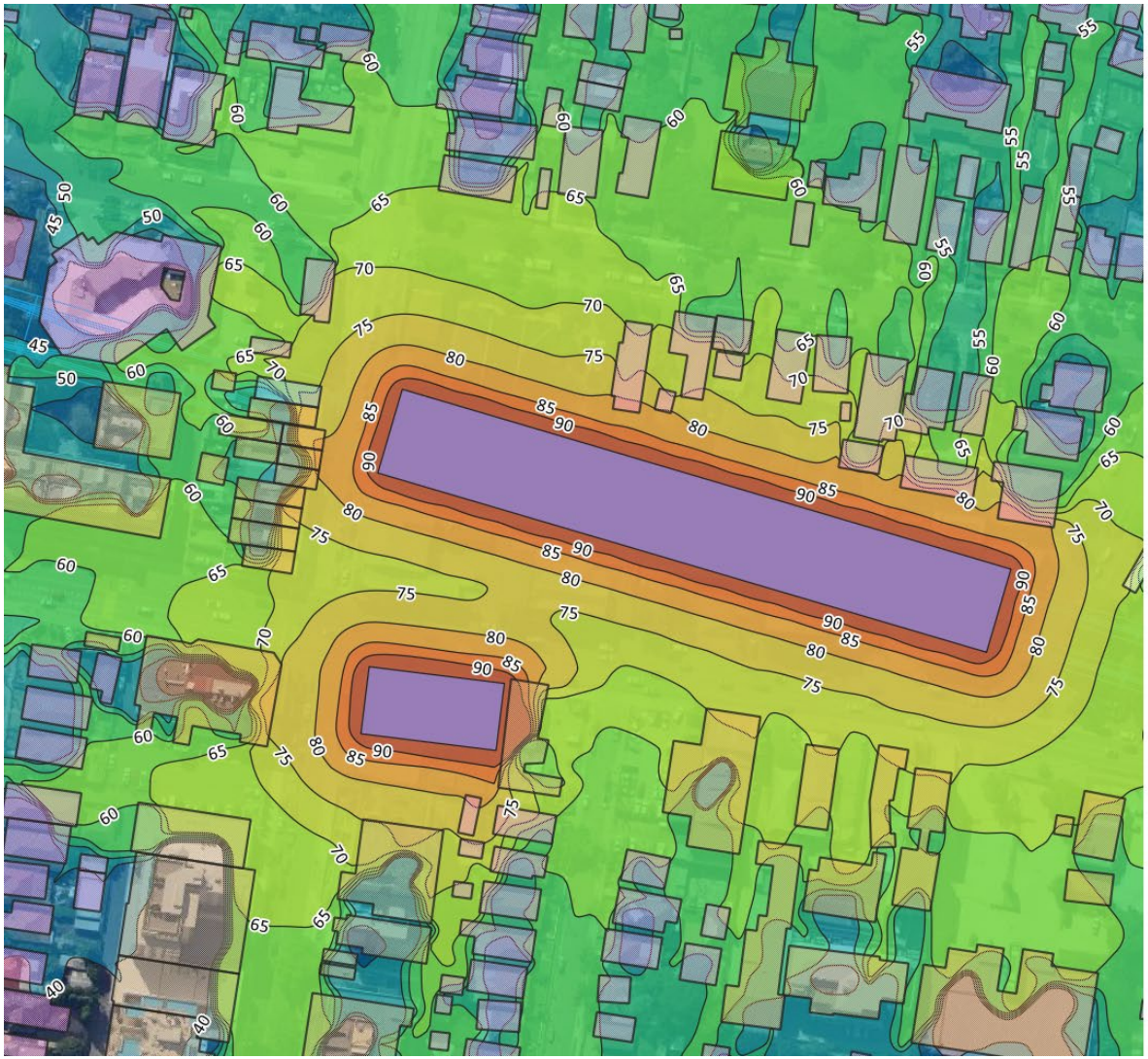
					Ripper (Saw Cutting/ Trimming))											
		Retention- Ground Anchors /Rockbolts	6f	Retention	Drill Rig (ECM 660IV)	1	114	0.4	5	119	115	0	0	115	0	0
					Shotcrete rig	1	106	0.4	0	111	102	0	0			
					EWP	1	100	0.4	0	105	96	0	0			
7	Mucking out- Southern Shaft	Mucking Out - Excavator	7a	Mucking Out - Excavator	50T Excavator + Bucket	1	112	0.4	0	117	108	0	0	108	0	0
8	Pedestrian adit	Adit Excavation	8a	Adit nozzle	50t Excavator	1	108	0.8	0	113	107	0	0	121	0	0
					35t Excavator	1	109	-0.5	0	114	0	0	0			
					Twin Boom Jumbo Drill Rig	1	118	0.5	0	126	115	0	0			
					Meyco Potenza Shotcrete Rig	1	106	0.4	0	111	102	0	0			
					15T Excavator (Hammer)	1	118	0.4	5	126	119	0	0			
					E.W.P	2	89	0.3	0	94	87	0	0			
		Concrete Lining	8b	Concrete lining	6m3 agi truck	3	103	0.3	0	108	103	0	0	107	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			

Notes: * All equipment located inside cavern tunnel

Appendix C. Construction noise and vibration contours

C.1 Construction noise contours





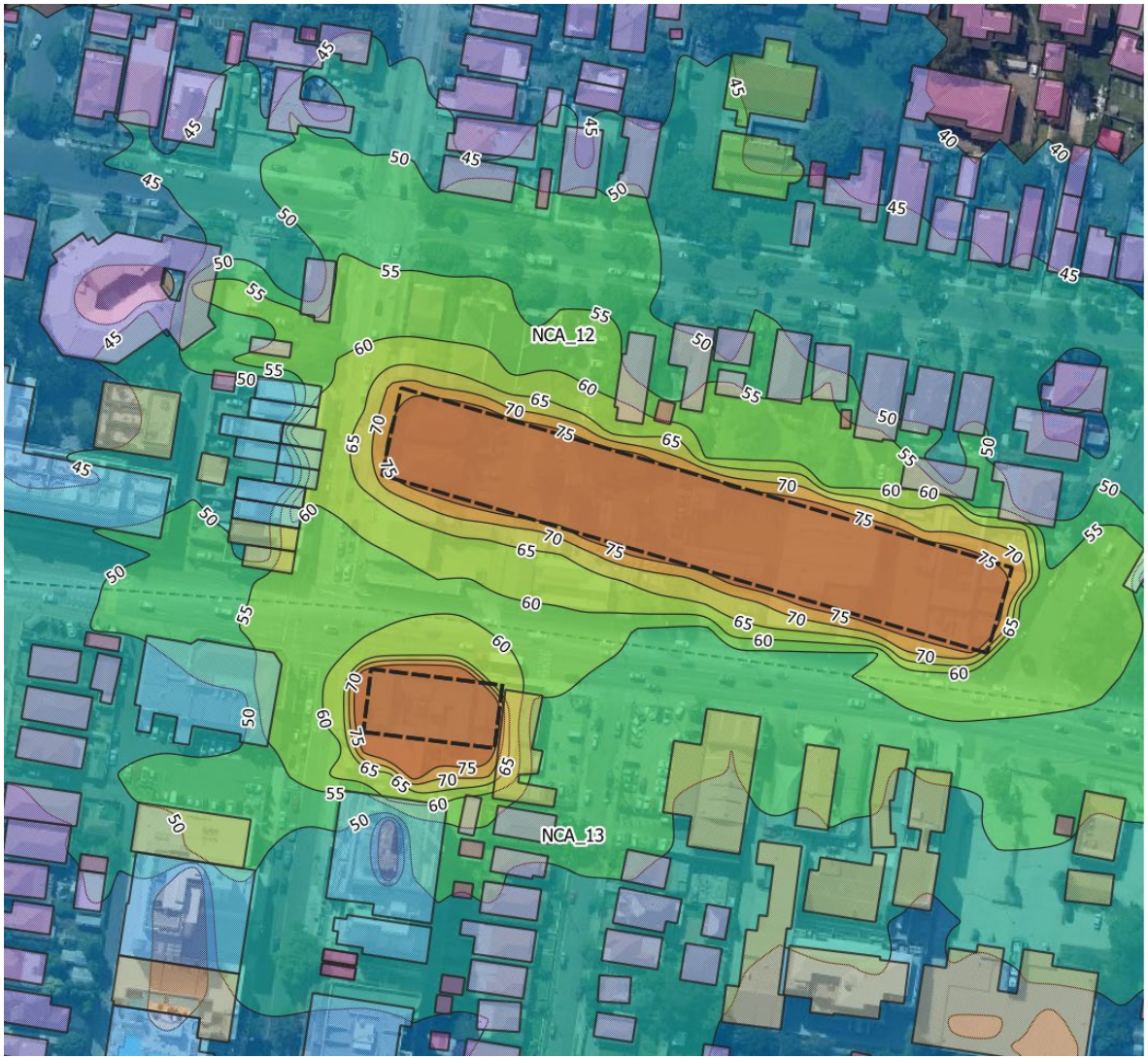
Piling Works
Daytime noise contours
Burwood

Piling Area

Receiver types
- Childcare
- Commercial/Business
- Commercial/Residential
- Community Use
- Education
- Hotel
- Industrial/Utilities
- Residential
- Place of Worship
- None

Predicted noise level, dBA
- 40.00
- 45.00
- 50.00
- 55.00
- 60.00
- 65.00
- 70.00
- 75.00
- 80.00
- 85.00
- 90.00

0 20 40 m



OTR Excavation Works
Daytime Noise Contours
Burwood

Excavation Area

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

Precited Noise Levles, dBA
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

0 20 40 m

Ripping Excavation Works
Daytime Noise Contours
Burwood

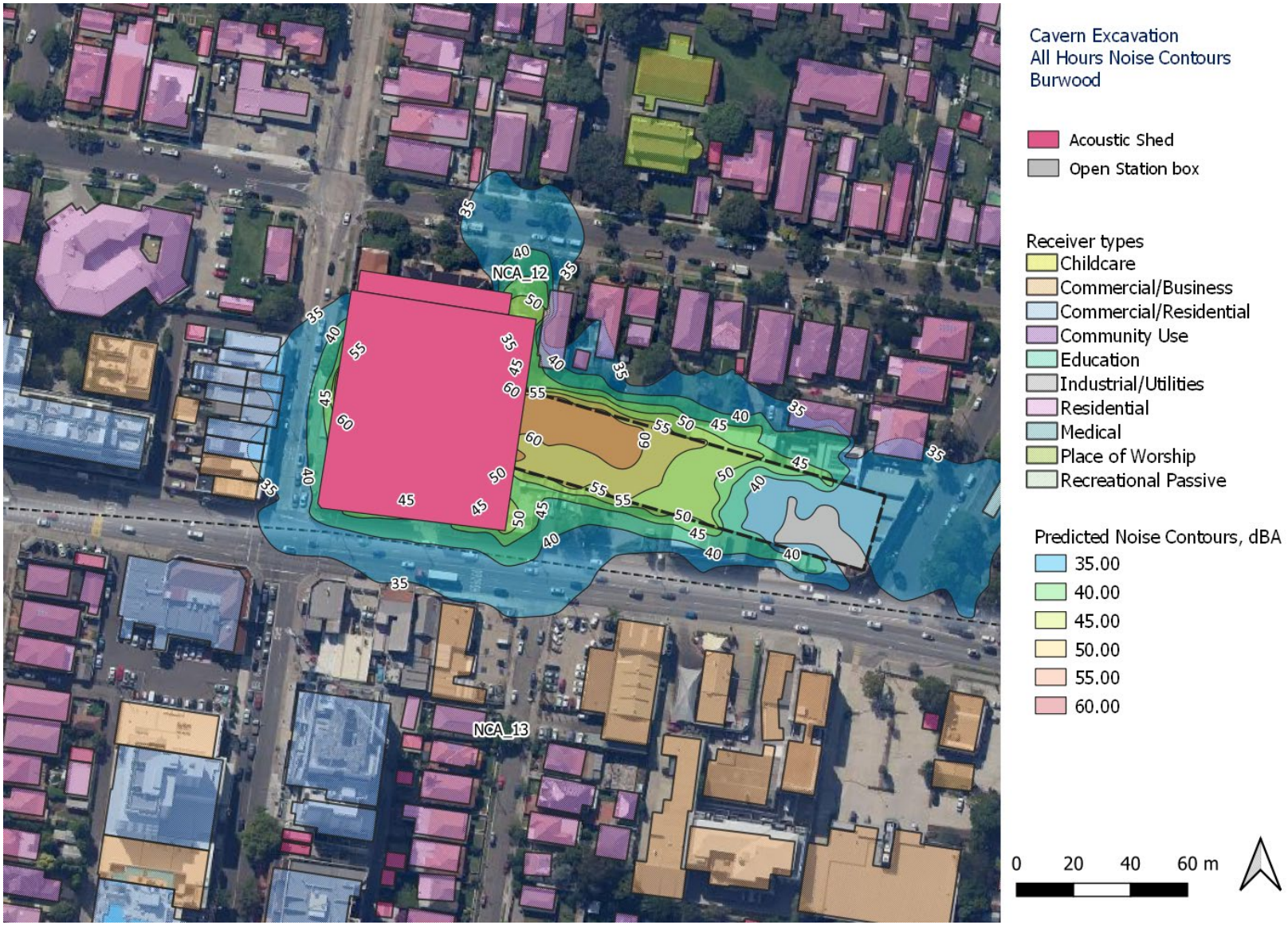
Excavation Area

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

Precited Noise Levles, dBA
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

0 20 40 m


NCA_12
NCA_13
East Nozzle Excavation
Day Noise Contours
Burwood
Acoustic Shed
Open Station box
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Industrial/Utilities
Residential
Medical
Place of Worship
Recreational Passive
Predicted Noise Contours, dBA
40
45
50
55
60
65
70
75
0
20
40
60 m



Cavern Excavation
All Hours Noise Contours
Burwood

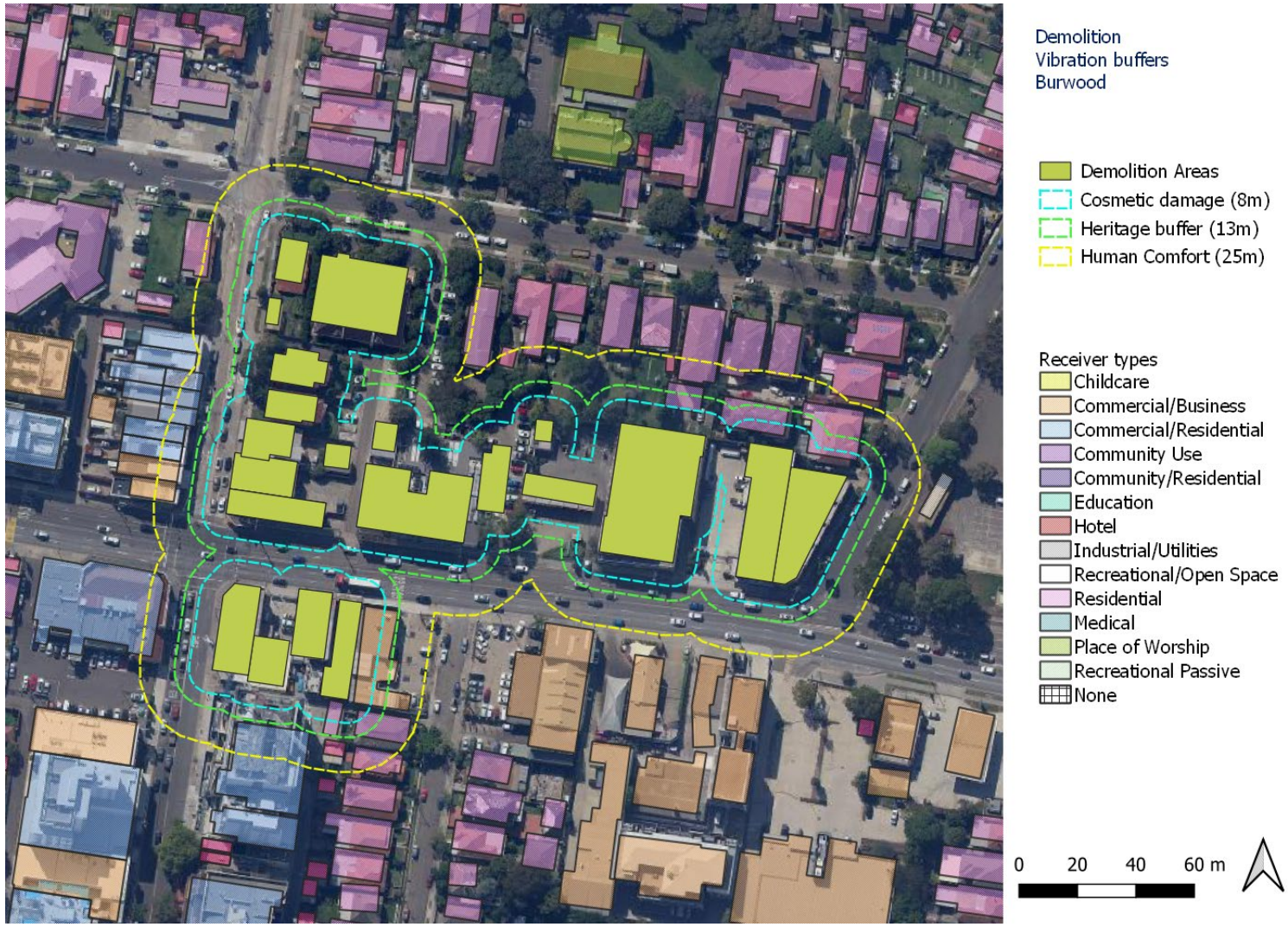
Acoustic Shed
Open Station box

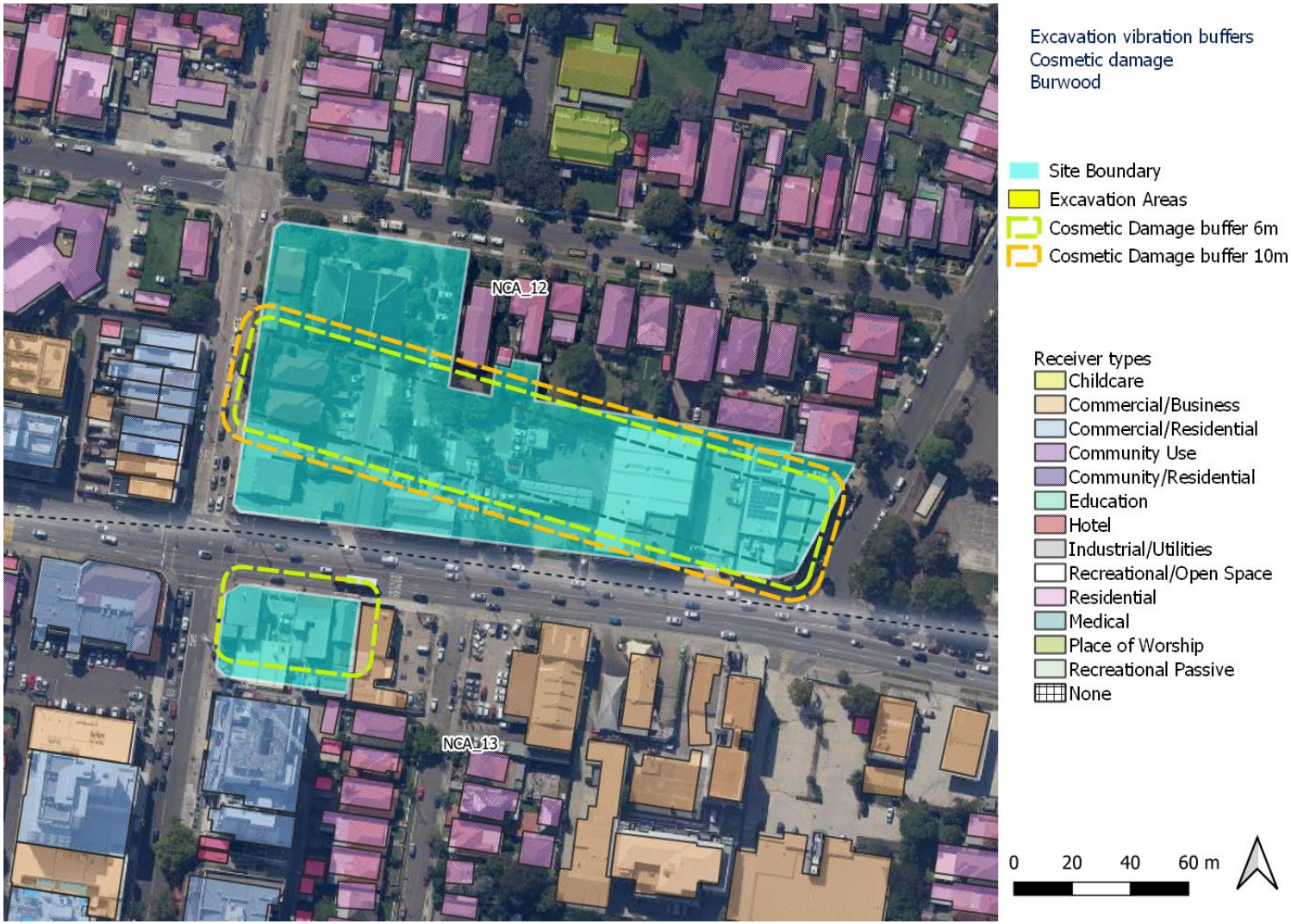
Receiver types
Childcare
Commercial/Business
Commercial/Residential
Community Use
Education
Industrial/Utilities
Residential
Medical
Place of Worship
Recreational Passive

Predicted Noise Contours, dBA
35.00
40.00
45.00
50.00
55.00
60.00

0 20 40 60 m

C.2 Construction vibration contours




NCA_12
NCA_13
Excavation vibration buffers
Cosmetic damage
Burwood
Site Boundary
Excavation Areas
Cosmetic Damage buffer 6m
Cosmetic Damage buffer 10m
Receiver types
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
20
40
60 m

Appendix D. Detailed noise predictions for individual receivers

D.1 Phase 1 and 5 - Site Establishment

D.2 Phase 2 to 8 Piling and Excavation

Supplied as Excel spreadsheets