Sydney Metro West

Major civil construction between The Bays and Sydney CBD

Modification Request (Mod 1)

1 February 2023

NSW GOVERNMENT

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Contents

1 Introduction

Sydney Metro is requesting a modification to Condition D23 of the Sydney Metro West The Bays to Sydney CBD project approval (SSI-19238057) in accordance with the requirements of section 5.25 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Sydney Metro West The Bays to Sydney CBD Environmental Impact Statement (EIS), exhibited by Sydney Metro between November and December 2021 assessed tunnelling outside of standard construction hours by means other than tunnel boring machines (non-TBM tunnelling). This modification request seeks to be consistent with this assessment in the Sydney Metro West The Bays to Sydney CBD EIS by altering the current wording of condition D23(d)(i).

This document outlines:

- the proposed revised wording for condition D23(d)(i)
- consultation undertaken with the community during exhibition of the Sydney Metro West The Bays to Sydney CBD Environmental Impact Statement (EIS), with the Environment Protection Authority (EPA) during preparation of this modification request and ongoing consultation during construction
- background information including where non-TBM tunnelling was identified and assessed in the EIS and a discussion on the potential use of other pathways available under the approval
- justification for the proposed modification, i.e. justification for undertaking non-TBM tunnelling out of standard construction hours
- the potential impacts of non-TBM tunnelling during daytime, evening and night-time period in accordance with the terminology from the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009). The assessment also includes further clarity to the information provided in the EIS including a separate assessment for each location where non-TBM tunnelling is proposed
- mitigation and management of non-TBM tunnelling, including a preliminary application of the additional mitigation measures from the Sydney Metro Construction Noise and Vibration Standard (CNVS).

1.1 Proposed modification

Table 1 provides the condition number and the current wording of the condition, and the proposed revised wording for the condition. Recommended removed text is provided in red and is struck out.

Table 1 Proposed revised condition wording

CoA #	Current wording of condition	Proposed revised wording of condition
D23	Variation to Work Hours Notwithstanding Conditions D21 and D22 work may be undertaken outside the hours specified in the following circumstances: (d) By Prescribed Activity, including: (i) tunnelling by tunnel boring machine (excluding cut and cover tunnelling and surface works) are 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 D21 to directly support tunnelling activities, except between the hours 10:00 pm and 7:00 am to / from the Pyrmont construction site which could result in a sleep disturbance event for receivers in the proximity of Pyrmont Street, Edward Street, Union Street, Paternoster Row and Pyrmont Bridge Road; or (iii) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from the Pyrmont construction site; or (iv) 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.	Variation to Work Hours Notwithstanding Conditions D21 and D22 work may be undertaken outside the hours specified in the following circumstances: (d) By Prescribed Activity, including: (i) tunnelling ~~by tunnel boring machine~~ (excluding cut and cover tunnelling and surface works) are 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 D21 to directly support tunnelling activities, except between the hours 10:00 pm and 7:00 am to / from the Pyrmont construction site which could result in a sleep disturbance event for receivers in the proximity of Pyrmont Street, Edward Street, Union Street, Paternoster Row and Pyrmont Bridge Road; or (iii) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from the Pyrmont construction site; or (iv) 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.

1.1.1 Summary of justification for the proposed modification

Further information regarding the justification for the proposed modification is provided in Section 4 of this report. In summary:

- the need and justification for non-TBM tunnelling outside of standard hours, as well as an assessment of this work, was included in the EIS. Details of where this was explained in the EIS is provided in Section 3.1 of this report and the potential impacts of non-TBM tunnelling is provided in Section 5 of this report
- approval for non-TBM tunnelling out of standard hours is consistent with the construction of all recent tunnel projects in Sydney including Sydney Metro West - Major civil construction between Westmead and The Bays (Stage 1 of the planning approval process)
- out of hours work is required to ensure the stability of the excavation, minimise potential ground movement and settlement and make the excavation safe for construction workers

- non-TBM works being restricted to daytime would result in a substantial program delay to Sydney Metro West, including to the opening of the line to passenger services. This would have flow on impacts including prolonged construction impacts and disruption for receivers across the whole Sydney Metro West alignment and the later realisation of the substantial operational benefits of Sydney Metro West
- detailed noise and vibration assessments being undertaken along the Sydney Metro West alignment have confirmed that non-TBM tunnelling would result in lower worst-case ground-borne noise levels than those produced by TBMs
- non-TBM tunnelling out of standard hours can be effectively managed through application of the Sydney Metro CNVS.

2 Consultation

2.1 Community consultation during EIS exhibition

As outlined in Section 3.1 of this report, the need for non-TBM tunnelling (including out of standard hours) was identified and assessed in the EIS. An excerpt from Table 5-8 of the EIS which includes the justification for the requirement for non-TBM tunnelling out of standard hours is included in Figure 1.

Table 5-8 Proposed construction hours

Construction work	Construction hours	Justification
Tunnelling (including associated excavation) and tunnelling support work (including tunnel boring machine launch/retrieval and spoil handling).	24 hours per day, seven days per week	Tunnelling and associated excavation work would define the overall proposal duration. Earlier completion would bring considerable benefits to the community and would reduce the duration of construction related disruption. Other aspects of the justification for 24 hours per day, seven days per week tunnelling and support operations include: • Need to install ground support systems immediately following excavation • Need to construct cross passages closely following the progress of the tunnel boring machines to provide a critical secondary egress for people to evacuate and access for emergency services in the event of an incident • Reducing peak demand on the electricity network • Need to handle the spoil produced 24 hours per day, up to seven days per week, operation of the tunnel boring machines and the proposed out of hours transport of spoil.

Figure 1 Excerpt from Table 5-8 of the EIS showing the justification for all tunnelling (includuing associated excavation) to be undertaken 24 hours per day, seven days per week

Stakeholders and the community were given the opportunity to provide feedback on the proposed non-TBM tunnelling works during the public exhibition of the EIS.

This section outlines the consultation undertaken during exhibition of the EIS to make information available to the community and encourage them to make a submission.

The EIS was released in early November 2021 during changes to public health orders related to the COVID-19 pandemic in New South Wales. Sydney Metro used digital engagement and personal outreach to ensure the community and stakeholders could learn about the project, have their questions answered and understand how to have their say while the EIS was on exhibition.

Section 2.1.1 further outlines engagement undertaken.

The EIS was made publicly available on the Department of Planning and Environment's Major Projects website (https://www.planningportal.nsw.gov.au/major-projects/project/41851), and an online interactive portal (sydneymetro.info/metrowest). The EIS was also publicly displayed at Town Hall House, Sydney, and the City of Sydney Darling Square Library.

Further information regarding the engagement undertaken and materials used during exhibition of the EIS is provided in Chapter 3 of the Sydney Metro West The Bays to Sydney CBD Submissions Report.

2.1.1 Consultation activities

The following consultation activities were carried out to support exhibition of the EIS:

- virtual community engagement

- virtual stakeholder briefings
- doorknocking
- phone calls and emails
- letterbox drops.

Further information on these methods and activities is provided in Table 2.

Table 2 Consultation activities during EIS exhibition

Activity	Details
Virtual community engagement	Virtual community engagement included an interactive portal and a virtual information room. The interactive portal provided community members the ability to explore maps and learn what to expect in their project area. The portal displayed information from the EIS helping depict key activities the community would see in their local area during construction, including noise mitigation measures. The portal used a multimedia platform that could be translated into a number of languages to reach people of all backgrounds including culturally and linguistically diverse communities and people who may normally have difficulty in participating in the engagement of major projects. The virtual information room gave the community and stakeholders the opportunity to virtually 'walk around', read information boards and hear from experts, just as they would at a traditional community information session. A key feature of the virtual information room was a series of videos featuring project experts explaining the more complex aspects of the project including tunnelling. These videos were viewed about 1900 times during the exhibition period and were used to address many community questions. The virtual information room hosted about 5700 visitors during public exhibition of the EIS.
Stakeholder briefings	Key stakeholders (including local government, NSW Government agencies, peak bodies and industry associations) were briefed via emails, phone calls, and via virtual meetings throughout the exhibition period. The briefings were designed to ensure stakeholders were appropriately informed about the EIS and received the relevant information to make a submission. Briefings were held with NSW Government agencies, local councils, interest groups and major landowners near the project.

Activity	Details
Phone calls, emails and doorknocks	During the exhibition period, Sydney Metro made a total of 27 phone calls and sent 78 emails to residents, businesses, councils and other key stakeholders in addition to the other engagement materials available. Place Managers also doorknocked businesses near the proposed Hunter Street Station (Sydney CBD) construction sites. On 3 November 2021, an email alert with an e-newsletter titled "Sydney Metro West Project Update" was sent to more than 16,000 community members registered on the Sydney Metro West project database. The email advised of the EIS exhibition dates and encouraged recipients to visit the project website for more information. Follow-up emails were also sent out to the community encouraging them to review the project information and to make a submission.
Letter box drops	Letterbox drops to 25,000 properties and businesses near proposed construction sites and the proposed tunnel alignment took place, enclosing newsletters "Major civil construction between The Bays and Sydney CBD – Environmental Impact Statement". Project information magnets, featuring project contact details were also delivered on a separate occasion to 25,000 properties and businesses. The newsletter provided a snapshot of the key features of the EIS, including contact details for Sydney Metro West and outlined how the community could have their say on the project by making a submission via the Department of Planning and Environment major projects website. To cater for the culturally and linguistically diverse community, the newsletter was translated into seven local languages, including Korean, Chinese, Vietnamese, Hindi, Thai, Malay and Japanese. Translated versions of the newsletter were provided on the project website.

2.1.2 Place managers

Sydney Metro West's place managers play a vital role in building and maintaining strong relationships with local communities and businesses during the planning and delivery of the project. Their key role is to engage with the community, address concerns and provide accurate and transparent information to ensure the community's understanding of the project and any potential impacts.

At the start of the EIS exhibition, place managers reached out to community members, businesses, councils, schools, adjoining projects and community groups to inform them of the exhibition, to answer questions and to encourage them to make a submission. Place managers maintained regular contact with community members throughout the exhibition period and where required, organised phone briefings and virtual meetings with subject matter experts to provide further information. Place managers also responded to questions, provided assistance in locating answers in the EIS chapters and emailed or organised printed sections from the EIS on request.

An Environmental Impact Statement Summary document was also produced to support EIS exhibition. This EIS Summary document clearly identified to the community that:

- non-TBM tunnelling for crossovers and cross passages would be undertaken 24 hours per day, seven days per week
- excavation of station caverns at Pyrmont and Hunter Street would be undertaken 24 hours per day.

The EIS Summary also provided information on managing noise and vibration, including common strategies such as provision of respite, identified the range of Sydney Metro plans and strategies that would be implemented to manage potential impacts including the Sydney Mero CNVS and provided links to where further information was available in the EIS.

Since exhibition of the Sydney Metro West The Bays to Sydney CBD EIS, ongoing engagement with the community has included phone calls and emails with stakeholders to discuss the project and project additional information; and briefings and meetings with surrounding stakeholders to provide an overview of the project, construction impacts, and operations. This has involved:

- at Pyrmont, 123 phone calls with community members, sent personal emails to around 800 recipients (in addition to project update emails sent to the local area distribution list) and conducted 21 briefings and meetings
- at Hunter Street, 186 phone calls with community members, sent personal emails to around 1200 recipients (in addition to project update emails sent to the local area distribution list) and conducted 53 briefings and meetings.

2.1.3 Submissions received related to out of hours work

Three submissions received during EIS exhibition were related to potential noise and vibration impacts, including noise related to work outside of standard construction hours. These submissions included suggestions related to the management of work outside standard construction hours including temporary alternative accommodation and provision of respite for sleep disturbance. The provision of these mitigation measures is outlined in the Sydney Metro CNVS.

2.2 EPA consultation

The preparation of this modification request considered feedback provided by the EPA to the Department of Planning and Environment (DPE) prior to determination of the proposal, and at a meeting with Sydney Metro, EPA and DPE held on 19 October 2022. Key feedback and how this has been considered is provided in Table 3.

Table 3 EPA Feedback

EPA feedback	How feedback has been considered
Suggested that time restrictions could be put on roadheader and rock breaker tunnel excavation as an impact mitigation measure given this methodology does not have the same continuous operation that applies to tunnelling by TBM.	Tunnelling by non-TBM means (roadheader and rock breaker) is not conducive to starting and stopping at any point. Following excavation of an advance (which can take between 8 and 18 hours), ground support is required to be put in place to minimise potential settlement above the tunnel and ensure the excavation is safe for workers. Further information is provided in Section 4.

EPA feedback	How feedback has been considered
Tunnelling by means other than a TBM should be restricted to daytime in sensitive areas where reasonable and feasible (e.g. where tunnelling impacts are expected to exceed ground-borne noise levels in the ICNG and/or acceptable vibration values in *Assessing vibration – a technical guideline*) (DEC, 2006). It is not intended to prevent cross passage excavation being undertaken 24 hours per day but to limit excavation outside of standard hours where impacts are above the criteria.	As noted above, time restrictions on tunnelling by non-TBM means are not feasible. Potential noise and vibration impacts from non-TBM tunnelling would be managed in accordance with the Sydney Metro Construction Noise and Vibration Standard. Further information is provided in Section 6.
Tunnelling by roadheader / rock breaker usually follows the TBM pass and this can create compounded impacts to receivers which has generated community complaints and has been an issue on other Sydney Metro projects.	Non-TBM tunnelling following the TBM pass is usually associated with cross passage excavation. Cross passage excavation typically takes between two to four weeks and, as such, the duration of impacts following the TBM pass is relatively short-term. Non-TBM tunnelling for caverns and the turnback tunnels would be instead of TBM works (i.e. TBMs would not excavate the tunnels in these locations), and therefore would not result in compounded impacts post TBM excavation. Community complaints from both TBM and non-TBM tunnelling have been relatively low from the Sydney Metro City & Southwest tunnelling from Chatswood to Sydenham. Further information is provided in Section 6.
The proposal to undertake non-TBM tunnelling outside of standard hours needs to be transparent to the community.	The need for tunnelling by means other than tunnel boring machines (non-TBM tunnelling) was identified and assessed in the EIS. This was also identified in the EIS Summary which supported EIS exhibition. Stakeholders and the community were given the opportunity to provide feedback on the proposed non-TBM tunnelling works, including those works to be undertaken outside of standard construction hours, during the public exhibition of the EIS. Submissions received to the EIS from the community regarding work outside of standard hours were related to the management of these works with suggestions including temporary accommodation and respite. The provision of these mitigation measures is outlined in the Sydney Metro Construction Noise and Vibration Standard (CNVS). Further information including specific references to the EIS is provided in Section 3.1.

2.3 Public exhibition of this report

2.3.1 Consultation and engagement during public exhibition

The Department of Planning and Environment will place this Modification Report on exhibition for a period of two weeks. During the exhibition period, the community, organisations and government agencies are invited to provide feedback and make a submission. The Department of Planning and Environment will consider these submissions in their assessment of the proposed modification.

In addition to exhibition of the Modification Report, Sydney Metro will continue to consult with the community though the following communication channels:

- the Sydney Metro West website and Sydney Metro West interactive portal
- a letterbox drop notification to the local community
- a direct email notification to a local database of people signed up for project alerts.

2.3.2 Consideration of submissions

The Department of Planning and Environment will provide Sydney Metro with a copy of all submissions received following the closure of public exhibition of the Modification Report. If required, the Department of Planning and Environment may request Sydney Metro to respond to issues raised in the submissions. If responses to the submissions are required, these will be made available on the Department of Planning and Environment website with anyone who made a submission to receive a letter to notify them a publication of the response will be available on the Department of Planning and Environment website.

2.4 Ongoing consultation during construction

Sydney Metro will continue to work with stakeholders and the community to ensure they are informed and have opportunities to provide feedback to the Sydney Metro West team during each stage of the project.

Sydney Metro recognises the diverse engagement and information needs of the community and stakeholders and is committed to robust and transparent engagement processes that are inclusive in nature.

Table 4 outlines the range of engagement activities that would occur prior to and during construction.

Table 4 Ongoing engagement activities

Activity	Timing
Awareness and marketing campaign to engage future customers	Ongoing
Community events	Ongoing
Community information sessions (in person and/or virtually)	As required
Community Communication Strategy	Prior to construction
Construction Complaints Management System	Prior to construction
Construction notifications	Seven days prior to construction

Activity	Timing
Door knocking	As required
Email updates / e-newsletters	Relevant milestones
Enquiries and complaints hotline	Ongoing
Fact sheets	As required
Engagement with stakeholders including government, peak bodies and local businesses	As required; relevant milestones
Interactive portal	Ongoing
Media releases	Relevant milestones
Newsletter	Relevant milestones
Newspaper advertising	Relevant milestones
Online webinars, meetings and forums	As required
Place managers	Ongoing
Project briefings (in person and/or virtually)	Relevant milestones
Project overview document	Relevant milestones
Site signage	Prior to construction
Social media updates	As required; relevant milestones
Sydney Metro Connect mobile application notifications	As required
Virtual information room	Relevant milestones
Website and online forums	Ongoing

The Sydney Metro Overarching Community Communications Strategy sets the requirements for community and stakeholder engagement to be carried out by the project and delivery partners (provided in Appendix B of the Environmental Impact Statement).

Contract specific Community Communication Strategies will be developed by appointed project delivery communication teams to address contract and site-specific needs of the community, stakeholders and businesses, and reflect the requirements of the Sydney Metro Overarching Community Communications Strategy. The contract specific Community Communications Strategies will also address the requirements of the conditions of approval, specifically condition D52 related to social impact management.

Contractors will be required to adhere to a Construction Complaints Management System which will outline the framework for managing complaints, enquiries and escalation processes throughout the project lifecycle.

Mitigation measure NV01 (provided in Section 6.1.2) also requires further engagement with the community to understand their preference for noise mitigation and management and implementation where feasible and reasonable.

2.4.1 Detailed noise and vibration impact statements

As required by the Sydney Metro CNVS and the conditions of approval (condition D29), detailed noise and vibration impact statements will be prepared for any work that may exceed the Noise Management Levels (NMLs), vibration criteria and / or ground-borne noise levels. This will include all tunnelling work (both TBM and non-TBM).

The detailed noise and vibration impact statements will identify all feasible and reasonable mitigation measures for the tunnelling work, including the application of standard measures outlined in the CNVS and the additional measures outlined in Chapter 5 of the CNVS. Section 6.1.1 of this report provides the preliminary application of additional measures based on the assessment presented in this report.

As required by condition of approval D29, the specific mitigation measures identified in the detailed noise and vibration impact statements will be identified through consultation with the affected sensitive land users. The proposed mitigation measures in detailed noise and vibration impact statements are informed by community needs and concerns identified through a range of community consultation activities, including Place Manager conversations with nearby receivers.

Additional community consultation with the affected community is required once the detailed noise and vibration impact statements have been prepared, as these are based on the contractor's methodology and present a more refined assessment of potential impacts. This consultation period would provide more specific information on the mitigation measures available to each receiver during the construction period. The detailed noise and vibration impact statements will identify which receivers are eligible for each of the additional mitigation measures in the Sydney Metro CNVS. Following preparation of the detailed noise and vibration impact statements and prior to the commencement of work, specific consultation would be carried out with eligible receivers discuss the mitigation options available to each receiver.

The detailed noise and vibration impact statements will also be provided to the independent Acoustic Advisor and the independent Environmental Representative prior to the commencement of tunnelling work.

3 Background

3.1 Identification of non-TBM tunnelling in Environmental Impact Statement

The need for tunnelling by means other than tunnel boring machines (non-TBM tunnelling) was identified and assessed in the EIS (refer to Table 5) and stakeholders and the community were given the opportunity to provide feedback on the proposed non-TBM tunnelling works during the public exhibition of the EIS.

Table 5 Identification of non-TBM tunnelling in EIS

EIS Section	Description
Chapter 5 (Project description); Section 5.5.3; Table 5-5 (Tunnelling methodology)	Section 5.5.3 of the EIS provides a description of the proposed tunnelling methodology and Table 5-5 describes the different methodologies expected to be used. Table 5-5 states: *'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 and the mined adits for Pyrmont Station and Hunter Street Station (Sydney CBD).'* *'Rock hammers would be used to excavate cross passages and niches within the tunnels. These would generally be constructed following excavation of the main tunnels by the tunnel boring machines.'*
Chapter 7 (Noise and Vibration); Section 7.3.3; Table 7-1 (Construction scenario descriptions)	Section 7.3.3. of the EIS provides a description of the construction scenarios considered in the noise and vibration assessment. Table 7-1 states: *'At this stage, tunnel boring machines are proposed to be used for the majority of the alignment with roadheaders and rockbreakers used at stations, stub tunnels, cross passages and crossover and turnback caverns.'*

EIS Section	Description
Chapter 7 (Noise and vibration); Section 7.5 (Potential impacts from tunnelling)	Section 7.5 of the EIS provides an assessment of potential ground-borne noise and vibration impacts from tunnelling activities and identifies that the assessment includes excavation by non-TBM means. Section 7.5.1 provides an assessment of potential ground-borne noise impacts and states (emphasis added): *'The assessment of ground-borne noise is based on the worst-case predicted ground-borne noise levels for sensitive receivers located above the proposed tunnelling work. The predictions represent the likely highest noise level inside sensitive receivers when the tunnelling work is directly below each receiver.* ***The assessment also includes potential noise impacts from the excavation of irregular shaped tunnels such as stub tunnels, cross passages, crossover and turnback caverns and niches, by roadheaders.'*** Section 7.5.2 provides an assessment of potential vibration impacts and states (emphasis added): *'The ground-borne vibration assessment is based on the worst-case predicted ground-borne vibration level for sensitive receivers above the proposed tunnelling work. The predictions represent the likely highest vibration level when tunnelling work is below each receiver.* ***The assessment also includes potential vibration impacts from the excavation of irregular shaped tunnels such as stub tunnels, cross passages, crossover and turnback caverns and niches, by roadheaders.'***
Technical Paper 2: Noise and vibration; Section 5.3 (Tunnelling from The Bays to Sydney CBD)	Section 5.3 of the Technical Paper 2 provides an assessment of potential ground-borne noise and vibration impacts from tunnelling activities and identifies that the assessment includes excavation by non-TBM means. Section 5.3 states: *'The following sections present an assessment of the predicted ground-borne noise and vibration impacts from the proposed tunnelling work, which includes:* • *Tunnel boring machines excavating rock and constructing the main tunnel exterior structure* • ***Roadheaders and rockbreakers excavating stations, station shafts, crossover caverns, cross passages, turnback cavern, stub tunnels and adits.'***

3.2 Potential alternate pathways

The conditions of approval provide potential alternate pathways (other than a modification of condition D23(d)) for the approval of non-TBM tunnelling out of standard hours. Further description of these pathways and justification as to why they are not suitable for the approval of non-TBM tunnelling are outlined in Table 6.

Table 6 Alternate approval pathways

Condition number	Discussion
Condition D23(a) Safety and Emergencies	This condition is intended to allow the delivery of materials outside of standard hours where required for safety reasons; and emergency works where they are required to avoid injury or loss of life, avoid damage or loss of property, or prevent environmental harm. This condition is not applicable to non-TBM tunnelling works.
Condition D23(b) Low Noise Impact Works	This condition is to allow for works that comply with certain noise management level and vibration goals to be undertaken outside of standard hours. While non-TBM tunnelling may achieve these criteria in certain locations, it would not be possible to meet this criteria for all non-TBM tunnelling works. Note: in these cases, the work would be managed through the measures and processes outlined in Section 6.
Condition D37(c) By Approval	This condition allows works to be separately approved through an Environment Protection Licence (EPL), through an out of hours works protocol (where an EPL does not apply) or through negotiation agreements with directly affected residents and sensitive land uses. Non-TBM tunnelling works are a critical component of delivery of the CSSI project, and it is considered appropriate for this to be conditioned as part of the planning approval to provide certainty for delivery. Secondary approval pathways such as an EPL or negotiated agreements are more appropriately used for shorter-term works.
Condition D38 Out of hours works protocol	The out of hours works protocol applies to works which are not subject to an EPL. The tunnelling works would be subject to an EPL and, as such, the out of hours works protocol would not apply.

4 Justification for non-TBM tunnelling out of standard hours

The EIS included a justification for undertaking non-TBM tunnelling out of standard hours. Technical Paper 2: Noise and vibration; Table 18 provided justification for out of hours works including for non-TBM tunnelling works. Table 18 stated:

> *'For mined excavations, temporary support in the form of shotcrete, steel sets and rockbolts must be installed immediately to ensure stability of the work and to minimise any potential ground movement or settlement. Grouting is required to transfer load directly to the adjacent rock and needs to occur immediately after bolt installation for safety and quality reasons. 24/7 work would allow for the completion of the entire support system following excavation.'*

In addition to this information, excavating an advance using non-TBM methods (roadheaders and rockbreakers) can take between 8 to 18 hours depending on the geometry and 'length' of the advance, and the strength of the rock encountered. Following excavation of the advance, ground support (as described in the above excerpt from the EIS) is required to be put in place to provide adequate ground support, minimise potential settlement above the tunnel and ensure the excavation is safe for workers.

The current wording of the condition which only allows non-TBM tunnelling works during daytime periods would result in a substantial program delay to Sydney Metro West, including to the opening of the line to passenger services. This has substantial flow on impacts including:

- prolonged construction impacts and disruption for receivers across the whole Sydney Metro West alignment
- later realisation of the substantial benefits that Sydney Metro West would bring to the community (as outlined in the *Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD* (Sydney Metro, 2020).

The proposed modification to the wording of Condition D23 is consistent with all recent tunnel projects in Sydney, including:

- Sydney Metro West - Major civil construction between Westmead and The Bays (Stage 1 of the planning approval process)
- Sydney Metro – Western Sydney Airport
- Sydney Metro - Chatswood to Sydenham
- North West Rail Link (Sydney Metro Northwest)
- Western Harbour Tunnel
- All stages of WestConnex
- M6 Stage 1
- NorthConnex.

5 Potential impacts of non-TBM tunnelling

Based on the current design and construction methodology (and consistent with the design and construction method assessed in the EIS), the following are expected to be excavated by non-TBM means:

- the crossover cavern
- Pyrmont Station cavern
- Hunter Street Station cavern
- the turnback and stub tunnels located to the east of Hunter Street Station
- cross-passages between the running tunnels.

5.1 Construction approach and duration

For tunnelling by TBM, the excavation is expected to progress at a rate of around 20 to 30 metres per day. This means the worst-case ground-borne noise impacts from tunnelling at each receiver would likely only last for a few days for each tunnel boring machine as the tunnelling work passes beneath.

For non-TBM tunnelling, the indicative duration of excavation works would be:

- station caverns – around 12 months
- turnback tunnels – around 12 months
- crossover cavern – around five months
- cross passages – around two to four weeks.

Any one particular receiver would only be impacted for a portion of this duration when the works are directly below and in the vicinity of the receiver.

A cavern is typically excavated in around six passes consisting of three headings, two benches and the invert (as outlined in Figure 2 below). Each pass typically proceeds at around four to seven metres per day with a full pass taking between two to four weeks. As they are located at the crown of the cavern, the headings generate the highest level of impact to receivers above, with the benches and invert resulting in lower impact. As a result, the worst-case impacts to any receiver above a cavern may be expected to last for around six to 12 weeks during the three heading passes. Worst-case impacts to receivers above cross passages would be expected to occur for around two to four weeks.

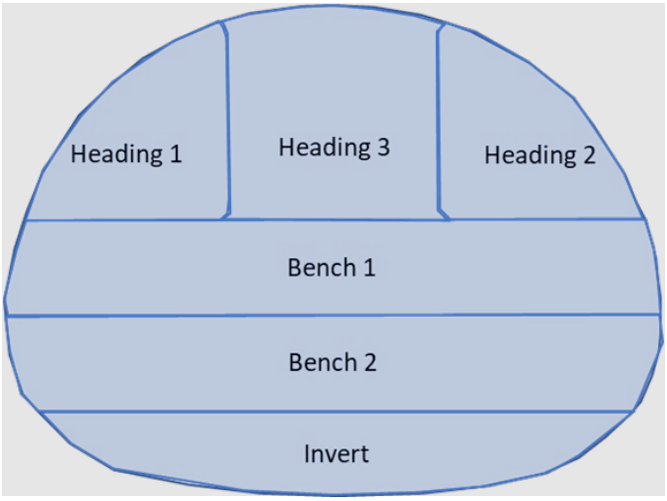


Figure 2 Typical cavern excavation passes

5.2 Potential ground-borne noise impacts

The potential ground-borne noise impacts from tunnelling, including non-TBM tunnelling, was assessed in Section 7.5.1 of the EIS and Section 5.3.1 of Technical Paper 2: Noise and vibration. Relevant information from the EIS has been re-produced in this section.

The assessment shows the worst-case impacts when tunnelling works are directly below each particular receiver. Ground-borne noise levels would reduce when works are not directly below the receiver. As outlined in Section 4.2.2 of Technical Paper 2: Noise and vibration of the EIS, the modelling approach undertaken for the EIS assessment includes a number of conservative assumptions such as coupling loss to buildings and crest factors for tunnelling equipment.

The EIS assessment for Sydney Metro West - Major civil construction between Westmead and The Bays predicted that receivers located above a crossover excavation would experience exceedances of the ground-borne noise management level of 1-10dB, whereas the detailed noise and vibration impact statement for that works indicated that these receivers would comply with the noise management level. Similarly the EIS assessment for Sydney Metro West - Major civil construction between Westmead and The Bays predicts that receivers directly above a station cavern excavation may experience exceedances of the ground-borne noise management level of 11-20dB, whereas the detailed noise and vibration impact statement for this same excavation area shows that these receivers would comply with the noise management level.

The potential ground-borne noise impacts are provided in Table 7, where the results from the EIS are broken into 5dB exceedance bands. These results are consistent with the assessment presented in Chapter 7 of the EIS, and provide more detail regarding the level of exceedance. The potential impacts are also shown graphically in Attachment A (consistent with Appendix E of Technical Paper 2: Noise and vibration). Although the maps in Appendix E make reference to TBM tunnelling, the potential ground-borne noise levels shown are applicable to both TBM and roadheader (non-TBM) tunnelling which generate similar (and potentially lower) levels of ground-borne noise. The following graphs are reproduced from Technical Paper 2: Noise and vibration for TBMs and from the Central Tunnel Package detailed noise and vibration impact statements prepared for Sydney Metro West - Major civil construction between Westmead and The Bays. These show the indicative ground-borne noise levels from TBMs and roadheaders (non-TBM tunnelling). The graph showing ground-borne noise levels from roadheader excavation shows that the residential night-time noise management level of 35dBA would only be exceeded when works are within a 30 metre slant distance from receivers.

In relation to rockbreaking, it is noted that the conditions of approval provide other restrictions regarding the timing of rock breaker works through condition D40.

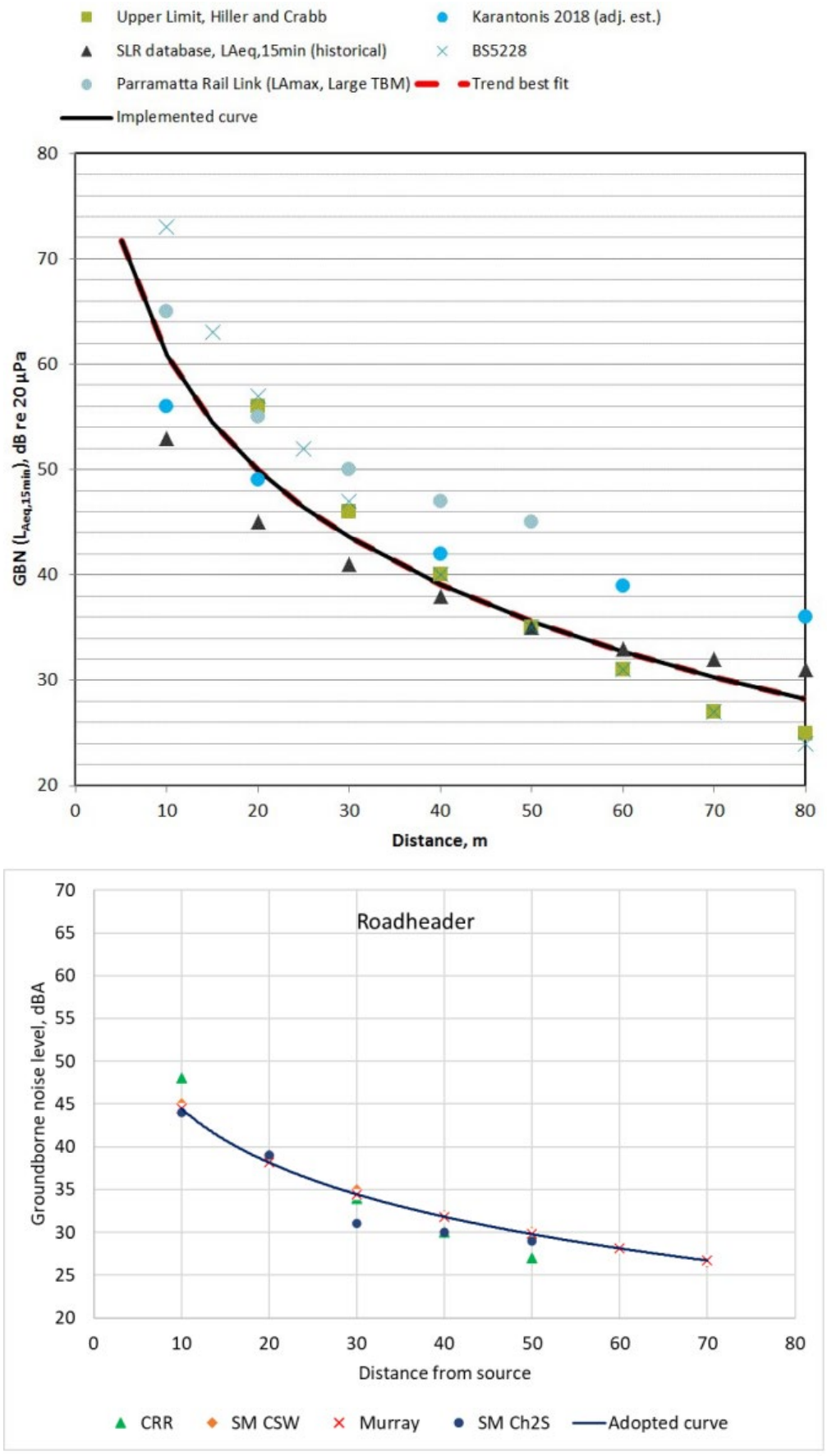


Figure 3 **Indicative Ground-borne Noise Levels from TBMs (top) and Roadheaders (bottom)**

Table 7 Summary of tunnelling ground-borne NML exceedances – all receiver types

Study area	NCA	Number of Receivers																				
		Total	With NML Exceedance[1]																			
			Daytime[2]							Evening							Night-time						
			1-5 dB	6-10 dB	11-15 dB	16-20 dB	21-25 dB	26-30 dB	>30 dB	1-5 dB	6-10 dB	11-15 dB	16-20 dB	21-25 dB	26-30 dB	>30 dB	1-5 dB	6-10 dB	11-15 dB	16-20 dB	21-25 dB	26-30 dB	>30 dB
The Bays	NCA01	491	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NCA02	842	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NCA03	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrmont	NCA04	728	27	26	5	-	-	-	-	42	25	24	4	-	-	-	47	41	24	23	4	-	-
	NCA05	461	-	-	-	-	-	-	-	7	-	-	-	-	-	-	6	7	-	-	-	-	-
Hunter Street	NCA06	399	1	3	6	-	-	-	-	-	1	3	-	-	-	-	2	-	-	1	3	-	-
	NCA07	250	1	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1	-	-

Note 1: Based on worst-case predicted noise levels in each NCA.

Note 2: Daytime ground-borne noise NMLs taken from preceding Sydney Metro planning applications for consistency. Daytime ground-borne noise NMLs are not specified in the ICNG or Sydney Metro CNVS.

It is acknowledged that, as well as noise level, other factors such as the intensity, character, time of day and duration of noise can affect the actual impact to receivers. For example, a 5dB exceedance of the noise management level at night may result in a higher impact than a 5dB exceedance during the daytime period. This is also reflected in the more stringent noise management levels for the night-time period (as per the Interim Construction Noise Guideline), and reflected in the additional mitigation measures outlined in the CNVS which provide for higher levels of mitigation for evening and night-time periods.

The ground-borne noise assessment for all tunnelling (TBM and non-TBM) during the worst-case impacts shows that:

- no receivers within The Bays study area (NCA 01 – NCA 03) are predicted to experience any exceedance of the NMLs
- the ground-borne noise impacts during tunnelling work are predicted to comply with the daytime NMLs at most receivers. A small number of the nearest receivers at the Pyrmont Station and Hunter Street Station (Sydney CBD) construction sites are predicted to experience exceedances of the NML by between:
    - 1-5 dB (29 receivers in total)
    - 6-10 dB (29 receivers in total)
    - 11-15 dB (12 receivers in total)
    - no receivers are predicted to receive greater that 16dB exceedances of the daytime NMLs.
- during the night-time, the impacts are more wide-spread due to a lower NML. The impacts to some receivers are predicted to be between 21 and 25 dB above the NML in the Pyrmont and Hunter Street (Sydney CBD) study areas where the tunnel depth is shallowest (up to four receivers in each location). During the night-time period, receivers at the Pyrmont Station and Hunter Street Station (Sydney CBD) construction sites are predicted to experience exceedances of the NML by between:
    - 1-5 dB (56 receivers in total)
    - 6-10 dB (48 receivers in total)
    - 11-15 dB (24 receivers in total)
    - 16-20 dB (24 receivers in total)
    - 21-24 dB (8 receivers in total)
    - no receivers are predicted to receive greater that 25dB exceedances of the Night-time NMLs.
- the affected receivers are mostly residential properties in the Pyrmont study area. In the Hunter Street (Sydney CBD) study area the impacts are mostly commercial receivers with some hotels.

The ground-borne noise predictions are based on the nearest receivers within each building at ground floor. The impacts would reduce for sensitive receivers which are further away from the work or for receivers on higher floors in multistorey buildings.

The following sections provide a summary of the potential ground-borne noise impacts for the locations expected to be excavated by non-TBM tunnelling means.

Crossover cavern

As part of design development, Sydney Metro investigated the relocation of the crossover cavern that was indicatively identified in the EIS as being located east of

The Bays Station to the west of the Pyrmont Station cavern. The Pyrmont location would provide a more suitable disembarkment location for customers in the event of degraded mode operations or an emergency evacuation, as the site is more connected to other transport modes such as the light rail and is in closer proximity to the Sydney CBD. This design would reduce risk associated with the cavern excavation in proximity to the Anzac Bridge foundations, and also provide a net reduction in crossover cavern length compared to the location identified in the EIS at The Bays. The relocation of the crossover has been subject to separate environmental assessment for consistency with the approved project.

A detailed noise and vibration impact statement has been prepared by the construction contractor to assess the noise impacts using the preferred construction methodology for this proposed change. This detailed noise and vibration impact statement therefore contains a more refined assessment of the predicted noise levels when compared to the more conservative assumptions in the EIS (refer to Section 2.4.1). The conservative assumptions in the EIS have been used in the assessment in this report for the other project elements, such as the station caverns, and a more refined assessment of impacts of these project elements will be undertaken once the relevant detailed noise and vibration impact statements are prepared.

The detailed noise and vibration impact statement identifies the potential worst-case ground-borne noise impacts from excavation of the crossover cavern to the west of Pyrmont Station at receivers. The detailed noise and vibration impact statement confirmed that noise levels associated with non-TBM tunnelling for the crossover cavern would be lower than TBM tunnelling at this location. These worst-case potential impacts to any receiver above the cavern are expected to last for around six to 12 weeks. The detailed noise and vibration impact statement identifies that:

- worst-case ground-borne noise levels during the construction of the Pyrmont crossover are predicted to comply with the relevant NML at receivers for daytime standard hours
- between 1-10 dB exceedances of the NMLs for the daytime period outside of standard hours (i.e. between 8am and 6pm on Sundays and on public holidays), evening and night time periods are predicted for:
    - up to 16 receivers during day time outside of standard hours (note: this represents a reduction in the number of impacted receivers compared to the TBM tunnelling in this area assessed in the EIS. TBM tunnelling is this area was predicted to result in potential 1-10dB NML exceedances at up to 56 receivers during this period)
    - up to 16 receivers during the evening period (note: this represents a reduction in the number of impacted receivers compared to the TBM tunnelling in this area assessed in the EIS. TBM tunnelling is this area was predicted to result in potential 1-10dB NML exceedances at up to 56 receivers during this period)
    - up to 50 receivers during night time period (note: this represents a reduction in the number of impacted receivers compared to the TBM tunnelling in this area assessed in the EIS. TBM tunnelling is this area was predicted to result in potential 1-10dB NML exceedances at up to 91 receivers and potential 11-20dB exceedances at up to seven receivers during this period).

The crossover cavern at this location to be excavated by non-TBM tunnelling would therefore impact fewer receivers and have a lower noise impact than those expected to be experienced by TBM tunnelling in the same location. No receivers are predicted to experience an exceedance of the NML by greater than 10dB during construction of the Pyrmont crossover during any time period. However, the duration of construction

by non-TBM tunnelling would mean the noise impacts would likely be experienced for a longer duration when compared to tunnelling by TBM.

Pyrmont Station cavern

Based on the assumptions and assessment in the EIS, the potential worst-case ground-borne noise impacts from excavation of the Pyrmont Station cavern at receivers above the cavern would be:

- between 1-20 dB for the daytime and evening periods, with around 80% of these receivers in the 1-10 dB range
- between 21-25 dB during the night-time period for four receivers located directly above the cavern. These receivers are located Edward Street and Union Street where the cavern is shallowest.

These worst-case potential impacts to any receiver above the cavern are expected to last for around six to 12 weeks. Some receivers in proximity to the Pyrmont crossover cavern adjacent to the station cavern may experience impacts for a longer duration as a result of additional non-TBM tunnelling, however the impacts are similarly expected to remain for around six to 12 weeks. These potential impacts would be mitigated and managed through the measures and processes outlined in Section 6.

Notwithstanding the above conservative assessment, the proposed depth of Pyrmont Station cavern ranges from around 36-39 metres. Applying the ground-borne noise level graph in Figure 3 above, noise levels would be expected to comply with noise management levels in most cases with some potential for marginal exceedances in the 1-5dB range. Prior to construction, a detailed noise and vibration impact statement would be prepared for this project element which would contain a more refined assessment of the predicted noise levels when compared to the more conservative assumptions and assessment in the EIS.

Hunter Street Station cavern

Based on the assumptions and assessment in the EIS, the potential worst-case ground-borne noise impacts from excavation of the Hunter Street Station cavern at recovers above the cavern would be:

- between 1-15 dB for the daytime and evening periods for a small number of receivers (up to 12 receivers in total for daytime works and up to five receivers for evening works) located immediately above the cavern
- between 21-25 dB during the night-time period for four receivers located directly above the cavern. These receivers are hotels fronting Hunter Street.

These worst-case potential impacts to any receiver above the cavern are expected to last for around six to 12 weeks and would be mitigated and managed through the measures and processes outlined in Section 6.

Notwithstanding the above conservative assessment, the proposed depth of Hunter Street Station cavern ranges from around 26-31 metres. Applying the ground-borne noise level graph in Figure 3 above, noise levels would be expected to comply with noise management levels in most cases with some potential for marginal exceedances in the 1-10dB range.

Turnback and stub tunnels

Based on the assumptions and assessment in the EIS, ground-borne noise levels are predicted to comply with the relevant NML at receivers (except one receiver) in the vicinity of the turnback and stub tunnels located to the east of Hunter Street Station. The exception is one hotel located on Phillip Street which would have a worst-case predicted exceedance of between 1-5 dB when works are located directly beneath the

receiver. This worst-case potential impact to the hotel is expected to last for around six to 12 weeks.

Cross-passages

Based on the assumptions and assessment in the EIS, the potential ground-borne noise levels from cross-passage excavation would depend on the location of each cross passage and the nature of the receiver(s) located above.

For the majority of the alignment, ground-borne noise levels would be expected to comply with the relevant NML, with some locations potential experiencing exceedances of 1-10 dB. The potential impacts from cross passage excavation would be minimised through the implementation of mitigation measure NV10 as outlined in Section 6.

These impacts would typically be consistent with those from the TBM passby and would be expected to occur for two to four weeks.

5.3 Potential vibration impacts

Based on the assumptions and assessment in the EIS, the potential vibration impacts from tunnelling, including non-TBM tunnelling, was assessed in Section 7.5.2 of the EIS and Section 5.3.2 of Technical Paper 2: Noise and vibration. Relevant information this the EIS has bene re-produced in this section.

The assessment shows the worst-case impacts when tunnelling works are directly below each particular receiver. Vibration levels would reduce when works are not directly below the receiver. As noted above, the modelling approach includes a number of conservative assumptions such as coupling loss to buildings and crest factors for tunnelling equipment.

The potential vibration impacts are provided in Table 8 (reproduced from Chapter 7 of the EIS). The potential impacts are also shown graphically in Attachment B (reproduced from Appendix F of Technical Paper 2: Noise and vibration). Although the maps in Appendix F make reference to TBM tunnelling, the potential ground-borne noise levels shown are applicable to both TBM and roadheader tunnelling which generate similar levels of vibration. As noted above, the conditions of approval provide other restrictions regarding the timing of rock breaker works through condition D40.

Table 8 Summary of tunnelling vibration criteria exceedances – all receiver types

Construction site	Noise catchment area	Number of receivers				
		Total	With vibration criteria exceedance			
			Cosmetic damage	Human comfort		Sensitive equipment
			Day / night	Day	Night	Day / night
The Bays	NCA01	491	-	-	-	-
	NCA02	842	-	-	-	-
	NCA03	47	-	-	-	-
Pyrmont	NCA04	728	-	25	43	-
	NCA05	461	-	-	-	-
Hunter Street	NCA06	399	-	7	3	-
	NCA07	250	-	1	1	3

The vibration assessment for all tunnelling (TBM and non-TBM) during the worst-case impacts shows the following:

- vibration levels during tunnelling, including non-TBM tunnelling, are predicted to comply with the cosmetic damage criteria
- potential exceedances of the human comfort criteria are likely at a small number of receivers in the Pyrmont and Hunter Street (Sydney CBD) study areas, meaning perceptible levels of vibration may occur when tunnelling work is below these areas. These impacts are typically at receivers which surround the construction sites, as this is where the tunnel depth is shallowest. A greater number of receivers are expected to be impacted at night due to the more stringent human comfort criteria during this period.
- as noted above, worst-case impacts would be expected for a few days for tunnel boring machine works, for around six to 12 weeks for non-TBM tunnelling works associated with caverns, and for around two to four weeks for non-TBM tunnelling works associated with cross passages.
- three buildings at the Sydney Hospital are predicted to potentially have exceedances of the sensitive equipment criteria. These buildings have been identified based on an initial screening assumption that they contain vibration sensitive equipment with VC-C criteria.
- no vibration impacts at the former White Bay Power Station are predicted as vibration intensive work during cavern mining would be around 300 metres away.

The following sections provide a summary of the potential ground-borne noise impacts for the locations expected to be excavated by non-TBM tunnelling means.

Crossover cavern

As described in Section 5.1.2, as part of design development, Sydney Metro investigated the relocation of the crossover cavern that was indicatively identified in the EIS as being located east of The Bays Station to the west of the Pyrmont Station cavern.

A detailed noise and vibration impact statement has been prepared by the construction contractor to assess the vibration impacts using the preferred construction methodology for this proposed change. This detailed noise and vibration impact statement therefore contains a more refined assessment of the predicted vibration levels when compared to the more conservative assumptions in the EIS (refer to Section 2.4.1).

The detailed noise and vibration statement confirms that vibration levels from the excavation of the crossover cavern are predicted to be below the human comfort criteria and the cosmetic damage screening level at receivers in the vicinity of the crossover cavern.

Pyrmont Station cavern

Based on the assumptions and assessment in the EIS, the potential worst-case vibration impacts from excavation of the Pyrmont Station cavern at recovers above the cavern would be:

- no receivers are expected to exceed the cosmetic damage screening criteria
- 25 receivers are expected to exceed the human comfort level during the daytime period

- 43 receivers are expected to exceed the human comfort level during the night-time period. This is due to the more stringent criteria during this period for residential receivers.

These worst-case potential impacts to any receiver above the cavern are expected to last for around six to 12 weeks and would be mitigated and managed through the measures and processes outlined in Section 6.

Hunter Street Station cavern

Based on the assumptions and assessment in the EIS, the potential worst-case vibration impacts from excavation of the Hunter Street Station cavern at recovers above the cavern would be:

- no receivers are expected to exceed the cosmetic damage screening criteria
- eight receivers are expected to exceed the human comfort level during the daytime period. These receivers are a combination of commercial premises and hotels
- four receivers are expected to exceed the human comfort level during the night-time period. This reduction from the daytime is due to commercial receivers that are not considered sensitive during night-time periods.

These worst-case potential impacts to any receiver above the cavern are expected to last for around six to 12 weeks and would be mitigated and managed through the measures and processes outlined in Section 6.

Turnback and stub tunnels east of Hunter Street Station

Based on the assumptions and assessment in the EIS, three buildings at the Sydney Hospital are predicted to potentially have exceedances of the sensitive equipment criteria. These buildings have been identified based on an initial screening assumption that they contain vibration sensitive equipment with VC-C criteria. Further assessment of potential vibration impacts would be undertaken during development of the detailed noise and vibration impact statement. Depending on the outcome of this assessment, further consultation would occur with Sydney Hospital to obtain further information on potential vibration sensitive equipment and develop appropriate mitigation options.

Vibration levels are predicted to be below the human comfort criteria and the cosmetic damage screen level at all other receivers in the vicinity of the turnback and stub tunnels located to the east of Hunter Street Station.

Cross-passages

Based on the assumptions and assessment in the EIS, vibration levels are predicted to be below the human comfort criteria and the cosmetic damage screen level at receivers in the vicinity of all potential cross passage locations.

6 Mitigation and management of non-TBM tunnelling

Potential impacts associated with out of hours non-TBM tunnelling would be managed through the robust noise and vibration management measures as part of Sydney Metro systems, including the Construction Noise and Vibration Standard (CNVS) and the mitigation measures identified in the Submissions Report.

Receivers above the tunnels would also be consulted in accordance with the Overarching Community Communications Strategy (OCCS) (provided as Appendix B to the EIS) which includes advanced consultation prior to tunnelling works commencing in their vicinity.

These processes have been successfully implemented on previous Sydney Metro projects to manage potential ground-borne noise and vibration from TBM and non-TBM tunnelling activities. This is evidenced by very few complaints from non-TBM tunnelling on previous Sydney Metro projects. Sydney Metro City & Southwest tunnelling from Chatswood to Sydenham was undertaken over an approximate 18 month period and received less than 50 complaints from receivers affected by non-TBM tunnelling works and around 25 complaints from receivers affected by TBM tunnelling works across the 15 kilometre alignment. This included works beneath a number of residential areas in Chatswood, Artarmon, Crows Nest, North Sydney, McMahons Point, Blues Point, Redfern, Waterloo and St Peters.

6.1 Construction Noise and Vibration Standard

The CNVS (provided as Appendix E to the EIS) establishes a consistent strategy for the assessment, mitigation and monitoring of noise and vibration generated by construction activities across Sydney Metro, including this proposal. It defines a minimum standard for managing noise and vibration impacts that considers currently best practice guidelines and other regulatory requirements, and adopts strategic objectives to understand and manage potential noise and vibration impacts.

The CNVS outlines the process for development of detailed noise and vibration impact statements which would identify all feasible and reasonable mitigation measures. This would include the standard measures outlined in the CNVS and the additional measures outlined in Chapter 5 of the CNVS (refer to Tables 17 and 18 below).

In relation to ground-borne noise impacts at night, this includes project specific respite offers and alternative accommodation where noise levels are anticipated to be more than 10 dB above the noise management level. In relation to vibration impacts at night, this includes project specific respite offers and alternative accommodation when vibration levels are predicted to exceed maximum levels (human comfort levels).

Table 17: Additional Mitigation Measures – Ground Borne Construction Noise

Time Period		Mitigation Measures		
		Predicted $L_{Aeq\ (15minute)}$ noise level Above NML		
		0 to 10 dB	10 to 20 dB	> 20 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	No NML for GBN during standard hours, refer to Table 18		
	Sat (8.00 am - 1.00 pm)			
	Sun/Pub Hol (Nil)			
OOHW (Evening)	Mon-Fri (6.00 pm - 10.00 pm)	LB	LB, M, SN	LB, M, SN, IB, PC, RO
	Sat (1.00 pm - 10.00 pm)			
	Sun/Pub Hol (8.00 am - 6.00 pm)			
OOHW (Night)	Mon-Fri (10.00 pm - 7.00 am)	LB, M, SN	LB, M, SN, IB, PC, RO, AA	LB, M, SN, IB, PC, RO, AA
	Sat (10.00 pm - 8.00 am)			
	Sun/Pub Hol (6.00 pm - 7.00 am)			

Note: LB = Letter box drop; PC = Phone call / email; M = Monitoring; RO = Project specific respite offer; AA = Alternative accommodation; IB = Individual briefing; SN = Specific notification, individual briefing, or phone call

Table 18: Additional Mitigation Measures - Ground-borne Vibration

Time Period		Mitigation Measures
		Predicted Vibration Levels Exceed Maximum Levels
Standard	Mon-Fri (7.00 am - 6.00 pm)	LB, M, RO
	Sat (8.00 am - 1.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW (Evening)	Mon-Fri (6.00 pm - 10.00 pm)	LB, M, IB, PC, RO, SN
	Sat (1.00 pm - 10.00 pm)	
	Sun/Pub Hol (8.00 am - 6.00 pm)	
OOHW (Night)	Mon-Fri (10.00 pm - 7.00 am)	LB, M, IB, PC, RO, SN, AA
	Sat (10.00 pm - 8.00 am)	
	Sun/Pub Hol (6.00 pm - 7.00 am)	

Note: LB = Letter box drop; PC = Phone call / email; M = Monitoring; RO = Project specific respite offer; AA = Alternative accommodation; IB = Individual briefing; SN = Specific notification, individual briefing, or phone call

Preliminary application of CNVS additional mitigation measures

Based on the potential impacts presented in Section 5 of this report which reflect the conservative assumptions and assessment provided in the EIS, the following additional mitigation measures would be applicable for ground-borne noise and vibration impacts during tunnelling works (TBM and non-TBM). Further information on the approach to management of impacts to hotels is provided below.

The number of receivers eligible for alternative accommodation due to tunnelling work will be refined as part of the detailed noise and vibration impact statements undertaken by the construction contractor. For example, the detailed noise and vibration impact statement prepared for the Pyrmont crossover cavern excavation by non-TBM tunnelling identified that out of hours noise levels would be less than 10dB above the relevant NML, which would not result in any alternative accommodation being required in accordance with the CNVS. As outlined in the detailed noise and vibration impact statement, these noise levels are predicted to be lower than those

that would be experienced by TBM tunnelling. As required by condition of approval D29, detailed noise and vibration impact statements for the construction activities outlined in this Modification Request will include specific mitigation measures identified through consultation with affected sensitive land users. Receivers would be consulted as part of this process in relation to mitigation options available in accordance with the CNVS.

Table 9 Preliminary application of CNVS additional mitigation measures

Additional mitigation measure	Ground-borne noise		Vibration	Comments
	Evening	Night-time	Night-time	
Pyrmont				
Letter box drop	102	152	43	The 43 receivers eligible due to vibration impacts are all a subset of the receivers eligible from ground-borne noise impacts. Of the 51 receivers eligible for respite offers and alternative accommodation, 9 are known to be non-residential (reducing the eligible receivers to 42). These are: • TEN network, 2GB and Nova 96.9 which are only impacted by the TBM passby • 2 hotels • 4 commercial buildings (1 of which is a data centre).
Specific notification	28	51	43	
Monitoring	28	51	43	
Phone call / email	-	51	43	
Individual briefing	-	51	43	
Respite offer	-	51	43	
Alternative accommodation	-	51	43	
Hunter Street				
Letter box drop	5	8	4	The 4 receivers eligible due to vibration impacts are all a subset of the receivers eligible from ground-borne noise impacts. Of the 5 receivers eligible for respite offers and alternative accommodation, all are non-residential (hotels) (reducing the eligible receivers to zero). Further information on management of impacts to hotels is provided below.
Specific notification	4	5	4	
Monitoring	4	5	4	
Phone call / email	-	5	4	
Individual briefing	-	5	4	
Respite offer	-	5	4	
Alternative accommodation	-	5	4	

Note: this preliminary application of the CNVS has been undertaken on the conservative EIS assumptions and assessment. This has not considered the detailed noise and vibration statement that has been prepared for the Pyrmont crossover cavern. This table therefore represents a conservative worst-case assessment.

Local capacity to provide alternative accommodation needs

Based on the potential impacts presented in Section 5 of this report, there may be up to 42 residential receivers eligible for alternative accommodation from tunnelling works (both TBM and non-TBM). This section has applied the following conservative assumptions:

- all 42 receivers would be impacted at the same time. In reality, the timing of peak impacts to each receiver would vary. Some receivers are also only impacted for a few days by the TBM passby.
- all 42 receivers would take up the offer of alternative accommodation. Based on experience from the Power Enabling Works in Rozelle, the take up rate for alternative accommodation was around 30 per cent and it is anticipated the rate could be lower in the inner-city environment of Pyrmont where residents are accustomed to higher background noise levels.

Notwithstanding the above conservative assumptions, the local area contains a number of hotels (which are not impacted by the works) which would provide sufficient capacity for this volume of alternative accommodation. This includes The Star Grand Hotel, The Darling Hotel and ibis Hotel Sydney Darling Harbour. In addition, there are numerous hotels located in close proximity within the Sydney CBD which could also provide options for alternative accommodation.

Management of impacts to hotels

Based on the result of the detailed noise and vibration impact statement(s), Sydney Metro and the construction contractor will undertake further consultation with hotels where exceedances of the ground-borne noise levels are predicted to occur.

This consultation will aim to determine sensitive periods for each individual hotel. This information will be considered as part of developing appropriate mitigation measures. Examples of measures that have been implemented on previous Sydney Metro projects based on consultation with hotels, or that could be implemented on Sydney Metro West include:

- provision of respite. For example, some hotels have previously expressed a preference for works to be scheduled as one night on, one night off to provide respite for guests who book two night stays
- altering the timing of the works such as scheduling excavation works directly beneath hotels to less sensitive periods of the day or for non-peak season times. In some cases, such as hotels who cater to flight crews, undertaking excavation works during the night-time period could result in less impacts to the hotel operations.

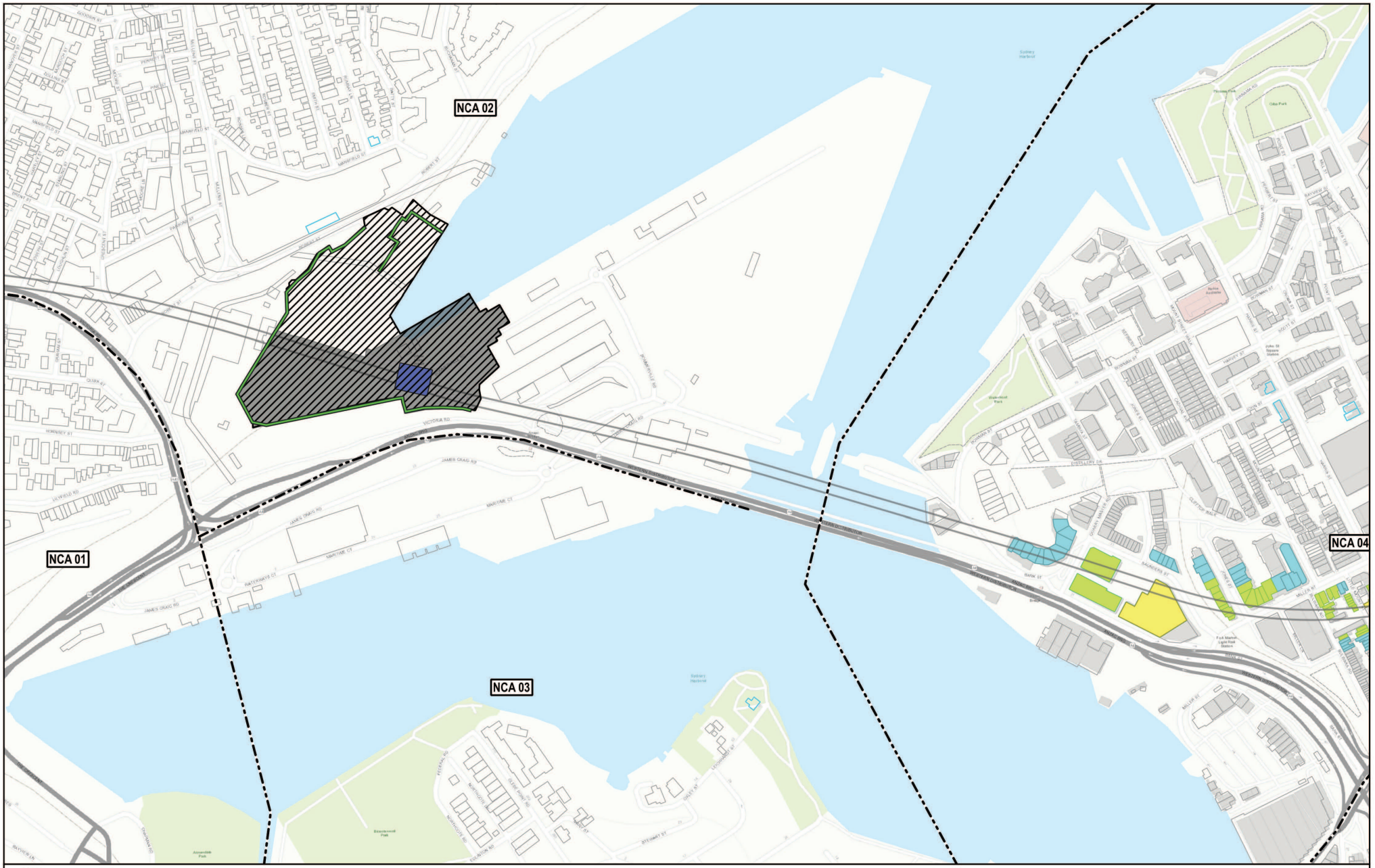
6.1.1 Relevant mitigation measures

The Submissions Report provided a consolidated list of environmental mitigation measures applicable to the project. The construction noise and vibration mitigation measures relevant to managing potential impacts from non-TBM tunnelling are provided in Table 10.

Table 10 Relevant environmental mitigation measures

Reference	Impact/issue	Mitigation measure	Applicable location(s)
NV01	Community preference for noise mitigation and management	Where justified by the application of the Construction Noise and Vibration Standard, further engagement and consultation would be carried out in accordance with the Sydney Metro Overarching Community Communications Strategy with: • The affected communities to understand their preferences for mitigation and management measures • 'Other sensitive' receivers such as schools, medical facilities, theatres, or places of worship to understand periods in which they are more sensitive to impacts. Based on this consultation, appropriate mitigation and management options would be considered and implemented where feasible and reasonable to minimise the impacts.	All
NV09	Ground-borne noise	Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedances are predicted. This may require implementation of less ground-borne noise and less vibration intensive alternative construction methodologies.	All
NV10	Ground-borne noise – cross passages	The proximity of cross passages to nearby receivers and the corresponding construction groundborne noise and vibration impacts during the excavation work would be considered when determining locations. Relocation of cross passages to be further away from sensitive receivers to mitigate potential construction impacts would be considered, where feasible and reasonable.	Metro rail tunnels
NV11	Ground-borne noise – underground rockbreaking	Activity specific Detailed and/or General Noise and Vibration Impact Statement (in accordance with the requirements of the Construction Noise and Vibration Standard) would be developed for rockbreaking in the tunnel and at cross passages, specifically addressing the activity where it is required between 10pm - 7am.	Metro rail tunnels

Attachment A Ground-borne noise impacts from tunnelling



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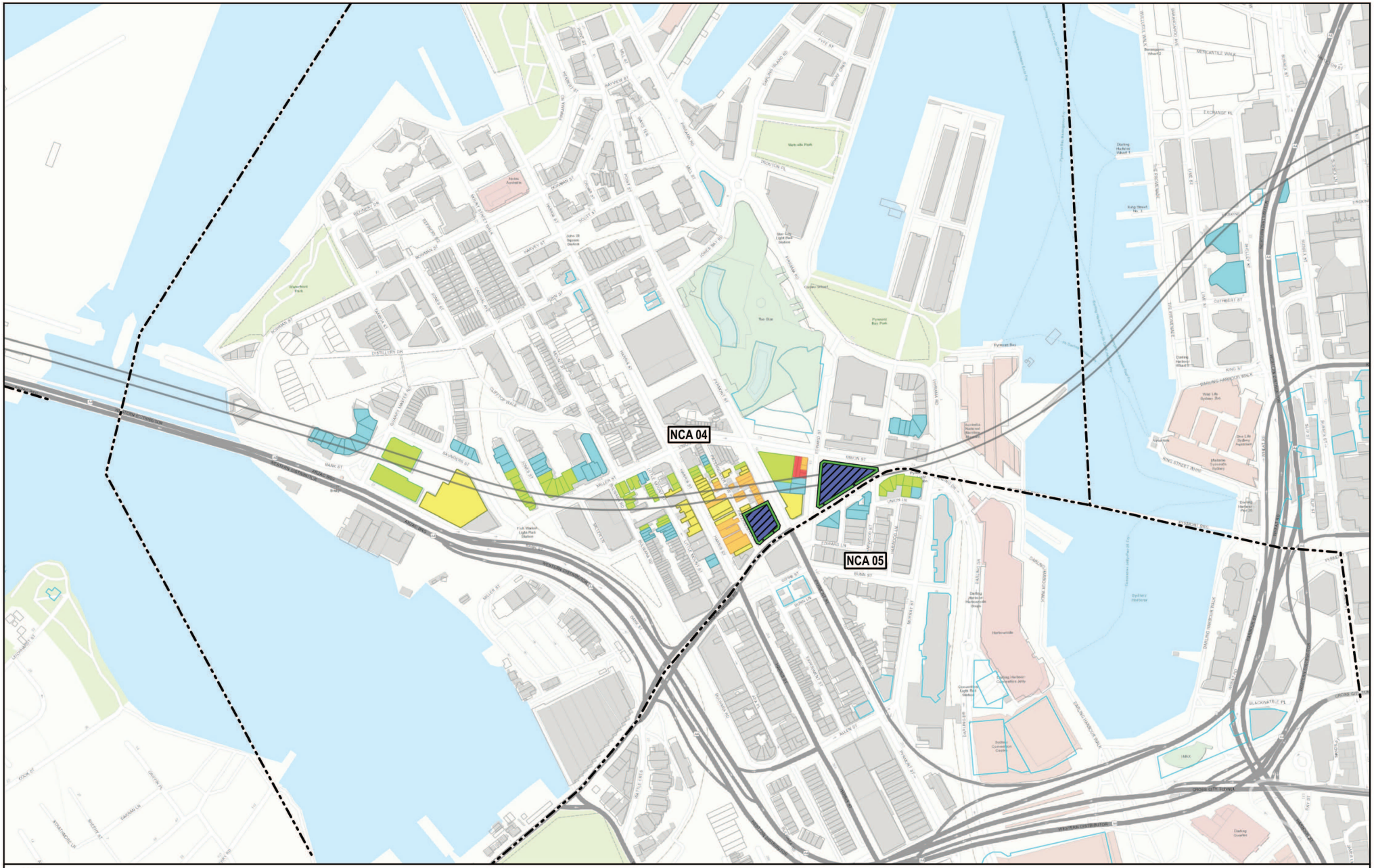
Sydney Metro Authority
Sydney Metro West Stage 2

Worst-case Ground-borne Noise Impacts from Tunnelling All Periods



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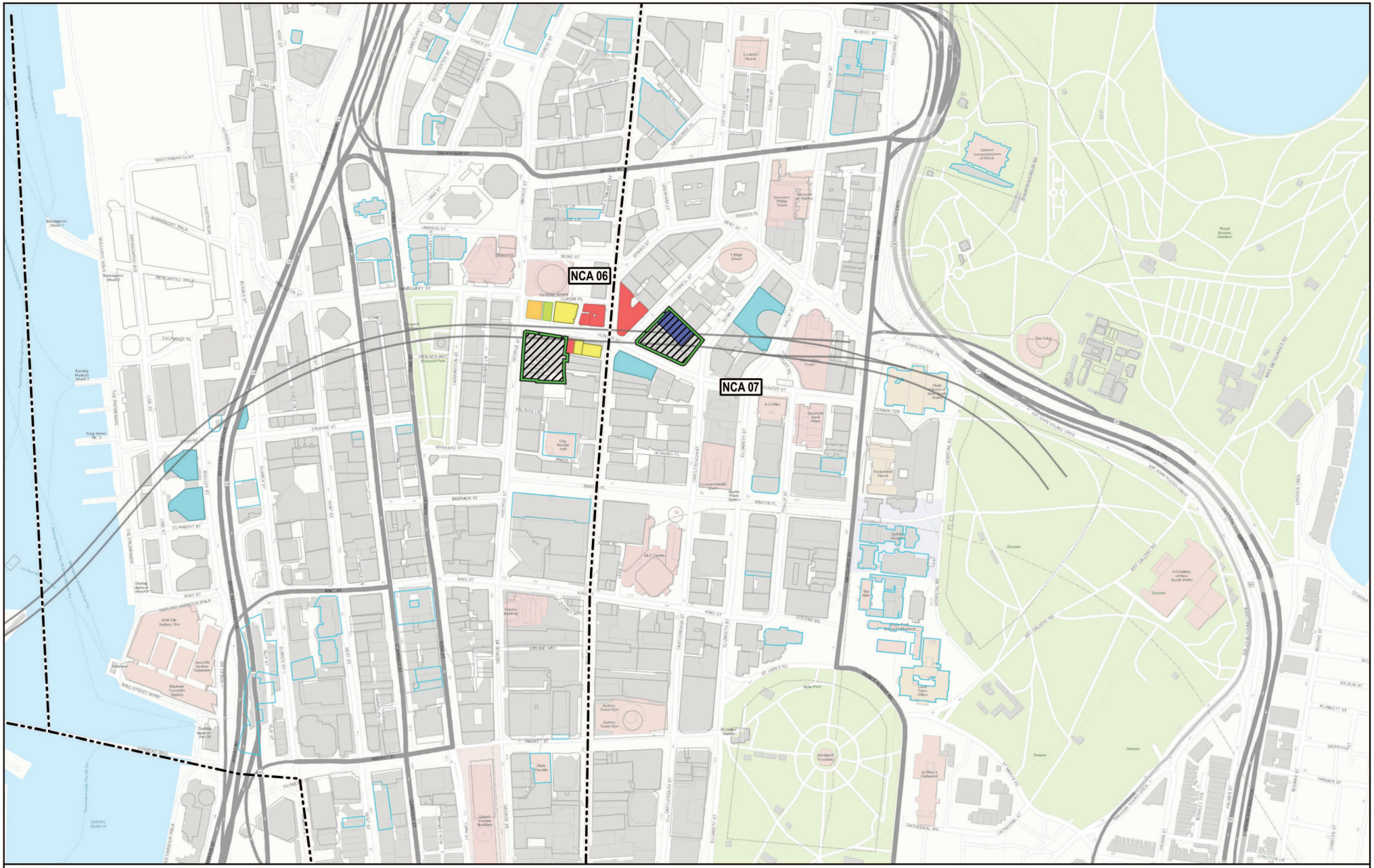
Scale: 1:5,000
GDA 1994 MGA Zone 56

Sydney Metro Authority
Sydney Metro West Stage 2

Worst-case Ground-borne Noise Impacts from Tunnelling All Periods



0 100 200 300 400 Meters

610.18331
14-Dec-2022

Scale: 1:5,000
GDA 1994 MGA Zone 56

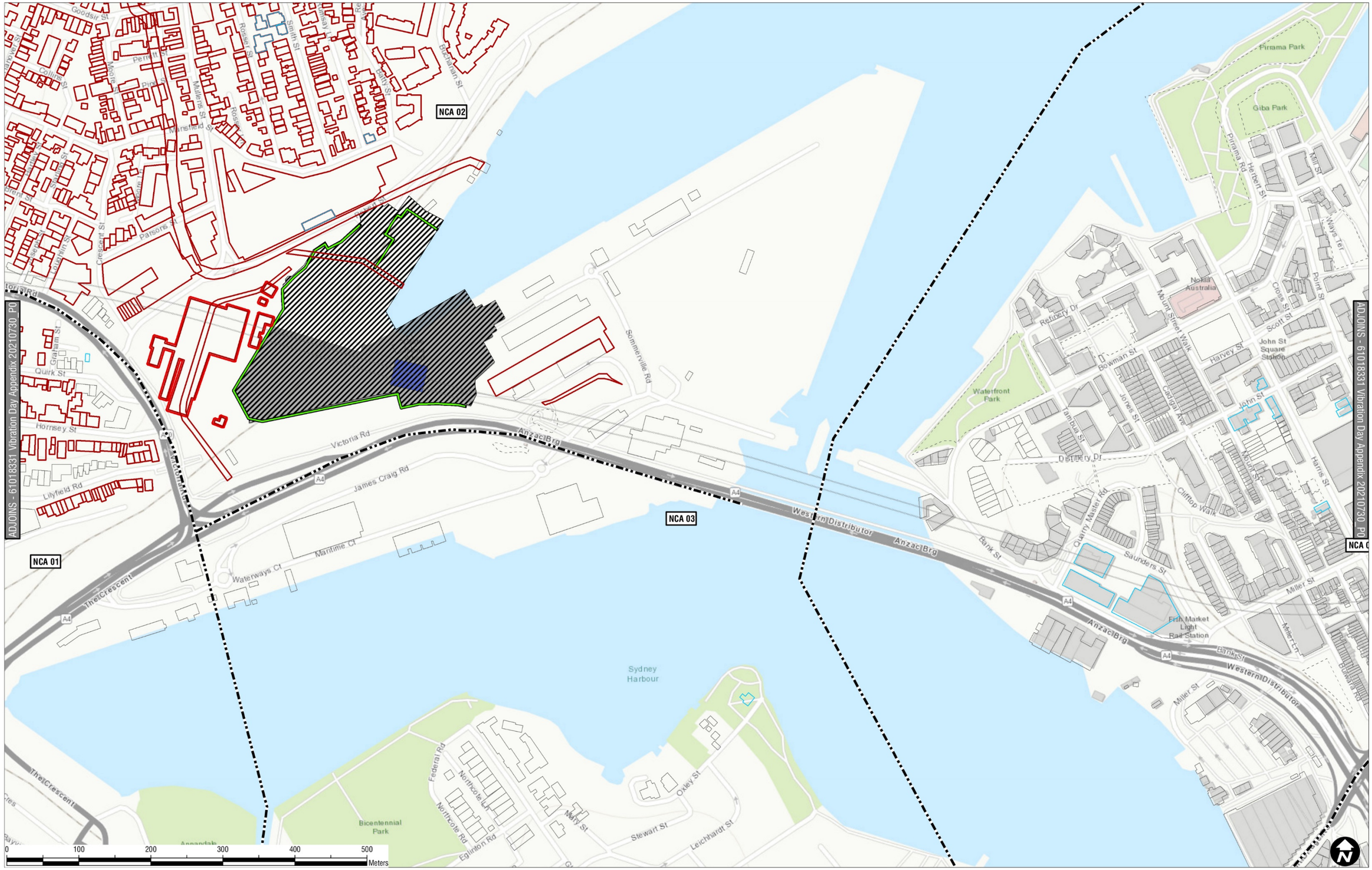
LEGEND

- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Other Sensitive Receivers
- No Exceedance
- 1 to 5 dB
- 6 to 10 dB
- 11 to 15 dB
- 16 to 20 dB
- 20 to 25 dB

Sydney Metro Authority
Sydney Metro West Stage 2

Worst-case Ground-borne Noise Impacts from Tunnelling All Periods

Attachment B Vibration impacts from tunnelling



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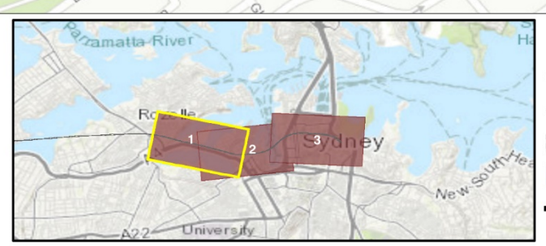
Projection:	GDA2020 MGA Zone 56



- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Heritage/Conservation Listed
- Vibration Sensitive Heritage
- Vibration Sensitive Equipment
- Human Comfort Criteria Exceedance
- Cosmetic Damage Screening Criteria Exceedance
- Sensitive Equipment Screening Criteria Exceedance

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Worst-case Vibration Impacts from TBM Tunnelling Day Time

61018331 Vibration Day Appendix 20210730_P01

ADJOINS - 61018331 Vibration Day Appendix 20210730_P0

ADJOINS - 61018331 Vibration Day Appendix 20210730_P0

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NCA 04

NCA 05

0 100 200 300 400 500 Meters

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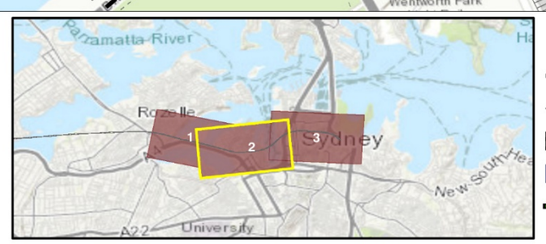

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- Vibration Sensitive Equipment
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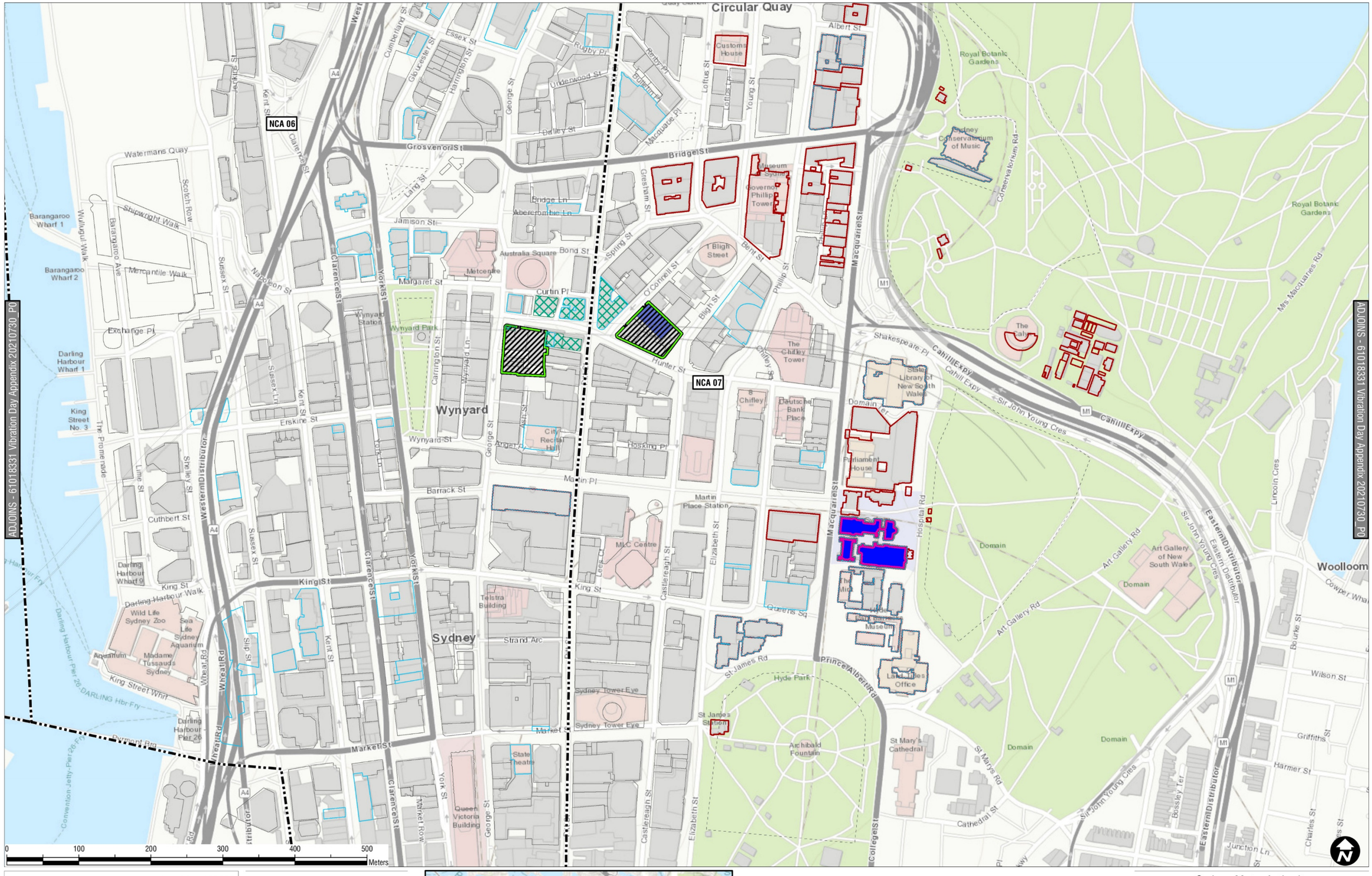
Stage 2

Worst-case Vibration Impacts from TBM Tunnelling Day Time

61018331 Vibration Day Appendix 20210730_P02

ADJOINS - 61018331 Vibration Day Appendix 20210730_P0



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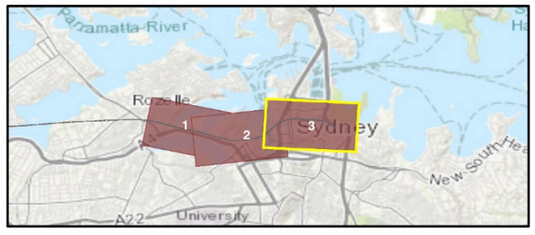

- NCA Boundary
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- Heritage/Conservation Listed
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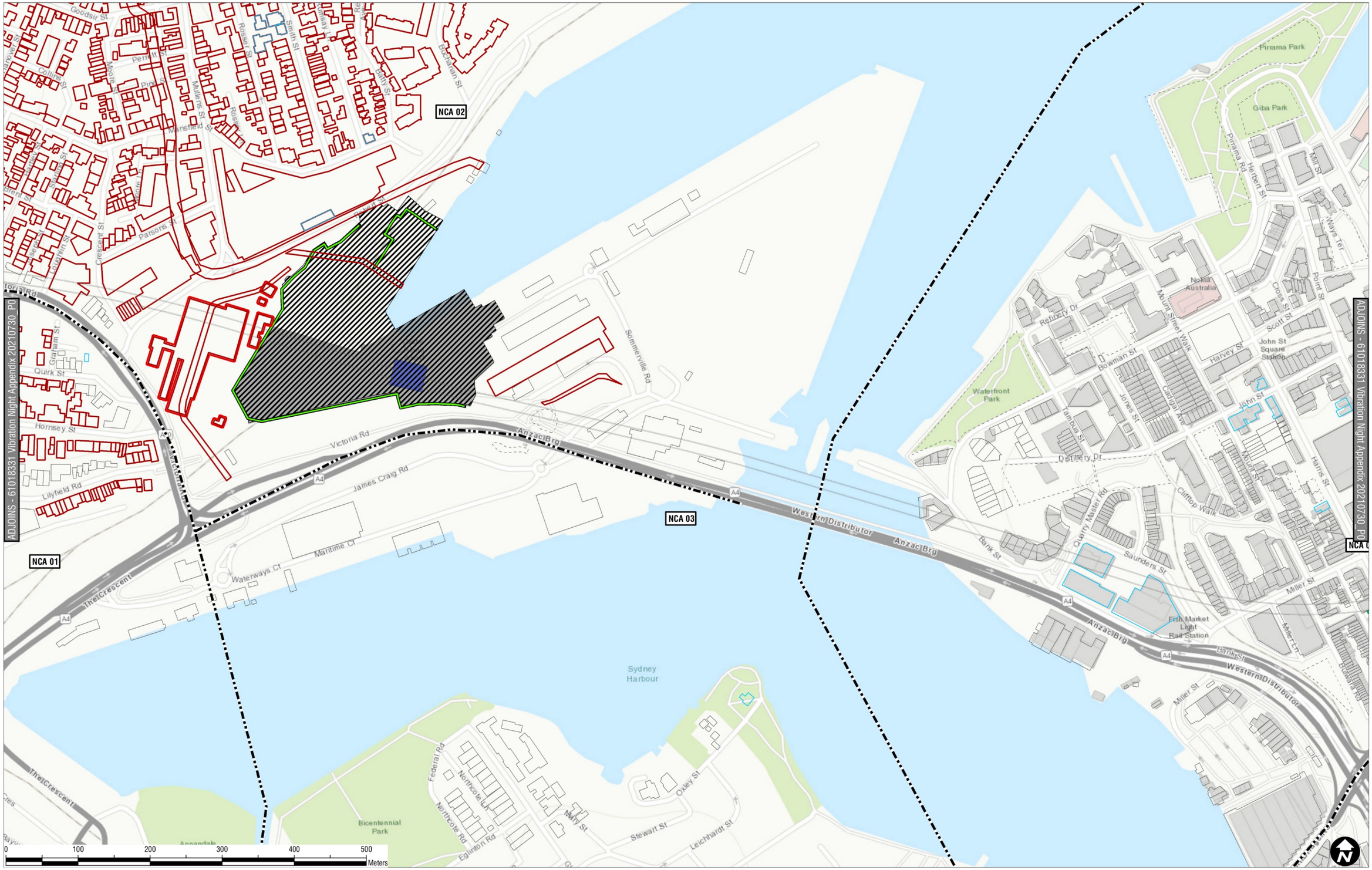
Worst-case Vibration Impacts from TBM Tunnelling Day Time

61018331 Vibration Day Appendix 20210730_P03



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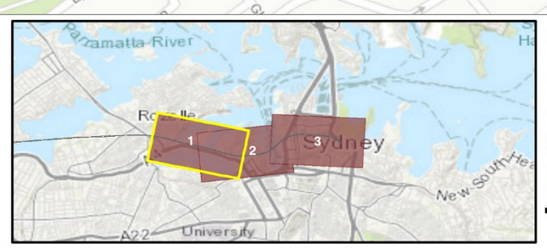

LEGEND

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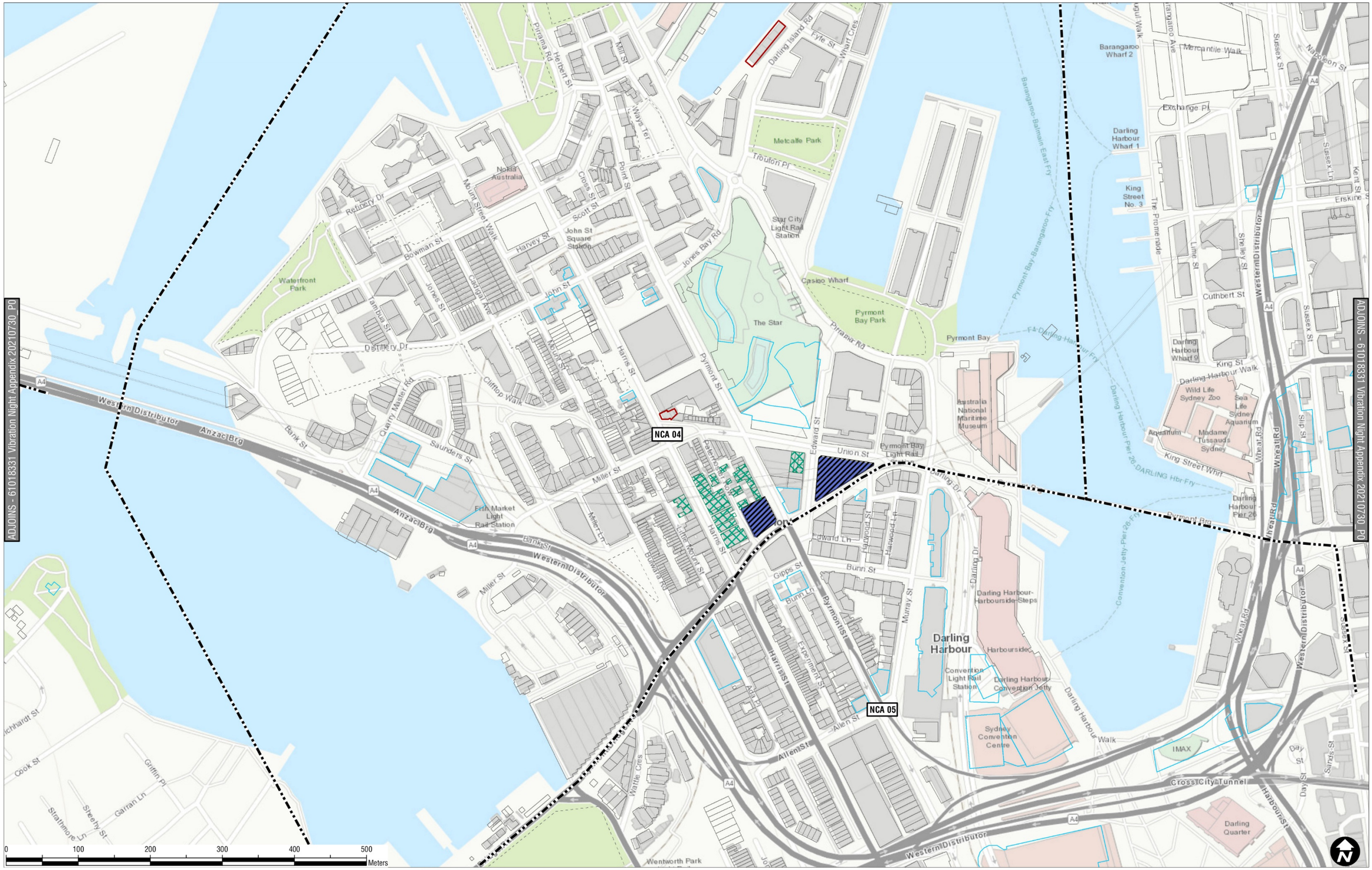
Stage 2

Worst-case Vibration Impacts from TBM Tunnelling Night Time

61018331 Vibration Night Appendix 20210730_P01



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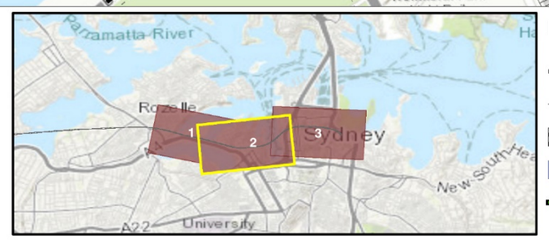

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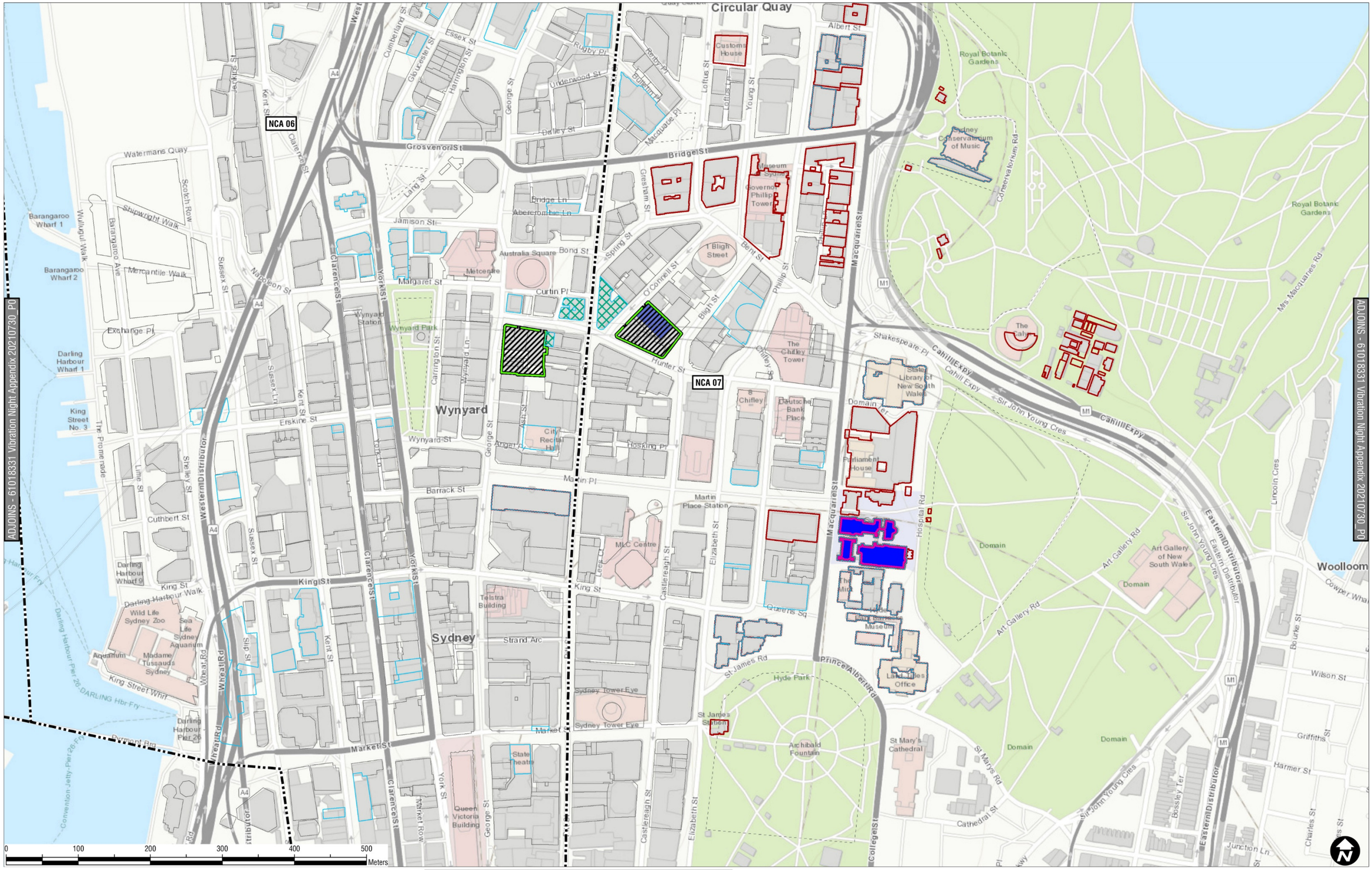
Stage 2

Worst-case Vibration Impacts from TBM Tunnelling Night Time

61018331 Vibration Night Appendix 20210730_P02



ADJOINS - 61018331 Vibration Night Appendix 20210730_P0

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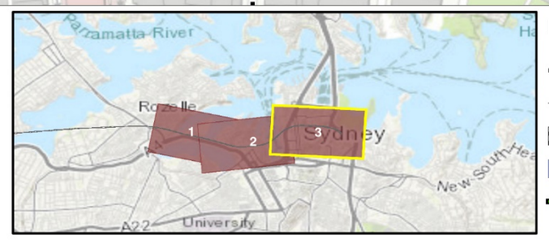

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Worst-case Vibration Impacts from TBM Tunnelling Night Time

61018331 Vibration Night Appendix 20210730_P03