11 Noise and vibration – Stage 1

11 Noise and vibration – Stage 1

This chapter provides an assessment of the potential noise and vibration impacts as a result of Stage 1 and identifies mitigation measures to address these impacts. This chapter draws on information provided in Technical Paper 2 (Noise and vibration).

11.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to noise and vibration and where they have been addressed in the Environmental Impact Statement are outlined in Table 11-1.

Table 11-1: Secretary's Environmental Assessment Requirements – Noise and vibration Stage 1

Reference	Secretary's Environmental Assessment Requirements	Where addressed
4. Noise and Vibration		
4.1	Commitments made in Section 9.2.2 of the Scoping Report.	Section 11.5 to 11.14
4.2	An assessment of construction noise and vibration impacts must address: a. the nature of construction activities and related noise characteristics;	Section 11.3
	b. the intensity and duration of noise (both air and ground borne) and vibration impacts. This must include consideration of extended construction impacts associated with ancillary facilities (and the like) and construction fatigue;	Section 11.5 to 11.14
	c. the identification and nature of receivers, existing and proposed, during the construction period;	
	d. the nature of the impact and the sensitivity of receivers and level of impact including for out of hours works;	
	e. the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management);	Section 11.3
	f. noise impacts of out-of-hours works (including utility works and works associated with the SSI including those undertaken under another assessment pathway), possible locations where out-of-hours works would be undertaken, the activities that would be undertaken, the estimated duration of those activities and justification for these activities in terms of the Interim Construction Noise Guideline (DECCW, 2009);	Section 11.5 to 11.14
	g. sleep disturbance (including the number of noise-awakening events);	
	h. a cumulative noise and vibration assessment inclusive of impacts from Stage 1, including concurrent construction activities within Stage 1 and the construction of other relevant development in the vicinity of Stage 1;	Section 11.15
	i. details and analysis of the predicted effectiveness of mitigation measures to adequately manage identified impacts, including impacts as identified in (h);	Section 11.5 to 11.14 Section 11.16
	j. any potential residual noise and vibration impacts following application of mitigation measures; and	
	k. a description of how receiver feedback received would be taken into account in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	Section 11.16.2
4.3	The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Section 11.5 Section 11.6 to 11.14
4.4	Blast impacts (if required) can comply with current guidelines.	Section 11.3.9 Section 11.16.2

11.2 Legislative and policy context

The guidelines used to assess noise and vibration impacts from Stage 1 are listed in Table 11-2.

Table 11-2: Noise and vibration guidelines

Guideline/policy name	Where guideline has been used
Interim Construction Noise Guideline (ICNG) (Department of Environment and Climate Change, 2009)	Assessment of airborne noise and ground-borne noise impacts on sensitive receivers.
Assessing Vibration: a technical guideline (Department of Environment and Conservation, 2006)	Assessment of vibration impacts on sensitive receivers.
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces.
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)	Assessment of construction traffic impacts.
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, (British Standards Institute, 1993)	Screening trigger levels for vibration (cosmetic damage) to sensitive buildings and structures.
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures (Deutsches Institute fur Normung, 1999)	Screening assessment of vibration impacts (cosmetic damage) to heritage sensitive structures, where the structure is found to be unsound.
Sydney Metro Construction Noise and Vibration Standard (Sydney Metro, 2020)	Assessment and management protocols for construction of Sydney Metro projects. This standard is based on the requirements of the ICNG, as appropriate to Sydney Metro and is the guiding document for Stage 1.
Guideline for Child Care Centre Acoustic Assessment Version 2.0, (Association of Australasian Acoustical Consultants, 2013)	Contains the reference criteria for child care centres.
Noise Policy for Industry (Environment Protection Authority, 2017a)	Establishment of Rated Background Levels and procedure for noise monitoring.

11.3 Assessment approach

11.3.1 Overview

The assessment methodology for noise and vibration impacts generally involved:

- Identifying and classifying sensitive receivers relevant to Stage 1 construction sites
- Characterising the existing noise environment based on attended and unattended noise measurements at specific locations across Stage 1
- Determining noise and vibration management levels in accordance with relevant guidelines
- Modelling to quantify potential noise and vibration impacts
- Assessing the significance of potential impacts identified
- Examining the proposed construction methodologies and identifying mitigation measures that are likely to be required to minimise construction noise and vibration impacts
- Consultation with the Environment Protection Authority to discuss the approach to the noise and vibration assessment.

The noise and vibration assessment considered the following components of Stage 1:

- Tunnelling construction activities, construction road traffic noise (i.e. spoil and material transport) and utility works – refer to Section 11.5
- All surface construction sites (i.e. metro station construction sites, Clyde stabling and maintenance facility and services facility construction sites), including associated activities such as tunnel boring machine launch/retrieval, concrete batching plants and segment production facility – refer to sections 11.6 to 11.14
- Operational aspects associated with road network changes at Westmead and Clyde – refer to sections 11.6 and 11.8 respectively
- Cumulative construction impacts including any interaction with nearby major projects – refer to Section 11.15.

11.3.2 Construction site work scenarios

Representative scenarios have been developed to assess the likely impacts from the various construction phases of Stage 1. These scenarios are listed in Table 11-3 for the required construction sites and for the remaining construction activities, which include tunnelling and ancillary works.

Table 11-3: Construction scenario descriptions

Scenario	Description
Construction site activities	
Enabling and site establishment works	These works are required to demolish existing buildings and structures, clear or protect trees, establish access points and erect hoarding. Relocation of services or third-party assets may also be required. Includes provision of high voltage power supplies for excavation equipment, which is required early in the program. The works are split into: • 'Typical' works which would include operation of supporting equipment such as generators, cranes, compressors, etc., and loading of heavy vehicles with equipment such as excavators • 'Peak' works which would include the use of noise intensive equipment such as rock breakers and concrete saws at times, especially during demolition of existing structures. The number of construction faces would double during 'peak' works for most construction sites.
Piling	Piling is required at all construction sites for the foundations of future structures and to support linings for the stations and shafts. The works are split into: • 'Typical' works which would include operation of supporting equipment such as excavators and cranes, as well as concreting equipment such as concrete mixer heavy vehicles and concrete pumps • 'Peak' works which would use all supporting equipment and the use of piling rigs. The number of piling faces would double during 'peak' works with most construction sites requiring up to four piling faces where there is sufficient space.
Surface construction	Following site establishment and piling works, civil works and surface structures such as abutments, roads, hardstand areas, and facilities such as water treatment equipment and site offices would be constructed. 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.
Excavation	All Sydney Metro West stations would be underground. Stations, service facility shafts and tunnel boring machine launch shafts would need to be excavated from the surface down. Excavation would begin immediately after the piling works and would be separated into two phases – 'initial excavation' and 'main excavation'. These two phases are explained below. **Initial excavation** Initial excavation involves removal of the upper layers of soil and rock to a depth suitable for the construction of an acoustic shed or acoustic panels (which are covers placed over the top of the excavation pit to minimise noise emissions). Initial excavation would take around two months to complete at each site and would be performed during standard construction hours. Initial excavation of soil and soft rock can be undertaken using 'ripping' where the earth is separated using a manual pick attachment on an excavator. Initial excavation of hard rock would require rock breaking, which is noise intensive. The time required for ripping versus rock breaking would vary at each site depending on the depth of rock. The works are split into: • 'Typical' initial excavation works which would include the use of support equipment for spoil handling and a process called 'mucking out' which is described below • 'Peak' works which would involve the concurrent use of support equipment and noise intensive rock breakers. The number of construction faces would double during 'peak' works for most construction sites. Initial excavation works are not assessed for construction sites without acoustic sheds (or other acoustic measures). At these sites only 'main excavation' would occur. **Main excavation** Main excavation (referred to as 'excavation' below) 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 other acoustic measures) at most sites except for the Parramatta metro station construction site, North Strathfield metro station construction site, service facilities sites at Silverwater and Rosehill, and the tunnel dive structure at Rosehill. 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. The works are split into: • 'Typical' excavation works which would include the use of supporting equipment for spoil handling and a process called 'mucking out' which is described below • 'Peak' works which would involve the concurrent operation of supporting works and rock breakers. The number of construction faces would double during 'peak' works for most construction sites with most sites requiring concurrent use of two rock breaking faces. Construction equipment outside the acoustic sheds (or other acoustic measures) would include heavy vehicles and fixed ancillary equipment such as temporary ventilation systems and water treatment facilities.
Mucking out	At times during excavation, works would pause so the loose spoil can be removed using excavators and transferred to heavy vehicles. This is referred to as 'mucking out'. Mucking out is the 'typical' works activity for the initial excavation and excavation works scenarios.

Scenario	Description
Mined caverns	Once the shafts have been excavated, areas of the underground station caverns can be mined using road headers. These works would be required at Burwood North and Five Dock Station construction sites. The works are split into: • 'Typical' works which would include operation of supporting equipment associated with spoil removal • 'Peak' works include the concurrent use of road headers and supporting equipment. The number of construction faces would double during 'peak' works for some construction sites with up to two road headers operating at the same time. Excavation of stub tunnels, connecting tunnels, and crossover and turnback caverns have been included in the assessment of tunnelling activities.
Tunnel boring machine launch, extraction, and support	Tunnel boring machines would be launched and supported from the Westmead metro station and The Bays Station construction sites. At each site, support activities would be needed to provide tunnel ventilation, supply high voltage power and extract/stockpile spoil for removal. Tunnel boring machines would be extracted at the Sydney Olympic Park Metro Station construction sites. Tunnel boring machine assembly, launch and extraction would occur 24 hours per day, seven days a week, however the majority of these works would be completed inside acoustic sheds (or other acoustic measures). Some less noisy works would be required outside the shed, such as loading and unloading of heavy vehicles. Once the tunnel boring machines are operational, spoil handling and removal would occur 24 hours per day, seven days a week at launch and support sites. The works require heavy vehicles, spoil conveyors, loading activities, tunnel ventilation fans, dust collectors, and materials and equipment deliveries. 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.
Concrete batching plant and segment production facility	A concrete segment production facility would be established at the Clyde stabling and maintenance facility construction site. This would include a concrete batching plant, a pre-cast production facility and storage yard. 'Typical' and 'peak' works scenarios for the concrete batching plant and pre-cast facility would generally include operation of concrete processing equipment such as concrete pumps, agitators, and vibrators, as well as the loading of heavy vehicles and stockpiles with concrete and tunnel lining segments. The facility is assumed to operate as follows: • 50 per cent capacity during the 'typical' scenario • 100 per cent capacity during the 'peak' scenario. The concrete batching plant and segment production facility would operate 24 hours per day, seven days a week. The use of the concrete batching plant and segment production facility has been included in the assessment of Clyde earthworks and civil works.
Clyde earthworks and civil works	The Clyde stabling and maintenance facility construction site would include earthwork and civil works needed to prepare the site for construction of stabling and maintenance facility facilities. The works are split into: • 'Typical' works which would include operation of supporting equipment such as excavators and trucks • 'Peak' works which would use all supporting equipment and noise intensive equipment such as concrete saws and jackhammers. The number of working faces would double during 'peak' works.
Tunneling and ancillary activities	
Tunnelling – excavation and construction	The tunnelling works would occur 24 hours per day, seven days a week. Depending on the rate of progress, noise and vibration impacts from tunnelling would likely only be apparent for relatively short periods at most locations. At this stage, tunnel boring machines are proposed to be used for most of the alignment, with roadheaders and rockbreakers proposed to be used at stations, stub tunnels, cross passages and crossover and turnback caverns. Roadheaders would also be used to excavate the tunnels that connect the stabling and maintenance facility to the main alignment.
Tunnelling – work trains	Consistent with the tunnelling methodology used on other Sydney Metro projects, work trains would be used to supply materials, such as precast tunnel lining segments, and workers to the workface. Spoil would be removed via conveyor. Work trains are anticipated to operate on a temporary narrow gauge rail with resilient mounts and/or use rubber wheels. The work trains would be loaded at the tunnel boring machine launch site and unloaded at the tunnel boring machine. The operating speed of work trains is around 10 kilometres per hour and they would be required 24 hours per day seven days a week to support tunnelling. On the basis of the above, work trains are not expected to result in any significant noise and vibration impacts.
Spoil and materials transport	Spoil and materials transport would be required to and from all construction sites. Spoil and materials transport would be via heavy vehicles. The possibility of bulk removal of spoil from The Bays Station construction site via barge is being investigated as an alternative option that may reduce the need for road transportation.
Road intersection modification	Road works would be required to modify intersections near the Westmead metro station construction site. These works would likely occur during the night-time period to minimise disruption on the road network. The works are split into: • 'Typical' works which would include operation of supporting equipment such as lighting towers, excavators and trucks • 'Peak' works which would use all supporting equipment plus noise intensive equipment like concrete saws and rockbreakers at times.
Utility works	Construction associated with utility relocation and diversion works would likely be required in various areas near most construction sites, however at this early stage the required locations are unknown. Works would likely be required along various streets to allow access and modification to underground utilities.

11.3.3 Noise impact assessment scenarios

The noise levels presented in the assessment are based on a realistic worst-case assessment of each works scenario, where construction equipment is at the closest point to each receiver. Stage 1 includes a number of base case mitigation measures to minimise the potential airborne noise impacts. These measures are considered as part of the design or construction methodology in the impact assessment. These are listed in Table 11-4.

Table 11-4: Stage 1 specific base case noise mitigation measures

Included mitigation measures	Description
Bored piling	The construction activities assume that bored piling would be used as opposed to impact piling, wherever possible. Bored piling is significantly less noise intensive than impact piling.
Acoustic perimeter hoardings	For construction concentrated in a single area, such as at the station and service facility construction sites, temporary acoustic hoardings around the site perimeter would be used where receivers are potentially affected and where feasible and reasonable. On this basis, three metre high acoustic hoardings of solid construction (as opposed to standard wire mesh fence) have been included in the assessment although other means of achieving the same noise outcome may be applied.
Acoustic sheds	Acoustic sheds have been assumed to be used for all construction sites where construction activities would regularly occur on a 24 hours per day, seven days per week basis near sensitive receivers. Typically, the sheds are designed to cover all excavation and spoil handling activities. At this stage, detailed designs for sheds have not been developed and a typical shed construction based on those used on previous stages of Sydney Metro have been used, with indicative shed dimensions. Shed ventilation would be designed to maintain the integrity of the shed, which indicatively would require attenuators for supply and return air ducting. When the main doors of the acoustic shed are opened to allow heavy vehicle access, noise emissions would potentially increase. The assessment presents predicted noise levels for doors open and doors closed. Where opening the shed doors during the night-time is predicted to result in noise management level exceedances, a two-stage 'airlock' door may be required to provide additional mitigation. The specific noise mitigation measures would be determined during detailed construction planning and would take into account the construction program, construction working hours and construction traffic management in accordance with the Sydney Metro Construction Noise and Vibration Standard.
Acoustic panels	Where acoustic sheds are constructed over part of a cut and cover station, the excavated section between the sheds would be covered by acoustic panels to minimise noise emissions. This assessment assumes that such panels would be consistent with those used in previous stages of Sydney Metro and would not allow a significant transfer of construction noise.

For most construction activities, it is expected the construction noise levels during less intensive activities would frequently be lower than predicted.

The noise impact assessment scenarios have been categorised into 'peak' and 'typical' works which have been used to define the likely range of potential noise impacts:

- 'Peak' works represent the noisiest stages and can require the use of noise intensive equipment such as rockbreakers or concrete saws for some construction scenarios. While 'peak' works would be required at times in most locations, the noisiest activities would not occur over the full duration of construction. The 'peak' scenarios also include the maximum anticipated number of construction faces at each of the various construction sites. The assessment is generally considered conservative as the calculations assume several items of equipment at each construction face are in use at the same time within individual scenarios
- 'Typical' works represent typical noise emissions from Stage 1 when noise intensive equipment is not in use. The 'typical' works includes all items of equipment for a given activity except for the loudest item. These items of equipment generally support the 'peak' works activity and are referred to as 'supporting equipment'.

Certain construction scenarios would require the concurrent operation of several construction teams (or 'construction faces') performing the same works in different areas of the site.

11.3.4 Construction program and hours

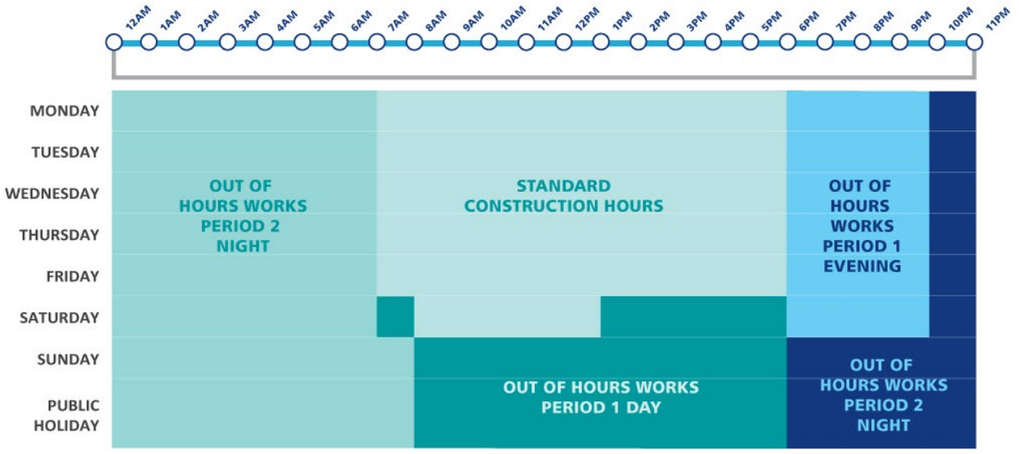
Subject to planning approval, construction of Stage 1 is planned to commence in 2021, with completion of Stage 1 works planned for 2026. The total duration of Stage 1 construction works is expected to be around five years. An indicative construction program for Stage 1 is provided in Chapter 8 (Stage 1 description).

Construction of Stage 1 would be carried out during standard construction hours where possible although evening and night-time work would be required during some periods. Standard construction hours for normal construction activities are:

- 7am to 6pm, Monday to Friday
- 8am to 1pm, Saturday
- No work on Sundays or public holidays.

Standard construction hours and other works periods are identified in the ICNG. These are further defined in the Sydney Metro Construction Noise and Vibration Standard, shown in Table 11-5.

Table 11-5: Standard construction hours



Note 1: Work outside of standard construction hours is defined as out-of-hours work and can be divided into 2 periods of sensitivity. Out-of-hours work period 1 is defined as Monday to Saturday 6pm to 10pm (evenings), Saturday 7am to 8am and 1pm to 6pm (day) and Sunday and public holidays 8am to 6pm (days). Out-of-hours work period 2 is defined as Monday to Saturday 10pm to 7am (nights) and Sundays and public holidays 6pm to 8am (nights).

A summary of the proposed construction hours for Stage 1 is shown in Table 11-6.

As the tunnel boring machines operate continuously, tunnelling and associated support activities would need to be carried out on a 24 hour per day, seven day a week basis. Most surface construction works, however, would be carried out during the standard construction hours.

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.

Table 11-6: Proposed construction hours

Activity	Construction hours	Comments or exceptions
Aboveground construction activities		
Enabling works	ICNG standard construction hours and daytime OOHW Period 1 at some sites	Works restricted to standard construction hours with the exception of Parramatta, Silverwater and The Bays construction sites (refer Table 11-7). Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm and 5pm or Sundays between 8am and 5pm.
Piling		
Surface construction		
Initial excavation		
Tunnel boring machine launch, extraction, and support	24 hours per day, seven days per week	Restrictions would be in place during peak hours.
Concrete batching plant		
Segment production facility		
Construction traffic for material supply to and spoil removal from tunnelling and underground excavation (station and ancillary facility sites)		
Westmead intersection modification works		
Utility works		
Underground construction activities		
Controlled blasting	ICNG standard construction hours	Drill and blast, if required, would be carried out during periods anticipated to have the least impact on receivers. This is expected to be during standard construction hours.
Tunnelling works	24 hours per day, seven days per week. ICNG standard construction hours (Parramatta and North Strathfield only)	Activities that support tunnelling may need to occur 24 hours per day, up to seven days per week. Rockbreaking in the tunnel and cross-passages between 10pm and 7am would not occur except where appropriate noise impact management measures have been established.
Underground excavation at station and ancillary sites		

The Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) identifies the following categories of work that might be carried out outside the recommended standard hours:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

It is anticipated that in addition to the delivery of oversize plant/structures, the activities listed in Table 11-7 would need to be completed out of hours. Justification for these requirements is provided in the table.

Table 11-7: Works outside of standard construction hours

Activity	Justification for Out-of-hours activities
Tunnelling (including cross passages) and tunnelling support activities (including tunnel boring machine launch/retrieval and spoil handling).	Tunnelling and excavation works would define the overall Stage 1 duration. Earlier completion would bring considerable benefits to the community and would reduce the duration of construction related disruption. Other aspects of the justification for out-of-hours tunnelling and support operations include the need to: • Install ground support systems immediately following excavation • 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 • Reduce peak demand on the electricity network • Handle the spoil produced by the 24 hour per day, 7 days a week operation of the tunnel boring machines and the proposed out of hours transport of spoil.
Precast concrete segment production	The production of precast concrete tunnel segments is needed to support the tunnel following the tunnel boring excavation. The production facility needs to operate outside standard hours to achieve the precast segment production rates required by 24 hour per day, 7 days a week tunnel boring machine operation.
Construction traffic for material supply to and spoil removal from tunnelling and underground excavation (station and ancillary facility sites)	Tunnelling and excavation works would require materials deliveries and the transport by road of substantial quantities of spoil. To avoid further impacting the operation of the road network, construction vehicle movements during the AM and PM peak periods need to be minimised. Given the volumes of spoil and space constraints at construction sites, which limit the extent of on-site spoil storage, transport of materials and spoil cannot be limited to the hours between 10am and 3pm. Night-time vehicle movements are therefore necessary.
Underground excavation at station and ancillary sites	For mined excavations, temporary support in the form of shotcrete, steel sets and rockbolts must be installed immediately to ensure stability of the works 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. Out-of-hours works would allow for the completion of the entire support system immediately following excavation.
Intersection modifications at Westmead	These works would require lane closures and, in some cases, total closure of roads. Intersection modification works would, therefore, likely be required to occur during the evening and night-time period when traffic volumes are lower to minimise disruption to local traffic.
Daytime out-of-hours works (Period 1 Saturday only)	Enabling works, pilling, surface construction, and initial excavation works are proposed during the Saturday daytime out-of-hours works period 1 at Parramatta, Silverwater and The Bays construction sites. Residential receivers are generally around 100 metres or further away from these construction sites and are screened from view by intervening non-residential buildings, meaning impacts would be low.

Further detail on the approach to out of hours work is provided in the Sydney Metro Construction Noise and Vibration Standard.

11.3.5 Construction noise metrics

Noise parameters most relevant to construction noise are described below and were evaluated for daytime (7am-6pm), evening (6-10pm) and night-time (10pm-7am) periods:

- Rating background level (RBL) or L_{A90} – the background noise level in the absence of proposed construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods and is used to set the $L_{Aeq(15\ minute)}$ noise management levels (NMLs) for residential receivers
- $L_{Aeq\ (period)}$ – the 'energy average noise level' evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring)
- L_{Amax} or $L_{A1(1min)}$ – the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods.

11.3.6 Noise catchment areas and sensitive receivers

The area surrounding each construction site is divided into one or more Noise Catchment Areas (NCAs) that reflect the ambient noise environment of that area, as well as the noise and vibration sensitivity of the surrounding land uses.

The sensitivity of occupants to noise and vibration varies according to the nature of the occupancy and the activities performed within the affected premises. For example, premises with sensitive equipment or uses are more likely to be sensitive to vibration and ground-borne noise than residential premises, which in turn are more sensitive than typical commercial premises.

Receivers potentially sensitive to noise and vibration have been categorised into the following receiver categories:

- Residential buildings
- Commercial/industrial buildings
- 'Other sensitive' land uses, which includes educational institutions, childcare centres, medical facilities, places of worship, outdoor recreation areas.

A description of each of the NCAs is provided for each of the construction sites (beginning in Section 11.6).

New developments

A review of recently approved developments in the study area has been completed and those that would be categorised as sensitive have been included in the assessment.

11.3.7 Construction noise management levels

Airborne construction noise

Noise management levels

The Construction Noise and Vibration Standard references the ICNG for assessing and managing construction noise impacts from Sydney Metro works.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers. The 'worst-case' noise levels from construction of a project are predicted and then compared to the NMLs in a 15 minute assessment period to determine the likely impact of Stage 1.

The NMLs are not mandatory limits, however where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

Residential receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers by applying the measured $L_{A90(15minute)}$ background noise levels, as described in Table 11-8.

Table 11-8: Determination of NMLs for residential receivers

Time of day	NML $L_{Aeq(15minute)}$	How to apply
Standard construction hours: **Monday to Friday** **7am-6pm** **Saturday** **8am-1pm** **No work on Sundays or public holidays**	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to meet the noise affected level • The proponent would also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dBA	• A strong justification would typically be required for works outside the recommended standard hours • The proponent would apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent would negotiate with the community.

Other sensitive land uses and commercial receivers

The Stage 1 specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in Table 11-9.

Table 11-9: NMLs for other sensitive receivers

Land use	NML $L_{Aeq(15minute)}$ (applied when the land use is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operation theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
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 dBA
Passive recreation areas **(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion e.g. reading, meditation)**	External noise level 60 dBA
Commercial	External noise level 70 dBA
Industrial	External noise level of 75 dBA

Rosehill Gardens racecourse stables have been included in the assessment and are assessed as 'other sensitive' active recreation areas. This is consistent with the CBD and South East Light Rail Environmental Impact Statement (Transport for NSW, 2013).

Other noise-sensitive receivers require separate Stage 1 specific noise goals. The ICNG recommends that the internal construction noise levels at these premises are determined based on the 'maximum' internal levels presented in AS 2107. These recommended 'maximum' internal noise levels are provided in Table 11-10.

Table 11-10: NMLs for other receivers

Description	Time period	NML derived from	Noise management level (dBA) $L_{Aeq(15minute)}$	
			Internal	External
Hotel	Daytime and evening	AS2107: Bars and lounges	50	70[1]
	Night-time	AS2107: Sleeping areas: Hotels near major roads	40	60[1]
Childcare centres	Daytime	GCCCAA: Outdoor play areas	-	55
		GCCCAA: Sleeping areas	40	50[2]
Public building	When in use	AS2107: Public space	50	60[2]
Recording studio	When in use	AS2107: Music recording studios	25	45[1]
Theatre/auditorium	When in use	AS2107: Drama theatres	30	50[1]
Stables	When in use	ICNG: Outdoor passive recreation	-	60

Note 1: The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been assumed that these receivers have fixed windows with a conservative 20 dB reduction for external to internal noise levels.

Note 2: Receiver conservatively assumed to have openable windows and a 10 dB reduction from outside to inside facade levels.

Assessing airborne construction noise impacts

The assessment of predicted airborne noise impacts around construction sites is based on the exceedance of the NMLs as per the construction scenarios identified in Section 11.3.2. The likely subjective response of people affected by the impacts is shown in Table 11-11 and is used at all construction sites to describe the level of impact during standard construction hours.

Table 11-11: Exceedance bands and corresponding subjective response to impacts

Exceedance of management level	Likely subjective response	Impact colouring
No exceedance	Negligible to low	
1 to 10 dB	Minor to marginal	
11 dB to 20 dB	Moderate	
>20 dB	High	

Ground-borne construction noise

Construction works can cause ground-borne noise impacts in nearby buildings when vibration intensive equipment is in use, such as during tunnelling works using tunnel boring machines, roadheaders or rockbreakers. Ground-borne noise NMLs are defined in the ICNG for residential receivers and in the Sydney Metro Construction Noise and Vibration Standard for commercial receivers.

The NMLs are applicable to tunnelling works and also where ground-borne noise levels are higher than airborne noise levels, which can occur during rockbreaking for example, where airborne noise levels are shielded by noise barriers or other such structures.

Ground-borne NMLs for residential and commercial receivers, based on levels provided in the ICNG, are presented in Table 11-12.

Table 11-12: Internal ground-borne NMLs for residential and commercial receivers

Time of day	Ground-borne NMLs $L_{Aeq(15\ minute)}$
Daytime 7am-6pm	• Residential 45 dBA • Commercial 50 dBA
Evening 6-10pm	• Residential 40 dBA
Night-time 10pm-7am	• Residential 35 dBA

At locations where the construction noise levels are predicted to exceed the NMLs, consideration must be given to applying all feasible and reasonable work practices for each site and activity to minimise potential noise impacts.

For 'other sensitive' receivers such as education institutions, hospital wards, operating theatres and places of worship, neither the ICNG nor Sydney Metro Construction Noise and Vibration Standard provide guidance in relation to acceptable ground-borne noise levels. For these receivers, the ICNG internal airborne NMLs listed in Table 11-9 and Table 11-10 have been used to identify potential ground-borne noise impacts.

11.3.8 Ground-borne construction vibration

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where the building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

These are discussed further in the following sections.

Human comfort and building contents

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings. Vibration from construction works tends to be intermittent in nature and the EPA's Assessing Vibration: a technical guideline (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The VDV provides a measurement of the presence of 'jolts and jars' experienced and combines the magnitude of vibration with the time for which it occurs. The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in Table 11-13.

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Table 11-13: Vibration dose values for intermittent vibration

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

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

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes are located in buildings near to construction works. Criteria for vibration sensitive equipment are discussed below.

Cosmetic damage

If vibration from construction works is sufficiently high it could potentially cause cosmetic damage to elements of affected buildings. Examples of potential damage include cracking or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. The levels of vibration required to cause cosmetic damage tends to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration (human comfort VDVs).

Industry standard cosmetic damage vibration limits are contained in Australian Standard AS 2187-2, British Standard BS 7385 and German Standard DIN 4150, which are referenced in the Sydney Metro Construction Noise and Vibration Standard. The Sydney Metro Construction Noise and Vibration Standard recommends limits for transient vibration which correspond to minimal risk of cosmetic damage for residential and industrial buildings.

The Sydney Metro Construction Noise and Vibration Standard notes that where dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in British Standard BS 7385:2 – 1993 may need to reduce by up to 50 per cent. On this basis, the Sydney Metro Construction Noise and Vibration Standard recommends the adoption of conservative cosmetic damage screening limits shown in Table 11-14.

Table 11-14: Transient vibration values for minimal risk of cosmetic damage

Type of building	Peak component particle velocity
Reinforced or framed structures **Industrial and heavy commercial buildings**	25 mm/s
Unreinforced or light framed structures **Residential or light commercial type buildings**	7.5 mm/s

Heritage buildings and structures

The Sydney Metro Construction Noise and Vibration Standard states that heritage buildings and structures should be assessed according to the cosmetic damage screening criteria outlined in Table 11-14 and should not be assumed to be more sensitive to vibration unless found to be structurally unsound.

Sydney Metro West would complete condition surveys of potentially affected buildings and structures near to the tunnel and excavations prior to the commencement of excavation, where appropriate. Where heritage buildings and structures are found to be structurally unsound, a more conservative cosmetic damage screening level of 2.5 millimetres per second peak particle velocity (PPV) (from DIN 4150) would be adopted prior to more specific consideration of appropriate levels for each building or structure.

Utilities and other vibration sensitive assets

Construction of Stage 1 could potentially affect other utilities and assets which may be particularly sensitive to vibration. Examples include pipelines, tunnels, fibre optic cables and high pressure gas pipelines.

German Standard DIN 4150 provides the guideline vibration limits for buried pipework shown in Table 11-15. For other potentially affected assets, specific vibration limits should be determined on a case-by-case basis in consultation with the asset owner.

Table 11-15: Transient vibration values for minimal risk of cosmetic damage

Pipe material	Guideline values vibration velocity at the pipe
Steel, welded	100 mm/s
Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
Masonry, plastic	50 mm/s

Sensitive scientific equipment

Some scientific equipment, such as electron microscopes and microelectronics manufacturing equipment can require more stringent vibration limits. Other equipment used for various business requirements as well as medical equipment may also have specific vibration goals. Vibration sensitive equipment is however often housed in buildings/rooms specifically designed and constructed for that purpose. Vibration criterion for vibration sensitive equipment is provided in Table 13 of Technical Paper 2 (Noise and vibration).

11.3.9 Controlled blasting

Controlled blasting is often used where deep excavation of rock is required and can be used as an alternative to rockbreaking. Controlled blasting events have the potential to result in brief ground vibration and air overpressure impacts at nearby receivers. Where controlled blasting is used to substitute or complement the operation of construction equipment to break rock, blasting can substantially reduce the length of time that noise and vibration impacts occur when compared to rockbreaking alone.

The ICNG recommends blasting occur between Monday to Friday (9am to 5pm) and Saturday (9am to 1pm) with no blasting on Sundays or public holidays.

Consistent with recent approvals for NSW infrastructure projects, the Sydney Metro Construction Noise and Vibration Standard defines the vibration and overpressure limits for blasting applied to Stage 1:

- Vibration (PPV): 25 millimetres per second
- Overpressure: 125 dBL.

As noted above, heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. Where heritage buildings and structures are found to be structurally unsound, a more conservative cosmetic damage objective of 2.5 mm/s PPV (from DIN 4150) would be adopted.

11.3.10 Construction traffic noise

The potential impacts from construction traffic associated with Stage 1 when travelling on public roads are assessed under the NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011a).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2 dB due to construction traffic. Where this is considered likely, further assessment is required using the following relevant road traffic noise criteria:

- Existing freeway/arterial/sub-arterial roads:
  - $L_{Aeq(15hour)}$ 60 dBA day
  - $L_{Aeq(9hour)}$ 55 dBA night
- Existing local roads:
  - $L_{Aeq(1hour)}$ 55 dBA day
  - $L_{Aeq(1hour)}$ 50 dBA night.

Where the criteria are exceeded Sydney Metro would consider the use of all feasible and reasonable mitigation and management measures to minimise the impacts.

11.3.11 Sleep disturbance

Where night works are located close to residential receivers there is potential for sleep disturbance impacts.

The ICNG lists five categories of works that might be undertaken outside the standard construction hours:

- The delivery of oversized equipment or structures that require special arrangements to transport on public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Where construction works are planned to extend over more than two consecutive nights, the ICNG recommends an assessment of sleep disturbance impacts should be completed.

The most current method for assessing sleep disturbance from NSW transport infrastructure projects is contained in the EPA's Noise Policy for Industry (NPfI) (EPA, 2017). The NPfI defines sleep disturbance criteria as being 52 dBA L_{AFmax} or a maximum level of 15 dB above the RBL, whichever is the greater.

Where this criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

11.4 Avoidance and minimisation of impacts

The design development of Stage 1 has aimed to avoid or minimise potential construction noise and vibration impacts. This included:

- Positioning Westmead metro station south of the existing rail corridor to minimise construction noise and vibration impacts to sensitive receivers (medical equipment) within the hospital precinct located north of the station
- Locating the stabling and maintenance facility at Clyde within an industrial area to minimise potential construction noise impacts on sensitive receivers
- Locating the services facility at Silverwater within an industrial area to minimise potential construction noise impacts on sensitive receivers
- Retrieval of tunnel boring machines at Sydney Olympic Park which provides ready access to the arterial road network (and the M4 Motorway) and minimises potential road traffic noise impacts.

11.5 Project-wide impacts

Potential construction noise and vibration impacts would be managed in accordance with the Sydney Metro Construction Noise and Vibration Standard (Appendix E), which aims to manage noise and vibration levels through feasible and reasonable measures. The Standard provides a process for the development of site or activity specific Construction Noise and Vibration Impact Statements, standard mitigation measures and additional mitigation measures to be implemented based on noise and vibration trigger levels.

11.5.1 Ground-borne noise impacts from tunnel boring machines

The assessment of ground-borne noise is based on the worst-case predicted ground borne noise levels for sensitive receivers located above the proposed tunnel alignment. The predictions represent the likely highest noise level inside sensitive receivers when the tunnelling works are directly below each receiver.

The tunnel boring machines are expected to progress at a rate of around 20 metres per day. This means the worst-case ground-borne noise impacts from tunnelling at individual receivers would likely only be apparent for a few days for each tunnel boring machine, when the tunnelling works are directly beneath. As the works progress and move away, a particular receiver's exposure to ground-borne noise would reduce accordingly.

A summary of the predicted ground-borne noise levels from tunnelling in each Noise Catchment Area is shown in Table 11-16. Each Noise Catchment Area is identified in Section 11.6 to 11.14.

Table 11-16: Summary of tunnelling ground-borne NML exceedances – all receiver types

Location	Noise Catchment Area	Number of receivers									
		Total	With NML exceedance[1, 2]								
			Tunnelling with tunnel boring machine								
			Standard daytime			Evening			Night-time		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Westmead	NCA01	340	-	-	-	-	-	-	2	-	-
	NCA02	806	15	-	-	24	3	-	23	15	-
Parramatta	NCA03	509	13	-	-	8	-	-	4	5	-
Clyde	NCA04	392	51	-	-	91	1	-	80	49	-
	NCA05	477	-	-	-	-	-	-	-	-	-
	NCA06	207	-	-	-	-	-	-	-	-	-
	NCA07	553	-	-	-	-	-	-	-	-	-
Silverwater	NCA07	1,389	-	-	-	-	-	-	8	-	-
Olympic Park	NCA08	95	4	-	-	-	-	-	-	-	-
	NCA09	32	-	-	-	-	-	-	-	-	-
North Strathfield	NCA10	614	20	1	-	13	13	-	19	20	-
	NCA11	1,280	39	11	-	57	27	-	69	39	11
Burwood	NCA12	1,200	14	-	-	94	-	-	168	11	-
	NCA13	957	-	-	-	1	-	-	3	-	-
Five Dock	NCA14	1,242	71	-	-	93	-	-	54	61	-
	NCA15	966	14	-	-	43	-	-	47	14	-
Between Five Dock and The Bays	NCA16	389	-	-	-	-	-	-	-	-	-
	NCA17	679	-	-	-	41	-	-	60	-	-
	NCA18	921	-	-	-	-	-	-	-	-	-
	NCA19	962	-	-	-	-	-	-	-	-	-
The Bays	NCA20	873	-	-	-	-	-	-	-	-	-
	NCA21	844	-	-	-	6	-	-	12	-	-
	NCA22	46	-	-	-	-	-	-	-	-	-

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

Note 2: Noise management levels for standard daytime, evening and night-time works are outlined in Section 11.3.7

The above assessment shows that:

- The worst-case ground-borne noise impacts from tunnelling during the daytime are predicted to generally be compliant with the NML or result in only 'minor' impacts. 'Moderate' impacts are predicted at 12 receivers near to North Strathfield (in Noise Catchment Area NCA10, NCA11), which is due to the tunnel being at its most shallow point in this location. These 'moderate' impacts are generally at residential receivers on Queen Street, to the north of the North Strathfield metro station construction site
- During the night-time, the impacts are more wide-spread due to a lower NML. The worst-case impacts are predicted to be 'high' to the north of the North Strathfield metro station construction site (NCA11), with 'moderate' impacts also predicted at certain receivers in Westmead, Parramatta, Clyde, North Strathfield and Five Dock. These impacts are typically at receivers which surround the construction sites, as this is where the tunnel depth is shallowest
- The ground-borne noise predictions are based on the nearest sensitive receivers and most exposed floor (i.e. ground floor for commercial and lowest habitable floor for residential). The ground-borne noise impacts would reduce for sensitive receivers which are further away from the alignment or for receivers with a higher ground floor, or on a higher storey in buildings.

11.5.2 Vibration impacts from tunnel boring machines

The assessment of ground-borne vibration is based on the worst-case predicted ground-borne vibration levels for sensitive receivers located above the proposed tunnel alignment. The predictions represent the likely highest vibration level when the tunnelling works are directly below each receiver. Similar to ground-borne noise, worst-case vibration impacts from tunnelling at individual receivers would likely only be apparent for a few days for each tunnel boring machine, when the tunnelling works are directly beneath. As the works progress and move away, a particular receiver's exposure to vibration would reduce accordingly.

A summary of the predicted ground-borne vibration levels from tunnelling in each NCA where an exceedance is predicted is shown in Table 11-17. Exceedances are predicted in NCA02, NCA03, NCA04, NCA10, NCA11 and NCA14. No exceedances are predicted in other NCAs.

Table 11-17: Summary of vibration criteria exceedances – all receiver types

Location	Noise Catchment Area[2]	Number of receivers				
		Total	With vibration criteria exceedance[1]			
			Tunnelling with tunnel boring machine			
			Cosmetic damage	Human comfort		Sensitive equipment
			Day / Night	Day	Night	Day / Night
Westmead	NCA02	806	-	2	8	-
Parramatta	NCA03	509	-	-	5	-
Clyde	NCA04	392	-	-	17	-
North Strathfield	NCA10	614	-	11	19	-
	NCA11	1,280	-	26	45	-
Burwood	NCA12	1,200	-	-	6	-
Five Dock	NCA14	1,242	-	-	43	-
	NCA15	966	-	-	9	-

Note 1: Based on worst-case predicted vibration levels

Note 2: Noise catchment areas where exceedances are not predicted are not included in the table.

The above shows the following:

- No receivers are predicted to be subject to tunnelling vibration levels which exceed the cosmetic damage criteria
- Potential exceedances of the human comfort criteria are predicted in Westmead, Parramatta, Clyde, North Strathfield and Five Dock, meaning perceptible levels of vibration may occur when tunnelling works are below certain areas. These impacts are typically at receivers which surround the construction sites, as this is where the tunnel depth is shallowest
- Potential exceedances of the relevant sensitive equipment criteria is predicted at one building in Parramatta (Cryo Australia) which is anticipated to contain sensitive equipment with a VC-A criterion.

11.5.3 Cross passages

Ground-borne noise

Ground-borne noise levels during rockbreaking are expected to be around 3 dB higher than during tunnelling. The night-time NML is likely to be exceeded during excavation of cross passages at the distances shown in Table 11-18.

'Moderate' exceedances of the night-time NML are expected where residential receivers have a slant distance of around 30 metres or less from the nearest cross passage.

'High' exceedances at residential receivers are likely where the slant distance is less than around 17 metres. The tunnel alignment depth is less than 17 metres from the surface elevation near the Olympic Park and North Strathfield metro station construction sites.

The duration of excavation for each cross passage is expected to vary between sites but may take up to several months in some areas.

Table 11-18: Minimum slant distance which results in exceedance of night-time NML

Receiver type	Criteria (dBA)	Minimum slant distance which results in exceedance of NML		
		Minor (1-10 dB)	Moderate (11-20 dB)	High (> 20 dB)
Residential (daytime)	45	30	17	10
Residential (night-time)	35	52	30	17
Educational	45	30	17	10
Medical	45	30	17	10
Place of worship	45	30	17	10
Child care	40	39	23	13
Commercial	50	23	13	7

Vibration impacts

Vibration levels from the excavation of cross passages using roadheaders and rockbreakers would be similar to the levels from excavation of the tunnels using tunnel boring machines. The tunnel alignment is sufficiently distant from nearby buildings for the risk of exceedances of the cosmetic damage criteria to be low.

Exceedances of the daytime human comfort criteria are, however, likely at residential receivers with a slant distance of less than 20 metres from cross passages and at commercial receivers with a slant distance of less than 15 metres.

Exceedances of the night-time human comfort criteria are likely at residential receivers with a slant distance of less than 30 metres from cross passages.

No identified vibration sensitive receivers are predicted to be subject to cross passage excavation vibration levels which exceed the appropriate sensitive equipment criteria.

11.5.4 Work trains

Work trains would be required in the tunnels to move equipment. The speed of these trains is typically limited to 10 kilometres per hour for safety reasons and it is assumed they would have some form of resilient rubber tyres. The work trains would be used 24 hours per day, seven days a week.

Given the slow speeds and assumed rubber tyres, the potential ground-borne noise and vibration impacts from work trains are expected to be minimal. The potential impacts should be reviewed as Stage 1 progresses and detailed information regarding work trains becomes available.

11.5.5 Utility works

An assessment of the potential noise levels from the likely plant items associated with utility works is provided in Table 11-19. Noise levels have been predicted at various offset distances (15 to 70 metres) to give an indication of the possible impacts.

During construction, noise impacts associated with utility works would be temporary and would move progressively along the utility service corridor resulting in impacts at particular receivers for only a limited period of time. For example, the excavation work along power supply routes is anticipated to progress at about 30 metres per day and it is therefore likely that any individual receiver would be affected by the highest noise levels for up to two consecutive days at most.

Table 11-19: Potential noise levels from utility works

Equipment	Predicted Noise Level at Distance ($L_{Aeq(15minute)}$ dBA)			
	15 m	30 m	50 m	70 m
Asphalt milling machine	79	73	69	66
Concrete saw[1]	80	74	70	67
Excavator	77	71	67	64
Excavator (breaker)[1]	86	80	76	73
Hand tools	65	59	55	52

Note 1: Assumed to be working for 7.5 minutes in worst-case 15 minute period.

Relatively high noise impacts are likely where noise intensive plant items are required near adjacent receivers. On typical streets where the closest receivers are about 15 metres from the road, noise levels between 80 to 86 dBA are possible when noise intensive plant items are in use.

Where night-time works are required, worst-case exceedances of greater than 25 to 30 dB above NML are possible where noise intensive plant items are in use.

11.6 Westmead metro station construction site

11.6.1 Existing environment

Existing noise levels surrounding the Westmead metro station construction site are controlled by transportation noise (i.e. road and rail) and general background noise in an urban location. The area surrounding the construction site is mainly residential and the nearest receivers are near the boundary of the site. The Westmead health precinct is to the north of the site and educational facilities are also located relatively close by.

The area surrounding Westmead metro station construction site includes two Noise Catchment Areas (NCA01 and NCA02) which are separated by the existing rail corridor. The construction site is located to the south of the existing rail station. The Westmead noise catchment areas are shown in Figure 11-1.

NCA01 is north of the existing rail corridor in Westmead and is mainly residential. 'Other sensitive' receivers include Westmead Hospital, Western Sydney University – Westmead, and Parramatta Marist High School. A child care centre and a number of medical facilities are to the north of the existing Westmead Station.

NCA02 south of the existing rail corridor and is mainly residential. Westmead Primary School is in the north of the catchment on Hawksbury Road.

Figure 11-1: Location of sensitive receivers near Westmead metro station construction site

Unattended noise monitoring was undertaken at two sensitive receivers located in the vicinity of Westmead metro station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-20.

Table 11-20: Summary of unattended noise monitoring – Westmead metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.01	8-12 Alexandra Avenue, Westmead[2]	49	47	37	67	67	62
L.02	8 Ashley Lane, Westmead	48	46	41	58	53	51

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.6.2 Construction impacts

The construction scenarios at the Westmead metro station construction site, and the anticipated working hours are shown in Table 11-21. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at Westmead metro station construction site are anticipated to have a total duration of about five years. The turnback cavern at Westmead is assessed as part of the tunnelling assessment in Section 11.5.1.

Temporary construction noise and vibration impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-21: Construction activities and period of works at Westmead metro station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	15	1	✓	-	-	-	
	Demolition using a rockbreaker	15	2	✓	-	-	-	
Piling	Supporting works	36	2	✓	-	-	-	
	Bored piling with support plant	36	4	✓	-	-	-	
Surface construction	General works	12	1	✓	-	-	-	
	Noise intensive works	12	1	✓	-	-	-	
Initial excavation	Mucking out	8	1	✓	-	-	-	
	Through soft soil/ rock	4	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment. No noise attenuation from an acoustic shed (or other acoustic measures) is included for these works.

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Initial excavation cont.	Through rock using rockbreaker	4	2	✓	-	-	-	Excavation through rock using rockbreaker. Works restricted to daytime hours only. No noise attenuation from an acoustic shed (or other acoustic measures) is included for these works.
Excavation within shed	Mucking out	23	1	✓				Out-of-hours works would only be conducted once the acoustic shed (or other acoustic measures) have been fully installed.
	Through rock using rockbreaker	23	2	✓				
Tunnel boring machine launch and support site	Tunnel boring machine support and spoil removal	78	1	✓	✓	✓	✓	The majority of works would be completed in the acoustic shed (or other acoustic measures). Loading of tunnel boring machine components and other less noisy works would occasionally occur outside the shed.
	Tunnel boring machine assembly and launch	2	1	✓	✓	✓	✓	
Intersection modifications	Supporting works	2	1	✓	✓	✓	✓	
	Intensive works	2	1	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 3: Durations are indicative and represent the total estimated duration of works at a typical construction site over the entire Stage 1 construction period.

Airborne construction noise

The predicted airborne NML exceedances for residential receivers around the Westmead metro station construction site are summarised in Table 11-22. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-23. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, intersection modifications and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-22: Overview of NML exceedances (residential receivers) – Westmead metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	15	Day	10	-	-
	'Peak'	Demolition using a rockbreaker with supporting plant	15	Day	130	27	8
Piling	'Typical'	Supporting works	36	Day	9	-	-
	'Peak'	Bored piling with support plant	36	Day	22	-	-
Surface construction	'Typical'	General works	12	Day	1	-	-
	'Peak'	Noise intensive works	12	Day	11	-	-
Initial excavation	'Typical'	Mucking out	8	Day	14	-	-
	'Peak'	Through soft soil/rock	4	Day	30	1	-
		Through rock using rockbreaker	4	Day	136	30	1
Excavation within shed	'Typical'	Mucking out	23	Day	-	-	-
				Day OOH	-	-	-
				Evening	1	-	-
				Night	12	1	-
				Sleep disturbance	38	10	2
	Peak	Through rock using rockbreaker (Doors Closed)	23	Day	-	-	-
				Day OOH	2	-	-
				Evening	3	-	-
				Night	22	3	-
				Sleep disturbance	38	10	2
	Peak	Through rock using rockbreaker (Doors Open)	23	Day	7	-	-
				Day OOH	13	1	-
				Evening	16	1	-
				Night	63	16	1
				Sleep disturbance	39	10	2
Tunnel boring machine launch and support	'Typical'	Tunnel boring machine support and spoil removal	78	Day	-	-	-
				Day OOH	2	-	-
				Evening	2	-	-
				Night	14	2	-
				Sleep disturbance	38	10	2
	'Peak'	Tunnel boring machine assembly and launch	2	Day	2	-	-
				Day OOH	6	-	-
				Evening	11	-	-
				Night	48	11	-
				Sleep disturbance	38	10	2

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Intersection modifications	'Typical'	Supporting works	2	Day	10	5	-
				Day OOH	16	8	-
				Evening	24	10	-
				Night	68	22	10
				Sleep disturbance	51	12	7
	'Peak'	Noise intensive works	2	Day	146	37	15
				Day OOH	329	83	24
				Evening	406	98	34
				Night	347	376	100
				Sleep disturbance	449	89	43

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 941

Note 3: Based on worst-case predicted noise levels.

Table 11-23: Overview of NML exceedances ('other' sensitive receivers) – Westmead metro station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Childcare	1	-	-
	Demolition using a rockbreaker with supporting plant	Educational	3	-	-
		Commercial	1	-	-
		Childcare	-	-	1
		Educational	3	4	1
		Public building	1	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
		Medical (daytime)	3	-	-
Piling	Supporting works	Childcare	1	-	-
		Educational	2	-	-
	Bored piling with support plant	Childcare	-	1	-
		Educational	4	-	-
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Childcare	1	-	-
		Educational	4	-	-
Initial excavation	Mucking out	Childcare	1	-	-
		Educational	4	-	-
	Through soft soil/rock	Childcare	-	1	-
		Educational	4	1	-
Initial excavation cont.	Through rock using rockbreaker	Commercial	1	-	-
		Childcare	-	-	1
		Educational	6	4	1
		Public building	2	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
		Medical (daytime)	3	-	-
Excavation within shed	Mucking out (doors closed)	No receiver types impacted	-	-	-
	Through rock using rockbreakers (doors closed)	No receiver types impacted	-	-	-
	Through rock using rockbreaker (doors open)	Educational	1	-	-
Tunnel boring machine launch and support	Tunnel boring machine support and spoil removal	No receiver types impacted	-	-	-
	Tunnel boring machine assembly and launch	Educational	1	-	-
Intersection modification	Supporting works	Child care	1	-	-
		Educational	3	1	-
	Noise intensive works	Commercial	4	-	-
		Child care	-	-	1
		Educational	5	1	4
		Public building	-	1	-
		Place of worship	4	-	-
		Passive recreation	1	-	-
		Medical (daytime)	4	-	-
		Medical (night-time)	4	-	-

The preliminary findings of the construction noise impact assessment around the Westmead metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential and educational buildings. Some of the worst-case impacts are predicted during enabling works and initial excavation which would occur before the acoustic shed (or other acoustic measures) is constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used outdoors intermittently and the duration is around 10 days during enabling works and four weeks during Initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to generally be reduced to 'minor' or 'moderate' at the nearest receivers
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor'. These works would also be completed during standard construction hours, prior to the acoustic shed (or other acoustic measures) being built
- Noise intensive works outside of standard construction hours would only be completed in the acoustic shed (or other acoustic measures) once it is built (except for intersection modification works). The worst-case impacts from works in the shed during the night-time are generally predicted to be 'minor' or 'moderate' during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open the impacts are increased for receivers near to the doors of the shed

- 'High' impacts are also predicted during intersection modifications which are required on certain roads surrounding the construction site. These works are required during all periods, including some works during the evening and night-time period, however, they are only expected to last for two weeks.

Highly affected residential receivers

Residential receivers that are subject to noise levels of 75 dBA or greater are considered highly Noise Affected by the ICNG. Receivers can be highly noise affected when noisy works are occurring close to residents.

The receivers which could potentially be highly noise affected during the worst-case impacts from Stage 1 are summarised in Table 11-24 and shown by Figure 11-2. The table shows the activity and number of residential receivers affected in each NCA.

Table 11-24: Predicted number of highly noise affected residential receivers – Westmead metro station construction site

Scenario	Activity	NCA01			NCA02		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	-	n/a[1]	n/a	-	n/a	n/a
	Demolition using a rockbreaker	1	n/a	n/a	11	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	-	n/a	n/a	-	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	-	n/a	n/a	-	n/a	n/a
Initial excavation	Mucking out	-	n/a	n/a	-	n/a	n/a
	Through soft soil/rock	-	n/a	n/a	-	n/a	n/a
	Through rock using rockbreaker	2	n/a	n/a	8	n/a	n/a
Excavation within shed	Mucking out (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	-	-	-
TBM retrieval	Supporting works	-	-	-	-	-	-
	Intensive works	-	-	-	-	-	-
Intersection modifications	Supporting works	-	-	-	-	-	-
	Intensive works	1	1	1	23	23	23

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-2: Predicted highly noise affected residential receivers – Westmead metro station construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-22. 'High' sleep disturbance impacts are predicted at the nearest residential during noisy works as part of excavation with shed, tunnel boring machine launch and support, and intersection modifications.

Sleep disturbance impacts from within the construction site are generally controlled by heavy vehicle movements in the outdoor areas of the site as part of the excavation within shed and tunnel boring machine launch and support. Night-time truck movements at this construction site are expected to be around 25 trucks per hour.

Sleep disturbance impacts associated with intersection modifications are generally from use of noise intensive equipment such as concrete saws and rockbreakers. The number of night-time awakenings during Intersection modifications would depend on several factors, including the type of equipment being used, the duration of the noisy works and the distance of the works to nearest residential receivers.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic shed (or other acoustic measures) are shown in Figure 11-3 and Figure 11-4 for the daytime and night-time, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

Figure 11-3: Ground-borne noise impacts (daytime construction hours) – Westmead metro station construction site

Figure 11-4: Ground-borne noise impacts (night-time construction hours) – Westmead metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-5. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the cosmetic damage screening criteria or the sensitive equipment screening criteria at this site. The human comfort criteria are predicted to be exceeded at one residential receiver to the east of the site, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

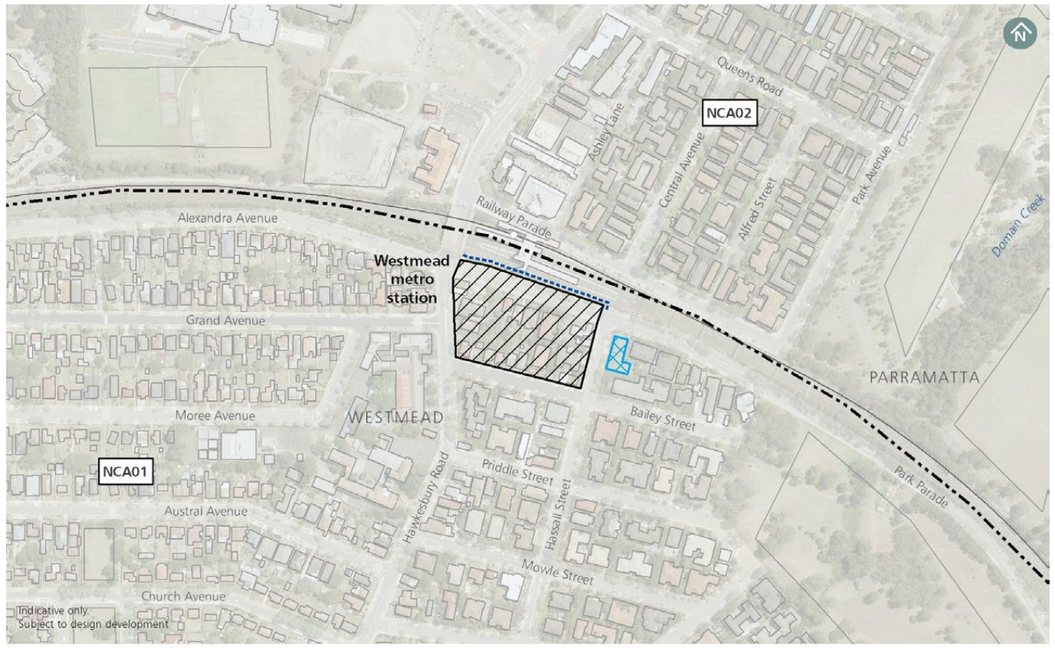


Figure 11-5: Worst case vibration impacts – Westmead metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers adjacent to construction haul routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Hawkesbury Road to the south of the construction site, Grand Avenue to the west of the construction site, Hassall Street and Bailey Street. Temporary road reconfigurations in the Westmead study area that divert traffic from Alexandra Avenue through Hassall Street, Bailey Street and Grand Avenue are likely to result in noticeable increases on these roads. The increase represents the worst-case predicted increase in any period.

11.6.3 Operational impacts of permanent road network changes

The predicted operational road noise levels at residential receivers are summarised in Table 11-25. The table shows the worst-case impacts in each NCA, which typically correspond to receivers nearest the roadworks.

In total, 71 residential receivers are predicted to experience exceedances of the operational road traffic noise criteria. Noise levels at one 'other' sensitive receiver, Westmead Public School, are predicted to experience noise impacts which exceed the trigger level. The locations of the receivers experience noise impacts above the noise trigger levels and, as such, are eligible for consideration of mitigation, are shown in Figure 11-6.

Residential receivers are predicted to experience noise impacts above the trigger levels adjacent to the realignment of Alexandra Avenue and also along Grand Avenue. The triggers near Bailey Street are due to Alexandra Avenue moving closer to these receivers. The triggers along Grand Avenue are due to the functional class change of Grand Avenue. This means the impacts here are required to be assessed against 'new' road criteria.

Noise levels at residential receivers to the south on Bailey Street are predicted to increase by around 3 dB due to the realigned section of Alexandra Avenue. Noise levels along Grand Avenue are predicted to increase by around 5 to 6 dB which is due to the increased volume of traffic on this road.

Exceedances of the NCG cumulative limit criteria (i.e. 5 dB or more above the NCG controlling criterion) are predicted at the receivers which have noticeable increases in noise.

While average noise levels are expected to increase at receivers on Grand Avenue during the night-time due to increased traffic, the road reconfigurations are not expected to result in any noticeable change to the maximum noise levels. The frequency of the maximum noise level event on Grand Avenue is likely to increase in line with the general increase in night-time traffic.

The works are predicted to result in acute noise levels (i.e. daytime noise levels are 65 dBA or higher, or night-time noise levels are 60 dBA or higher) at four residential receivers.

Table 11-25: Predicted road traffic noise levels at most affected residential receivers – Westmead metro station construction site

NCA	Predicted Noise Level (dBA)				Number of triggered buildings			
	At opening (2023)							
	Without project		With project		Triggers			
	Day	Night	Day	Night	>2 dB	Cumulative	Acute	Total
NCA01	70	64	70	63	-	-	-	-
NCA02	68	63	70	65	68	69	4	71

Figure 11-6: Operational traffic noise impacts – Westmead metro station construction site

11.7 Parramatta metro station construction site

11.7.1 Existing environment

Existing noise levels around the Parramatta metro station construction site are dominated by road traffic noise and the general urban noise associated with the Parramatta CBD. The area surrounding the construction site is mainly commercial, typically general office or retail use and includes one noise catchment area: NCA03 (refer to Figure 11-7).

NCA03 covers Parramatta CBD and is mainly commercial. Residential receivers are generally on the outskirts of the catchment. There are many 'other sensitive' receivers in this catchment, including Western Sydney University – Parramatta, Arthur Phillip High School, Parramatta Public School, and a number of nearby hotels and places of worship.

The nearest residential receiver is located about 20 metres to the north of the construction site on the corner of George Street and Horwood Place.

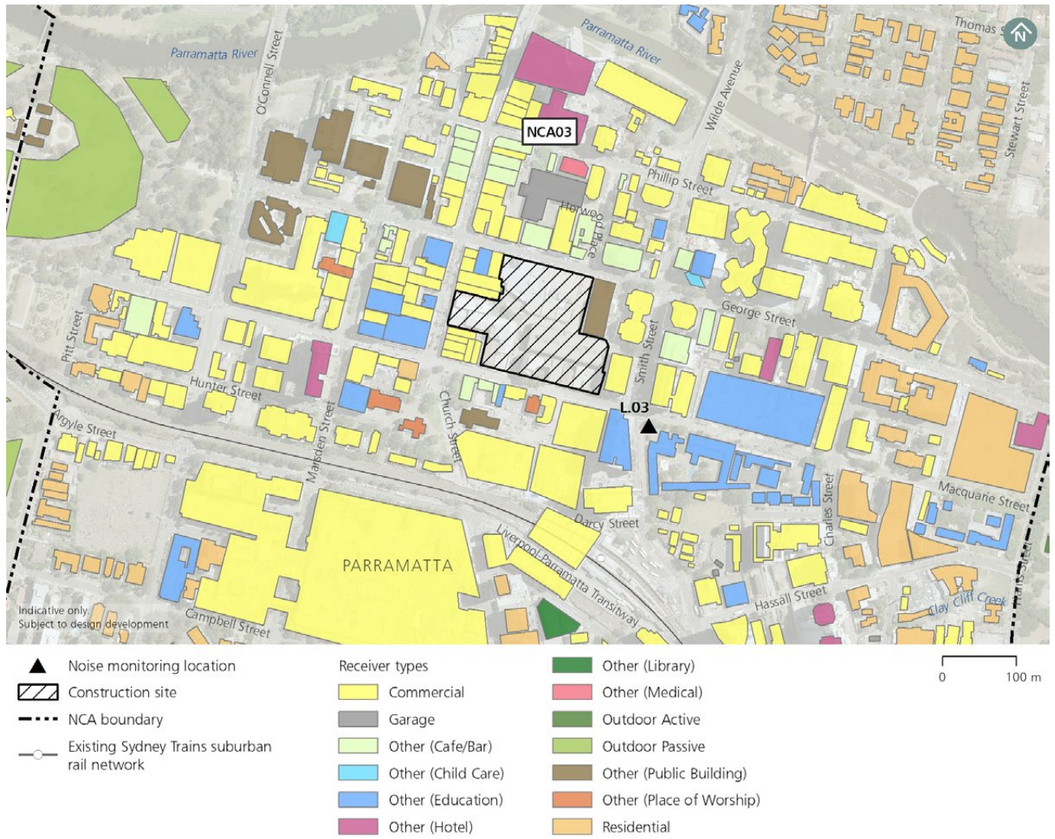


Figure 11-7: Location of sensitive receivers near Parramatta metro station construction site

Unattended noise monitoring was undertaken at one sensitive receiver located in the vicinity of Parramatta metro station construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-26.

Table 11-26: Summary of unattended noise monitoring– Parramatta metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.03	Arthur Phillip High School, Parramatta[2]	58	53	43	69	67	62

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.7.2 Construction impacts

The construction scenarios at the Parramatta metro station construction site, and the anticipated working hours are shown in Table 11-27. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works within the Parramatta metro station construction site are anticipated to have a total duration of about two years.

Temporary construction noise and vibration impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-27: Construction activities and period of works at Parramatta metro station construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Supporting and loading	24	1	✓	✓	-	-	
	Demolition using a rockbreaker	24	2	✓	✓	-	-	Would occur intermittently. Estimated total duration of about 20 days.
Piling	Supporting works	36	2	✓	✓	-	-	
	Bored piling with support plant	36	4	✓	✓	-	-	Would occur intermittently. Estimated total duration of about 36 weeks.
Surface construction	General works	12	1	✓	✓	-	-	
	Noise intensive works	12	2	✓	✓	-	-	
Excavation	Mucking out	30	1	✓	✓	✓	✓	Mucking out would occur through standard daytime and out-of-hours daytime periods only. Spoil haulage would occur during all periods.
	Through soft soil/rock	6	2	✓	✓	-	-	
	Through rock using rockbreaker	24	2	✓	✓	-	-	Excavation through rock using rockbreaker. Works restricted to standard construction hours only and Saturday out-of-hours Period 1.

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.
Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from site works in the Parramatta metro station construction site are summarised in Table 11-28 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-29. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

Works at Parramatta metro station construction site would typically be restricted to standard daytime construction hours, plus extended hours on Saturday afternoons. Spoil removal is proposed out of standard construction hours to reduce potential transport and traffic impacts in a busy CBD environment. This is not predicted to result in exceedances of noise management levels due to the limited number of residential receivers in the vicinity.

Table 11-28: Overview of NML exceedances (residential receivers) – Parramatta metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	24	No impact during any period	-	-	-
	'Peak'	Demolition using a rockbreaker	24	Day	1	-	-
				Day OOH	1	-	-
Piling	'Typical'	Supporting works	36	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	36	No impact during any period	-	-	-
Surface construction	'Typical'	General works	12	No impact during any period	-	-	-
	'Peak'	Noise intensive works	12	No impact during any period	-	-	-
Excavation	'Typical'	Mucking out	30	No impact during any period	-	-	-
	'Peak'	Through soft soil / rock	6	No impact during any period	-	-	-
		Through rock using rockbreaker	24	Day	1	-	-
				Day OOH	1	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 478

Note 3: Based on worst-case predicted noise levels.

Table 11-29: Overview of NML exceedances ('other' sensitive receiver types) – Parramatta metro station construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	24	Commercial	5	-	-
				Educational	4	1	5
				Public building	-	1	-
				Place of worship	-	1	-
	'Peak'	Demolition using a rockbreaker	24	Commercial	20	13	3
				Café/bar	2	5	-
				Childcare	-	2	-
				Educational	16	5	20
				Public building	6	1	1
				Place of worship	2	2	6
				Passive recreation	1	1	-
				Medical (daytime)	5	1	-
Piling	'Typical'	Supporting works	36	Commercial	3	-	-
				Educational	6	-	3
				Public building	-	1	-
				Place of worship	1	-	-
	'Peak'	Bored piling with support plant	36	Commercial	4	1	-
				Childcare	1	-	-
				Educational	5	3	4
				Public building	1	-	1
				Place of worship	2	1	1
Surface construction	'Typical'	General works	12	Commercial	1	-	-
				Educational	4	-	1
				Public building	1	-	-
				Place of worship	1	-	1
	'Peak'	Noise intensive works	12	Commercial	3	-	-
				Educational	5	2	3
				Public building	-	1	-
				Place of worship	-	1	-
Excavation	'Typical'	Mucking out	30	Commercial	4	-	-
				Educational	5	1	4
				Public building	-	1	-
				Place of worship	-	1	-

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Excavation cont.	'Peak'	Through soft soil/ rock	6	Commercial	7	1	-
				Childcare	1	-	-
				Educational	4	4	7
				Public building	1	-	1
				Place of worship	2	1	1
		Through rock using rockbreaker	24	Commercial	24	7	1
				Café/bar	6	-	-
				Childcare	1	1	-
				Educational	14	4	24
				Public building	4	1	1
				Place of worship	2	2	4
				Passive recreation	2	-	-
				Medical (daytime)	4	1	-

The preliminary findings of the construction noise impact assessment at Parramatta metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally commercial. The worst-case impacts are predicted during enabling works and excavation. These works are, however, limited to the daytime and would not typically occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'moderate' or 'minor' at the nearest receivers
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are generally predicted to be 'minor' or 'moderate'. These works would also only be undertaken during the daytime
- Most of the works are proposed to occur during the daytime. Spoil haulage (as part of mucking out) would be required during the evening and night-time, however, noise levels from this activity are relatively low and only predicted to result in two 'minor' exceedances during the evening.

Highly affected residential receivers

No receivers are predicted to be highly noise affected by the works at Parramatta metro station construction site.

Sleep disturbance

Only spoil haulage (as part of mucking out) would occur during the night-time. No impacts are predicted during this activity.

Ground-borne construction noise

Vibration intensive works during shaft excavation at this construction site would not be completed in an acoustic shed (or other acoustic measures) meaning airborne noise levels at the nearest receivers would likely be higher than the corresponding internal ground-borne noise levels.

Ground-borne noise levels have been assessed at this site and the potential worst-case impacts are shown in Figure 11-8. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

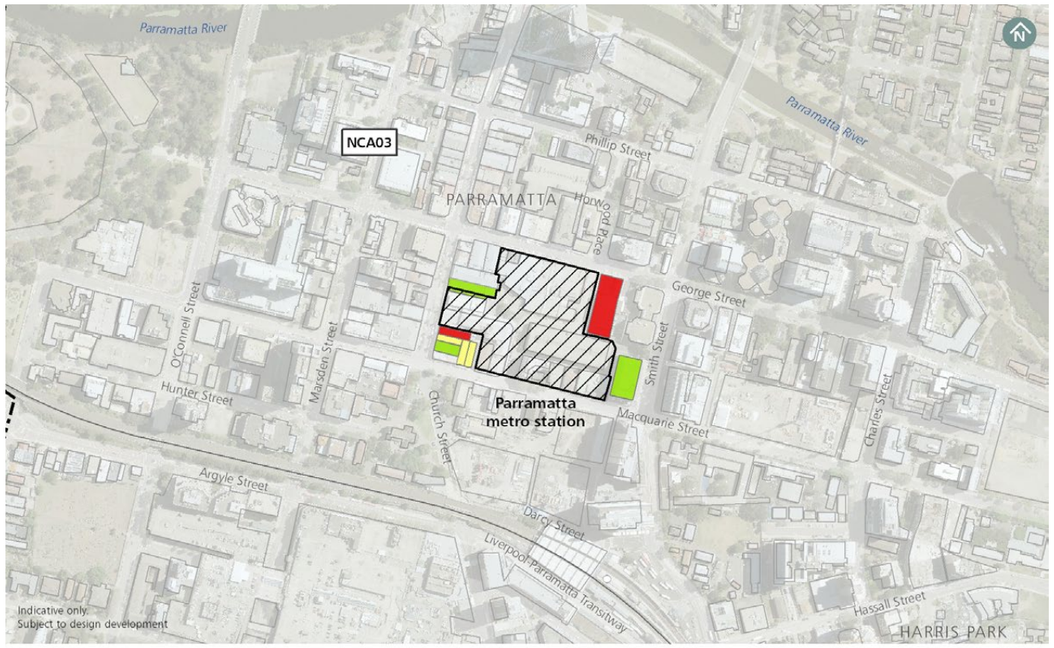


Figure 11-8: Ground-borne noise impacts (daytime construction hours) – Parramatta metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-9. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nine nearest buildings and structures to the site. This includes the Roxy Theatre to the east as well as two heritage listed buildings and one heritage listed structure (underground services) within the construction footprint. Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure.

The human comfort criteria are also predicted to be exceeded at some of the nearest commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

Exceedances of the vibration sensitive equipment screening criteria are predicted at the following two locations identified as potentially having vibration sensitive equipment:

- SunDoctors Skin Cancer Clinic, Parramatta
- Orthodontics Sydney Wide, Parramatta.

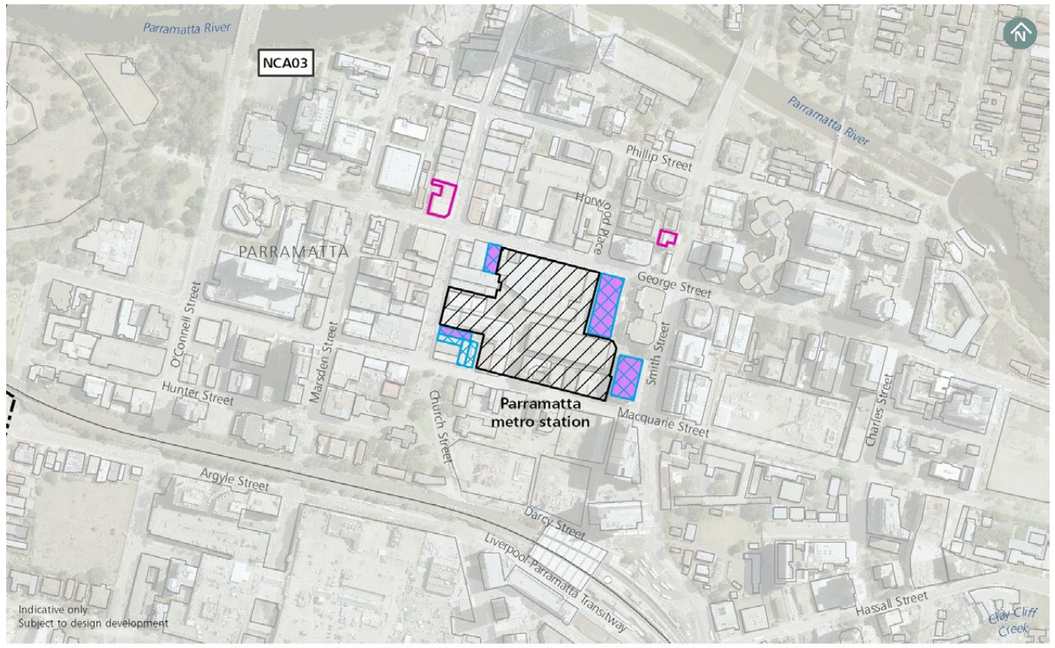


Figure 11-9: Worst-case vibration impacts – Parramatta metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haul routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) are likely. Roads anticipated to have a greater than 2 dB increase would include George Street to the west of the construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.8 Clyde stabling and maintenance facility construction site

11.8.1 Existing environment

Existing noise levels in area surrounding Clyde stabling and maintenance facility construction site are generally controlled by road traffic noise on the surrounding road network.

Clyde is categorised by four noise catchment areas: NCA04, NCA05, NCA06 and NCA07 (refer to Figure 11-10).

NCA04 is south of the Parramatta River and west of James Ruse Drive. The catchment is mainly residential with small areas of commercial receivers.

NCA05 is north of the M4 Motorway and west of James Ruse Drive. The catchment is mainly residential. 'Other sensitive' receivers include Rosehill Public School and a number of hotels and child care centres.

NCA06 is south of the M4 Motorway in Granville. The catchment is mostly residential adjacent to the motorway, with some commercial use in the south-east.

NCA07 is east of James Ruse Drive, this catchment is mostly commercial and covers Rosehill Gardens racecourse (and associated stables), the Clyde commercial/industrial area, and Silverwater and Newington. Residential receivers and Newington Public School are in the south-east.

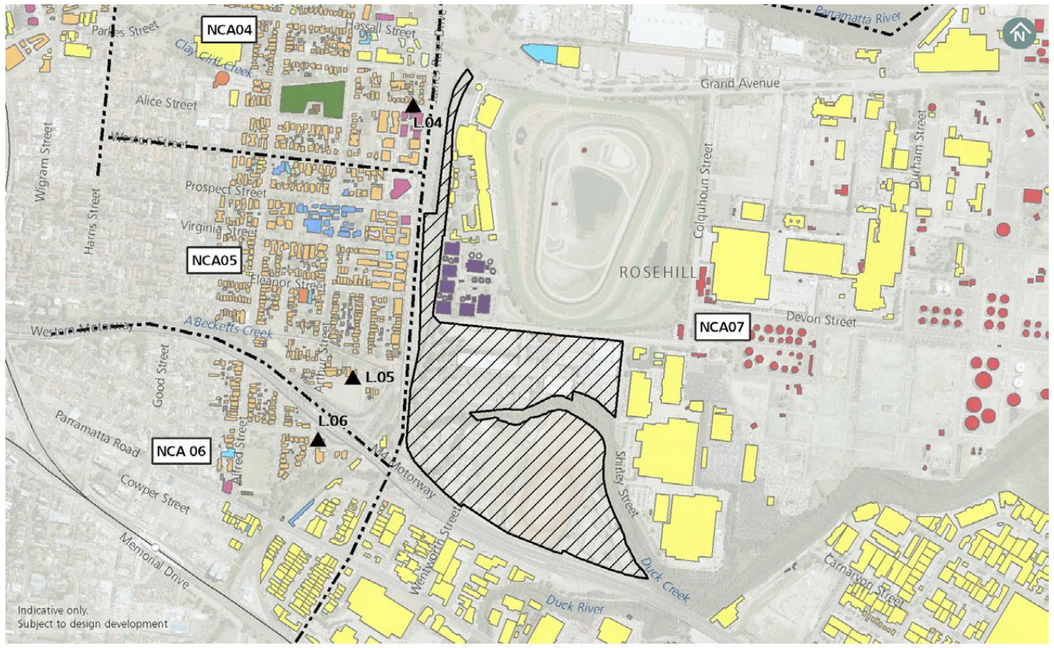


Figure 11-10: Locations of sensitive receivers near Clyde stabling and maintenance facility construction site

Unattended noise monitoring was undertaken at four sensitive receivers located in the vicinity of Clyde stabling and maintenance facility construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-30.

Table 11-30: Summary of unattended noise monitoring– Clyde stabling and maintenance facility construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L^{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.04	5 Hope Street, Rosehill[2]	51	48	41	61	58	57
L.05	9 A'Beckett Street, Granville[2]	50	49	45	56	55	53
L.06	4B Gray Street, Granville[2]	52	51	44	58	57	55
L.07	10 Carnarvon Street, Silverwater	46	44	41	60	57	55

Note 1: The RBL and L^{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.
Note 2: Data measured on other recent project (Parramatta Light Rail (Stage1)).

11.8.2 Construction impacts

The construction scenarios at the Clyde stabling and maintenance facility construction site, and the anticipated working hours are shown in Table 11-31. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at the Clyde stabling and maintenance facility construction site are anticipated to have a total duration of about three years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-31: Construction activities and period of works at Clyde stabling and maintenance facility construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Supporting and loading	19	1	✓	-	-	-	-
	Demolition using a rockbreaker	19	2	✓	-	-	-	Would occur intermittently. Estimated total duration of about 15 days.
Piling	Supporting works	5	1	✓	-	-	-	-
	Bored piling with support plant	5	2	✓	-	-	-	Would occur intermittently.
Earthworks and civil works	General works	38	1	✓	✓		✓	Delivery and stockpiling would occur on a 24-hour basis. No noise intensive equipment would operate during out-of-hours periods.
	Noise intensive works	38	2	✓	-	-	-	-
Surface construction	General works	13	1	✓	-	-	-	-
	Noise intensive works	13	2	✓	-	-	-	-
Excavation	Mucking out	35	1	✓	-	-	-	Includes concrete batching plant.
	Through soft soil/rock	5	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment. Includes concrete batching plant.
	Through rock using rockbreaker	30	2		-	-	-	Excavation through rock using rockbreakers. Works restricted to standard construction hours only. Includes concrete batching plant.
Concrete batch plant	50 per cent capacity	143	1	✓	✓	✓	✓	-
	100 per cent capacity	143	1	✓	✓	✓	✓	-

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Clyde stabling and maintenance facility construction site are summarised in Table 11-32 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-33. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

'High' worst-case impacts are predicted for enabling works and excavation works for periods when a rock breaker would be required. These works would be undertaken during standard daytime construction hours. Due to the distance of residential receivers from locations on the site where out of hours works proposed, potential noise impacts are predicted to be 'minor'.

Table 11-32: Overview of NML exceedances (residential receivers) – Clyde stabling and maintenance facility construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	19	Day	5	-	-
	'Peak'	Demolition using a rockbreaker	19	Day	153	20	5
Piling	'Typical'	Supporting works	5	Day	5	-	-
	'Peak'	Bored piling with support plan	5	Day	11	1	-
Earthworks and civil works	'Typical'	General works	38	Day	-	-	-
				Day OOH	3	-	-
				Evening	5	-	-
				Night	6	-	-
				Sleep disturbance	1	-	-
	'Peak'	Noise intensive works	38	Day	6	-	-
Surface construction	'Typical'	General works	13	Day	8	-	-
	'Peak'	Noise intensive works	13	Day	9	1	-
Excavation	'Typical'	Mucking out	35	Day	39	5	3
	'Peak'	Through soft soil / rock	5	Day	-	-	-
		Through rock using rockbreaker	30	Day	14	3	-
Concrete batch plant	'Typical'	50 per cent capacity	143	Night	6	-	-
	'Peak'	100 per cent capacity	143	Evening	3	-	-
				Night	25	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 2,764

Note 3: Based on worst-case predicted noise levels.

Table 11-33: Overview of NML exceedances ('other' sensitive receiver types) – Clyde stabling and maintenance facility construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	19	Child care	1	-	-
				Stables	8	-	-
	'Peak'	Demolition using a rockbreaker	19	Commercial	20	3	-
				Childcare	5	2	-
				Educational	19	2	-
				Place of worship	1	-	-
				Stables	12	10	5
				Hotel (daytime)	2	-	-
Piling	'Typical'	Supporting works	5	Child care	1	-	-
				Stables	2	-	-
	'Peak'	Bored piling with support plant	5	Child care	1	-	-
				Stables	10	-	-
Earthworks and civil works	'Typical'	General works	38	No receiver types impacted	-	-	-
	'Peak'	Noise intensive works	38	Commercial	1	-	-
				Child care	2	-	-
				Educational	1	-	-
				Stables	13	-	-
Surface construction	'Typical'	General works	13	No receiver types impacted	-	-	-
	'Peak'	Noise intensive works	13	Child care	1	-	-
				Stables	5	-	-
Excavation	'Typical'	Mucking out	35	Child care	1	-	-
				Stables	11	-	-
	'Peak'	Through soft soil/rock	5	Child care	1	-	-
				Stables	11	-	-
		Through rock using rockbreaker	30	Commercial	6	-	-
				Childcare	4	1	-
				Educational	14	-	-
				Stables	19	8	-
				Hotel (daytime)	2	-	-
Concrete batch plant	'Typical'	50 per cent capacity	143	No receiver types impacted	-	-	-
	'Peak'	100 per cent capacity	143		-	-	-

The preliminary findings of the construction noise impact assessment at Clyde stabling and maintenance facility construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during the higher noise generating activities. The nearest receivers to the site are generally residential and 'other sensitive' receivers at Rosehill Gardens racecourse (i.e. stables). The worst-case impacts are predicted during enabling works and excavation. These works are, however, limited to standard construction hours and would not occur during the evening or night-time. Impacts would be managed in accordance with the measures outlined in Section 11.16.2
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently during demolition works, and the total duration is around 15 days. Excavation works would also require intermittent use of rockbreakers over approximately 30 weeks. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or be compliant with the management levels
- Piling, earthworks and civil works and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'moderate' or 'minor'
- Works associated with delivery and stockpiling of spoil would occur outside of standard construction hours. The worst during the night-time are predicted to be 'minor' at the nearest receivers
- Works associated with the concrete batch plant and segment production facility would occur outside standard construction hours. The worst-case impacts during the night-time are predicted to be 'minor' at the nearest receivers if the facility operates at 100 per cent capacity during, as represented by the 'peak' scenario. The number of 'minor' night-time NML exceedances is substantially reduced when the facility operates at 50 per cent capacity.

Highly affected residential receivers

Enabling works (demolition using rockbreakers) and excavation (through rock using rockbreakers) would result in nine and five highly noise affected receivers during the daytime period (respectively). Figure 11-11 shows the location of predicted highly noise affected receivers near the Clyde stabling and maintenance facility construction site.

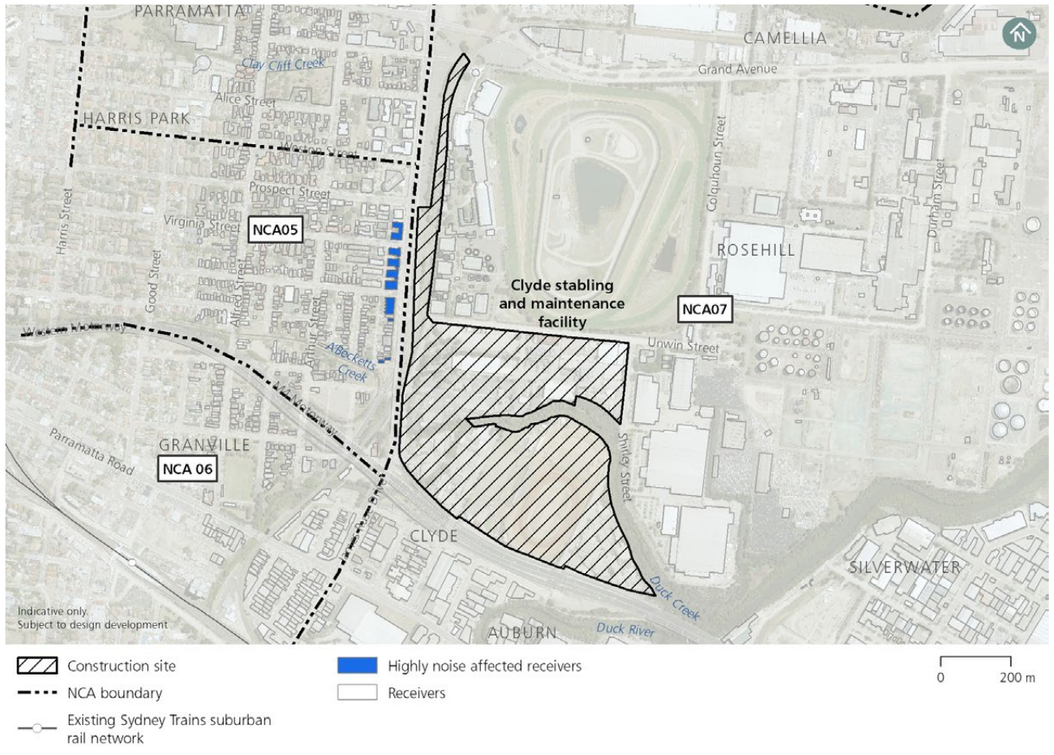


Figure 11-11: Predicted highly noise affected residential receivers – Clyde stabling and maintenance facility construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-32. 'Minor' sleep disturbance impacts are predicted at one residential receiver to the west during delivery and stockpiling of spoil.

Sleep disturbance impacts from within the construction site are generally controlled by heavy vehicle movements. Existing maximum noise levels from heavy vehicles on James Ruse Drive would likely be higher than maximum noise events at the Clyde stabling and maintenance facility construction site. Night-time truck movements at this construction site are expected to be around 22 trucks per hour with vehicles accessing the site via the southern entrance on Wentworth Street.

The number of night-time awakenings would depend on several factors, including the type of vehicles and equipment being used, the duration of the noisy works and the distance of the works to nearest residential receivers.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

Vibration intensive works during shaft excavation at this construction site would not be completed in an acoustic shed (or other acoustic measures) (as the works would only be undertaken during the daytime period) meaning airborne noise levels at the nearest receivers would likely be higher than the corresponding internal ground-borne noise levels.

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-12. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at four commercial buildings at Rosehill Gardens racecourse located east of the existing rail corridor section of the site. One heritage listed building at 1 Unwin Street, Rosehill, located to the north of the site would also be impacted. This building is a heritage listed free-standing building facade and is not occupied.

The human comfort criteria are also predicted to be exceeded at one of the nearest commercial buildings located to the north of the site, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

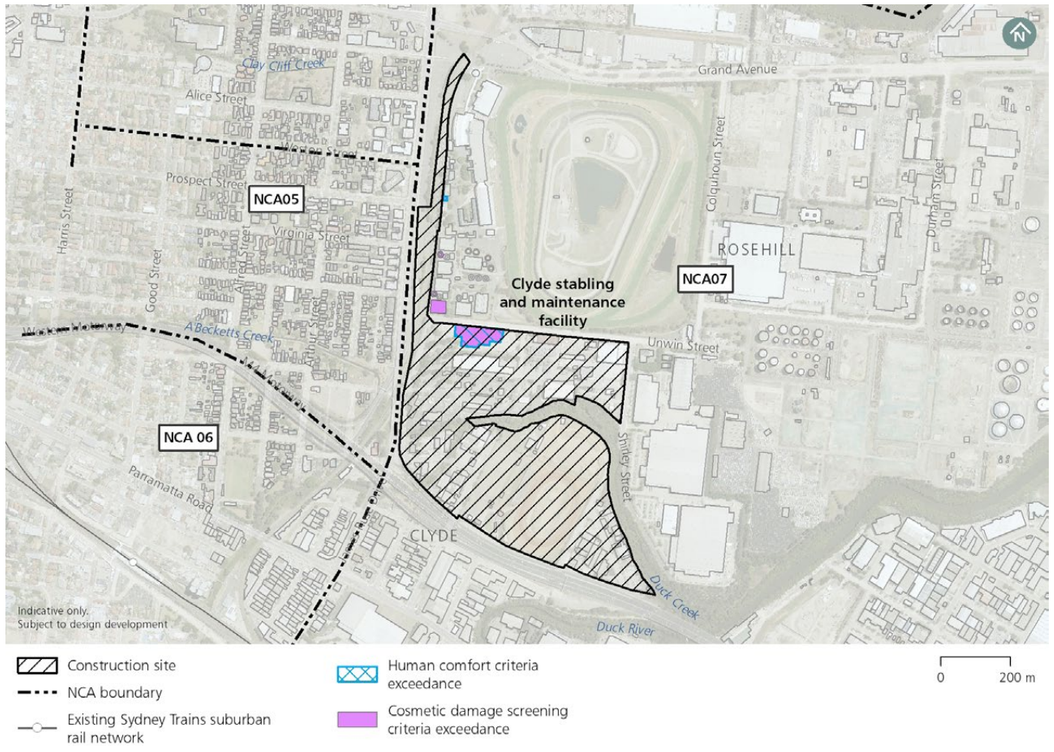


Figure 11-12: Worst-case vibration impacts – Clyde stabling and maintenance facility construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Wentworth street to the south of the construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.8.3 Operational impacts of permanent road network changes

Existing noise levels are not predicted to be altered by the road reconfigurations at Clyde. This is due to the relatively small contribution that the revised location of Unwin Street has to the noise levels at the nearest receivers. Existing and future noise levels at the nearest receivers are expected to be controlled by James Ruse Drive.

11.9 Silverwater services facility construction site

11.9.1 Existing environment

Existing noise levels surrounding the Silverwater services facility construction site are generally controlled by road traffic noise on the surrounding road network and commercial/industrial noise.

The area surrounding the Silverwater services facility construction site contains one Noise Catchment Area (NCA07) which covers the area to the north of the M4 Motorway (refer to Figure 11-13).

NCA07 is east of James Ruse Drive, this catchment is mostly commercial and covers Rosehill Gardens racecourse, the Clyde commercial/industrial area, and Silverwater and Newington. Residential receivers and Newington Public School are in the south-east.

Figure 11-13: Location of sensitive receivers near Silverwater services facility construction site

Unattended noise monitoring was undertaken at one sensitive receiver located in the vicinity of Silverwater services facility construction site between March and July 2019.

The results of the unattended noise surveys are summarised in Table 11-34.

Table 11-34: Summary of unattended noise monitoring – Silverwater services facility construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.07	10 Carnarvon Street, Silverwater	46	44	41	60	57	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.9.2 Construction impacts

The construction scenarios at the Silverwater services facility construction site, and the anticipated working hours are shown in Table 11-35. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis during every day of the activity.

Stage 1 works at the Silverwater services facility construction site are anticipated to have a total duration of about two years and nine months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-35: Construction activities and period of works at Silverwater services facility construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Delivery of equipment	4	1	✓	✓	-	-	No site clearing or demolition works would be required. Enabling works would be limited to general site mobilization activities.
	Assembly of site facilities	4	1		✓	-	-	
Piling	Supporting works	4	1	✓	✓	-	-	-
	Bored piling with support plant	4	2	✓	✓	-	-	Would occur intermittently.
Excavation	Mucking out	10	1	✓	✓	-	-	-
	Through soft soil/rock	4	2	✓	✓	-	-	Excavation through soil and soft rock using excavator ripper attachment.
	Through rock using rockbreaker	6	2		✓	-	-	Excavation through rock using rockbreakers. Works restricted to standard construction hours only.

Note 1: Day OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am - 8am, and 1pm - 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Silverwater services facility construction site are summarised in Table 11-36 for all residential receivers. The predicted airborne NML exceedances for commercial and other sensitive receiver types are summarised in Table 11-37. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods.

Due to the distance of residential receivers from the site, compliance with the noise management levels is predicted for most construction activities and most periods of the day.

Table 11-36: Overview of NML exceedances (residential receivers) – Silverwater services facility construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery of equipment	4	No impact during any period	-	-	-
	'Peak'	Assembly of site facilities	4	No impact during any period	-	-	-
Piling	'Typical'	Supporting works	4	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	4	No impact during any period	-	-	-
Excavation	'Typical'	Mucking out	10	No impact during any period	-	-	-
	'Peak'	Through soft soil/ rock	4	No impact during any period	-	-	-
		Through rock using rockbreaker	6	Daytime OOH	14	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 2,761

Note 3: Based on worst-case predicted noise levels.

Table 11-37: Overview of NML exceedances ('other' sensitive receiver types) – Silverwater services facility construction site

Scenario	Activity		Duration (weeks)	Receiver type	Number of receivers		
					With NML exceedance		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery	4	Commercial	1	-	-
	'Peak'	Assembly of site facilities	4	Commercial	2	-	-
Piling	'Typical'	Supporting works	4	Commercial	2	-	-
	'Peak'	Bored piling with support plant	4	Commercial	2	1	-
Excavation	'Typical'	Mucking out	10	Commercial	1	1	-
	'Peak'	Through soft soil/rock	5	Commercial	6	1	-
				Place of worship	1	-	-
		Through rock using rockbreaker	30	Commercial	13	3	-
				Place of worship	1	-	-

The preliminary findings of the construction noise impact assessment at Silverwater services facility construction site indicate:

- Stage 1 is predicted to result in 'moderate' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are commercial and the worst-case impacts are predicted during excavation. These works are would only be completed during the daytime
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce with much fewer exceeding receivers
- Enabling works and piling generate less noise and the worst-case impacts at the nearest receivers are generally predicted to be 'minor'
- The nearest residential receivers are predicted to have 'minor' worst-case impacts during the noisiest scenario.

Highly affected residential receivers

No receivers are predicted to be highly noise affected by the works at Silverwater services facility construction site.

Sleep disturbance

No works are proposed at this construction site during the night-time.

Ground-borne construction noise

Ground-borne noise levels have been assessed at this site and the worst-case impacts are shown in Figure 11-14. Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at one commercial building located to the east of the site.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to reduce.

Figure 11-14: Ground-borne noise impacts (daytime construction hours) – Silverwater services facility construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-15. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest commercial building located to the south of the site.

The human comfort criteria are also predicted to be exceeded at the two nearest buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

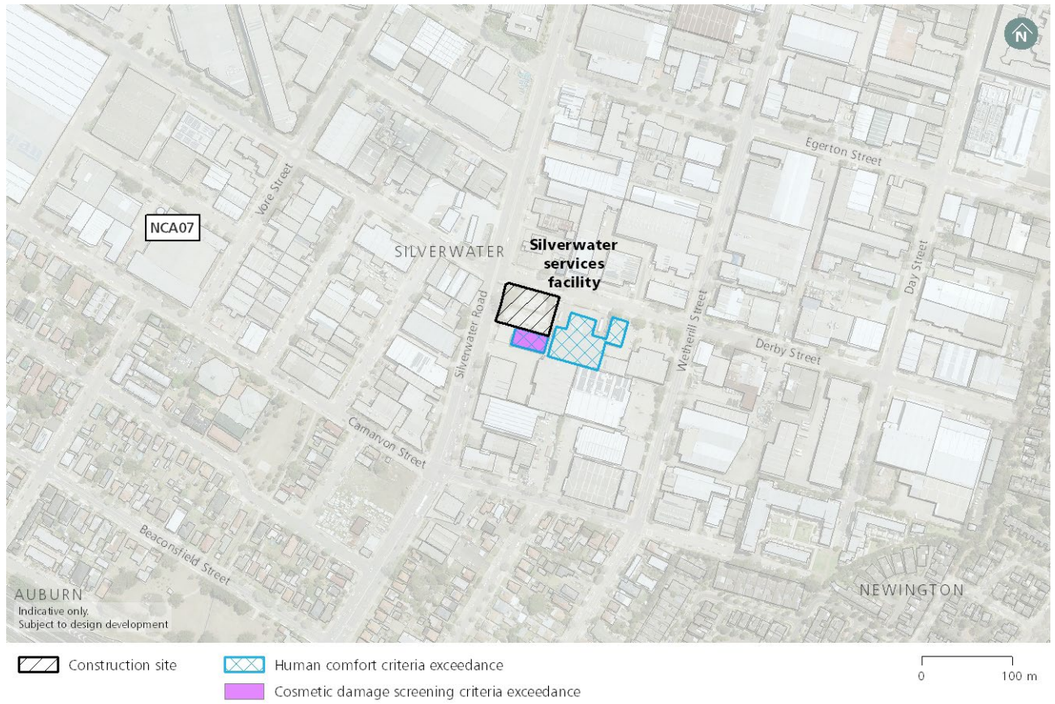


Figure 11-15: Worst case vibration impacts – Silverwater services facility construction site

Construction traffic

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Derby Street to the north-east of the Silverwater services facility construction site, although there are no residential receivers along this road. This increase represents the worst-case predicted increase in any period.

11.10 Sydney Olympic Park metro station construction site

11.10.1 Existing environment

Existing noise levels around the Sydney Olympic Park metro station construction site are dominated by distant road traffic noise from the M4 Motorway and Homebush Bay Drive and general noise from the sport and entertainment complex. The area surrounding the construction site is mainly of commercial use, typically general office or retail. The existing T7 Olympic Park Line circles around the construction site. The tunnels for this line run under Dawn Fraser Avenue and Olympic Boulevard and are aboveground alongside Sarah Durack Avenue and near to residential receivers on Australia Avenue.

Sydney Olympic Park has several open-air sports stadiums and various bars and restaurants. High levels of sporting/spectator noise are a regular feature of the area during sporting events and when crowds disperse afterwards. The stadiums are also used for special events such as music festivals and concerts, which can also result in high levels of noise during the daytime, evening, and parts of the night-time.

Sydney Olympic Park has been divided into two noise catchment areas: NCA08 and NCA09 (refer to Figure 11-16).

NCA08 is located west of Australia Avenue at Sydney Olympic Park and is a mixture of commercial, including two stadiums, and outdoor areas including Sydney Olympic Park Athletic Centre, Sydney Olympic Park Hockey Centre, Sydney Olympic Park Aquatic Centre and the Cathy Freeman Park. The nearest receivers are commercial buildings on Dawn Fraser Avenue, Olympic Boulevard, Herb Elliott Avenue and Figtree Drive. Two hotels and the New South Wales Rugby League Centre of Excellence educational building are also located within the catchment.

NCA09 is located to the east of Australia Avenue and is a mixture of commercial, residential and outdoor active areas including Bicentennial Park, Bressington Park and Mason Park. Residential receivers within the catchment are located on Australia Avenue, Bennelong Parkway and Betty Cuthbert Avenue.

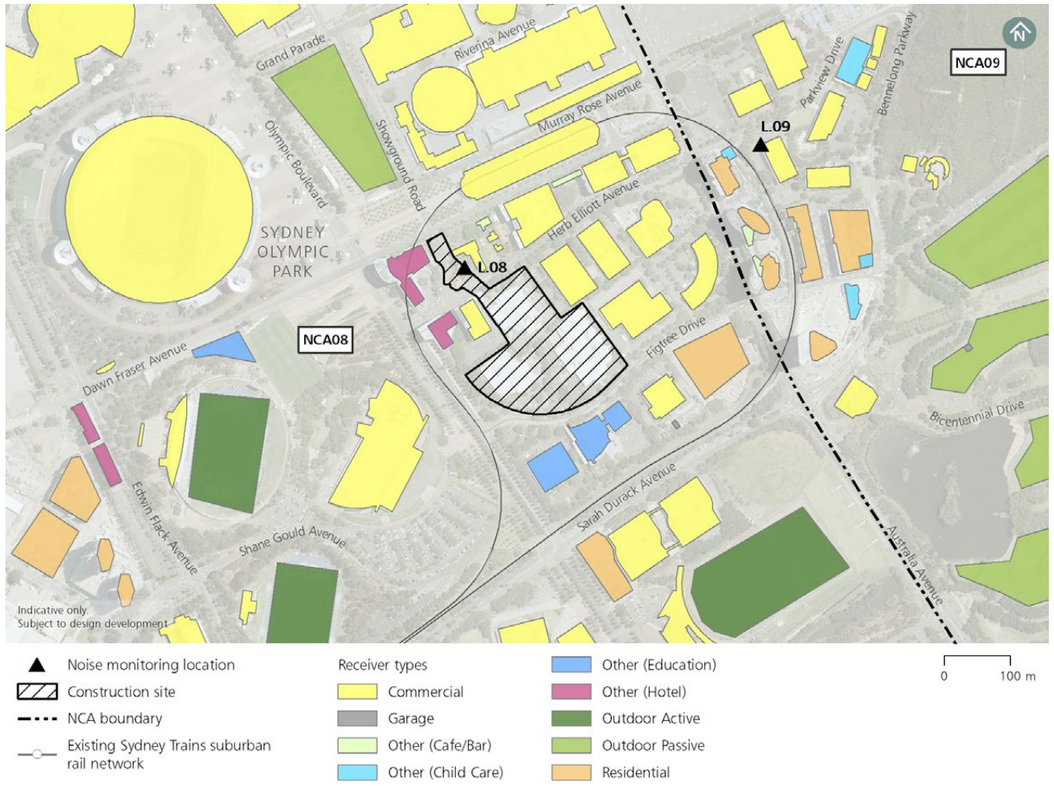


Figure 11-16: Location of sensitive receivers near Sydney Olympic Park metro station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations near Sydney Olympic Park metro station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-38.

Table 11-38: Summary of unattended noise monitoring – Sydney Olympic Park metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.08	1 Herb Elliot Avenue, Sydney Olympic Park	48	48	46	55	54	52
L.09	6 Parkview Drive, Sydney Olympic Park	48	46	41	57	58	53

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.10.2 Construction impacts

The construction scenarios at the Sydney Olympic Park metro station construction site and the anticipated working hours are shown in Table 11-39. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not occur on a continual basis.

Stage 1 works within the Sydney Olympic Park metro station construction site are anticipated to have a total duration of about two years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-39: Construction activities and period of works at Sydney Olympic Park metro station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	13	1	✓	-	-	-	
	Demolition using a rockbreaker	13	2		-	-	-	Would occur intermittently. Estimated total duration of about 10 days.
Piling	Supporting works	28	2	✓	-	-	-	
	Bored piling with support plant	28	4		-	-	-	Would occur intermittently. Estimated total duration of about 6 weeks.
Surface construction	General works	20	1	✓	-	-	-	
	Noise intensive works	20	2		-	-	-	
Initial excavation	Mucking out	4	1	✓	-	-	-	
	Through soft soil/rock	2	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper attachment, before construction of the acoustic shed (or other acoustic measures).
	Through rock using rockbreaker	2	2	✓	-	-	-	Excavation through rock using rockbreaker, before construction of the acoustic sheds (or other acoustic measures). Works restricted to standard construction hours only.
Excavation within shed	Mucking out	33	1	✓	✓	✓	✓	
	Through rock using rockbreaker	33	2	✓	✓	✓	✓	OOH work would only occur once the acoustic shed (or other acoustic measures) and acoustic panels (where appropriate) have been constructed.
Tunnel boring machine retrieval	Deliveries and on/off loading	7	1	✓	✓	✓	✓	Four tunnel boring machines would be retrieved over a one year period
	Tunnel boring machine disassembly	7	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from the Sydney Olympic Park metro station construction site are summarised in Table 11-40 for all residential receiver types and in Table 11-41 for commercial and other sensitive receivers. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Due to the distance of residential receivers form the site, works are generally predicted to either comply with the noise management levels or result in some 'minor' to 'moderate' impacts during all periods. 'High' worst-case impacts are predicted at one education receiver during enabling and excavation works for the short durations when rock breaker are in use.

Table 11-40: Overview of NML exceedances (residential receiver types) – Sydney Olympic Park metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2] With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	13	No impact during any period	-	-	-
	'Peak'	Demolition using a rockbreaker	13	Day	5	3	-
Piling	'Typical'	Supporting works	28	No impact during any period	-	-	-
	'Peak'	Bored piling with support plan	28	Day	1	-	-
Surface construction	'Typical'	General works	20	No impact during any period	-	-	-
	'Peak'	Noise intensive works	20	No impact during any period	-	-	-
Initial excavation	'Typical'	Mucking out	4	No impact during any period	-	-	-
	'Peak'	Through soft soil / rock	2	Day	3	-	-
		Through rock using rockbreaker	2	Day	5	3	-

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Excavation within sheds	'Typical'	Mucking out (doors closed)	33	No impact during any period	-	-	-
	'Peak'	Trough rock using rockbreakers (doors closed)	33	Night	1	-	-
		Through rock using rockbreakers (doors open)	33	Day OOH	2	-	-
				Evening	4	-	-
				Night	6	-	-
				Sleep disturbance	1	-	-
Tunnel boring machine retrieval	'Typical'	Deliveries and on/off loading	7	No impact during any period	-	-	-
	'Peak'	Tunnel boring machine disassembly	7	No impact during any period	-	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 99

Note 3: Based on worst-case predicted noise levels.

Table 11-41: Overview of NML exceedances ('other' sensitive receiver types) – Sydney Olympic Park metro station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Educational	2	-	-
	Demolition using a rockbreaker	Commercial	7	4	-
		Café/bar	1	-	-
		Childcare	4	-	-
		Educational	1	1	1
		Passive recreation	1	-	-
		Hotel (daytime)	2	-	-
Piling	Supporting works	Educational	1	1	-
	Bored piling with support plant	Commercial	2	-	-
		Educational	1	1	
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Commercial	1	-	-
		Educational	1	1	-
Initial excavation	Mucking out	Educational	1	1	-
	Through soft soil/rock	Commercial	2	-	-
		Educational	1	1	-
Initial excavation cont.	Through rock using rockbreaker	Commercial	7	2	-
		Café/bar	1	-	-
		Childcare	4	-	-
		Educational	1	1	1
		Passive recreation	1	-	-
		Hotel (daytime)	2	-	-
Excavation within sheds	Mucking out (door closed)	No impact on any receivers			
	Through rock using rockbreaker (doors closed)	No impact on any receivers			
	Through rock using rockbreaker (doors open)	Commercial	5	-	-
		Educational	1	-	-
		Hotel (night-time)	1	-	-
Tunnel boring machine retrieval	Deliveries and on/off loading	No impact on any receivers			
	Tunnel boring machine disassembly	No impact on any receivers			

The preliminary findings of the construction noise impact assessment at Sydney Olympic Park metro station construction site indicate:

- Stage 1 is generally predicted to result in 'moderate' or 'high' worst-case noise impacts at the nearest receivers during the higher noise generating activities. The nearest receivers to the site are generally commercial. The worst-case impacts are predicted during enabling works and initial excavation, which would occur before the acoustic shed (or other acoustic measures) are constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used outdoors intermittently for a duration of around 10 days during enabling works and two weeks during initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to generally be reduced to 'minor' or 'moderate' at the nearest receivers
- Piling, surface construction and excavation with sheds works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'moderate' or 'minor', but affecting much fewer receivers. These works would also be completed prior to the acoustic shed (or other acoustic measures) being built during standard construction hours
- Tunnel boring machine retrieval works are predicted to be compliant with the management levels during all periods
- Noise intensive outside of standard construction hours would only be completed in the acoustic shed (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are predicted to be 'minor' at one receiver during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open seven receivers are predicted to have 'minor' impacts.

Highly affected residential receivers

No residential receivers are predicted to be highly noise affected by works at the Sydney Olympic Park metro station construction site.

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-40. 'Minor' sleep disturbance impacts are predicted at one residential receiver as a result of occasional high noise levels from heavy vehicles accessing the site via Herb Elliott Avenue along with their movements around the outdoor areas of the site. The potential awakenings from heavy vehicles would be influenced by the number of trucks accessing the site during the night-time and the way in which the vehicles are operated. Night-time truck movements at this construction site are expected to be around seven trucks per hour.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-17 for the daytime period. Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at one educational receiver to the south of the construction site (NSW Institute of Sport).

The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

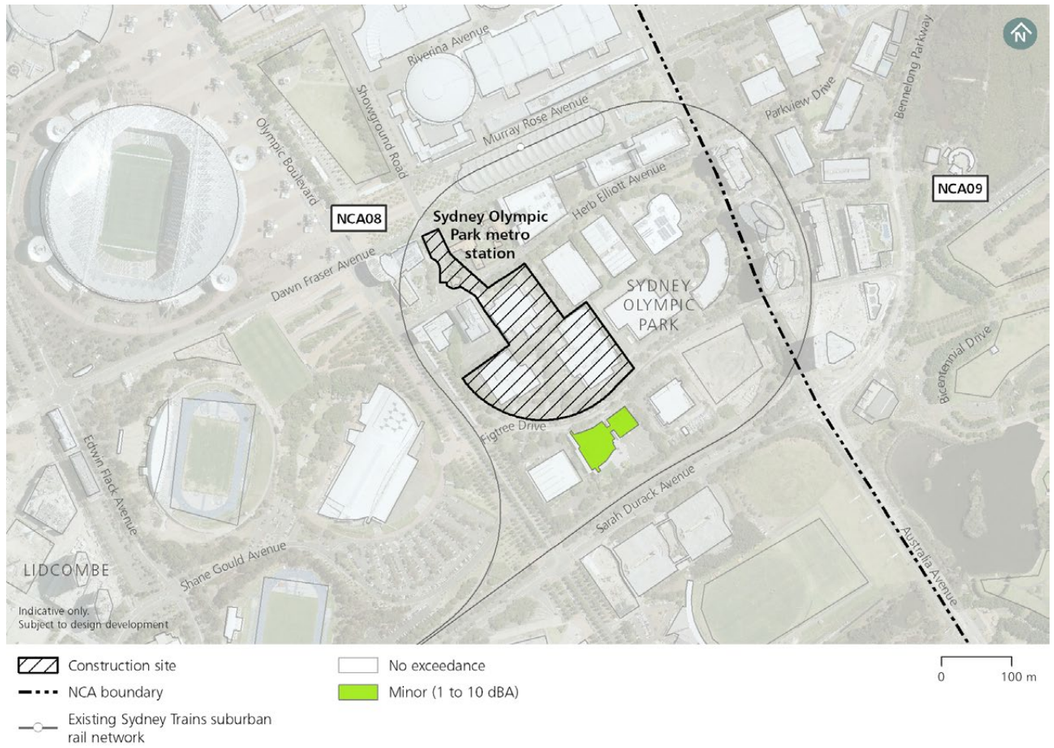


Figure 11-17: Ground-borne noise impacts (daytime construction hours) – Sydney Olympic Park metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-18. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the sensitive equipment screening criteria. The cosmetic damage screening criteria are predicted to be exceeded at the two nearest heritage listed buildings. This includes one building immediately adjacent the north eastern boundary of the site and one building within the construction site boundary.

The human comfort criteria are predicted to be exceeded at four of the nearest receivers, including two heritage listed buildings as well as a commercial building and hotel to the west, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

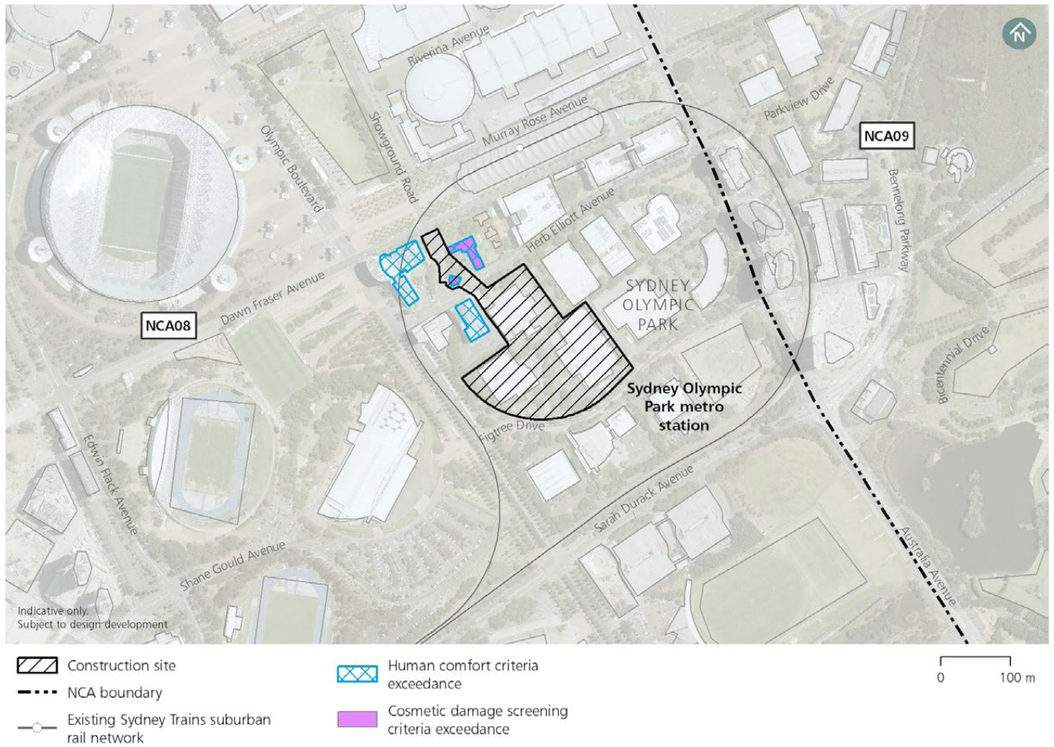


Figure 11-18: Worst-case vibration impacts – Sydney Olympic Park metro station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. No roads anticipated to have a greater than 2 dB increase.

11.11 North Strathfield metro station construction site

11.11.1 Existing environment

Existing noise levels around North Strathfield metro station construction site are dominated by noise from existing transport infrastructure (i.e. road and rail). Nearby sensitive land uses include a mixture of residential, commercial and educational facilities.

North Strathfield has been divided into two noise catchment areas; NCA10 and NCA11 (refer to Figure 11-19).

NCA10 is located west of the existing Sydney Trains suburban rail corridor in North Strathfield and is a mix of residential and educational land uses. The mainly residential area has the nearest receivers opposite the rail corridor off George Street. An area of commercial use is located near Underwood Road and Pomeroy Street. The McDonald College is located to the west of the site at a distance of around 50 metres and Our Lady of the Assumption Catholic Primary School is located about 500 metres south west of the construction site on Underwood Road.

NCA11 is located east of the rail corridor in North Strathfield and is mainly residential. The nearest receivers are opposite the rail corridor on Queen Street, around 10 to 20 metres from the site boundary. Two areas of commercial use are located near to Queen Street and Waratah Street and along Concord Road between Correys Avenue and Homedale Avenue. Strathfield North Public School is located in the north of the catchment on Concord Road, about 400 metres away.

Figure 11-19: Location of sensitive receivers near North Strathfield metro station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations near the North Strathfield metro station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-42.

Table 11-42: Summary of unattended noise monitoring – North Strathfield metro station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.18	17 George Street, North Strathfield	47	47	44	60	60	55
L.19	131 Queen Street, North Strathfield	51	47	39	61	60	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.11.2 Construction impacts

The construction scenarios at the North Strathfield metro station construction site and the anticipated working hours are shown in Table 11-43. The estimated duration of each activity is also provided, noting that most activities would occur irregularly and would not be expected to be undertaken on a continual basis.

Stage 1 works within the North Strathfield metro station construction site are anticipated to have a total duration of about one year and six months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-43: Construction activities and period of works at North Strathfield metro station construction site

Scenario	Activity	Total indicative duration (weeks)[2]	Maximum number of working faces	Hours of works				Comments
				Std. Day	Out-of-hours works			
					Day OOH[1]	Eve	Night	
Enabling works	Delivery of equipment	4	1	✓	-	-	-	Enabling works would be limited to general site mobilization activities.
	Assembly of site facilities	4	2	✓	-	-	-	
Piling	Supporting works	20	2	✓	-	-	-	
	Bored piling with support plant	20	4	✓	-	-	-	Would occur intermittently. Estimated total duration of about 20 weeks.
Surface construction	General works	12	1	✓	-	-	-	
	Noise intensive works	12	2	✓	-	-	-	
Excavation	Mucking out	29	1	✓	-	-	-	
	Through soft soil/rock	10	2	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	19	2		-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from the North Strathfield metro station construction site are summarised in Table 11-44 for residential receiver types. Predicted exceedances for commercial and other sensitive receivers are summarised in Table 11-45. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Works at North Strathfield metro station construction site would typically be restricted to standard daytime construction hours. The majority of works are predicted to result in 'minor' exceedances of the noise management levels with some 'moderate' and 'high' impacts during excavation for the periods when a rock breaker is in use.

Table 11-44: Overview of NML exceedances (residential receiver types) – North Strathfield metro station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Delivery of equipment	4	Day	4	-	-
	'Peak'	Assembly of site facilities	4	Day	18	-	-
Piling	'Typical'	Supporting works	20	Day	9	-	-
	'Peak'	Bored piling with support plan	20	Day	27	-	-
Surface construction	'Typical'	General works	12	No impact during any period	-	-	-
	'Peak'	Noise intensive works	12	Day	12	-	-
Excavation	'Typical'	Mucking out	10	Day	15	-	-
	'Peak'	Through soft soil/rock	4	Day	43	3	-
		Through rock using rockbreaker	6	Day	380	43	3

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.
Note 2: Total number of receivers: 1388
Note 3: Based on worst-case predicted noise levels.

Table 11-45: Overview of NML exceedances ('other' sensitive receiver types) – North Strathfield metro station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Delivery of equipment	Child care	1	-	-
		Educational	1	-	-
	Assembly of site facilities	Child care	1	-	-
		Educational	6	-	-
Piling	Supporting works	Commercial	3	-	-
		Café/bar	1	-	-
		Educational	6	-	-
	Bored piling with support plant	Commercial	15	-	-
		Café/bar	1	-	-
		Childcare	2	-	-
		Educational	3	3	-
Surface construction	General works	Educational	1	-	-
	Noise intensive works	Commercial	3	-	-
		Café/bar	1	-	-
		Childcare	1	-	-
		Educational	6	-	-
Excavation	Mucking out	Commercial	10	-	-
		Café/bar	1	-	-
		Childcare	1	-	-
		Educational	5	1	-
	Through soft soil/rock	Commercial	15	-	-
		Café/bar	1	-	-
		Childcare	2	-	-
		Educational	2	4	-
	Through rock using rockbreaker	Commercial	4	15	-
		Café/bar	-	1	-
		Childcare	1	2	-
		Educational	3	2	4
		Public building	1	-	-
		Place of worship	3	-	-

The preliminary findings of the construction noise impact assessment at North Strathfield metro station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are a mixture of residential, commercial and educational buildings. The worst-case impacts are predicted during excavation works. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or 'moderate' at the nearest receivers
- Enabling works, piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor' or 'moderate'. These works would also be completed during standard construction hours.

Highly affected residential receivers

The receivers that could potentially be highly noise affected during the worst-case impacts from Stage 1 are shown on Figure 11-20. Two receivers in NCA10 and 13 receivers in NCA11 are predicted to be highly noise affected during rockbreaking activities during the day period.

Figure 11-20: Highly noise affected residential receivers (during any works) – North Strathfield metro station construction site

Sleep disturbance

No works are proposed at this construction site during the night-time.

Ground-borne construction noise

Ground-borne noise levels have been assessed at this site and the worst-case impacts are shown in Figure 11-21. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'minor' worst-case ground-borne noise impacts during the daytime at the nearest receivers on the eastern side of Queen Street, which includes residential and commercial and 'other sensitive' (café) buildings.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to reduce.

Figure 11-21: Ground-borne noise impacts (daytime construction hours) – North Strathfield metro station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-22. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

There are no predicted exceedances of the cosmetic damage screening criteria or the sensitive equipment screening criteria.

The human comfort criteria are predicted to be exceeded at the nearest residential, commercial and 'other sensitive' (café) receivers to the east, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

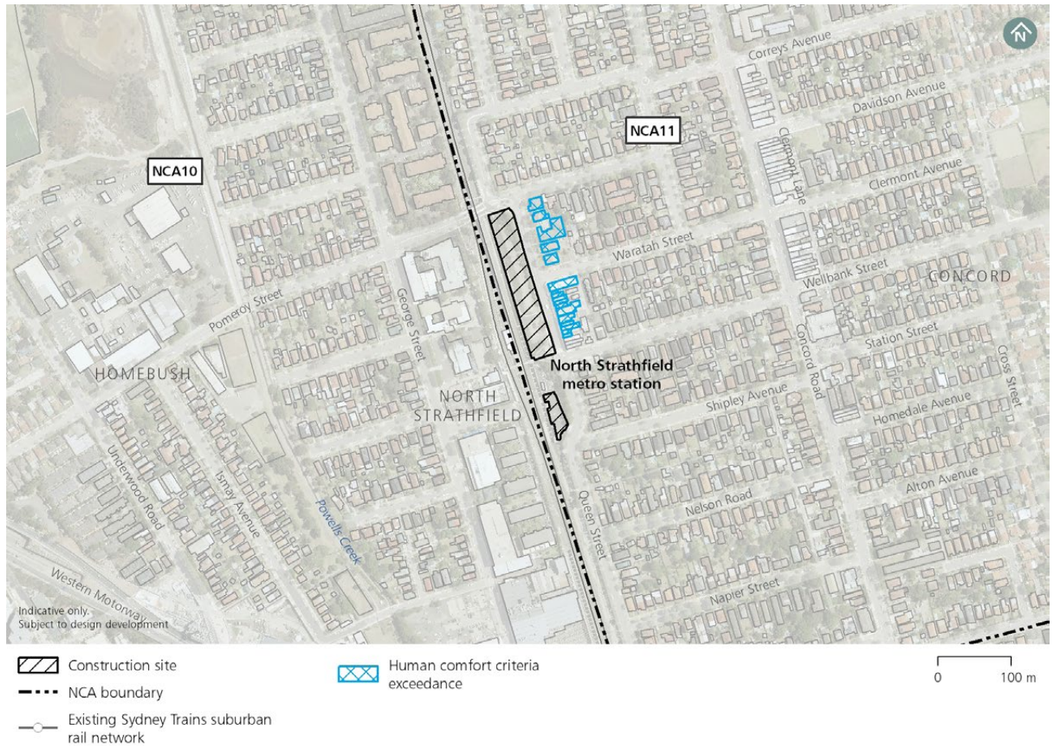


Figure 11-22: Worst case vibration impacts – North Strathfield Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Queen Street and Wellbank Street, to the east of the North Strathfield metro station construction site, although these construction traffic movements would generally be restricted to standard daytime construction hours. This represents the worst-case predicted increase in any period.

11.12 Burwood North Station construction site

11.12.1 Existing environment

Existing noise levels around Burwood North Station construction site are dominated by road traffic noise. The area surrounding the construction site is mostly residential with some commercial receivers, typically retail use.

Burwood North has been divided into two noise catchment areas; NCA12 and NCA13 (refer to Figure 11-23).

NCA12 is located to the north of Parramatta Road and is predominately residential with several outdoor active areas including Concord Oval, Cintra Park, St Lukes Park and Goddard Park. The nearest receivers are residential buildings on Burton Street, within around 5-20 metres of the northern construction site. Several commercial receivers and educational facilities are also located within the catchment including St Mary's Catholic Primary School, Concord High School, Concord Public School and Lucas Special School.

NCA13 is located south of Parramatta Road and is a mixture of residential, commercial and educational facilities, including Southern Cross Catholic Vocational College and Methodist Ladies' College School. The nearest residential buildings on Burwood Road and Esher Street, are around five metres from the southern construction site. Several commercial receivers are also located along Parramatta Road. Burwood Park recreation area is located around 350 metres south west of the construction site south of Comer Street.

Figure 11-23: Location of sensitive receivers near Burwood North Station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of Burwood North Station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-46.

Table 11-46: Summary of unattended noise monitoring – Burwood North Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.20	17 Burton Street, Concord	43	43 (47)[2]	42	56	55	50
L.21	8 Esher Street, Burwood	48	48	44	57	56	55

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

Note 2: The monitored evening level was found to be higher than the daytime, the NSW EPA Noise Policy for Industry therefore requires that the evening level be reduced to match the daytime level.

11.12.2 Construction impacts

The construction scenarios at the Burwood North Station construction site and the anticipated working hours are shown in Table 11-47. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within the Burwood North Station construction site are anticipated to have a total duration of about two years and three months. The crossover cavern at Burwood North is assessed as part of the tunnelling assessment in Section 11.51.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-47: Construction activities and period of works at Burwood North Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	16	2	✓	-	-	-	Enabling works would be limited to general site mobilization activities.
	Demolition using a rockbreaker	16	3	✓	-	-	-	
Piling	Supporting works	22	3	✓	-	-	-	Would occur intermittently. Estimated total duration of about 22 weeks.
	Bored piling with support plant	22	6	✓	-	-	-	
Surface construction	General works	10	2	✓	-	-	-	
	Noise intensive works	10	4	✓	-	-	-	
Initial excavation	Mucking out	9	2	✓	-	-	-	
	Through soft soil/rock	4	4	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	5	4	✓	-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.
Excavation with shed	Mucking out	32	2	✓	✓	✓	✓	Out of hours works would only occur once the acoustic sheds (or other acoustic measures) have been constructed.
	Through rock using rockbreaker	32	4		✓	✓	✓	
Mined cavern with shed	Spoil removal	34	2	✓	✓	✓	✓	
	Mining with support	34	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Burwood North Station construction site are summarised in Table 11-48 for residential receiver types. Predicted airborne NML exceedances from construction site works for commercial and other sensitive receivers are summarised in Table 11-49. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, piling and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-48: Overview of NML exceedances (residential receiver types) – Burwood North Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	16	Day	23	9	1
	'Peak'	Demolition using a rockbreaker	4	Day	433	62	26
Piling	'Typical'	Supporting works	22	Day	24	6	-
	'Peak'	Bored piling with support plan	22	Day	43	14	3
Surface construction	'Typical'	General works	10	Day	13	3	-
	'Peak'	Noise intensive works	10	Day	28	7	2
Initial excavation	'Typical'	Mucking out	9	Day	32	9	2
	'Peak'	Through soft soil/rock	4	Day	62	17	4
		Through rock using rockbreaker	5	Day	454	62	21
Excavation with shed	'Typical'	Mucking out	32	Day	3	-	-
	'Peak'	Through rock using rockbreaker (doors closed)	32	Day	7	1	-
				Day OOH	8	-	-
				Evening	8	-	-
				Night	15	1	-
				Sleep disturbance	1	-	-
		Through rock using rockbreaker (doors open)	32	Day	56	13	2
				Day OOH	72	16	3
				Evening	72	16	3
				Night	145	20	5
				Sleep disturbance	27	5	-
Mined cavern with shed	'Typical'	Spoil removal (doors closed)	34	Day	1	-	-
	'Peak'	Mining with support (doors closed)	34	Day	3	-	-
				Day OOH	1	-	-
				Evening	1	-	-
				Night	2	-	-
				Sleep disturbance	1	-	-
		Mining with support (doors open)	34	Day	14	2	-
				Day OOH	17	2	-
				Evening	17	2	-
				Night	22	5	-
				Sleep disturbance	5	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1455

Note 3: Based on worst-case predicted noise levels.

Table 11-49: Overview of NML exceedances ('other' sensitive receiver types) – Burwood North Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Place of worship	1	-	-
	Demolition using a rockbreaker	Commercial	15	-	-
		Café/bar	-	1	-
		Childcare	1	-	-
		Educational	12	-	-
		Active recreation	1	-	-
		Place of worship	1	1	-
		Hotel (daytime)	-	1	-
Piling	Supporting works	No impact at any receiver type	-	-	-
	Bored piling with support plant	Place of worship	1	-	-
		Hotel (daytime)	1	-	-
Surface construction	General works	No impact at any receiver type	-	-	-
	Noise intensive works	Place of worship	1	-	-
Initial excavation	Mucking out	Place of worship	1	-	-
	Through soft soil/rock	Place of worship	1	-	-
		Hotel (daytime)	1	-	-
	Through rock using rockbreaker	Commercial	16	-	-
		Café/bar	-	1	-
		Childcare	1	-	-
		Educational	14	-	-
		Active recreation	1	-	-
		Place of worship	1	1	-
		Hotel (daytime)	-	1	-
Excavation within sheds	Mucking out (doors closed)	No impact at any receiver type	-	-	-
	Through rock using rockbreaker (doors closed)	No impact at any receiver type	-	-	-
	Through rock using rockbreaker (doors open)	Commercial	2	-	-
		Café/bar	1	-	-
		Place of worship	1	-	-
		Hotel (daytime)	1	-	-
		Hotel (nighttime)	-	1	-
Mined cavern with shed	Spoil removal (doors closed)	No impact at any receiver type	-	-	-
	Mining with support (doors closed)	No impact at any receiver type	-	-	-
	Mining with support (doors open)	Hotel (night time)	1	-	-

The preliminary findings of the construction noise impact assessment at Burwood North Station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential receivers on Burton Street, which are immediately adjacent to the northern construction site boundary. The worst-case impacts are predicted during enabling works, piling, surface construction and initial excavation which would occur before the acoustic shed (or other acoustic measures) is constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which generally require noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is around 10 days for enabling works and five weeks for initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce, however, 'high' or 'moderate' worst-case impacts remain at the nearest receivers
- Noise intensive works outside of standard construction hours would only be completed in the acoustic sheds (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are predicted to be 'moderate' at one receiver during excavation with shed when rockbreakers are in use and the shed doors are closed. When rockbreakers are in use and the doors are open five receivers are predicted to have 'high' impacts with 21 having 'moderate' impacts.

Highly affected residential receivers

The receivers which could potentially be highly noise affected during the worst-case impacts from Stage 1 are summarised in Table 11-50 and shown on Figure 11-24. The table shows the activity and number of residential receivers affected in each NCA.

The assessment shows that the nearest receivers to the site are predicted to be highly noise affected during daytime works involving rockbreakers before the acoustic shed (or other acoustic measures) is constructed. Two receivers are predicted to be highly noise affected when rockbreaking is completed in the shed when the doors are open.

Table 11-50: Highly noise affected residential receivers – Burwood North Station construction site

Scenario	Activity	NCA12			NCA13		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	1	n/a[1]	n/a	-	n/a	n/a
	Demolition using a rockbreaker	21	n/a	n/a	6	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	2	n/a	n/a	1	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	2	n/a	n/a	-	n/a	n/a
Initial excavation	Mucking out	1	n/a	n/a	1	n/a	n/a
	Through soft soil/rock	3	n/a	n/a	1	n/a	n/a
	Through rock using rockbreaker	15	n/a	n/a	9	n/a	n/a
Excavation within shed	Mucking out	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	-	-	-
Mined cavern with shed	Spoil removal (doors closed)	-	-	-	-	-	-
	Mining with support (doors closed)	-	-	-	-	-	-
	Mining with support (doors open)	-	-	-	-	-	-

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-24: Highly noise affected residential receivers – Burwood North Station construction site

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is also summarised in Table 11-48. 'Moderate' sleep disturbance impacts are predicted for some residential receivers. The number of night-time awakenings during construction works would depend on several factors, including the type of equipment being used, the duration of the noisy works and the distance of the works to residential receivers. Awakening events are generally controlled by limiting the use of noise intensive equipment such as rock breakers to inside the acoustic sheds

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-25 and Figure 11-26 for the daytime and night-time periods, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by adjacent receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'high' worst-case ground-borne noise impacts during the daytime at the nearest residential receiver to the north of the northern construction site. 'Moderate' or 'minor' exceedances are also predicted at a number of the other receivers surrounding both sites.

The worst-case impacts during the night-time are predicted to be 'high' at the two nearest residential receivers to the north of the northern construction site. 'Moderate' or 'minor' exceedances are also predicted at the other surrounding receivers at both sites.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to be reduce.

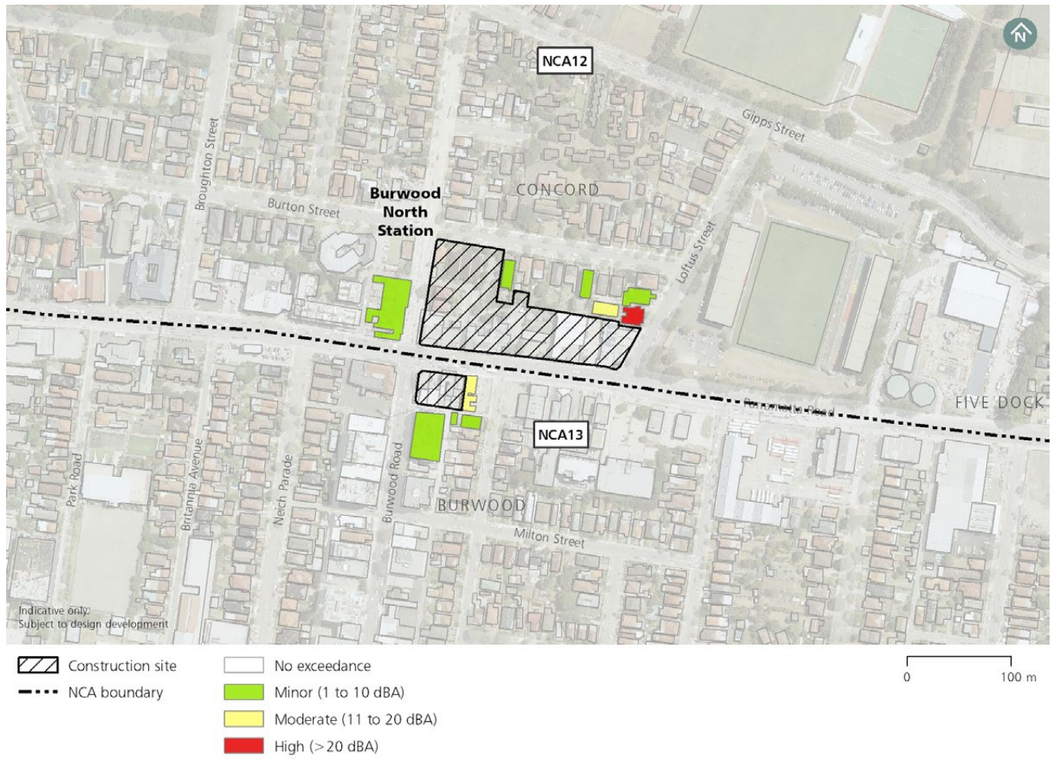


Figure 11-25: Ground-borne noise impacts (daytime construction hours) – Burwood North Station construction site

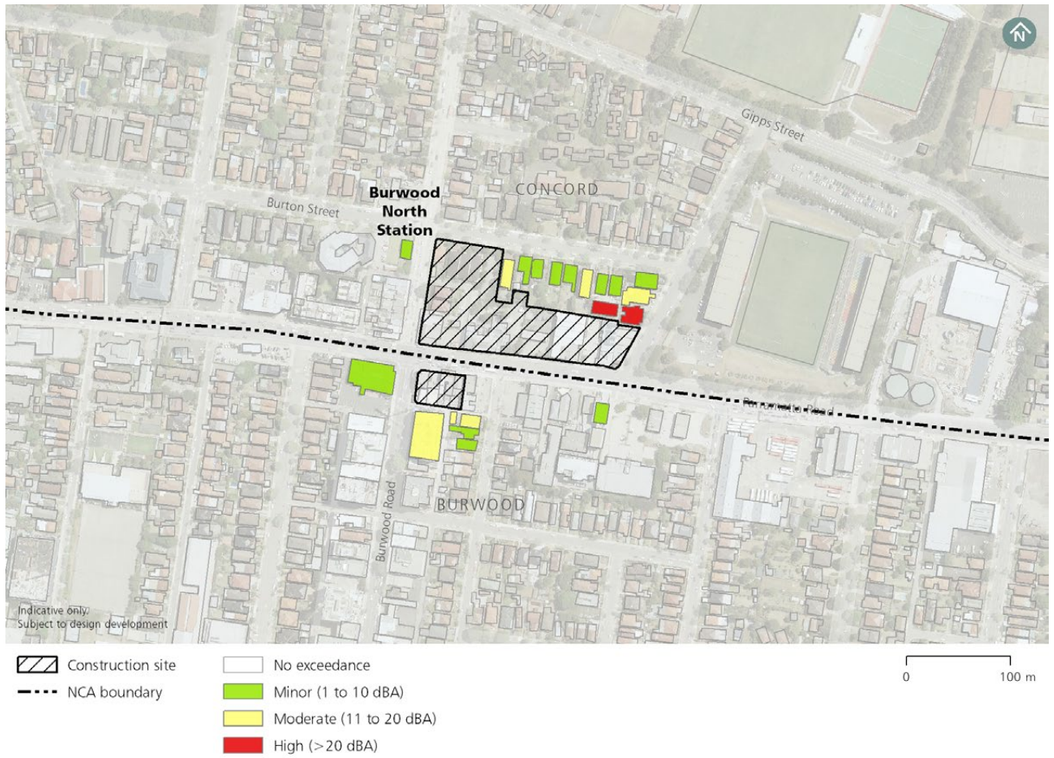


Figure 11-26: Ground-borne noise impacts (night-time construction hours) – Burwood North Station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-27. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest residential buildings to the north of the northern construction site and to the south of the southern construction site.

The human comfort criteria are also predicted to be exceeded at several of the nearest residential and commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

Exceedances of the vibration sensitive equipment screening criteria are predicted to be experienced at Central Sydney ENT in Burwood, which was identified as potentially having vibration sensitive equipment with a VC-A criterion.

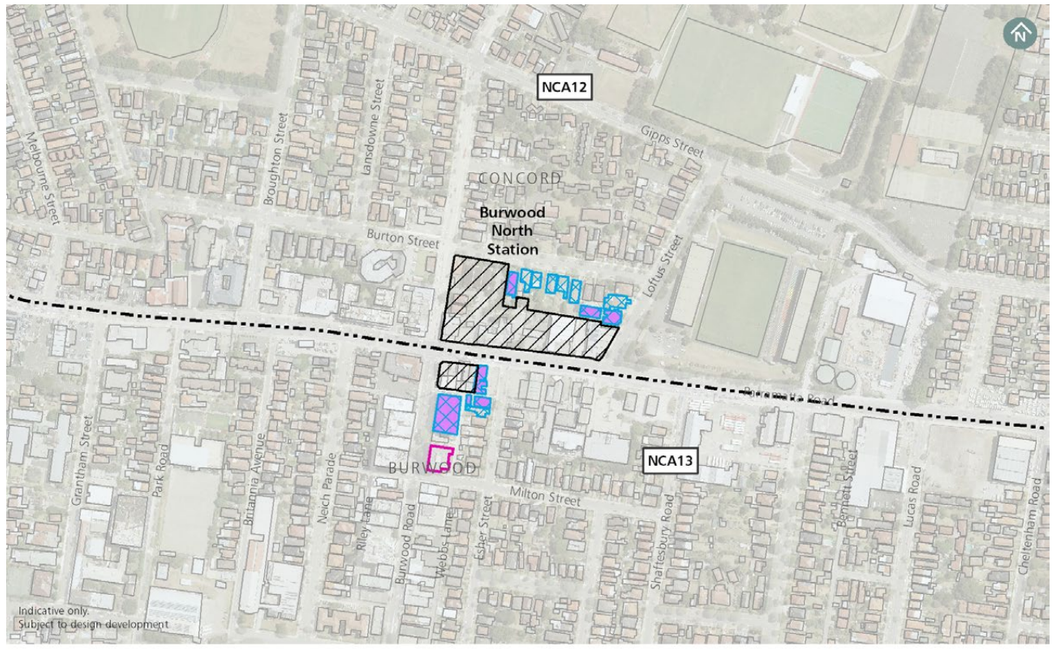


Figure 11-27: Worst-case vibration impacts – Burwood North Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Loftus Street and Burton Street to the east of the Burwood North Station construction site. This increase represents the worst-case predicted increase in any period.

11.13 Five Dock Station construction site

11.13.1 Existing environment

Existing noise levels surrounding Five Dock Station construction site are generally controlled by road traffic noise on the surrounding road network. The area surrounding the construction site is a mixture of commercial, 'other sensitive' and residential receivers, with the nearest receivers being close to the boundary of both the sites.

Five Dock has been divided into two noise catchment areas; NCA14 and NCA15 (refer to Figure 11-28).

NCA14 is located to the west of Great Northern Road and contains the western construction site. The nearest receivers to the western construction site are residential buildings and the Caring4Kids Child Care centre on East Street, which are around 20 metres from the site boundary. St Albans Anglican Church is to the immediate north of the western construction site and Five Dock Public School is around 100 metres to the west.

NCA15 is located east of Great Northern Road and contains the eastern construction site. The nearest receivers to the eastern construction site are residential buildings to the immediate east, west and south of the site, near Waterview Street. These receivers are around five to 20 metres from the site boundary. Domremy Catholic College is around 300 metres to the east of the eastern construction site.

Figure 11-28: Location of sensitive receivers near Five Dock Station construction site

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of Five Dock Station construction sites between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-51.

Table 11-51: Summary of unattended noise monitoring – Five Dock Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.22	3 Henry Street, Five Dock	42	41	33	58	56	51
L.23	8 Waterview Street, Five Dock	43	43 (44)[2]	38	57	56	50

Note 1: The RBL and L_{Aeq} noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

Note 2: The monitored evening level was found to be higher than the daytime, the NSW EPA Noise Policy for Industry therefore requires that the evening level be reduced to match the daytime level.

11.13.2 Construction impacts

The construction scenarios at the Five Dock Station construction site and the anticipated working hours are shown in Table 11-52. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within the Five Dock Station construction site are anticipated to have a total duration of about two years and three months.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-52: Construction activities and period of works at Five Dock Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	13	2	✓	-	-	-	Intermittent rockbreaking over a total duration of 10 days between 7am – 6pm.
	Demolition using a rockbreaker	13	3	✓	-	-	-	
Piling	Supporting works	26	3	✓	-	-	-	Would occur intermittently.
	Bored piling with support plant	26	6	✓	-	-	-	
Surface construction	General works	5	2	✓	-	-	-	-
	Noise intensive works	5	4	✓	-	-	-	-
Initial excavation	Mucking out	10	2	✓	-	-	-	-
	Through soft soil/ rock	4	4	✓	-	-	-	Excavation through soil and soft rock using excavator ripper.
	Through rock using rockbreaker	6	4	✓	-	-	-	Excavation through rock using rockbreaker and restricted to standard construction hours only.
Excavation with shed	Mucking out	30	2	✓	✓	✓	✓	Out of hours works would only occur once the acoustic shed (or other acoustic measures) has been constructed.
	Through rock using rockbreaker	30	4		✓	✓	✓	
Mined cavern with shed	Spoil removal	30	2	✓	✓	✓	✓	
	Mining with support	30	2	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH is Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at the Five Dock Station construction site are summarised in Table 11-53 for residential receiver types. Predicted airborne NML exceedances from construction site works for commercial and other sensitive receivers are summarised in Table 11-54. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

'High' worst-case impacts are generally associated with early activities such as enabling works, intersection modifications and initial excavation. These works are typically of short duration and undertaken during standard daytime construction hours (unless required to be undertaken outside these times such as for traffic management and safety reasons). The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures).

Table 11-53: Overview of NML exceedances (residential receiver types) – Five Dock Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	13	Day	30	14	1
	'Peak'	Demolition using a rockbreaker	13	Day	540	107	37
Piling	'Typical'	Supporting works	26	Day	37	11	1
	'Peak'	Bored piling with support plan	26	Day	72	23	1
Surface construction	'Typical'	General works	5	Day	24	1	-
	'Peak'	Noise intensive works	5	Day	41	12	1
Initial excavation	'Typical'	Mucking out	10	Day	60	21	1
	'Peak'	Through soft soil/ rock	4	Day	102	25	5
		Through rock using rockbreaker	6	Day	507	102	30
Excavation with shed	'Typical'	Mucking out	30	Day OOH	2	-	-
				Evening	1	-	-
				Night	13	-	-
				Sleep disturbance	61	20	4
	'Peak'	Through rock using rockbreaker (doors closed)	30	Day	7	-	-
				Day OOH	30	-	-
				Evening	25	-	-
				Night	112	16	-
				Sleep disturbance	61	20	4
		Through rock using rockbreaker (doors open)	30	Day	71	14	2
				Day OOH	173	33	7
				Evening	167	29	6
				Night	375	88	17
				Sleep disturbance	108	22	6
Mined cavern with shed	'Typical'	Spoil removal (doors closed)	30	Day OOH	1	-	-
				Evening	1	-	-
				Night	9	-	-
				Sleep disturbance	61	20	4

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Mined cavern with shed cont.	'Peak'	Mining with support (doors closed)	30	Day	2	-	-
				Day OOH	13	-	-
				Evening	11	-	-
				Night	62	8	-
				Sleep disturbance	61	20	4
		Mining with support (doors open)	30	Day	21	4	-
				Day OOH	51	9	1
				Evening	57	7	1
				Night	164	28	4
				Sleep disturbance	61	20	5

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1814

Note 3: Based on worst-case predicted noise levels.

Table 11-54: Overview of NML exceedances ('other' sensitive receiver types) – Five Dock Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Café/bar	1	-	-
		Child care	1	1	-
		Public building	2	-	-
		Place of worship	1	1	-
		Passive recreation	-	1	-
	Demolition using a rockbreaker	Commercial	14	1	-
		Café/bar	5	5	-
		Childcare	2	2	1
		Educational	10	6	-
		Public building	-	1	1
		Place of worship	2	-	2
		Recording studio	1	-	-
		Passive recreation	-	-	1
Piling	Supporting works	Café/bar	1	-	-
		Child care	-	1	-
		Public building	2	-	-
		Place of worship	1	1	-
		Passive recreation	1	-	-
Piling cont.	Bored piling with support plant	Café/bar	2	-	-
		Child care	1	1	-
		Educational	3	-	-
		Public building	2	-	-
		Place of worship	-	1	1
		Passive recreation	1	-	-
Surface construction	General works	Child care	1	-	-
		Place of worship	1	1	-
	Noise intensive works	Café/bar	1	-	-
		Child care	1	1	-
		Educational	1	-	-
		Public building	2	-	-
		Place of worship	1	-	1
		Passive recreation	1	-	-
Initial excavation	Mucking out	Café/bar	2	-	-
		Child care	1	1	-
		Educational	3	-	-
		Public building	2	-	-
		Place of worship	-	2	-
		Passive recreation	1	-	-
	Through soft soil/rock	Café/bar	3	-	-
		Child care	2	1	-
		Educational	5	-	-
		Public building	2	-	-
		Place of worship	-	1	1
		Passive recreation	1	-	-
	Through rock using rockbreaker	Commercial	13	-	-
		Café/bar	7	3	-
		Childcare	3	2	1
		Educational	10	5	-
		Public building	-	2	-
		Place of worship	2	-	2
		Recording studio	1	-	-
		Passive recreation	-	1	-
Excavation within sheds	Mucking out (doors closed)	No receivers	-	-	-
	Through rock using rockbreaker (doors closed)	Child care	1	-	-
		Place of worship	1	-	-

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Excavation within sheds cont.	Through rock using rockbreaker (doors open)	Café/bar	2	-	-
		Child care	2	1	-
		Educational	1	-	-
		Public building	2	-	-
		Place of worship	2	-	-
		Passive recreation	1	-	-
Mined cavern with shed	Spoil removal (doors closed)	No receivers	-	-	-
	Mining with support (doors closed)	Place of worship	1	-	-
	Mining with support (doors open)	Child care	1	-	-
		Public building	1	-	-
		Place worship	2	-	-

The preliminary findings of the construction noise impact assessment at Five Dock Station construction site indicate:

- Stage 1 is predicted to result in 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are generally residential and 'other sensitive' receivers. The worst-case impacts are predicted during enabling works and initial excavation which would occur before the acoustic sheds (or other acoustic measures) are constructed. These works are, however, limited to standard construction hours and would not occur during the evening or night-time
- The highest impacts are during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is around 10 days for enabling works and around six weeks for initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce, however, 'high' or 'moderate' worst-case impacts remain at the nearest receivers
- Noise intensive works outside of standard construction hours would only be completed in the acoustic sheds (or other acoustic measures) once built. The worst-case impacts from works in the sheds during the night-time are generally predicted to be 'moderate' at the nearest receivers during excavation with sheds and mined cavern with sheds when rockbreakers are in use and the shed doors are closed. When rockbreakers and roadheaders are in use and the doors are open several of the nearest receivers are predicted to have 'high' impacts with many surrounding receivers having 'moderate' impacts.

Highly affected residential receivers

The receivers predicted to be highly noise affected during the worst-case impacts are summarised in Table 11-55 and shown in Figure 11-29. The table shows the activity and number of residential receivers affected in each NCA.

The assessment shows that the nearest receivers to the site are predicted to be highly noise affected during the noisiest daytime works before the acoustic shed (or other acoustic measures) is constructed. Works in the shed are predicted to result in highly noise affected impacts at one receiver which is adjacent to the site boundary of the western construction site.

Table 11-55: Highly noise affected residential receivers – Five Dock Station construction site

Scenario	Activity	NCA14			NCA15		
		Day	Eve	Night	Day	Eve	Night
Enabling works	Supporting and loading	-	n/a[1]	n/a	1	n/a	n/a
	Demolition using a rockbreaker	11	n/a	n/a	22	n/a	n/a
Piling	Supporting works	-	n/a	n/a	-	n/a	n/a
	Bored piling with support plant	-	n/a	n/a	1	n/a	n/a
Surface construction	General works	-	n/a	n/a	-	n/a	n/a
	Noise intensive works	-	n/a	n/a	1	n/a	n/a
Initial excavation	Mucking out	-	n/a	n/a	1	n/a	n/a
	Through soft soil/rock	-	n/a	n/a	1	n/a	n/a
	Through rock using rockbreaker	9	n/a	n/a	17	n/a	n/a
Excavation within shed	Mucking out	-	-	-	-	-	-
	Through rock using rockbreaker (doors closed)	-	-	-	-	-	-
	Through rock using rockbreaker (doors open)	-	-	-	1	1	1
Mined cavern with shed	Spoil removal (doors closed)	-	-	-	-	-	-
	Mining with support (doors closed)	-	-	-	-	-	-
	Mining with support (doors open)	-	-	-	-	-	-

Note 1: 'n/a' represents where works would not be performed during the evening or night-time periods

Figure 11-29: Highly noise affected residential receivers – Five Dock Station construction site

Sleep disturbance

A sleep disturbance screening assessment is summarised in Table 11-53. 'High' sleep disturbance impacts are predicted at the adjacent residential receivers during some 'peak' activities, with 'moderate' impacts at receivers which are more distant. These impacts result from heavy vehicles and movements in the outdoor areas of the site. Sleep disturbance impacts are predicted to increase if acoustic shed (or other acoustic measures) doors are opened during excavation works. Night-time truck movements at these construction sites are expected to be around five trucks per hour per site.

Further investigation of awakenings would be completed during the next stages of Stage 1 when detailed construction planning information becomes available.

Ground-borne construction noise

The predicted ground-borne impacts from vibration intensive station shaft excavation works inside the acoustic sheds (or other acoustic measures) are shown in Figure 11-30 and Figure 11-31 for the daytime and night-time periods, respectively. The predictions are representative of the highest ground-borne noise levels that would likely be experienced by adjacent receivers when excavation works are at their closest.

Vibration intensive works are predicted to result in 'high' worst-case ground-borne noise impacts during the daytime at the nearest residential receiver to the west of the eastern construction site. 'Moderate' or 'minor' exceedances are also predicted at several other receivers surrounding both sites.

The worst-case impacts during the night-time are predicted to be 'high' at the same residential receiver to the west of the eastern construction site. 'Moderate' or 'minor' exceedances are also predicted at the receivers surrounding the sites.

The predictions represent the worst-case scenario when shaft excavation works are at surface level and are, therefore, at the closest point to the affected buildings. As the works progress deeper, the impacts are expected to be reduce.

Figure 11-30: Ground-borne noise impacts (daytime construction hours) – Five Dock Station construction site

Figure 11-31: Ground-borne noise impacts (night-time construction hours) – Five Dock Station construction site

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-32. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the nearest buildings to both sites. This includes St. Alban's Anglican Church that is located to the north of the western construction site.

The human comfort criteria are also predicted to be exceeded at some of the nearest buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby.

There are no predicted exceedances of the sensitive equipment screening criteria.

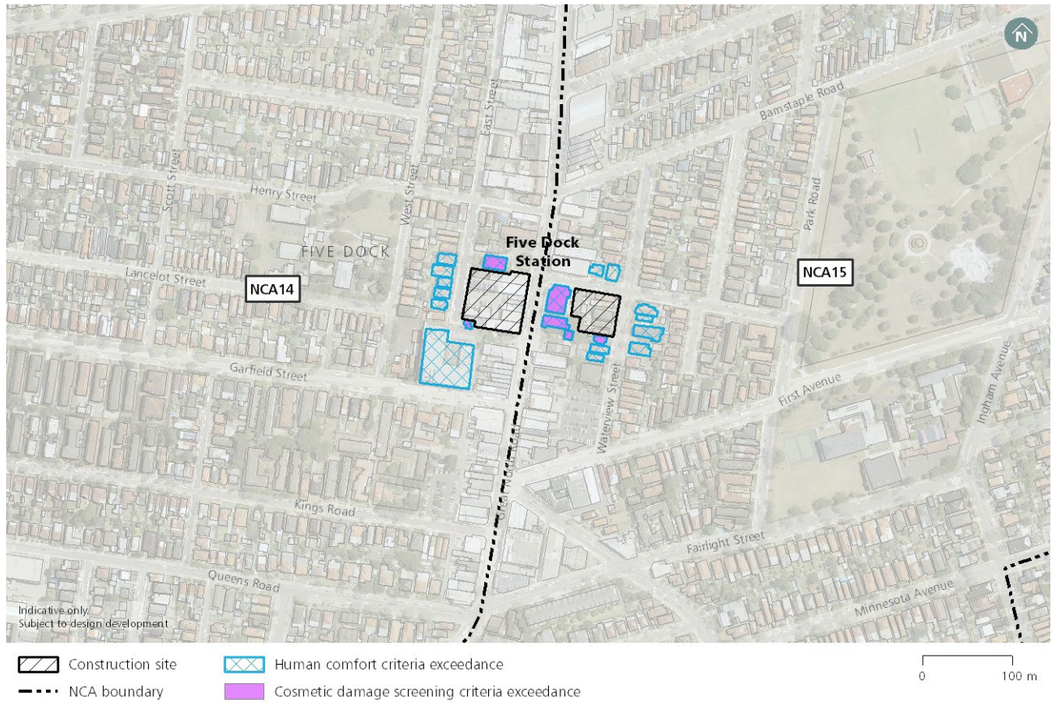


Figure 11-32: Worst-case vibration impacts – Five Dock Station construction site

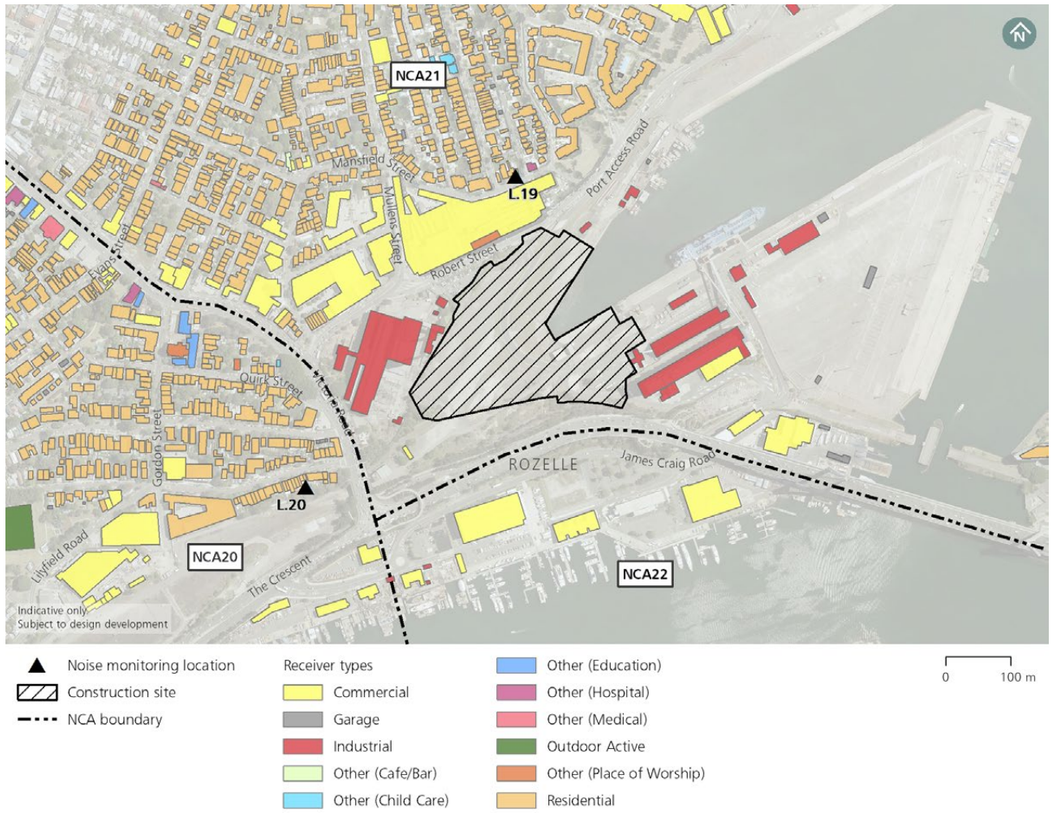


Figure 11-33: Location of sensitive receivers near The Bays Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase would include Second Avenue and Waterview Street to the east of the Five Dock Station construction site. This increase represents the worst-case predicted increase in any period.

11.14 The Bays Station construction site

11.14.1 Existing environment

Existing noise levels around The Bays Station construction site are dominated by road traffic noise from Victoria Road and Anzac Bridge, and industrial noise from White Bay and Glebe Island. The area immediately surrounding the construction site consists mainly of commercial/industrial use, with large areas of residential receivers to the east and south of the site.

The Bays has been divided into three noise catchment areas; NCA20, NCA21 and NCA22 (refer to Figure 11-33).

NCA20 is located west of Victoria Road at Rozelle. This catchment is comprised of residential receivers and a mixture of commercial, places of worship (St Joseph's Catholic Church), educational facilities (Sydney Community College) and childcare facilities (Rosebud Cottage Child Care) along Victoria Road.

NCA21 is located north of the Anzac Bridge and east of Victoria Road at Rozelle. This catchment is comprised of commercial/industrial buildings associated with White Bay, Glebe Island and Rozelle Bay. A large commercial area is also located near Robert Street. Large areas of residential receivers are also located to the north west of the catchment. The Bald Rock Hotel is located around 130 metres north of the construction site on Mansfield Street.

NCA22 is located south of the Anzac Bridge and is comprised of residential areas near Glebe Point Road and recreation areas including Jubilee Park and Blackwattle Bay Park.

Unattended noise monitoring was undertaken at sensitive receiver locations in the vicinity of The Bays Station construction site between March and July 2019. The results of the unattended noise surveys are summarised in Table 11-56.

Table 11-56: Summary of unattended noise monitoring – The Bays Station construction site

Location ID	Address	Noise level (dBA)[1]					
		Background noise (RBL)			Average noise level (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.27	21 Mansfield Street, Rozelle	43	43	35	56	54	47
L.28	22 Lilyfield Road, Rozelle	51	51	45	57	57	54
L.29	308 Glebe Point Road, Glebe	48	47	39	59	58	51

Note 1: The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the Noise Policy for Industry.

11.14.2 Construction impacts

The construction scenarios at The Bays Station construction site, and the anticipated working hours are shown in Table 11-57. The estimated duration of each activity is also provided, noting that most activities would be intermittent during this period and would not be expected to be undertaken on a continual basis.

Stage 1 works within The Bays Station construction site are anticipated to have a total duration of about three years.

These temporary airborne noise impacts would be managed through the implementation of standard and additional mitigation measures in accordance with the Sydney Metro Construction Noise and Vibration Standard.

Table 11-57: Construction activities and period of works at The Bays Station construction site

Scenario	Activity	Total indicative duration (weeks)[3]	Maximum number of working faces	Hours of works[1]				Comments
				Std. Day	Out-of-hours works			
					Day OOH[2]	Eve	Night	
Enabling works	Supporting and loading	4	1	✓	✓	-	-	
	Demolition using a rockbreaker	4	2	✓	✓	-	-	Would occur intermittently with an estimated total duration of about 10 days.
Piling	Supporting works	30	2	✓	✓	-	-	
	Bored piling with support plant	30	4	✓	✓	-	-	Would occur intermittently.
Surface construction	General works	12	1	✓	✓	-	-	
	Noise intensive works	12	2	✓	✓	-	-	
Initial excavation	Mucking out	8	1	✓	✓	-	-	
	Through soft soil/rock	1	2	✓	✓	-	-	Excavation through soil and soft rock using excavator ripper attachment, before construction of the acoustic shed (or other acoustic measures).
	Through rock using rockbreaker	7	2	✓	✓	-	-	Excavation through rock using rockbreaker, before construction of the acoustic shed (or other acoustic measures).
Excavation within shed	Mucking out	26	1	✓	✓	✓	✓	
	Through rock using rockbreaker	26	2	✓	✓	✓	✓	OOH work would only occur once the acoustic sheds (or other acoustic measures) have been constructed.
Tunnel boring machine launch and support	Tunnel boring machine support and spoil removal	78	1	✓	✓	✓	✓	The majority of works would be conducted within the acoustic shed (or other acoustic measures) with some loading and other less noisy works being conducted outside the shed.
	Tunnel boring machine assembly and launch	2	1	✓	✓	✓	✓	

Note 1: Noise intensive works outside of standard construction hours would only be undertaken within the acoustic shed (or other acoustic measures).

Note 2: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 3: Durations should be regarded as indicative and represent the total estimated duration of works at a typical worksite over the entire construction period.

Airborne construction noise

The predicted airborne NML exceedances from works at The Bays Station construction site are summarised in Table 11-58 for residential receiver types. Predicted exceedances for commercial and other sensitive receivers are summarised in Table 11-59. The predictions are representative of the highest noise levels that would be experienced when the works are nearest to the sensitive receivers.

The number of receivers predicted to experience exceedances of the NMLs are summarised in bands of 10 dB and are separated into day, evening and night-time periods, as appropriate.

Due to the distance of residential receivers from the site, the majority of works are predicted to result in 'minor' exceedances of the noise management levels, with some 'moderate' exceedances for the periods when rock breakers are in use. These works would generally be undertaken during standard daytime construction hours and extended hours of Saturday afternoons. The majority of works out of standard hours would only be undertaken after the establishment of the acoustic shed (or other acoustic measures) and typically result in 'minor' exceedances of noise management levels.

Table 11-58: Overview of NML exceedances (residential receiver types) – The Bays Station construction site

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Enabling works	'Typical'	Supporting and loading	4	Day	1	-	-
				Day OOH	12	-	-
	'Peak'	Demolition using a rockbreaker	4	Day	536	40	-
				Day OOH	618	182	5
Piling	'Typical'	Supporting works	30	Day OOH	15	-	
	'Peak'	Bored piling with support plan	30	Day	2	-	-
				Day OOH	91	-	-
Surface construction	'Typical'	General works	12	Day OOH	1	-	-
	'Peak'	Noise intensive works	12	Day	5	-	-
				Day OOH	39	-	-
Initial excavation	'Typical'	Mucking out	8	Day OOH	39	-	-
	'Peak'	Through soft soil/ rock	1	Day	26	-	-
				Day OOH	154	-	-
		Through rock using rockbreaker	7	Day	500	26	-
				Day OOH	623	154	-
Excavation with shed	'Typical'	Mucking out	26	Day OOH	1	-	-
				Evening	1	-	-
				Night	118	1	-
				Sleep disturbance	3	-	-
	'Peak'	Through rock using rockbreaker (doors closed)	26	Day	1	-	-
				Day OOH	20	-	-
				Evening	20	-	-
				Night	333	2	-
				Sleep disturbance	3	-	-

Scenario	Activity		Duration (weeks)	Period[1]	Number of receivers[2]		
					With NML exceedance[3]		
					1-10 dB	11-20 dB	>20 dB
Tunnel boring machine launch and support	'Typical'	Tunnel boring machine support and spoil removal	78	Night	21	-	-
				Sleep disturbance	3	-	-
	'Peak'	Tunnel boring machine assembly and launch	2	Day OOH	3	-	-
				Evening	3	-	-
				Night	182	-	-
				Sleep disturbance	3	-	-

Note 1: OOH = Out-of-hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 6pm.

Note 2: Total number of receivers: 1126

Note 3: Based on worst-case predicted noise levels.

Table 11-59: Overview of NML exceedances ('other' sensitive receiver types) – The Bays Station construction site

Scenario	Activity	Receiver type	Number of receivers		
			With NML exceedance		
			1-10 dB	11-20 dB	>20 dB
Enabling works	Supporting and loading	Place of worship	1	-	-
	Demolition using a rockbreaker	Commercial	8	2	-
		Child care	4	2	-
		Educational	3	-	-
		Passive recreation	1	-	-
		Place of worship	2	-	1
Piling	Supporting works	No impact on any receiver type	-	-	-
	Bored piling with support plant	Child care	1	-	-
		Place of worship	1	-	-
Surface construction	General works	No impact on any receiver type	-	-	-
	Noise intensive works	Place of worship	1	-	-
Initial excavation	Mucking out	No impact on any receiver type	-	-	-
	Through soft soil/rock	Child care	3	-	-
		Place of worship	1	-	-
	Through rock using rockbreaker	Commercial	2	-	-
		Childcare	3	3	-
		Educational	3	-	-
		Passive recreation	1	-	-
		Place of worship	1	1	-
Excavation within sheds	Mucking out (doors closed)	No impact on any receiver type	-	-	-
	Through rock using rockbreaker (doors closed)	Place of worship	1	-	-
	Through rock using rockbreaker (doors open)	No impact on any receiver type	-	-	-
Tunnel boring machine launch and support	Supporting works	No impact on any receiver type	-	-	-
	Assembly and launch	No impact on any receiver type	-	-	-

The preliminary findings of the construction noise impact assessment at The Bays Station construction site indicate:

- Stage 1 is predicted to result in 'moderate' or 'high' worst-case noise impacts at the nearest receivers during higher noise generating activities. The nearest receivers to the site are a mixture of commercial/industrial and residential. The worst-case impacts are predicted during enabling works and Initial excavation which would occur before the acoustic shed (or other acoustic measures) are constructed. These works are, however, limited to the daytime and would not occur during the evening or night-time
- The highest impacts are predicted during 'peak' scenarios which use noise intensive equipment such as rockbreakers. Rockbreakers would, however, only be used intermittently and the duration is only for around 10 days during enabling works and for up to seven weeks during initial excavation works. When noise intensive equipment is not in use during 'typical' works, the worst-case impacts are predicted to reduce to 'minor' or be compliant with the management levels
- Piling and surface construction works generate less noise and the worst-case impacts at the nearest receivers are predicted to be 'minor'
- Noise intensive works outside of daytime hours would only be completed in the acoustic shed (or other acoustic measures) once built. The worst-case impacts during the night-time are predicted to be 'minor' at most surrounding residential receivers with 'moderate' impacts at two of the nearest receivers.

Highly affected residential receivers

No residential receivers are predicted to be highly noise affected by works at The Bays Station construction site.

Sleep disturbance

A sleep disturbance screening assessment has been completed for the construction works and is summarised in Table 11-58. Minor sleep disturbance impacts are predicted three residential receivers to the north during noisy works as part of Excavation with shed and TBM launch and support. The potential awakenings from heavy vehicles would be in line with the number of trucks accessing the site during the night-time. Night-time truck movements at this construction site are expected to be around 25 trucks per hour with vehicles accessing the site via the southern entrance off James Craig Road. The spoil loading facilities would be on the north-eastern side of the acoustic sheds which is approximately 260 metres from the nearest residential receivers on Mansfield Street.

Further investigation of awakenings would be completed during the next stages of the project when detailed construction planning information becomes available.

Ground-borne construction noise

The offset distances from the shaft excavation areas to the nearest receivers are large enough for there to be no predicted exceedances of the ground-borne noise criteria.

Vibration impacts

The predicted impacts during vibration intensive works are shown in Figure 11-34. The predictions are representative of the highest vibration levels that would likely be experienced by the nearest receivers when excavation works are at their closest.

The cosmetic damage screening criteria are predicted to be exceeded at the following buildings:

- One heritage listed underground canal structure (White Bay Power Station inlet canal)
- One heritage listed building at the former White Bay Power Station
- One commercial building at Gypsum Resources Australia located east of the construction site.

The human comfort criteria are also predicted to be exceeded at some of the nearest commercial buildings, meaning occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use nearby. This includes two buildings on the former White Bay Power Station site which are expected to be disused but are included in this assessment for completeness.

There are no predicted exceedances of the sensitive equipment screening criteria.

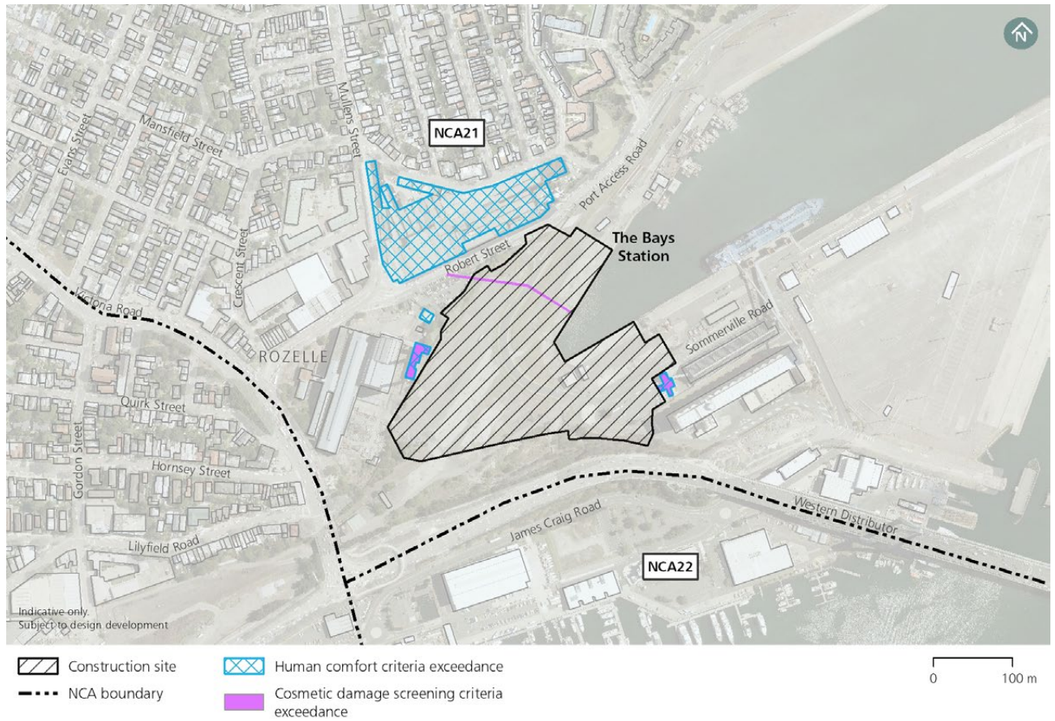


Figure 11-34: Worst-case vibration impacts – The Bays Station construction site

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers adjacent to construction haulage routes. The forecast construction traffic volumes in the study area have been used to determine where potentially noticeable increases in road traffic noise (i.e. a greater than 2 dB increase above the existing noise level) is likely. Roads anticipated to have a greater than 2 dB increase include James Craig Road, Port Access Road, Sommerville Road and Solomon's Way, generally to the south of The Bays Station construction site. No residential receivers are located along these roads. This increase represents the worst-case predicted increase in any period.

11.15 Cumulative impacts

Potential cumulative impacts were considered for assessment based on the likely interactions of Stage 1 with other projects and plans that met the adopted screening criteria. The approach to assessment and the other projects considered are described further in Appendix G (Cumulative impacts assessment methodology – Stage 1).

Potential cumulative construction noise impacts have been considered with reference to both concurrent impacts (the combined effects of multiple projects occurring at the same time) and consecutive impacts (where projects occur consecutively and there is the potential for prolonged construction noise impacts affecting the same receivers).

The main concurrent construction noise impacts identified for Stage 1 are:

- Potential temporary impacts on receivers in NCA01 and NCA02 at Westmead and in NC03 at Parramatta due to the concurrent noise from Parramatta Light Rail Stage 1
- Potential temporary impacts on receivers (mainly commercial) at Sydney Olympic Park due to the construction of various projects consistent with the Sydney Olympic Park Masterplan 2030
- Potential temporary impacts on receivers near The Bays Station construction site due to concurrent construction activities associated with the following projects:
    - WestConnex M4–M5 Link
    - Sydney Metro City & Southwest (Chatswood to Sydenham) truck marshalling facility
    - Bays Precinct Urban Transformation Plan
    - Glebe Island Multi-User Facility
    - Glebe Island Concrete Batching Plant
    - Western Harbour Tunnel and Warringah Freeway Upgrade.

While WestConnex M4–M5 Link has been identified as involving higher impact works near The Bays Station construction site, the potential concurrent impacts from Stage 1 and WestConnex M4-M5 Link for receivers west of Victoria Road between the two sites is considered minimal. If works were occurring on both projects at the same time near this area, construction noise impacts at nearby receivers would generally be limited by the much closer WestConnex M4-M5 Link works.

Other areas to south of Victoria Road in Rozelle Bay could be affected by temporary concurrent impacts, however, these areas are commercial/industrial with relatively low sensitivity to noise impacts.

In relation to other concurrent projects identified near The Bays Station the likelihood of worst-case noise levels being generated by two different works at the same time is low, however if this did occur there could be a temporary increase in worst-case noise levels by around 3 dB. Construction noise levels in any one location would vary and would be frequently much lower than worst-case due to construction phasing moving works around and, in many cases, only a few items of equipment being used at any one time.

In addition to concurrent impacts, if more than one project occurs in the same area consecutively, there may be a prolonged effect from the extended duration of construction noise impacts. This effect is typically referred to as 'construction fatigue'. Table 11-60 identifies the potential for consecutive construction noise impacts at each Stage 1 site.

Table 11-60: Areas with potential consecutive construction noise impacts

Stage 1 construction site	Potential cumulative impacts
Westmead metro station	• Parramatta Light Rail Stage 1 is to north of the construction site. Construction works are currently being undertaken • Western Sydney University Westmead Campus Upgrade is to the north-west of the site. Construction works are currently occurring • Westmead Medical Precinct Redevelopment is located to the north of the site, although this is over 300 metres away • A mixed use development is proposed at 24-26 Railway Parade, Westmead, which is next to the future Parramatta Light Rail Westmead stop.
Parramatta metro station	• One local development project is proposed adjacent to the Parramatta metro station construction site at 69 George Street • The New Powerhouse Museum is located to the north of the site, however, this is over 170 metres away with many intervening buildings.
Clyde stabling and maintenance facility	• Parramatta Light Rail Stage 1 light rail alignment and stabling yard is to north of the construction site • Camellia Town Centre is to the north of the site • Clyde Terminal Conversion is to the east of the site • WestConnex M4 Widening was constructed to the south of the site between 2015 and mid-2017.
Sydney Olympic Park metro station	• Sydney Olympic Park Masterplan 2030 sets out the strategy for future development in the area • WestConnex M4 Widening was constructed to the south of the site between 2015 and mid-2017 • WestConnex M4 Widening, Hill Road Modification is proposed to the south of the site • WestConnex M4 East was constructed to the south-east of the site between 2016 and mid-2019 • Planned Parramatta Light Rail Stage 2 located to the north on Dawn Fraser Avenue.
North Strathfield metro station	• North Strathfield Station Upgrade was completed in late 2019 • WestConnex M4 East was constructed to the south-east of the site between 2016 and mid-2019.
Burwood North Station	• WestConnex M4 East was constructed to the east of the site between 2016 and mid-2019 • Concord Oval Redevelopment is proposed immediately next to the site.
The Bays Station	• WestConnex M4–M5 Link is currently under construction to the south-west of the site and is expected to be complete by 2023 • The Sydney Metro City & Southwest (Chatswood to Sydenham), White Bay truck marshalling yard is currently in use to the north of the site and expected to be in use until 2020 • Glebe Island Multi-User Facility is proposed to the north and east of the site • The Bays Precinct Urban Transformation Plan surrounds the site • Western Harbour Tunnel and Warringah Freeway Upgrade is proposed to the north-east and south-west of the site. Construction scheduling information is not currently available for this project.

11.16 Management and mitigation measures

11.16.1 Approach to management and mitigation

Construction Environmental Management Framework

Noise and vibration would be managed in accordance with Sydney Metro's Construction Environmental Management Framework (described in Chapter 27 (Synthesis of the Environmental Impact Statement)).

The Construction Environmental Management Framework would require the preparation of a Construction Noise and Vibration Management Plan in line with the requirements of the ICNG and the Sydney Metro Construction Noise and Vibration Standard. The Construction Noise and Vibration Management Plan would be prepared before any works begin and would define how the predicted impacts would be mitigated and managed. The Construction Noise and Vibration Management Plan would also consider cumulative construction impacts and the likelihood for 'construction fatigue' from consecutive projects in the areas which have substantial night-time works.

Sydney Metro Construction Noise and Vibration Standard

Stage 1 noise and vibration impacts would be managed in accordance with the Sydney Metro Construction Noise and Vibration Standard (Appendix E), which aims to manage all construction noise and vibration impacts from Stage 1 including tunnelling and utility works where feasible and reasonable using a variety of mitigation measures.

Site-specific Construction Noise and Vibration Impact Statements would be prepared for:

- All works outside standard construction hours likely to exceed the relevant NMLs
- Activities likely to result in highly noise affected receivers
- Activities likely to generate vibration levels at receivers in excess of the relevant criteria.

The Sydney Metro Construction Noise and Vibration Standard also provides:

- A list of standard mitigation measures that would be implemented where feasible and reasonable at all construction sites which includes measures such as prior notification of the works, monitoring of the impacts and offers of alternative accommodation where night-time impacts are expected to be high
- Trigger levels (based on exceedances of airborne and ground-borne NMLs) for the implementation of additional mitigation measures.

These standard and additional mitigation measures would be applied on Sydney Metro West construction sites.

11.16.2 Mitigation measures

Project-specific mitigation measures, in addition to those contained within the Sydney Metro Construction Noise and Vibration Standard, that would be implemented to address potential noise and vibration impacts are described in Table 11-61.

Table 11-61: Specific construction mitigation measures – Noise and vibration Stage 1

Reference	Impact/issue	Mitigation measures	Applicable location(s)[1]
NV01	Community preference for noise mitigation and management	Further engagement and consultation would be carried out with: • The affected communities to understand their preferences for mitigation and management measures. • 'Other sensitive' receivers such as schools, medical facilities 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
NV02	Alternative construction methodologies	Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive works would be investigated and implemented where feasible and reasonable. This would include consideration of alternative techniques that have been effective on previous similar projects such as: • The use of hydraulic concrete shears in lieu of hammers/rock breakers • Sequencing works to shield noise sensitive receivers by retaining building wall elements • Locating demolition load out areas away from the nearby noise sensitive receivers • Providing respite periods for noise intensive works • Minimising structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition • Installing sound barrier screening to scaffolding facing noise sensitive neighbours • Using portable noise barriers around particularly noisy equipment, such as concrete saws • Modifying demolition works sequencing / hours to minimise impacts during peak pedestrian times and / or adjoining neighbour outdoor activity periods.	All
NV03	Construction noise – respite periods	Appropriate respite would be provided to affected receivers in accordance with the Sydney Metro Construction Noise and Vibration Standard. This would include consideration of impacts from Stage 1 utility and power supply works when determining appropriate respite periods for affected receivers. When determining appropriate respite, the need to efficiently undertake construction would be balanced against the communities' preferred noise and vibration management approach.	All
NV04	Construction noise – out of hours work	The use of noise intensive equipment at construction sites with 'moderate' and 'high' out-of-hours noise management level exceedances would be scheduled for standard construction hours, where feasible and reasonable. Where this is not feasible and reasonable, the works would be undertaken as early as possible in each work shift.	All
NV05	Night-time noise impacts	Air brake silencers would be used on heavy vehicles that access construction sites multiple times per night or over multiple nights.	All
NV06	Sleep disturbance impacts from heavy vehicles	Perimeter site hoarding would be designed with consideration of on-site heavy vehicle movements with the aim of minimising sleep disturbance impacts.	All
NV07	Noise emissions from equipment	Long term construction site support equipment and machinery would be low noise emitting and suitable for use in residential areas, where feasible and reasonable. Examples include: • Low noise water pumps for use in water treatment facilities • Low noise generators and compressors • Low noise air conditioner units for use of amenities buildings.	All
NV08	Acoustic sheds	For all sites where acoustic sheds are proposed, the sheds would be designed and constructed to minimise noise emissions. This would likely include the following considerations: • All significant noise producing equipment that would be used during the night-time would be inside the shed, where feasible and reasonable • Noise generating ventilation systems such as compressors, scrubbers, etc, would also be inside the shed and external air intake/discharge ports would be appropriately acoustically treated • The door of the acoustic shed would be kept closed during the night-time period, where feasible and reasonable. Where night-time vehicle access is required, the doors would be designed and constructed to minimise noise breakout.	WMS, SOPMS, BNS, FDS, TBS
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 ground-borne noise and vibration impacts during the excavation works 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	An activity specific Construction 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
NV12	Blasting Management Strategies	Blasting would be planned during hours that would cause the least disruption and disturbance to the nearest receivers. Notification protocols prior to blasting for the nearest sensitive receivers would be established.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS
NV13	Blasting Monitoring	Attended vibration and overpressure measurements would be completed at the start of any blasting activities to confirm that vibration levels are within the blasting criteria.	WMS, PMS, SSF, SOPMS, NSMS, BMS, FDS, TBS

Reference	Impact/issue	Mitigation measures	Applicable location(s)[1]
NV14	Construction traffic noise	Further assessment of construction traffic would be completed during detailed design, including consideration of the potential for exceedances of the NSW Road Noise Policy base criteria (where greater than 2 dB increases are predicted). The potential impacts would be managed using the following approaches, where feasible and reasonable: • On-site spoil storage capacity would be maximised to reduce the need for truck movements during sensitive times • Vehicle movements would be redirected away from sensitive receiver areas and scheduled during less sensitive times • The speed of vehicles would be limited and the use of engine compression brakes would be avoided • Heavy vehicles would not be permitted to idle near sensitive receivers.	All
NV15	Noise impacts to horses at Rosehill Racecourse Stables	Consultation with the owners and operators of the horse stables near the Clyde stabling and maintenance facility construction site would be carried out so that potential impacts to horses are appropriately managed.	CSMF
NV16	Construction vibration	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and attended vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	All
NV17	Building condition surveys – construction vibration	Condition surveys of buildings and structures near to the tunnel and excavations would be undertaken prior to the commencement of excavation at each site, where appropriate. For heritage buildings and structures the surveys would consider the heritage values of the structure in consultation with a structural engineer.	All
NV18	Cumulative construction noise impacts	The likelihood of cumulative construction noise impacts would be reviewed during detailed design when detailed construction schedules are available. Co-ordination would occur between potentially interacting projects to minimise concurrent or consecutive works in the same areas, where possible. Specific mitigation strategies would be developed to manage impacts. Depending on the nature of the impact, this could involve adjustments to construction program or activities of Sydney Metro West or of other construction projects.	All
NV19	Operational road traffic noise impacts	Further assessment of operational road traffic noise mitigation would be undertaken for receivers identified as being eligible for consideration of treatment. The mitigation would likely include at-property treatment. Receivers that are identified as requiring at-receiver noise mitigation would be identified and, where possible, offered treatment prior to the start of construction works which have the potential to affect them.	WMS

Note 1: WMS: Westmead metro station; PMS: Parramatta metro station; CSMF: Clyde stabling and maintenance facility; SSF: Silverwater services facility; SOPMS: Sydney Olympic Park metro station; NSMS: North Strathfield metro station; BNS: Burwood North Station; FDS: Five Dock Station; TBS: The Bays Station; Metro rail tunnels: Metro rail tunnels not related to other sites (e.g. tunnel boring machine works); PSR: Power supply routes.

11.16.3 Interactions between mitigation measures

Mitigation measures to control construction noise and vibration impacts generally do not overlap with other measures proposed for other environmental issues.

Measures to manage construction traffic would potentially assist in minimising road traffic noise by minimising vehicle numbers where feasible and reasonable and limiting the use of local streets.

There are no mitigation measures identified in the assessment of other environmental aspects that are likely to affect the assessment of noise and vibration impacts.

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