sydney METRO | city & southwest

SYDENHAM TO BANKSTOWN

ENVIRONMENTAL IMPACT STATEMENT

> Technical Paper 2 - Noise and vibration assessment

NSW GOVERNMENT

Sydney Metro City & Southwest Sydenham to Bankstown

Technical Paper 2 - Noise and Vibration Assessment

Report Number 610.15897-R02

28 August 2017

Transport for NSW
Level 43, 680 George Street
SYDNEY NSW 2000

Version: v1.6

Sydney Metro City & Southwest Sydenham to Bankstown

Technical Paper 2 - Noise and Vibration Assessment

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.15897-R02-v1.6	28 August 2017	Dominic Sburlati Antony Williams	Antony Williams	Dominic Sburlati
610.15897-R02-v1.5	10 August 2017	Dominic Sburlati Antony Williams	Antony Williams	Dominic Sburlati
610.15897-R02-v1.4	31 July 2017	Dominic Sburlati Antony Williams	Antony Williams	Dominic Sburlati
610.15897-R02-v1.3	7 July 2017	Dominic Sburlati Antony Williams	Antony Williams	Dominic Sburlati
610.15897-R02-v1.2	16 May 2017	Dominic Sburlati Antony Williams	Antony Williams	Dominic Sburlati
610.15897-R02-v1.1	29 March 2017	Dominic Sburlati Antony Williams	Robert Hall	Dominic Sburlati
610.15897-R02-v1.0	1 March 2017	Dominic Sburlati Antony Williams	Michael Allan	Dominic Sburlati

Executive Summary

Introduction

The New South Wales (NSW) Government is implementing *Sydney's Rail Future* (Transport for NSW, 2012a), a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of rail customers into the future.

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*, providing 66 kilometres of metro rail line and 31 metro stations. The NSW Government is currently delivering the first two stages of Sydney Metro, which consist of Sydney Metro Northwest (between Rouse Hill and Chatswood) and Sydney Metro City & Southwest (between Chatswood and Bankstown).

Sydney Metro Northwest is currently under construction. Sydney Metro Northwest services will start in the first half of 2019, with a metro train running every four minutes in the peak period. Services will operate between a new station at Cudgegong Road (beyond Rouse Hill) and Chatswood Station.

Sydney Metro City & Southwest will extend the Sydney Metro system beyond Chatswood to Bankstown, delivering about 30 kilometres of additional metro rail, a new crossing beneath Sydney Harbour, new railway stations in the lower North Shore and Sydney central business district (CBD), and the upgrade of existing stations from Marrickville to Bankstown. Sydney Metro City & Southwest comprises two core components:

- The Chatswood to Sydenham project
- The Sydenham to Bankstown upgrade ('the project' and the subject of this document).

Identification of Sensitive Receivers

The sensitivity of building occupants to noise and vibration varies according to the nature of the occupancy and activities within the affected premises. A desktop study was undertaken within a corridor extending at least 100 m either side of the project alignment and typically 200 m from the construction compounds to identify the sensitivity of each nearby receiver (building occupancy category). This region of investigation constitutes the study area. Receivers were classified as commercial, educational, industrial, residential, place of worship or other sensitivity (active and passive recreation areas, educational, and medical) to assist in determining appropriate noise and vibration management levels.

Ambient Noise Monitoring

In order to characterise the existing ambient noise environment across the study area, environmental noise monitoring was performed at 23 representative locations during June 2016 and July 2016.

The purpose of the noise monitoring was to quantify the existing noise environment and to determine the existing LAeq, LA90 and other relevant statistical noise levels during the daytime, evening and night-time periods. These results were used to assist in determining the appropriate noise criteria for assessment of fixed facilities and to determine noise management levels (NMLs) as a basis for assessing the potential noise impacts during construction.

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Construction Noise and Vibration Strategy

A Sydney Metro City & Southwest Construction Noise and Vibration Strategy (Sydney Metro CNVS – refer to Volume 3, Appendix F of the Environmental Impact Statement) has been developed by the project design team and will be adopted by all contractors to manage construction noise and vibration emissions across the various worksites and construction compounds. In preparing this strategy, consideration has been given to several guideline documents including the Interim Construction Noise Guideline (EPA 2009), Transport Construction Authority's Construction Noise Strategy (2012), and Australian Standard AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites and the Road Noise Policy (EPA 2011).

Construction Noise

Construction noise levels have been predicted from the project in noise catchment areas (NCAs) along the alignment. Noise levels are typically higher for front row receivers which have line of sight to the works, and where worksites or construction compounds are situated in close proximity to receivers. Where works are required in close vicinity of receivers, the assessment has identified the realistic worst-case construction noise levels at the nearest receivers are likely to be above 75 dBA during noise intensive activities, and are therefore predicted to be 'highly noise affected' at some stages of the works.

For most construction activities, it is however expected that the construction noise levels would frequently be lower than the worst-case predicted noise levels presented in this report as equipment moves away from individual receivers and as works move around the various worksites.

The train network would remain operational during the majority of the construction period. However, some construction activities, such as major station works, major earthworks and bridge works, would need to be undertaken during rail possession periods (when trains are not running) to remove the risk of affecting operations and risk to rail worker safety. This would therefore require some construction works to be undertaken on a 24/7 basis during rail possessions.

Possessions would involve closing only those portions of the rail line necessary to carry out works. Possessions are anticipated to include 'weekend possessions' which would be undertaken over several weekends throughout a calendar year, 'school holiday possessions', and a 'final possession' which would likely be between three to six months.

The majority of the construction works associated with the project would be undertaken during standard daytime working hours. However, as the project is located within an active rail corridor, works outside of standard construction hours would be required where works cannot safely be undertaken due to their proximity to the existing rail lines or where there would be a risk that the works may adversely affect the existing operating lines. Works outside of standard construction hours would be required within the boundary of the rail corridor, at stations, and at bridges.

During standard daytime construction hours, the highest impacts are generally predicted to be at receivers which are adjacent to worksites. Receivers which are further back from the works would have lower predicted noise levels and correspondingly lower Noise Management Level (NML) exceedances.

The highest noise levels and greatest impacts are typically associated with activities that have noise intensive plant items, including rockbreakers, diamond saws and/or ballast tampers.

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Work outside of standard daytime construction hours would only be undertaken as part of possessions/closedowns of the active rail corridor, during which time the rail lines would be shut down so construction works can be safely undertaken on a 24/7 basis. Construction works such as major station works, major earthworks and bridge works, would likely need to be undertaken during rail possession periods.

Construction NMLs for residential receivers are more stringent during out of hours works periods (especially during the night-time period), in order to reflect the increased sensitivity of residential receivers to noise during these times. In acknowledgement of the communities increased sensitivity to noise during the night-time period, the use of highly noise intensive rockbreaker plant would be restricted to standard daytime construction hours of 7 am to 6 pm (with occasional works being required in the evening between 6 pm to 10 pm). There may however be circumstances which may require limited use of rockbreakers during night-time works. This would however be expected to happen infrequently. Additionally, at no location would rockbreakers be used for more than two weeks total duration in one area.

Works activities that use noise intensive ballast tamper plant during the night-time are predicted to result in construction noise levels above NMLs for many receivers surrounding the works. The assessment has shown that removing this noise intensive plant items during the night-time provides a large benefit in reducing the predicted night-time noise levels and similarly reduces the extent and magnitude of the NML exceedances. Accordingly, it is recommended the use of noise intensive ballast tamper plant be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which require occasional night-time use of these plant items or if rail worker safety requirements require these activities to be performed during this period.

It is noted that with the exception of emergency works, activities would not take place outside standard hours without prior discussion with relevant government authorities.

Construction Vibration

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

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed (human perception or human comfort vibration).
- Those in which the integrity of building elements or the structure itself may be prejudiced.
- Those where the building contents may be highly sensitive to vibration (such as facilities with special microscopes or imaging systems).

A conservative vibration damage screening level of 7.5 mm/s has been adopted for the purpose of assessing potential construction vibration cosmetic damage impacts. The separation distance(s) between the works and the nearest sensitive receivers would generally be sufficient so that nearby buildings are unlikely to suffer 'cosmetic damage' for most of the construction equipment. However, based on the arrangement of the worksites and construction compounds, some items of construction equipment have the potential to be operated closer to sensitive receivers than the recommended minimum working distances.

During surface works, up to 360 buildings (including stations) in the vicinity of the works may be within the screening criteria should a large rockbreaker be used at the outer extents of each works area. In practice, it is unlikely that a rockbreaker would be required at all areas and therefore the vibration impacts presented in this assessment should be considered a worst-case.

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The required locations for vibration intensive equipment should be reviewed during detailed design to account for finalised information relating to the ground propagation characteristics, equipment type and specific works location. Review of receiver classifications for potentially impacted buildings would be undertaken during the detailed design phase to confirm occupancy type and building sensitivity to vibration.

Where vibration intensive works are required to be undertaken within the specified safe working distances, or in close proximity to vibration sensitive heritage structures, vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied.

Construction Road Traffic Noise

Temporary additional road traffic associated with the project generally falls into two categories:

- Construction related traffic – This includes heavy vehicle movements to/from the construction compounds transporting construction materials and spoil along defined haulage routes, as well as personal vehicles of construction personnel travelling to/from the construction compounds.
- Temporary transport arrangements – During periods of track possession associated with construction works, train replacement bus services would be required. This would introduce additional heavy vehicles (buses) onto the public road network during these periods. More information on the temporary transport arrangements can be found in Appendix G of the EIS.

It is appropriate to assess the noise impacts from each of the temporary construction road traffic categories individually, as these may occur during separate periods of construction works, and to also differentiate between predicted noise impacts from each of the road traffic noise sources. A cumulative noise assessment has also been undertaken to identify the potential impacts where these vehicle movements occur concurrently in the same location.

The assessment indicates that construction road traffic and temporary transport arrangements road traffic is predicted to result in an increase in road traffic noise levels of less than 2 dB on the majority of roads along the construction and bus routes.

Construction road traffic is however predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on eight roads. Similarly, temporary bus services associated with the proposed temporary transport arrangements are predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on six and three roads for the two temporary transport scenarios modelled.

Noticeable noise level increases from cumulative traffic impacts (from construction road traffic and temporary transport arrangement buses) are predicted on 10 road sections.

Operational Airborne Noise - Rail Operations

Airborne noise created by train operations on surface track requires the assessment of noise impacts against the noise trigger levels defined in the NSW EPA Rail Infrastructure Noise Guideline (RING). Where the project results in rail noise levels exceeding the noise triggers, the noise assessment identifies potentially feasible and reasonable mitigation for existing sensitive receivers, both at opening (2024) and at an indicative design year in the future (taken to be 10 years after opening - 2034).

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The project would involve adjustments of existing track alignments and the introduction of new single-deck metro trains. The proposed Metro services would provide an increased frequency of passenger train services and would operate at increased train speeds compared to existing passenger train services in some regions. Predicted rail noise levels would increase in some areas of the study area as a consequence.

Freight operations are present within the shared rail corridor in the eastern half of the project area between Marrickville and Belmore. Future freight service frequencies for the 2034 scenario are anticipated to increase by approximately 40% during the daytime and night-time periods compared to the 2024 scenario due to growth of the Sydney freight network (unrelated to the project). By comparison, the future Metro service frequencies for the 2034 scenario are anticipated to increase by 10% during the daytime and night-time periods compared to the 2024 scenario. This disproportionate increase in freight service volumes produces an increase in predicted freight rail L_{Aeq} noise level dominance in areas of the project where freight operations are present. As a result, the influence of the assessed project noise sources (Metro tracks) at nearby sensitive receivers is reduced for the 2034 scenario as rail noise levels are dominated by freight operations, thus resulting in fewer RING triggers in areas where freight noise is present. For this reason, the 2024 scenario is considered the controlling period for assessment of noise mitigation in this section of the study area, and the 2034 scenario for the remainder of the study area.

Adjustments to the existing track alignment would include realignment of the rail in some regions, a new turnback at Campsie, and changes to turnout and crossover locations along the length of the project area.

Noise modelling results for the project indicate that the noise trigger levels are exceeded at up to 121 sensitive receiver buildings within the study area. An investigation of potentially feasible and reasonable noise mitigation measures is therefore required to minimise the worst case predicted noise levels. Recommended potentially reasonable and feasible noise mitigation options presented in this report include a combination of conventional noise barriers and at property treatments.

The final form of the proposed mitigation measures are subject to further considerations such as construction limitations, overshadowing, urban design and community preference and would be determined during detailed design.

Operational Ground-borne Vibration - Rail Operations

The potential impacts of ground-borne vibration in buildings fall into three main categories: human comfort (disturbance); impacts on building contents; and structural damage. A fourth effect is ground-borne noise generated within buildings as a result of the vibration.

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. The controlling vibration design objectives during operations are therefore the human comfort goals.

Compliance with the ground-borne vibration objectives is predicted for all residential receivers and other sensitive receiver locations above or near to the proposed project alignment within the study area.

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Operational Ground-borne Noise - Rail Operations

Train noise in buildings adjacent to rail track where airborne noise does not travel directly to the receiver (such as where the airborne noise transmission path is blocked by a large screen or enclosure) is predominantly caused by the transmission of ground-borne vibration rather than the direct transmission of noise through the air. After entering a building, this vibration may cause the walls and floors to vibrate faintly and hence to radiate noise, which is commonly termed ground-borne or regenerated noise.

Predictions of ground-borne noise levels have been made for all buildings located adjacent to the proposed rail alignment. Ground-borne noise levels are assessed only where they are higher than the airborne noise from railways, such as when the railway is screened from view of the receiver or enclosed. On this basis, ground-borne noise levels are predicted to comply with the noise trigger levels at all residential and other sensitive receiver locations.

Operational Airborne Noise from Stations and Ancillary Facilities

Airborne noise criteria for the operation of stations and ancillary facilities such as traction substations were determined from the noise measurements undertaken in the surrounding area, in accordance with the procedures outlined in the Industrial Noise Policy.

There are five new traction substations incorporated in the project design. These were modelled at full load during the daytime, evening and night-time periods. Noise levels from the Marrickville traction substation are predicted to exceed the night-time criteria by up to 13 dB given the proximity to the nearest sensitive receiver. An exceedance of up to 5 dB is predicted from the Hurlstone Park substation. The remaining substations are either compliant with the criteria or are predicted to have minor exceedances (up to 1 dB).

These noise levels can be reduced by locating noise emitting components further from sensitive receivers and erecting a noise barrier between the components and the affected sensitive receivers. Acoustic louvres could be included in the design where ventilation is required. With these noise mitigation measures included, compliance with the applicable noise criteria can be achieved. Specific noise mitigation measures for the substations where exceedances are predicted should be considered in the detailed design stage of the project when more details about the equipment and layout are available.

At this stage of the design mechanical plant and PA systems for the train stations have not been selected and consequently the assessment has been limited to determination of applicable noise criteria. Compliance with the criteria should be assessed at the detailed design phase of the project to confirm any mitigation requirements.

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APPENDICES

GLOSSARY

Item	Description / Definition
AADT	Annual Average Daily Traffic (AADT) is the total yearly traffic volume in both directions divided by the number of days in the year
CNS	Construction Noise Strategy
CORTN	Calculation of Road Traffic Noise
DEC	Department of Environment and Conservation (now OEH / EPA)
DECC	Department of Environment and Climate Change (now OEH / EPA)
DECCW	Department of Environment, Climate Change and Water (now OEH / EPA)
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
FEL	Front End Loader
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
Lidar	Light Detection and Ranging
NML	Noise Management Level
NSW	New South Wales
RBL	Rating Background Level
RING	Rail Infrastructure Noise Guideline
RMS	Root Mean Square
RNP	Road Noise Policy
SEAR	Secretary’s Environmental Assessment Requirement
SLR	SLR Consulting Australia Pty Ltd
Sydney Metro CNVS	*Sydney Metro City & Southwest Construction Noise and Vibration Strategy (draft)*
SWL	Sound Power Level
TfNSW	Transport for NSW
TTMP	Temporary Transport Management Plans
TTS	Temporary Transport Strategy

1 INTRODUCTION

1.1 Project Background

The New South Wales (NSW) Government is implementing Sydney's Rail Future (Transport for NSW, 2012a), a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of rail customers into the future.

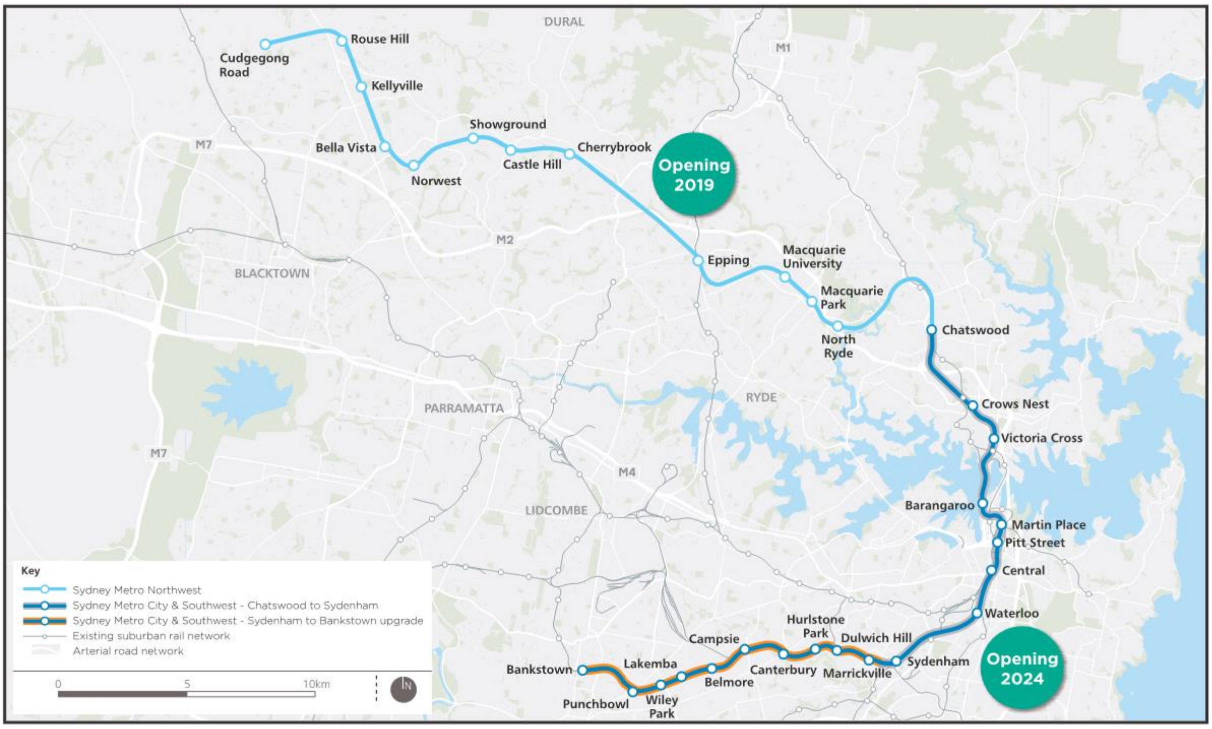
Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*, providing 66 kilometres of metro rail line and 31 metro stations. The NSW Government is currently delivering the first two stages of Sydney Metro, shown in **Figure 1**, which consist of Sydney Metro Northwest (between Rouse Hill and Chatswood) and Sydney Metro City & Southwest (between Chatswood and Bankstown).

Sydney Metro Northwest is currently under construction. Sydney Metro Northwest services will start in the first half of 2019, with a metro train running every four minutes in the peak period. Services will operate between a new station at Cudgegong Road (beyond Rouse Hill) and Chatswood Station. Sydney Metro City & Southwest will extend the Sydney Metro system beyond Chatswood to Bankstown, delivering about 30 kilometres of additional metro rail, a new crossing beneath Sydney Harbour, new railway stations in the lower North Shore and Sydney central business district (CBD), and the upgrade of existing stations from Marrickville to Bankstown. City & Southwest trains would run between Sydenham and Bankstown stations in each direction, at least every four minutes in peak periods, averaging around 15 trains per hour.

Sydney Metro City & Southwest comprises two core components (shown in **Figure 1**):

- The Chatswood to Sydenham project
- The Sydenham to Bankstown upgrade ('the project' and the subject of this document).

Figure 1 The Sydney Metro Network



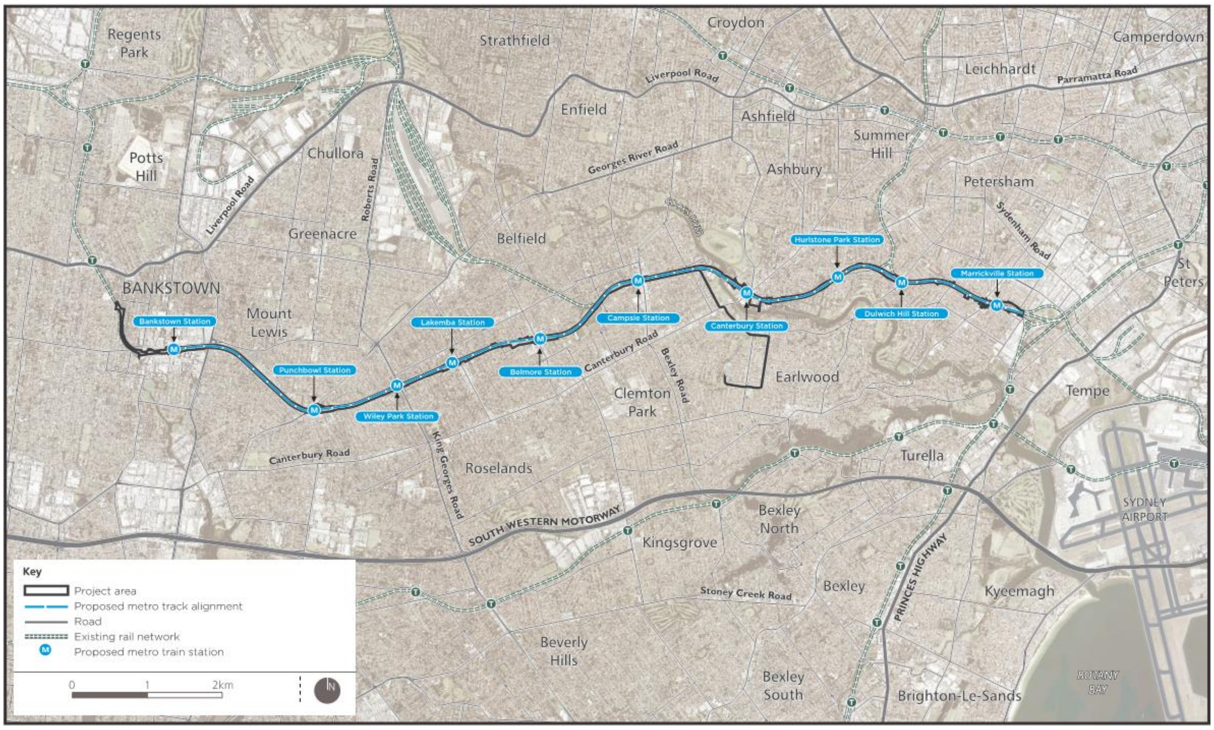
1.2 Overview of the Project

1.2.1 Location

The location of the project is shown in **Figure 2**.

The key elements of the project are located mainly within the existing rail corridor, from about 800 metres west of Sydenham Station in Marrickville, to about one kilometre west of Bankstown Station in Bankstown. The project is located in the Inner West and Canterbury-Bankstown local government areas.

Figure 2 Overview of the project



The term ‘project area’ is used throughout this document to refer to the area where the physical works for the project would be undertaken. This area encompasses the existing rail corridor (as described above), the 10 existing stations within the corridor, and areas surrounding the rail corridor.

A desktop study was undertaken within a corridor extending at least 100 m either side of the project alignment and typically 200 m from the construction compounds to identify the sensitivity of each nearby receiver. This region of investigation constitutes the study area.

1.2.2 Key Features

The key features of the project are summarised below:

Works to Upgrade Access at Stations

The project includes upgrading the 10 stations from Marrickville to Bankstown as required, to meet legislative requirements for accessible public transport, including the requirements of the *Disability Discrimination Act 1992* and the *Disability Standard for Accessible Public Transport 2002*. The proposed works include:

- Works to platforms to address accessibility issues, including levelling and straightening platforms
- New station concourse and station entrance locations, including:
- New stairs and ramps
- New or relocated lifts
- Provision of additional station facilities as required, including signage and canopies.

Works would also be undertaken in the areas around the stations to better integrate with other modes of transport, improve travel paths, and meet statutory accessibility requirements. This would include provision of pedestrian, cyclist, and other transport interchange facilities; as well as works to the public domain, including landscaping.

Works to Convert Stations and the Rail Line to Sydney Metro Standards

Station Works

In addition to the station upgrades, works to meet the standards required for metro services would be carried out, including:

- Installation of platform screen doors
- Provision of operational facilities, such as station services buildings.

Track and Rail System Facility Works

Upgrading the track and rail systems to enable operation of metro services would include:

- Track works where required along the rail corridor, including upgrading tracks and adjusting alignments, between west of Sydenham Station and west of Bankstown Station
- New turnback facilities and track crossovers
- Installing Sydney Metro rail systems and adjusting existing Sydney Trains rail systems
- Overhead wiring adjustments.

Other Works along the Rail Corridor

Other works proposed to support Sydney Metro operations include:

- Upgrading existing bridges and underpasses across the rail corridor
- Installation of security measures, including fencing
- Installation of noise barriers where required
- Modifications to corridor access gates and tracks
- Augmenting the existing power supply, including new traction substations and provision of new feeder cables

- Utility and rail system protection and relocation works
- Drainage works to reduce flooding and manage stormwater.

Active Transport Corridor and Surrounding Development

The project would also provide for:

- Parts of an active transport corridor where located within the station areas or surplus rail corridor land, to facilitate walking and cycling connections to each station and between Marrickville and Bankstown
- Enabling works to support future development at Campsie Station (future development would be subject to a separate approvals process).

Temporary Works During Construction

During construction, the project would involve:

- Provision of temporary facilities to support construction, including construction compounds and work sites
- Implementation of alternative transport arrangements for rail customers during possession periods and/or station closures, guided by the Temporary Transport Strategy.

1.2.3 Timing / Program

1.2.3.1 Construction

Construction of the project would commence once all necessary approvals are obtained (anticipated to be in 2018), and would take about take about six years to complete.

The T3 Bankstown Line would remain operational for the majority of the construction period. However, to ensure the station and infrastructure upgrade works are completed as efficiently and safely as possible, and to accommodate works that cannot be undertaken when trains are operating, it would be necessary to undertake some work during rail possession periods, when trains are not operating. It is anticipated that these rail possession periods would comprise the routine weekend maintenance possessions, together with some longer possession periods during periods of reduced patronage such as school holidays.

A final, longer possession of about three to six months would also be required. This would involve full closure of the line to enable conversion to metro operations. This would include works such as the installation of new signalling, communication systems, and platform screen doors.

During each possession period, alternative transport arrangements would be implemented to ensure that customers can continue to reach their destinations.

1.2.3.2 Operation

Sydney Metro City & Southwest would be fully operational by 2024, with the opportunity of operation commencing in two phases. Initially, Sydney Metro Northwest services would be extended by the City & Southwest project, and would operate from Chatswood Station to Sydenham Station. Some months later, metro operations would extend from Sydenham Station to Bankstown Station, with both phases planned to be completed before the end of 2024. The opportunity for phased opening of the project would enable metro trains to operate from Cudgegong Road Station to Sydenham Station prior to the final conversion of the T3 Bankstown Line to metro operations.

Once the project is operational, Sydney Trains services would no longer operate along the T3 Bankstown Line between Sydenham and Bankstown stations. Customers would be able to interchange with Sydney Trains services at Sydenham and Bankstown stations. Sydney Trains services to and from Bankstown to Liverpool and Lidcombe stations would not be affected.

1.2.4 Operation

The project would have the capacity for trains to run at least every four minutes in the peak, or up to 15 trains per hour, per direction, between Sydenham and Bankstown.

1.3 Purpose and Scope of this Report

The project has been declared State Significant Infrastructure and Critical State Significant Infrastructure and therefore is subject to assessment by the Department of Planning and Environment and approval by the Minister for Planning under Part 5.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

This technical paper is one of a number of technical documents that forms part of the Environmental Impact Statement for the project. The purpose of this technical paper is to identify and assess the noise and vibration impacts of the project during both construction and operation. In doing so it responds directly to the Secretary's environmental assessment requirements outlined in **Section 1.4**.

This technical paper considers the construction and operational noise and vibration impacts on the surrounding noise and vibration sensitive receivers.

The assessment of noise and vibration has included:

- Ambient noise and vibration surveys to determine the existing noise and vibration environment within the surrounding environment of the project.
- Identification of receivers along the alignment and in the vicinity of major construction sites/compounds potentially sensitive to noise and vibration.
- Prediction of noise and vibration from the construction and operation of the metro rail systems, including stations and ancillary facilities.
- Assessment of potential noise and vibration impacts in accordance with relevant legislation and guidelines.
- Identification of management and mitigation measures to reduce and control potential impacts where noise and vibration levels are predicted to be above the relevant assessment criteria.

1.4 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements relating to noise and vibration, and where these requirements are addressed in this technical paper, are outlined in **Table 1**.

Table 1 Secretary's Environmental Assessment Requirements - Noise and Vibration

Secretary's environmental assessment requirements	Where addressed
8. Noise and Vibration - Amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community. 1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise). 2. The EIS must include a framework for both an Out of Hours Works Strategy and the development of an Out of Hours Works Plan which incorporates community consultation.	Applicable guidelines outlined in **Section 3.2, 3.3**, **3.4**, **3.5, 4.2.2, 4.2.3,** and **4.4.1.** Assessment throughout **Sections 3**, and **4**.
9. Noise and Vibration - Structural Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act 1977* during operation of the project are effectively managed. 1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage). 2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Applicable guidelines outlined in **Sections 3.5.2** and **3.6** Assessment throughout **Section 3**

1.5 Relevant Guidelines

Noise from the operation of all rail systems within the study area has been assessed in accordance with guidance provided by the NSW Environment Protection Authority (EPA) in the *Rail Infrastructure Noise Guideline* (RING), NSW EPA, 2013[i].

Noise from mechanical plant at stations and ancillary facilities has been assessed in accordance with the NSW *Industrial Noise Policy* (INP), NSW EPA, 2000[ii], with guidance on sleep disturbance criteria taken from the online Application Notes to the INP.

Construction noise has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG), DECC, 2009[iii]. Construction road traffic noise has been assessed in accordance with the NSW *Road Noise Policy* (RNP), NSW EPA, 2011[iv].

Vibration from operation and construction has been assessed in accordance with *Assessing Vibration: A technical guideline*, DEC, 2006[v].

1.6 Terminology

The assessment has used specific acoustic terminology; an explanation of common terms is included as **Appendix A**.

Consistent with normal rail terminology, track chainages are referenced to 0 km at Central Station. Down and Up directions refer to trains travelling away from and towards Central Station, respectively consistent with standard transport terminology.

When referring to the start and end of a rail alignment in this report, consistent with normal rail terminology, the end of the alignment closest to Central Station (the Marrickville end of the project) is referred to as the 'city-end'. Conversely, the end of the alignment furthest from Central Station (the Bankstown end of the project) is referred to as the 'country-end'.

2 DESCRIPTION OF EXISTING ACOUSTIC ENVIRONMENT

The existing noise environment varies along the length of the project, as would be expected from the wide range of commercial, urban, residential and industrial land uses within the study area (within approximately 100 m on either side of the project alignment and within 200 m of the construction compounds).

2.1 Sensitive Receivers

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, recording studios are more sensitive to noise and vibration than residential premises, which in turn are more sensitive than typical commercial premises.

The sensitivity may also depend on the existing noise and vibration environment. For example, the INP (EPA 2000) and Australian / New Zealand Standard AS/NZS 2107:2000 *'Recommended Design Sound Levels and Reverberation Times for Building Interiors*[vi] (AS 2107) recommend higher acceptable noise levels in urban areas compared with suburban areas. Guidelines produced by the American Public Transit Association (APTA) also nominate higher ground-borne noise goals for multi-family dwellings than for single-family dwellings.

2.2 Sensitive Receiver Categories

The existing and proposed land use within a corridor extending approximately 100 m either side of the project rail alignment and typically 200 m from the construction compounds was reviewed. This information was collated from a combination of site inspections, street-level imagery and review of aerial photography. Each building was classified into one of the following receiver categories:

1. Residential
2. Commercial
3. Industrial
4. Educational
5. Place of Worship
6. Child care
7. Hospital (including hospital wards and operating areas)
8. Special Sensitive (eg areas containing specialist vibration sensitive equipment, such as hospital precision laboratories, recording studios)

The noise and vibration assessment presented in this report considers all residential receivers, educational receivers, places of worship, theatres, etc. to be of a sensitive nature within the study area. Commercial receivers are generally considered to be less sensitive to noise and vibration compared to residential and similar sensitive receivers.

The study area has been divided into multiple Noise Catchment Areas (NCAs). These NCAs reflect the changing land uses and ambient noise environments adjacent to the project. The NCAs and sensitive receivers are illustrated in the site map in **Appendix B** and include all identified sensitive receivers.

A review of potentially noise and vibration sensitive approved developments adjacent the project was performed as part of this assessment for inclusion in the noise and vibration modelling. In addition to the review undertaken as part of this assessment, a detailed investigation of potentially noise and vibration sensitive approved developments adjacent the project should be undertaken during the detailed design stage of the project when more information about potential developments is known.

Developments approved after the date of the approval for this project would be required to consider noise and vibration mitigation for industrial and rail sources at their site through appropriate acoustic design measures, with reference to the internal noise goals defined in the State Environment Planning Policy (Infrastructure) 2007 (ISEPP).

A detailed review of sensitive receiver classifications would be undertaken during the detailed design stage and would focus on the receivers which are most potentially affected by noise and vibration identified in this assessment.

2.3 Ambient Noise Surveys and Monitoring Locations

In order to characterise the existing ambient noise environment across the study area and to establish ambient noise levels on which to base the construction noise management levels and industrial noise intrusiveness criteria, environmental noise monitoring was performed at 23 representative locations during June and July 2016.

Noise monitoring locations were selected based on a detailed inspection of all the potentially affected areas and considering the following:

- Other noise sources which may influence the recordings
- Security issues for the noise monitoring devices
- Gaining permission for access to the location from the resident or landowner.

The “potentially most affected” receiver locations near each construction worksite have been chosen in accordance with the guidelines in Section 3.1.2 of the INP, which is reproduced in part below:

> *“NSW Industrial Noise Policy 3.1.2*
>
> *Most affected location(s) – locations that are most affected (or that will be most affected) by noise from the source under consideration as per Note 2 in Section 2.2.1. In determining these locations, the following need to be considered: existing background levels, noise source location/s, distance from source/s (or proposed source/s) to receiver, and any shielding (for example, building, barrier) between source and receiver. Often several locations will be affected by noise from the development. In these cases, locations that can be considered representative of the various affected areas should be monitored.”*

The monitoring locations are listed in **Table 2** and shown in **Appendix B** and detailed in **Appendix C**.

Table 2 Ambient Noise Monitoring Locations

Location	Address	Location in Study Area	Monitoring Period
B.01	143 Meeks Road Marrickville 2204	Marrickville Sation	21 June 2016 to 30 June 2016
B.02	10 Leofrene Avenue, Marrickville 2204	Marrickville Station	21 June 2016 to 30 June 2016
B.03	18 Randall Street, Marrickville 2204	Marrickville substation	21 June 2016 to 30 June 2016
B.04	15 Bedford Crescent, Dulwich Hill 2203	Dulwich Hill Station	21 June 2016 to 30 June 2016
B.05	36A The Parade, Dulwich Hill 2203	Track upgrades	21 June 2016 to 30 June 2016
B.06	3 Commons Street, Hurlstone Park 2193	Hurlstone Park Station	21 June 2016 to 30 June 2016
B.07	9 Canberra Street, Hurlstone Park 2193	Canterbury substation	21 June 2016 to 30 June 2016
B.08	23 Tincombe Street, Canterbury 2193	Canterbury Station	22 June 2016 to 30 June 2016
B.09	5 South Parade, Canterbury 2193	Track upgrades	22 June 2016 to 30 June 2016
B.10	34 North Parade, Campsie 2194	Campsie Station	21 June 2016 to 30 June 2016
B.11	48 Lilian Street, Campsie 2194	Campsie substation	21 June 2016 to 30 June 2016
B.12	1 Lark Street, Belmore 2192	Track upgrades	22 June 2016 to 30 June 2016

Location	Address	Location in Study Area	Monitoring Period
B.13	10 Acacia Street, Belmore 2192	Belmore Station	22 June 2016 to 30 June 2016
B.14	17 The Boulevarde, Lakemba 2195	Lakemba substation	21 June 2016 to 30 June 2016
B.15	63 The Boulevarde, Lakemba 2195	Lakemba Station	21 June 2016 to 30 June 2016
B.16	66 Railway Parade, Lakemba 2195	Track upgrades	21 June 2016 to 30 June 2016
B.17	5 Shadforth Street, Wiley Park 2195	Wiley Park Station	21 June 2016 to 30 June 2016
B.18	132 The Boulevarde, Wiley Park 2195	Track upgrades	21 June 2016 to 30 June 2016
B.19	42 Urunga Parade, Punchbowl 2196	Punchbowl Station	21 June 2016 to 30 June 2016
B.20	90 South Terrace, Bankstown 2200	Punchbowl substation	22 June 2016 to 30 June 2016
B.21	184 South Terrace, Bankstown 2200	Track upgrades	22 June 2016 to 30 June 2016
B.22	258 South Terrace, Bankstown 2200	Bankstown Station	27 June 2016 to 4 July 2016
B.23	17 Weigand Avenue, Bankstown 2200	Track upgrades	22 June 2016 to 30 June 2016

2.3.1 Methodology for Unattended Noise Monitoring

The purpose of the unattended noise monitoring is to determine the existing L_{Aeq}, L_{A90} and other relevant statistical noise levels during the daytime, evening and night-time periods. These were used to assist in determining the appropriate noise management levels for the construction works for the project.

Unattended noise loggers were deployed adjacent to sensitive receivers over a minimum period of one week in order to measure the prevailing levels of ambient noise. The measurements were generally conducted at a height of 1.5 m above the local ground level.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of Australian Standard AS 1259.2-1990 *'Acoustics - Sound Level Meters. Part 2: Integrating - Averaging*[vii] (AS1259.2) and carried appropriate and current NATA calibration certificates. All noise loggers were fitted with microphone wind shields. The instrumentation utilised for the continuous unattended noise surveys is noted in **Appendix C** along with the unit's make, model, and serial number for each measurement location.

The calibration of the loggers was checked before and after each measurement survey, and the variation in calibration at all locations was found to be within acceptable limits at all times.

All noise loggers were set to record statistical noise descriptors in continuous 15 minute sampling periods for the duration of their deployment.

The results of the noise monitoring have been processed in accordance with the procedures contained in the INP so as to establish representative sensitive receiver background noise levels.

Weather data recorded during the noise monitoring survey periods by the Sydney Bureau of Meteorology (at Canterbury Weather Station) was used to assist in identifying potentially adverse weather conditions, such as excessively windy or rainy periods, so that weather affected data could be discarded.

2.3.2 Unattended Noise Monitoring Results

The results of the unattended ambient noise surveys are presented in **Table 3**, with the 24 hour average noise level plots for each monitoring location being shown graphically in **Appendix C**.

Representative Rating Background Levels (RBL's) and L_{Aeq} (energy averaged) noise levels during the standard daytime, evening and night-time hours, are shown in **Table 3**.

Table 3 Summary of Unattended Noise Monitoring Results

Location	Noise Level (dBA)[1]					
	Daytime 7:00 am to 6:00 pm		Evening[2] 6:00 pm to 10:00 pm		Night-time 10:00 pm to 7:00 am	
	RBL	LAeq	RBL	LAeq	RBL	LAeq
B.01	47	61	45	61	40	58
B.02	38	59	38	58	33	51
B.03	38	57	38 (39)[2]	57	33	53
B.04	41	54	41	55	34	50
B.05	40	57	40	56	33	52
B.06	38	56	38 (39)[2]	53	34	49
B.07	40	53	40	50	35	47
B.08	43	56	43	53	36	49
B.09	36	57	36 (37)[2]	57	32	54
B.10	45	55	42	55	35	54
B.11	44	59	44 (45)[2]	57	40	57
B.12	37	50	37 (40)[2]	48	33	46
B.13	41	49	41	47	35	46
B.14	47	65	47	63	41	60
B.15	50	63	50	64	43	63
B.16	44	56	44	55	36	51
B.17	44	52	44 (46)[2]	51	41	49
B.18	46	65	46 (49)[2]	65	39	61
B.19	47	57	47	54	41	53
B.20	47	65	47 (49)[2]	64	39	60
B.21	53	66	52	66	43	61
B.22	54	64	51	63	42	60
B.23	42	56	42 (43)[2]	55	39	52

Note 1: The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the INP.

Note 2: For assessment purposes, the evening RBL is reduced to equal the lower daytime RBL in accordance with INP application notes. The measured noise level is presented in parenthesis.

2.4 Train Passby Measurements

Train passby noise and vibration measurements were carried out between 16 June 2016 and 4 July 2016 at four locations within the study area.

Noise and/or vibration measurements were undertaken at four locations (OP01 through OP04) representative of the varying rail operations and conditions across the study area. Noise measurement locations are denoted by the '.N1' suffix in the measurement location title while vibration measurement locations are denoted by the '.V1' suffix.

2.4.1 Train Passby Noise Measurement Locations

Train passby noise measurements were undertaken at the locations listed in **Table 4**. Detailed train passby noise measurement methodology is presented in **Appendix D**. A map showing the measurement locations in relation to the surrounding environment is presented in **Appendix B**.

Table 4 Train Passby Measurements - Noise Locations

Reference	Line	Chainage (km)	Measurement Dates	Distance to Near Track (m)	Description
OP01.N1	Goods Line	6.050	27/06/2016 to 04/07/2016	15	Corridor access road boundary between Goods Line and T3 Bankstown Line. Central Corridor reserve.
OP02.N1	T3 Bankstown Line	8.290	24/11/2015 and 27/06/2016 to 04/07/2016	7.5	Corridor access gate at the end of Terrace Lane, Dulwich Hill. Up side of corridor.
OP03.N1	T3 Bankstown Line	11.180	24/11/2015	15	Corridor access road opposite Gould Street, Campsie. Down side of corridor
OP04.N1	Goods Line	12.420	24/11/2015 and 27/06/2016 to 04/07/2016	15	Corridor access road adjacent Loftus Street, Campsie. Up side of corridor

2.4.2 Train Passby Noise Levels

Table 5 presents a summary of the measured noise levels at each location. For each track, the average noise levels (L_{AE} and L_{Amax}) have been determined, along with the 95th percentile L_{Amax} levels recorded during the attended measurements.

Table 5 Summary of Attended Measured Noise Levels

Location	Track	Distance from track centre (m)	Average Speed (km/h)[1]	Average L_{AE} (dBA)[2]	Average L_{Amax} (dBA)	95th Percentile L_{Amax} (dBA)
OP01.N1	Goods Up	19	-	92	80	89
	Goods Down	15	-	100	90	103
OP02.N1	Main Up	19	56	88	79	80
	Main Down	23	54	88	80	85
	Goods Up	10	-	101	91	98
	Goods Down	14	-	97	90	96
OP03.N1	Main Up	19	63	82	73	78
	Main Down	15	59	88	79	83
OP04.N1	Goods Up	15	-	100	88	104
	Goods Down	19	-	95	83	91

Note 1: Passenger train speeds presented for attended monitoring locations.
Note 2: Logarithmic average.

2.4.3 Train Passby Vibration Measurement Locations

Train passby vibration measurements were undertaken at the locations listed in **Table 6**. Detailed train passby vibration measurement methodology is presented in **Appendix D**. A map showing the measurement locations in relation to the surrounding environment is presented in **Appendix B**.

Table 6 Train Passby Measurements - Vibration Locations

Reference	Chainage (km)	Measurement Date	Distance to Near Track (m)
OP2.V1	8.290	27/06/2016	7.5
OP3.V1	11.180	27/06/2016	7.5

2.4.4 Train Passby Vibration Levels

Table 7 presents a summary of the measured vibration levels at each location. For each track, the average vibration levels (L_{eq} and L_{max}) have been determined. The maximum L_{max} levels recorded during the attended measurements are also shown. Maximum results presented in **Table 7** are unweighted slow-response maximum vibration levels.

Table 7 Summary of Measured Vibration Levels

Location	Track	Distance from track centre (m)	Average Speed (km/h)[1]	Average L_{eq} (dB)[2]	Average L_{max} (dB)	Maximum L_{max} (dB)
OP02.V1	Main Up	19	56	91	99	105
	Main Down	23	54	86	91	97
OP03.V1	Main Up	11.5	63	97	104	108
	Main Down	7.5	59	100	106	110

Note 1: Passenger train speeds presented for attended monitoring locations.

Note 2: Logarithmic average.

3 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

3.1 Overview

People are usually more tolerant to noise and vibration during the temporary construction phase of a project than during normal long-term operation. This response results from recognition that the construction emissions are of a temporary nature, especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery which can generate high noise and vibration levels at nearby buildings and receivers. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken, and the character of the noise or vibration emissions.

3.2 List of Applicable Guidelines

All guidelines referenced in this noise and vibration assessment are listed in **Table 8**.

Table 8 Construction Noise and Vibration Guidelines and Policies

Construction Noise and Vibration Guidelines and Policies	
Guideline/Policy Name	**When Guideline is Used**
Interim Construction Noise Guideline, DECC, 2009	Assessment of airborne noise and ground-borne noise impacts on sensitive receivers
NSW Road Noise Policy, EPA, 2011	Assessment of airborne noise from road vehicles on sensitive receivers
Construction Noise Strategy, TfNSW, 2012	Assessment of airborne noise, ground-borne noise and vibration impacts on sensitive receivers
Sydney Metro *Construction Noise and Vibration Strategy,* TfNSW	Assessment and management of potential impacts from the Sydney Metro project (provides procedures).
Assessing Vibration: a technical guideline, DEC, 2006	Assessment of vibration impacts on sensitive receivers
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts on non-heritage sensitive structures (damage)
DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999	Screening assessment of vibration impacts on heritage sensitive structures (damage), if structure is found to be unsound

3.3 Noise Guidelines

This section describes the guidelines used for the assessment of potential noise impacts from on-site works during construction of the project.

3.3.1 Noise Metrics

The three primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{AF1(1minute)}$ The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{AFmax} or maximum noise level.

$L_{Aeq(15minute)}$ The 'energy average noise level' evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{AF90} The 'background noise level' in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the L_{A90} background noise levels.

The subscript 'A' indicates that the noise levels are filtered to match normal hearing characteristics (A-weighted). 'F' indicates the noise signal has been 'Fast' time weighted.

3.3.2 NSW Interim Construction Noise Guideline

The *Interim Construction Noise Guideline* (ICNG) (DECC 2009) sets out ways to assess and manage the impacts of construction noise on residences and other sensitive land uses. It does this by presenting assessment and management approaches that are tailored to the scale of the construction works.

The ICNG requires project specific Noise Management Levels (NMLs) to be established for noise affected receivers. In the event construction noise levels are predicted to be above the NMLs, feasible and reasonable work practices are to be investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed via site specific construction noise management plans, to be prepared in the detailed design phase of the project.

For this project, exceedances of NMLs would also be managed by the procedures contained in the TfNSW Sydney Metro *Construction Noise and Vibration Strategy* (CNVS).

3.3.2.1 Residential Receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at adjacent residential receivers based on measured $L_{A90(15minute)}$ rating background noise levels (RBL), as described in **Table 9**.

Table 9 Determination of NMLs for Residential Receivers

<table>
<tr><th>Time of Day</th><th>NML
$L_{Aeq(15minute)}$</th><th>How to Apply</th></tr>
<tr><td rowspan="2">Standard hours
Monday to Friday
7:00 am to 6:00 pm
Saturday
8:00 am to 1:00 pm
No work on Sundays or public holidays</td><td>RBL + 10 dBA</td><td>• 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 should apply all feasible and reasonable work practises to meet the noise affected level.
• The proponent should 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.</td></tr>
<tr><td>Highly noise affected
75 dBA</td><td>• 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:
o 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.
o If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</td></tr>
<tr><td>Outside recommended standard hours</td><td>RBL + 5 dBA</td><td>• A strong justification would typically be required for works outside the recommended standard hours.
• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.
• Where all feasible and reasonable practises have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.</td></tr>
</table>

Note 1 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW *Industrial Noise Policy*.

3.3.2.2 Sleep Disturbance

The most recent guidance in relation to sleep disturbance is contained in the EPA's *Application Notes – NSW Industrial Noise Policy* (2010). The pertinent section of the Application Notes states the following:

> *"DECC*[W] *reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, DECC*[W] *recognised that current sleep disturbance criterion of an L_{A1}, (1 minute) not exceeding the L_{A90}, (15 minute) by more than 15 dBA is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DECC*[W] *will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*

The detailed analysis should cover the maximum noise level or L_{A1}, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- *How often high noise events will occur*
- *Time of day (normally between 10pm and 7am)*
- *Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods)*
- *The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under "fast" time response. DECC[W] will accept analysis based on either LA1, (1 minute) or LAmax".*

Where construction is required to be undertaken during the night-time period the potential for sleep disturbance should be assessed. The current approach to identifying potential sleep disturbance impacts is to set a screening criterion 15 dB above the RBL during the night-time period (10.00 pm to 7.00 am).

The term 'screening criterion' indicates a noise level that is intended as a guide to identify the likelihood of sleep disturbance. It is not a firm criterion to be met, however where the criterion is met sleep disturbance is considered to be unlikely. When the screening criterion is not met, a more detailed analysis is required.

The detailed analysis should assess the maximum noise level or $L_{AF1(1minute)}$, the extent that the maximum noise level exceeds the background noise level and the number of times any exceedance occurs during the night-time period.

3.3.2.3 Commercial and Industrial Premises

The ICNG notes that due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories:

- Industrial premises: external $L_{Aeq(15minute)}$ 75 dBA
- Offices, retail outlets: external $L_{Aeq(15minute)}$ 70 dBA
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

The external noise levels should be assessed at the most-affected occupied point of the premises.

3.3.2.4 Other Sensitive Land Uses

The ICNG's quantitative assessment method provides NMLs for other sensitive land uses, such as educational institutes, hospitals, medical facilities and outdoor recreational areas. These land uses are considered potentially sensitive to construction noise only when the properties are in use.

The ICNG does not however provide an NML for all classifications of sensitive land use. Where sensitive land uses with no classification are identified within a construction noise catchment, the following guidance is given:

The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels (Standards Australia 2000).

The project specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in **Table 10**.

Table 10 NMLs for Other Sensitive Receivers

Land Use	NML $L_{Aeq(15minute)}$ (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operating 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
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses.

For sensitive receivers such as schools and places of worship, the NMLs presented in **Table 10** are based on internal noise levels. For the purpose of this assessment, it is conservatively assumed that all schools and places of worship have openable windows. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external NML of 55 dBA $L_{Aeq(15minute)}$ has been adopted.

Other noise-sensitive receivers require separate project specific noise goals and, as per the guidance in the ICNG, NMLs for these receivers have been derived from the internal levels presented in AS 2107.

The ICNG and AS2107 do not provide specific guideline noise levels for childcare centres. Childcare centres generally have internal play areas and sleeping areas. For these areas, an internal NML of 55 dBA $L_{Aeq(15minute)}$ has been adopted together with an internal NML of 40 dBA $L_{Aeq(15minute)}$ (when in use) for sleeping areas.

On the assumption that windows and doors of childcare centres may be opened, an external NML of 65 dBA $L_{Aeq(15minute)}$ for play areas has been applied at the facade and would also be applicable to external play areas. For sleeping areas on the assumption that windows are open, the external NML is 50 dBA $L_{Aeq(15minute)}$.

3.3.3 NML Summary

Using the measured background noise levels in **Table 3**, the NMLs derived for the project are detailed in **Table 11**.

The noise monitoring locations were selected to capture background noise levels at the typically most affected receiver locations in the various catchments along the alignment. The most affected receivers are usually front row receivers which have a direct line of sight to the construction works.

Whilst background noise levels may reduce for receivers which are further back from the construction works (and nearby roads), the construction noise predictions are likely to drop off at a quicker rate meaning the level of impact would be lower than the most affected 'front row' receivers.

Table 11 Residential Receiver NMLs for Construction

NCA	Logger ID	Receiver Type	Standard Construction (RBL+10dB)	Out of Hours (RBL+5dBA)			Sleep Disturbance Screening (RBL+15)
			Daytime	Daytime	Evening	Night-time	
NCA01	B.04	Residential	48	43	43	38	48
NCA02	B.05	Residential	48	43	43	38	48
NCA03	B.06	Residential	48	43	43	39	49
NCA04	B.07	Residential	50	45	45	40	50
NCA05	B.09	Residential	46	41	41	37	47
NCA06	B.10	Residential	55	50	47	40	50
NCA07	B.13	Residential	51	46	46	40	50
NCA08	B.14	Residential	57	52	52	46	56
NCA09	B.16	Residential	54	49	49	41	51
NCA10	B.19	Residential	57	52	52	46	56
NCA11	B.20	Residential	57	52	52	44	54
NCA12	B.22	Residential	64	59	56	47	57
NCA13	B.23	Residential	52	47	47	44	54

Residential NMLs detailed in **Table 11** are also applicable for aged care facilities within the project area.

3.4 Construction Road Traffic Noise Guidelines

When trucks and other vehicles are operating within the boundaries of construction sites, road vehicle noise contributions are included in the predicted $L_{Aeq(15minute)}$ noise emissions and assessed against the ICNG criteria in **Section 3.3.2**.

When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements are regarded as 'additional road traffic' rather than as part of the works and as such would be assessed under the NSW EPA *Road Noise Policy* (RNP).

As required by the RNP, an initial screening test should first be applied by evaluating whether noise levels would increase by more than 2 dB (an increase in the number vehicles of approximately 60%) due to construction traffic or a temporary reroute due to a road closure. Where increases are 2 dB or less then no further assessment is required.

Where noise levels increase by more than 2 dB (ie 2.1 dB or greater) further assessment is required using criteria presented in the RNP (refer to **Table 12**).

Table 12 RNP Criteria for Assessing Construction Vehicles on Public Roads

Road Category	Type of Project/Land Use	Assessment Criteria (dB)	
		Daytime (7 am - 10 pm)	**Night-time (10 pm - 7 am)**
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Temporary additional road traffic associated with the project generally falls into two categories:

- Construction related traffic – This includes heavy vehicle movements to/from the construction compounds transporting construction materials and spoil along defined haulage routes, as well as personal vehicles of construction personnel travelling to/from the construction compounds.
- Temporary Transport Strategy (TTS) and associated Temporary Transport Management Plan (TTMP) scenarios – During periods of extended track possession associated with construction works, train replacement bus services would be required. This would introduce additional heavy vehicles (buses) onto the public road network during these periods. More information on the TTS and TTMPs can be found in Appendix G of the EIS.

It is appropriate to assess the noise impacts from each of the temporary construction road traffic categories individually, as these may occur during separate periods of construction works, and to also differentiate between predicted noise impacts from each of the road traffic noise sources. A cumulative noise assessment should also be undertaken to identify the potential impacts where these vehicle movements occur concurrently in the same location.

3.5 Vibration Guidelines

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be compromised.

3.5.1 Human Comfort Vibration

The EPAs *'Assessing Vibration: a technical guideline'* (DEC, 2006) recommends the use of BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

British Standard BS 6472-1992 *'Guide to evaluation of human exposure to vibration in buildings'* nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants.

BS 6472 provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose value is dependent on the level and duration of the short-term vibration event, as well as the number of events occurring during the daytime or night-time period.

The vibration dose values recommended in BS 6472 for which various levels of adverse comment from occupants may be expected are presented in **Table 13**.

Table 13 Vibration Dose Value Ranges which Might Result in Various Probabilities of Adverse Comment within Residential Buildings

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hr day.

3.5.2 Structural Damage Vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of cosmetic damage such as surface cracks, and are set well below the levels that have potential to cause structural damage. Cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

In terms of the most recent relevant vibration damage goals, AS 2187: Part 2-2006 *'Explosives - Storage and Use – Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in British Standard BS 7385 Part 2-1993 *'Evaluation and measurement for vibration in buildings Part 2* as they "are applicable to Australian conditions".

These Standards (AS2187 / BS7385) set guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

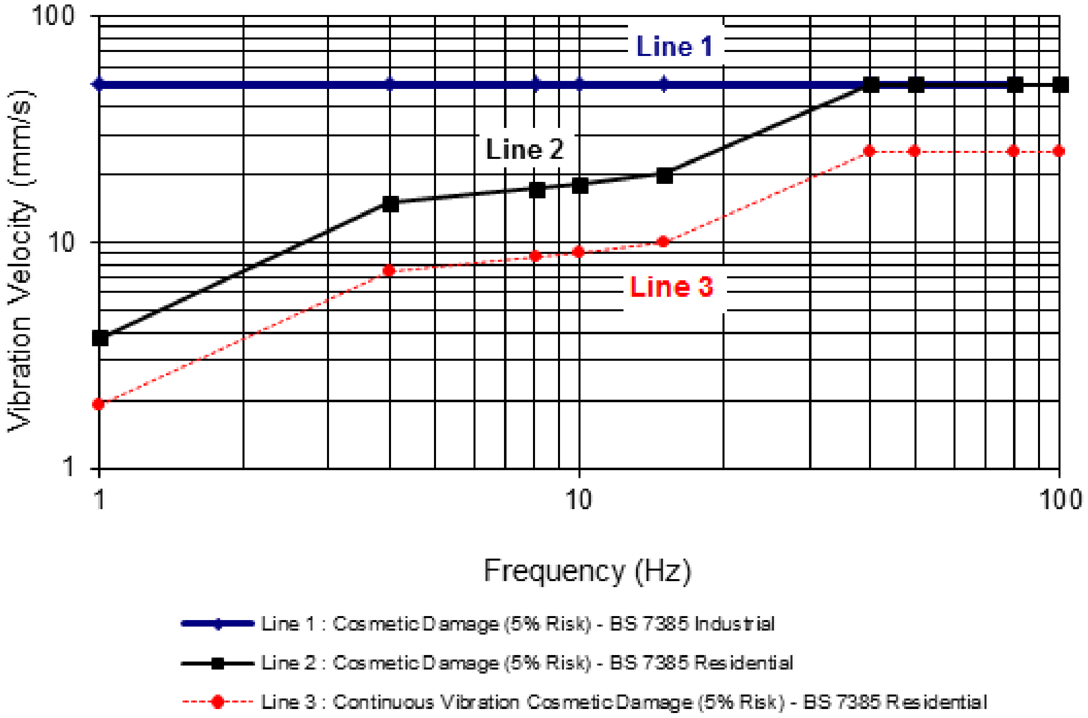
Cosmetic Damage Vibration

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in **Table 14** and **Figure 3**.

Table 14 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 3 Graph of Transient Vibration Guide Values for Cosmetic Damage



AS 2187 goes on to state that cosmetic damage is possible at vibration magnitudes which are greater than twice those given in **Table 14**, and damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in AS 2187 and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials), then the guide values in **Table 14** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the guidance curves presented in **Figure 3**.

It is noteworthy that extra to the guide values nominated in **Table 14**, the British Standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

3.6 General Vibration Screening Criterion

The Standard states that the guide values in **Table 14** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the 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 **Table 14** may need to be reduced by up to 50%.

Rockbreaking / hammering activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it is therefore appropriate to reduce the transient values by 50%.

For construction activities involving intermittent vibration sources such as rockbreakers, piling rigs, vibratory rollers and excavators, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

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

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity) monitoring should be performed during construction. At these locations a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be undertaken to determine the applicable safe vibration level.

3.6.1 Heritage

Heritage buildings are to be considered on a case by case bases, as a heritage listed structure may not (unless it is structurally unsound) be assumed to be more sensitive to vibration resulting in application of the 7.5 mm/s screening criterion. Where a historic building is deemed to be sensitive to damage from vibration (following inspection), more conservative superficial cosmetic damage criterion of 2.5 mm/s peak component particle velocity (from DIN 4150) should be considered.

No Aboriginal places or environmental heritage sites have been identified within the study area and are therefore not considered further in this assessment.

3.6.2 Sensitive Scientific and Medical Equipment

Some scientific equipment (eg electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use inside the premises of an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument should be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon - 28 September 1999) may be adopted as vibration goals. These generic VC curves are presented below in **Table 15** and **Figure 4**.

Table 15 Application and Interpretation of the Generic Vibration Criterion (VC) Curves (as shown in Figure 4)

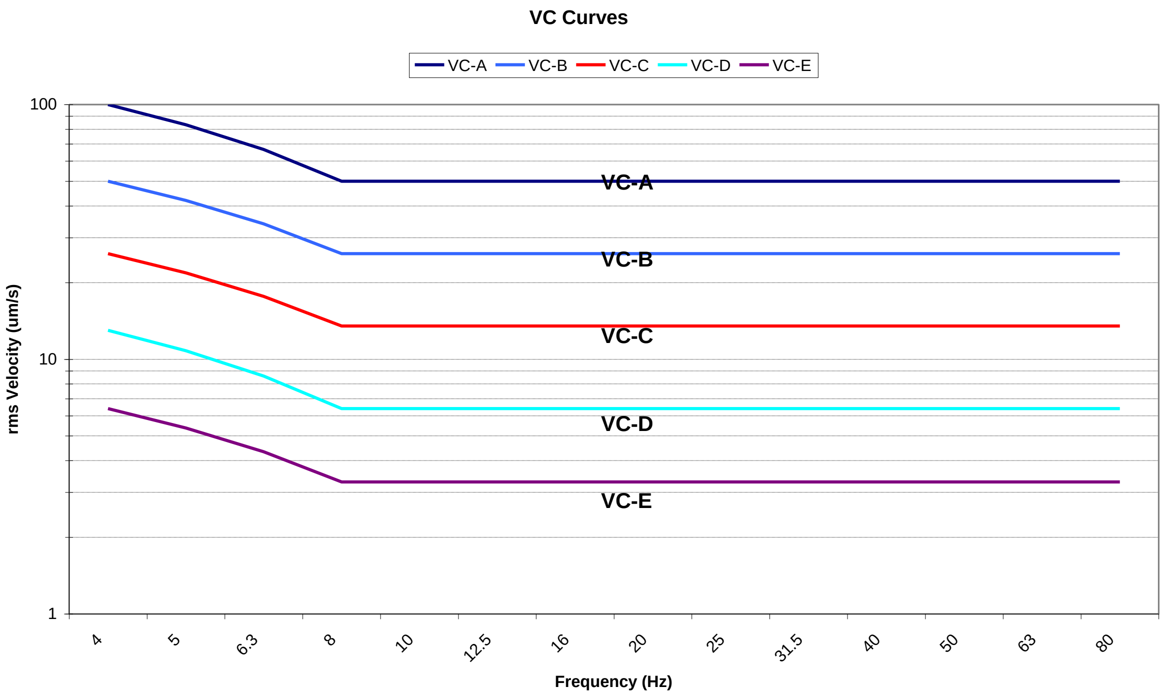
Criterion Curve	Max Level (µm/sec, rms)[1]	Detail Size (microns)[2]	Description of Use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.

Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation requirements of many items depend upon the detail size of the process.

Note 3: See Table 46 of Chapter 47 from ASHRAE Sound and Vibration Control Manual for additional equipment items with respect to the VC curves

Figure 4 Vibration Criterion (VC) Curves



3.6.3 Utilities and Other Vibration Sensitive Structures

Where structures and utilities are encountered which may be considered to be particularly sensitive to vibration, a vibration goal which is more stringent than structural damage goals presented in **Section 3.6** may need to be adopted. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables

Specific vibration goals should be determined on a case-by-case basis by an acoustic consultant. The acoustic consultant would be engaged by the construction contractor and would liaise with the structure or utility's owner in order to determine acceptable vibration levels.

3.7 Works Description

3.7.1 Construction Activities

The activities likely to be required to construct the project involve conventional rail infrastructure construction equipment such as rockbreakers, earth moving equipment, concreting equipment, paving plant, and cranes.

Construction noise and vibration emissions have been assessed for each of the major worksites and proposed construction phases (including site establishment and construction). For each worksite and construction phase, a noise and vibration modelling scenario was developed to assist in calculating the likely noise and vibration levels. These scenarios were developed in consultation with the Sydney Metro Constructability Team and are considered representative of the typical worst case impacts.

Table 16 outlines the construction scenarios and corresponding activities, as well as noting the periods that the various works would be required to be completed in. The anticipated durations of activities are also summarised, noting that the activities are intermittent during this period and would not be expected to be undertaken every day during the scheduled activity.

Table 16 Construction Activities and Period of Operation

Scenario[1]	Works ID	Total Indicative Duration (Weeks)[2]	Activity	Hours of Works[3]				
				Std. Day	Possession / Closedown Works			
					Day	Day OOH[4]	Eve	Night
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-
	W.0003	6	Piling	✓	✓	-	-	-
	W.0004	4	Site Establishment	✓	✓	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓

Scenario[1]	Works ID	Total Indicative Duration (Weeks)[2]	Activity	Hours of Works[3]				
				Std. Day	Possession / Closedown Works			
					Day	Day OOH[4]	Eve	Night
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓
	W.0019	2	Demolition	✓	✓	✓	✓	✓
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-

Note 1: Certain worksites are also major construction compounds. Compounds are referenced further in **Section 3.11.**

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. There would be sites within each category that require works to be shorter or longer than shown.

Note 3: Intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns – refer to **Section 3.7.2** for a discussion of working hours.

Note 4: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The worksites in the above table have been categorised by the main activity that is likely to occur within each site. Many construction worksites would however likely have more than one usage during the project timeline.

While the sequence of works activities performed at a given worksite would generally be undertaken in the order of works scenarios and activities listed above, it is anticipated that works performed across the project would involve the performance of several different activities across several worksites concurrently. More information on works scheduling is provided in **Section 3.7.3**.

It is also noted that works would be required at times throughout the length of the project corridor and not just within the worksites nominated above. The Corridor Works scenario in the above table represents typical works which could occur within the rail corridor. The study area is illustrated on the site map in **Appendix B**.

Construction works undertaken during rail possessions would generally be performed over the course of a few days or weeks at a time. Each rail possession would normally be separated by several months such that construction activities scheduled to be undertaken during possessions would be undertaken in stages with the total works duration spread across several possessions. More information on possession works is provided in **Section 3.7.4**.

The station upgrade works would take around two years for each station (depending on the extent of works required) with the exception of Campsie Station where works would be over a three year period. Minor works at stations would also happen outside this period. Site establishment activities would initially be required at all construction sites as described in Chapter 8 of the EIS. These works would predominantly be undertaken during the standard daytime construction hours. Construction site hoardings would be erected as noise barriers as part of this stage.

3.7.1.1 Bridge Works

A total of 17 overbridges, three footbridges/walkways and seven underbridge structures that support the rail tracks over roadways and waterways are located within the project area. The project would require works to all of these structures, however the level of works required on each structure would vary.

The following assumptions have been adopted regarding the bridge works construction process:

- No bridges would require greater than eight months of closures.
- Closure of multiple bridges within close proximity to each other would not occur simultaneously.
- Bridge works undertaken at or adjacent to stations during possessions, would be undertaken to avoid interaction with the refined baseline TTP bus routes.

Sydenham to Belmore

- Works would occur during ARTC shut down periods, where a possession is required to complete the works and therefore would not occur during school holiday periods.
- Bridge works requiring continuous shut down periods not exceeding two days would only occur during weekend and night works.
- All works to bridges that do not carry motorised traffic (such as pedestrian or rail overbridges) are not expected to impact the road network.
- Bridges directly adjacent to each other cannot be programmed for upgrade at the same time.

Belmore to Bankstown

- Bridge works undertaken at or adjacent to stations during possessions, would be undertaken to avoid interaction with the refined baseline TTP bus routes.
- For works on all of the bridges between Belmore and Bankstown, with the exception of Punchbowl Road overbridge and Chapel Road overbridge, it has been assumed that these works would continue for six to eight months, with two weeks of half or full road closures and the remaining construction occurring during weekends/nights.
- Punchbowl Road Overbridge and Chapel Road Overbridge are assumed to have no effect on traffic as no lane closures would be required.
- Bridges directly adjacent to each other cannot be programmed for upgrade at the same time.

3.7.2 Working Hours

Construction works would typically be undertaken during the recommended standard daytime construction hours defined in the ICNG as:

- 7.00 am and 6.00 pm Monday to Friday
- 8.00 am and 1.00 pm on Saturdays.

However, as the project is located within an active rail corridor, works outside of the recommended standard construction hours would also be required where works cannot safely be undertaken during standard construction hours due to their proximity to the existing rail lines or where there would be a risk that the works may adversely affect the existing operating lines.

Other works which may be undertaken outside of recommended standard construction hours without any further approval may include:

- The delivery of materials outside of approved hours as required by the Police or other authorities (including Roads and Maritime Services) for safety reasons
- Where it is required to avoid the loss of lives, property and/or to prevent environmental harm in an emergency.

With the exception of emergency works, activities would not take place outside the recommended standard hours without prior discussion with the relevant government authorities.

3.7.2.1 Rockbreaking and Other Highly Noise Intensive Works

Several construction sites are proposed to include activities which would be undertaken on a 24 hour per day basis during possession periods. At these sites, high noise activities such as use of rockbreakers would mainly be undertaken during the recommended standard daytime construction hours of 7 am to 6 pm (with occasional works being required in the evening between 6 pm to 10 pm). At no location would rockbreakers be used for more than two weeks total duration in one area.

Whilst the potential impacts from the project during night-time periods would be limited by restricting the use of noise intensive plant items such as rockbreakers, concrete saws, and ballast tampers to daytime and evening periods, there may however be occasional circumstances which may require the use of noise intensive plant items during night-time works. This would however be expected to happen infrequently.

It is acknowledged that due to operational and safety restrictions, ballast tamping works are commonly performed during the night-time period as part of routine rail possessions across the rail network. The noise impacts from ballast tamping activities associated with this project would be similar to those generated elsewhere on the suburban rail network.

3.7.3 Works Schedule

Subject to planning approval, construction of the project is planned to commence in 2018, with completion planned for 2024 (including commissioning). The total duration of construction works is expected to be around six years. An indicative construction program is shown in **Table 17**.

Table 17 Indicative Construction Program

Construction activity	2018				2019				2020				2021				2022				2023				2024			
Enabling works			■	■	■	■	■	■	■	■	■	■	■	■	■	■												
Platform demolition/ reconstruction												■	■	■	■	■	■	■	■	■	■	■	■	■				
Concourse/ station area works				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Track and overhead wiring works				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
Bridge works (where required)				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
Services buildings			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Traction power			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Line-wide metro system installation															■	■	■	■	■	■	■	■	■	■	■	■	■	■
Testing and commissioning															■	■	■	■	■	■	■	■	■	■	■	■	■	■
Final Conversion to Sydney Metro																												■

From the above it can be seen that works performed across the project would involve undertaking several different activities. These works would be performed across several worksites across the project area and would often be undertaken during possessions. Works activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity.

The requirement for works to be undertaken in possession periods means that the construction methodology is required to be planned around these periods and conducted in stages. The staging of the project and final construction methodology would be further developed with Sydney Trains in the contract procurement phase, and during detailed design development, with the view to minimising disruption to the community. More information on possession works is presented in **Section 3.7.4**.

Further information on the timing and duration of possessions is provided in the EIS (refer to Chapter 9 Project Description – construction).

3.7.4 Possessions/Closedown Periods Required for Construction

The Sydney Trains and ARTC rail networks would remain operational during the majority of the construction period. However, some construction activities, such as major station works, major earthworks and bridge works, would need to be undertaken during rail possession periods (when trains are not running) to remove the risk of affecting operations and risk to rail worker safety, during which time the construction works would be undertaken on a 24/7 basis.

Due to the scale of the project, the standard Sydney Trains maintenance possessions of four weekend possessions per year would not be sufficient. Longer possessions, tailored to facilitate the works, would be required. This would involve closing only those portions of the line necessary to carry out works, but noting that, to facilitate alternative train and bus operational requirements, it would be necessary for possessions to extend beyond Marrickville and Bankstown stations.

The outline of potential rail possessions provided below would be further investigated with relevant stakeholders and confirmed following the appointment of a construction contractor, with a view to minimising impacts on the community.

Standard Possessions

Possessions of the rail line would occur on weekends on four occasions over a calendar year.

School Holiday Possessions

This would involve possessions of the Bankstown Line during each of the December/January school holiday periods, including Christmas and New Year between 2019 and 2024, and two-week school holiday possession of the Bankstown Line in July of each year. Opportunities to minimise the number of such school holiday possessions would be investigated.

Timing construction-phase rail possessions to coincide with school holiday periods is proposed because there is:

- Lower patronage on the Sydney Trains network due to the absence of school children and number of parents on leave during these periods
- Reduced inconvenience for school children and parents
- Less traffic on the surrounding network due to the removal of school traffic, which benefits the operation of rail replacement bus services
- Increased availability of buses and drivers for rail replacement services as buses usually used for school routes would be available for use
- Greater available capacity on other lines to accommodate customers who would normally travel on the Bankstown Line.

Final Possession

This would involve a final possession period of about three to six months' duration at the end of the construction phase. This possession would be required for those works that could only be completed once the Sydney Trains service has ceased operating, in addition to Sydney Metro train testing, system integration and final commissioning works. The duration of the final possession would be made as short as possible, although it is dependent on achieving a safe technical solution to bringing Sydney Metro trains into service.

General

Further information on the timing and duration of possessions is provided in the EIS (refer to Chapter 9 Project Description - construction), as well as in community consultation material, which is expected to be released mid-2017.

It is noted that noise generating works outside of the ICNG recommended standard daytime construction hours would only be undertaken during rail possessions/closedowns and that detailed Construction Noise and Vibration Impact Statements (CNVIS) would be produced for each proposed possession/closedown to determine the potential noise levels, define a mitigation strategy, and to ensure that all feasible and reasonable mitigation measures are applied to minimise the potential impacts as far as practicable.

Activities listed in **Table 18** below are anticipated to be required to be perfomed out of hours during possessions/closedowns.

Table 18 Summary of Anticipated Out of Hours Works

Activity	Construction Hours	Justification for Out-of-Hours Activities
Station Works	Works would be undertaken during standard construction hours where possible, however, works would be required to occur during daytime, evening and night-time periods during possessions and closedowns.	Works cannot be undertaken safely due to proximity to operational rail tracks
Major Earthworks		
Bridge Works		

3.8 Overview of Construction Noise Modelling

3.8.1 Source Location

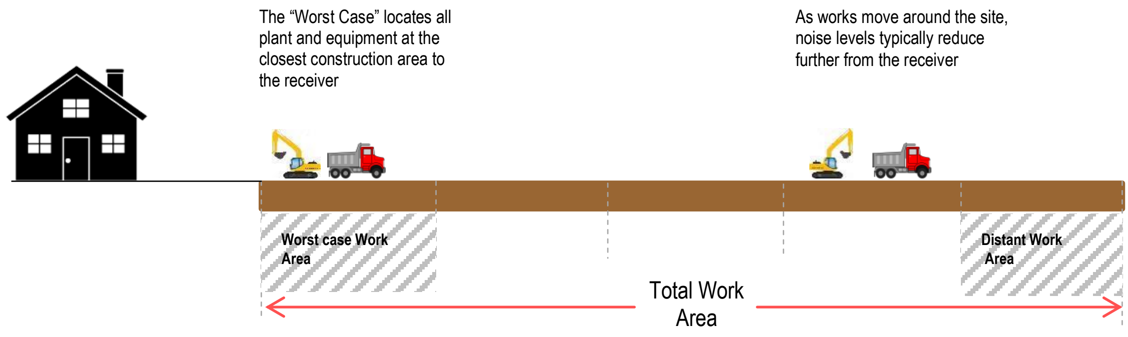
Consistent with the requirements of the ICNG, this assessment provides a 'realistic worst case' noise impact assessment based on the required construction works within a 15-minute period. This is typically associated with works located nearest to a particular receiver.

In reality, the potential construction noise impacts at any particular location can vary greatly depending on factors including the following:

- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The intensity of the noise levels
- The time at which the works are undertaken
- The character of the noise.

Noise levels at sensitive receivers can also be significantly lower than the worst case scenario when the construction works move to a more distant location in a works area. This concept is shown in **Figure 5**.

Figure 5 Illustration of Works Areas



The above figure illustrates that when works move away from a receiver the noise levels from the operation of the construction equipment would reduce accordingly. To account for this, the noise impacts from the project have been modelled using a number of area sources within the construction boundary footprint. The area sources have been sized to be representative of construction works as typically undertaken on large infrastructure projects. This modelling approach accounts for the density of construction plant for a given work activity, and the variability in positioning of the plant items within the construction boundary footprint.

The location of the works extents in relation to the surrounding sensitive receivers is presented in the construction area figures per precinct in **Section 3.11**.

3.8.2 Calculation Type

To quantify noise levels from the construction activities a computer noise prediction model using the ISO 9613 algorithms was developed using SoundPLAN software.

Local terrain, receiver buildings and structures have been digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding environment. In accordance with the ICNG, noise levels are predicted at all receivers in the catchment areas surrounding the works.

3.8.3 Construction Activity Source Noise Levels

Sound power levels for the typical operation of construction equipment applied in the modelling are listed in **Table 19**. These noise levels have been taken from verified test data and global standards that form part of SLR's noise database.

Table 19 Construction Works and Sound Power Levels for Construction Equipment

		Plant Item	Back Hoe	Ballast Tamper	Bobcat	Compressor	Concrete Pump	Concrete Truck / Agitator	Diamond Saw[1]	Excavator	Excavator (Breaker)[1]	Franna Crane	Front End Loader	Generator	Hand Tools	Mobile Crane (300 tonne)	Mobile Crane (50 tonne)	Piling Rig (Bored)	Roller (non-vibratory)[1]	Scissor Lift	Semi Trailer	Truck	Water Tanker	Welding Equipment
		Sound Power Level (L_{Aeq})	102	118	104	95	106	106	115	109	121	99	104	101	94	104	100	108	100	92	106	103	98	97
		Assumed On-time in 15 Minute Period (Minutes)	15	7.5	15	15	7.5	7.5	7.5	15	7.5	15	15	15	15	15	15	7.5	15	15	5	7.5	15	15
		SWL Max	111	126	110	97	109	112	123	115	124	107	111	104	100	110	106	118	108	102	112	108	103	100
Works ID	**Scenario**	**Activity**																						
W.0001	General Worksites	Earthworks								X		X										X		
W.0002		Earthworks - Breaker									X													
W.0003		Piling					X	X									X	X						
W.0004		Site Establishment										X					X		X			X	X	
W.0005		Operations										X										X		
W.0006	Corridor Works - Ground & Track	Earthworks								X		X										X		
W.0007		Earthworks - Breaker									X													
W.0008		Trackform			X											X						X		
W.0009		Trackform - Ballast Tamper		X																				
W.0010	Corridor Works - Track Support Systems	OHW Modifications			X										X		X			X				
W.0011		Comms & Signalling Works	X											X	X									X
W.0012		Segregation Fencing										X			X							X		

		Plant Item	Back Hoe	Ballast Tamper	Bobcat	Compressor	Concrete Pump	Concrete Truck / Agitator	Diamond Saw[1]	Excavator	Excavator (Breaker)[1]	Franna Crane	Front End Loader	Generator	Hand Tools	Mobile Crane (300 tonne)	Mobile Crane (50 tonne)	Piling Rig (Bored)	Roller (non-vibratory)[1]	Scissor Lift	Semi Trailer	Truck	Water Tanker	Welding Equipment
		Sound Power Level (L_{Aeq})	102	118	104	95	106	106	115	109	121	99	104	101	94	104	100	108	100	92	106	103	98	97
		Assumed On-time in 15 Minute Period (Minutes)	15	7.5	15	15	7.5	7.5	7.5	15	7.5	15	15	15	15	15	15	7.5	15	15	5	7.5	15	15
		SWL Max	111	126	110	97	109	112	123	115	124	107	111	104	100	110	106	118	108	102	112	108	103	100
W.0013	Station Worksites	Site Establishment										X					X		X			X		
W.0014		Demolition				X				X				X	X									
W.0015		Demolition - Breaker & Saw							X		X													
W.0016		Concrete & Structural Works					X	X									X					X		
W.0017		Station Installation & Fitout										X		X	X		X					X		
W.0018	Bridge Worksites	Site Estab. & Impact Protection					X	X				X					X		X			X	X	
W.0019		Demolition				X						X		X	X		X					X		
W.0020		Demolition - Breaker & Saw							X		X													
W.0021		Construction & Installation										X					X					X		
W.0022	Substation Worksites	Site Establishment					X	X				X					X		X			X		
W.0023		Construction & Installation										X					X					X		

Note 1: The ICNG requires that activities identified as particularly annoying (such as jackhammering, rock breaking and power saw operation) have a 5 dB ‘penalty’ added to predicted noise levels when using the quantitative method.

3.9 Early Opportunities for Noise Benefit

The construction works include a number of opportunities to achieve a noise benefit from the use of the following standard construction features:

- **Site hoarding** – for construction concentrated in a single area, such as at the station sites, temporary acoustic hoarding/barriers around the site perimeter should be considered where feasible and reasonable to mitigate construction noise levels at the adjacent receivers. On this basis, 3 m high fencing surrounding the station compounds of solid construction (as opposed to standard wire mesh fence) has been included in the assessment and has been shown on the precinct figures in the following sections.
- **Bored piling** – the construction activities assume that piling works would be undertaken using bored piles, as opposed to impact pilling, where possible. Bored pilling is significantly less noise intensive than impact pilling.

As these features form part of the construction works, these are included in the assessment prior to consideration of additional mitigation.

3.10 Predicted Noise Levels – Project Overview

A summary of the predicted noise levels (without additional mitigation) in each of the NCAs for the various work activities is presented in **Table 20**. The noise levels are representative of the realistic worst case impacts where works are at their closest and are intended to give an overview of the likely realistic worst case noise levels from the construction works.

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver, as the noise levels presented in this report are based on a realistic worst-case assessment. The typical variation in construction noise levels is described in more detail in **Section 3.8.1**.

Further description on construction activity timing, durations, and noise impacts is presented in Section **3.11** on a project precinct level. Refer to **Appendix E** for noise contours showing the worst-case noise predictions for all scenarios during the daytime and night-time.

Table 20 Predicted Worst case Noise Levels from Project - All Works and All NCAs (cell coloring refers to exceedance category, refer to table note 1)

Precinct	NCA	NML	Predicted Worst-case $L_{Aeq(15minute)}$ Noise Level (dBA)[1]																						
			General Worksites					Corridor Works - Ground & Track				Corridor Works - Track Support			Station Worksites					Bridge Worksites				Substation Worksites	
			W.0001 - Earthworks	W.0002 - Earthworks - Breaker	W.0003 - Piling	W.0004 - Site Establishment	W.0005 - Operations	W.0006 - Earthworks	W.0007 - Earthworks - Breaker	W.0008 - Trackform	W.0009 - Trackform - Ballast Tamper	W.0010 - OHW Modifications	W.0011 - Comms & Signalling Works	W.0012 - Segregation Fencing	W.0013 - Site Establishment	W.0014 - Demolition	W.0015 - Demolition - Breaker & Saw	W.0016 - Concrete & Structural	W.0017 - Station Installation & Fitout	W.0018 - Site Esta & Imp. Protec.	W.0019 - Demolition	W.0020 - Demolition - Breaker & Saw	W.0021 - Construction & Installation	W.0022 - Site Establishment	W.0023 - Construction & Installation
Residential – Standard Daytime																									
Marrickville	NCA01	48	76	84	75	72	69	77	85	75	82	76	76	73	68	72	81	70	68	74	72	84	69	53	48
Dulwich Hill	NCA02	48	80	88	79	76	73	78	86	76	83	76	76	73	70	74	83	72	70	79	77	89	74	78	73
Hurlstone Park	NCA03	48	80	88	79	76	73	80	88	78	85	76	76	73	63	67	76	65	63	78	76	88	73	65	60
Canterbury	NCA04	50	58	66	57	54	51	78	86	76	83	74	74	71	67	71	80	69	67	75	73	85	70	69	64
	NCA05	46	70	78	69	66	63	70	78	68	75	71	71	68	46	50	59	48	46	74	72	84	69	38	33
Campsie	NCA06	55	76	84	75	72	69	79	87	77	84	75	75	72	65	69	78	67	65	78	76	88	73	67	62
Belmore	NCA07	51	76	84	75	72	69	73	81	71	78	72	72	69	73	77	86	75	73	72	70	82	67	48	43
Lakemba	NCA08	57	61	69	60	57	54	70	78	68	75	69	69	66	68	72	81	70	68	70	68	80	65	71	66
Wiley Park	NCA09	54	45	53	44	41	38	77	85	75	82	73	73	70	73	77	86	75	73	43	41	53	38	41	36
Punchbowl	NCA10	57	60	68	59	56	53	71	79	69	76	68	68	65	62	66	75	64	62	41	39	51	36	56	51
Bankstown	NCA11	57	68	76	67	64	61	76	84	74	81	73	73	70	49	53	62	51	49	75	73	85	70	71	66
	NCA12	64	72	80	71	68	65	72	80	70	77	68	68	65	66	70	79	68	66	59	57	69	54	38	33
	NCA13	52	62	70	61	58	55	70	78	68	75	74	74	71	43	47	56	45	43	39	37	49	34	<30	<30

Legend

1 - 10 dB above NML | 11 - 20 dB above NML | >20 dB above NML

Precinct	NCA	NML	Predicted Worst-case $L_{Aeq(15minute)}$ Noise Level (dBA)[1]																						
			General Worksites					Corridor Works - Ground & Track				Corridor Works - Track Support			Station Worksites					Bridge Worksites				Substation Worksites	
			W.0001 - Earthworks	W.0002 - Earthworks - Breaker	W.0003 - Piling	W.0004 - Site Establishment	W.0005 - Operations	W.0006 - Earthworks	W.0007 - Earthworks - Breaker	W.0008 - Trackform	W.0009 - Trackform - Ballast Tamper	W.0010 - OHW Modifications	W.0011 - Comms & Signalling Works	W.0012 - Segregation Fencing	W.0013 - Site Establishment	W.0014 - Demolition	W.0015 - Demolition - Breaker & Saw	W.0016 - Concrete & Structural	W.0017 - Station Installation & Fitout	W.0018 - Site Esta & Imp. Protec.	W.0019 - Demolition	W.0020 - Demolition - Breaker & Saw	W.0021 - Construction & Installation	W.0022 - Site Establishment	W.0023 - Construction & Installation
Residential – Evening																									
Marrickville	NCA01	43	-	-	-	-	-	77	85	75	82	76	76	73	-	72	81	70	68	74	72	84	69	-	48
Dulwich Hill	NCA02	43	-	-	-	-	-	78	86	76	83	76	76	73	-	74	83	72	70	79	77	89	74	-	73
Hurlstone Park	NCA03	43	-	-	-	-	-	80	88	78	85	76	76	73	-	67	76	65	63	78	76	88	73	-	60
Canterbury	NCA04	45	-	-	-	-	-	78	86	76	83	74	74	71	-	71	80	69	67	75	73	85	70	-	64
	NCA05	41	-	-	-	-	-	70	78	68	75	71	71	68	-	50	59	48	46	74	72	84	69	-	33
Campsie	NCA06	47	-	-	-	-	-	79	87	77	84	75	75	72	-	69	78	67	65	78	76	88	73	-	62
Belmore	NCA07	46	-	-	-	-	-	73	81	71	78	72	72	69	-	77	86	75	73	72	70	82	67	-	43
Lakemba	NCA08	52	-	-	-	-	-	70	78	68	75	69	69	66	-	72	81	70	68	70	68	80	65	-	66
Wiley Park	NCA09	49	-	-	-	-	-	77	85	75	82	73	73	70	-	77	86	75	73	43	41	53	38	-	36
Punchbowl	NCA10	52	-	-	-	-	-	71	79	69	76	68	68	65	-	66	75	64	62	41	39	51	36	-	51
Bankstown	NCA11	52	-	-	-	-	-	76	84	74	81	73	73	70	-	53	62	51	49	75	73	85	70	-	66
	NCA12	56	-	-	-	-	-	72	80	70	77	68	68	65	-	70	79	68	66	59	57	69	54	-	33
	NCA13	47	-	-	-	-	-	70	78	68	75	74	74	71	-	47	56	45	43	39	37	49	34	-	<30

Legend

1 - 10 dB above NML	11 - 20 dB above NML	>20 dB above NML

Precinct	NCA	NML	Predicted Worst-case $L_{Aeq(15minute)}$ Noise Level (dBA)[1]																						
			General Worksites					Corridor Works - Ground & Track				Corridor Works - Track Support			Station Worksites					Bridge Worksites				Substation Worksites	
			W.0001 - Earthworks	W.0002 - Earthworks - Breaker	W.0003 - Piling	W.0004 - Site Establishment	W.0005 - Operations	W.0006 - Earthworks	W.0007 - Earthworks - Breaker	W.0008 - Trackform	W.0009 - Trackform - Ballast Tamper	W.0010 - OHW Modifications	W.0011 - Comms & Signalling Works	W.0012 - Segregation Fencing	W.0013 - Site Establishment	W.0014 - Demolition	W.0015 - Demolition - Breaker & Saw	W.0016 - Concrete & Structural	W.0017 - Station Installation & Fitout	W.0018 - Site Esta & Imp. Protec.	W.0019 - Demolition	W.0020 - Demolition - Breaker & Saw	W.0021 - Construction & Installation	W.0022 - Site Establishment	W.0023 - Construction & Installation
Residential – Night-time																									
Marrickville	NCA01	38	-	-	-	-	-	77	-	75	82	76	76	73	-	72	-	70	68	74	72	-	69	-	-
Dulwich Hill	NCA02	38	-	-	-	-	-	78	-	76	83	76	76	73	-	74	-	72	70	79	77	-	74	-	-
Hurlstone Park	NCA03	39	-	-	-	-	-	80	-	78	85	76	76	73	-	67	-	65	63	78	76	-	73	-	-
Canterbury	NCA04	40	-	-	-	-	-	78	-	76	83	74	74	71	-	71	-	69	67	75	73	-	70	-	-
	NCA05	37	-	-	-	-	-	70	-	68	75	71	71	68	-	50	-	48	46	74	72	-	69	-	-
Campsie	NCA06	40	-	-	-	-	-	79	-	77	84	75	75	72	-	69	-	67	65	78	76	-	73	-	-
Belmore	NCA07	40	-	-	-	-	-	73	-	71	78	72	72	69	-	77	-	75	73	72	70	-	67	-	-
Lakemba	NCA08	46	-	-	-	-	-	70	-	68	75	69	69	66	-	72	-	70	68	70	68	-	65	-	-
Wiley Park	NCA09	41	-	-	-	-	-	77	-	75	82	73	73	70	-	77	-	75	73	43	41	-	38	-	-
Punchbowl	NCA10	46	-	-	-	-	-	71	-	69	76	68	68	65	-	66	-	64	62	41	39	-	36	-	-
Bankstown	NCA11	44	-	-	-	-	-	76	-	74	81	73	73	70	-	53	-	51	49	75	73	-	70	-	-
	NCA12	47	-	-	-	-	-	72	-	70	77	68	68	65	-	70	-	68	66	59	57	-	54	-	-
	NCA13	44	-	-	-	-	-	70	-	68	75	74	74	71	-	47	-	45	43	39	37	-	34	-	-

Legend

1 - 10 dB above NML | 11 - 20 dB above NML | >20 dB above NML

Precinct	NCA	NML	Predicted Worst-case $L_{Aeq(15minute)}$ Noise Level (dBA)[1]																						
			General Worksites					Corridor Works - Ground & Track				Corridor Works - Track Support			Station Worksites					Bridge Worksites				Substation Worksites	
			W.0001 - Earthworks	W.0002 - Earthworks - Breaker	W.0003 - Piling	W.0004 - Site Establishment	W.0005 - Operations	W.0006 - Earthworks	W.0007 - Earthworks - Breaker	W.0008 - Trackform	W.0009 - Trackform - Ballast Tamper	W.0010 - OHW Modifications	W.0011 - Comms & Signalling Works	W.0012 - Segregation Fencing	W.0013 - Site Establishment	W.0014 - Demolition	W.0015 - Demolition - Breaker & Saw	W.0016 - Concrete & Structural	W.0017 - Station Installation & Fitout	W.0018 - Site Esta & Imp. Protec.	W.0019 - Demolition	W.0020 - Demolition - Breaker & Saw	W.0021 - Construction & Installation	W.0022 - Site Establishment	W.0023 - Construction & Installation
Commercial																									
Marrickville	NCA01	70	74	82	73	70	67	72	80	70	77	68	68	65	69	73	82	71	69	75	73	85	70	41	36
Dulwich Hill	NCA02	70	52	60	51	48	45	67	75	65	72	63	63	60	61	65	74	63	61	62	60	72	57	46	41
Hurlstone Park	NCA03	70	63	71	62	59	56	78	86	76	83	74	74	71	76	80	89	78	76	71	69	81	66	36	31
Canterbury	NCA04	70	59	67	58	55	52	76	84	74	81	72	72	69	65	69	78	67	65	70	68	80	65	46	41
	NCA05	70	77	85	76	73	70	56	64	54	61	69	69	66	46	50	59	48	46	60	58	70	55	31	<30
Campsie	NCA06	70	80	88	79	76	73	74	82	72	79	70	70	67	75	79	88	77	75	56	54	66	51	48	43
Belmore	NCA07	70	85	93	84	81	78	79	87	77	84	76	76	73	66	70	79	68	66	53	51	63	48	44	39
Lakemba	NCA08	70	84	92	83	80	77	79	87	77	84	75	75	72	69	73	82	71	69	84	82	94	79	59	54
Wiley Park	NCA09	70	38	46	37	34	31	54	62	52	59	65	65	62	64	68	77	66	64	37	35	47	32	<30	<30
Punchbowl	NCA10	70	77	85	76	73	70	79	87	77	84	75	75	72	72	76	85	74	72	38	36	48	33	49	44
Bankstown	NCA11	70	48	56	47	44	41	73	81	71	78	69	69	66	37	41	50	39	37	67	65	77	62	45	40
	NCA12	70	79	87	78	75	72	81	89	79	86	80	80	77	71	75	84	73	71	67	65	77	62	41	36
	NCA13	70	66	74	65	62	59	68	76	66	73	65	65	62	42	46	55	44	42	38	36	48	33	<30	<30

Legend

(light yellow)	1 - 10 dB above NML
(yellow)	11 - 20 dB above NML
(red)	>20 dB above NML

Precinct	NCA	NML	Predicted Worst-case $L_{Aeq(15minute)}$ Noise Level (dBA)[1]																						
			General Worksites					Corridor Works - Ground & Track				Corridor Works - Track Support			Station Worksites					Bridge Worksites				Substation Worksites	
			W.0001 - Earthworks	W.0002 - Earthworks - Breaker	W.0003 - Piling	W.0004 - Site Establishment	W.0005 - Operations	W.0006 - Earthworks	W.0007 - Earthworks - Breaker	W.0008 - Trackform	W.0009 - Trackform - Ballast Tamper	W.0010 - OHW Modifications	W.0011 - Comms & Signalling Works	W.0012 - Segregation Fencing	W.0013 - Site Establishment	W.0014 - Demolition	W.0015 - Demolition - Breaker & Saw	W.0016 - Concrete & Structural	W.0017 - Station Installation & Fitout	W.0018 - Site Esta & Imp. Protec.	W.0019 - Demolition	W.0020 - Demolition - Breaker & Saw	W.0021 - Construction & Installation	W.0022 - Site Establishment	W.0023 - Construction & Installation
Other Sensitive[2]																									
Marrickville	NCA01	-	70	78	69	66	63	61	69	59	66	76	76	73	61	65	74	63	61	73	71	83	68	47	42
Dulwich Hill	NCA02	-	55	63	54	51	48	63	71	61	68	63	63	60	62	66	75	64	62	63	61	73	58	60	55
Hurlstone Park	NCA03	-	49	57	48	45	42	63	71	61	68	74	74	71	48	52	61	50	48	77	75	87	72	38	33
Canterbury	NCA04	-	50	58	49	46	43	55	63	53	60	74	74	71	54	58	67	56	54	53	51	63	48	50	45
	NCA05	-	66	74	65	62	59	55	63	53	60	64	64	61	46	50	59	48	46	57	55	67	52	37	32
Campsie	NCA06	-	69	77	68	65	62	74	82	72	79	71	71	68	56	60	69	58	56	66	64	76	61	68	63
Belmore	NCA07	-	68	76	67	64	61	80	88	78	85	76	76	73	73	77	86	75	73	66	64	76	61	43	38
Lakemba	NCA08	-	62	70	61	58	55	71	79	69	76	67	67	64	65	69	78	67	65	66	64	76	61	51	46
Wiley Park	NCA09	-	40	48	39	36	33	52	60	50	57	63	63	60	63	67	76	65	63	37	35	47	32	36	31
Punchbowl	NCA10	-	75	83	74	71	68	75	83	73	80	71	71	68	68	72	81	70	68	40	38	50	35	58	53
Bankstown	NCA11	-	41	49	40	37	34	46	54	44	51	60	60	57	40	44	53	42	40	45	43	55	40	54	49
	NCA12	-	77	85	76	73	70	79	87	77	84	75	75	72	61	65	74	63	61	56	54	66	51	38	33
	NCA13	-	53	61	52	49	46	56	64	54	61	71	71	68	34	38	47	36	34	<30	<30	<30	<30	<30	<30

Note 1: Colouring indicates the range of predicted worst case NML exceedances without any additional mitigation based on nearest receiver (red >20 dB, orange 11 - 20 dB, yellow 1-10 dB) based on the controlling time period for a given activity (refer to **Table 16**).

Note 2: Other Sensitive receiver NMLs are dependent on classification. As the above table shows the highest predicted noise level for a particular activity, the most affected 'other sensitive' receiver type may change between each activity resulting in different NMLs therefore no single NML can be provided.

When considering the predicted noise levels from the project as a whole, the above tables indicate that:

- The highest noise levels are generally predicted during works which require noise intensive plant items, such as a rockbreaker, diamond saw and/or ballast tamper. This includes the following scenarios:
  - W.0002 – General Worksites, Earthworks - Breaker
  - W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
  - W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
  - W.0015 – Station Worksites, Demolition - Breaker & Saw
  - W.0020 – Bridge Worksites, Demolition - Breaker & Saw
- Whilst all NCAs are predicted to be subject to impacts, the highest impacts are generally seen in NCA01 to NCA08, due to the close proximity of residential receivers to the majority of the worksites in these catchments.
- Works activities that do not include high noise generating items of plant generally result in considerably lower impacts.
- As discussed in **Section 3.7.2.1**, impacts during the night-time have been controlled to some degree by restricting noise intensive plant items such as rockbreaking to between 7 am – 10 pm (unless unforeseen site conditions are encountered which may require night work). Significant impacts are however still likely during the evening periods where rockbreaking is required.
- The restriction on rockbreakers (and other similar noise intensive plant items) results in impacts during the night-time typically being substantially lower than those during the daytime and evening periods, however notable night-time impacts are still likely during:
  - W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper

  These would need to be undertaken during rail possession periods (when trains are not running) to remove the risk of affecting operations and risk to rail worker safety, during which time the construction works would be undertaken on a 24/7 basis. Activities would not take place outside standard hours without prior discussion with and/or notification of local residents, businesses and the EPA.

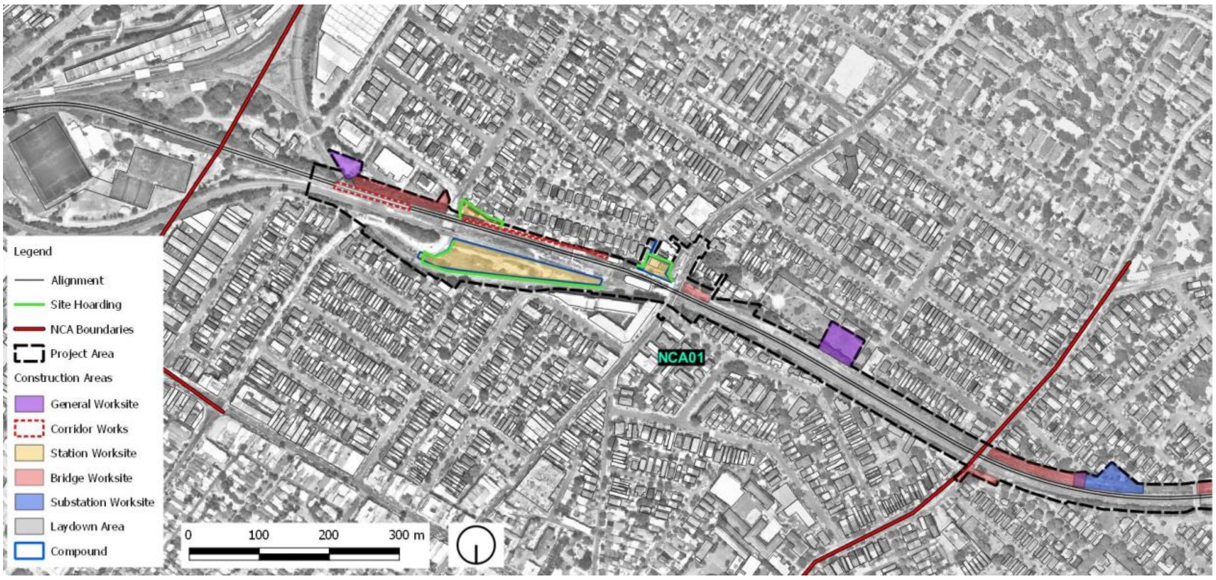
3.11 Predicted Noise Levels and NML Exceedances – Precincts

The construction works occur in a number of distinct areas. The predicted construction noise impacts from the project are summarised in the following sections based on precinct areas which generally follow the stations along the route.

3.11.1 Marrickville Precinct (NCA01)

The Marrickville precinct is located near various construction worksites that are associated with station works, track works, bridges, lineside works, and substation works. The Marrickville precinct is shown below in **Figure 6**.

Figure 6 Marrickville Precinct - Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.1.1 NCA Discussion

NCA01

- Front row residential receivers on Arthur Street, Jersey Street, Leofrene Avenue, Warburton street, Myrtle Street and Brynes Street are very close to the rail corridor and in some cases overlook it.
- Works associated with General Worksites and Bridge Worksites are in close proximity to the nearest receivers in this catchment, which are mainly residential dwellings.
- Station works are required near Charlotte Avenue, O'Hara Street, and Illawarra Road.

3.11.1.2 Construction Activities

Table 21 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 21 Construction Activities and Period of Works – Marrickville

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.1.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 22**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 22 Overview of NML Exceedances from Project – Marrickville Precinct (NCA01) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		1150	1	271	42	2	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		1150	4	496	200	28	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		1150	1	228	37	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		1150	-	146	16	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		1150	-	80	7	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		1150	4	291	80	17	455	195	36	454	195	36	542	289	97	453	195	36
W.0007		Earthworks - Breaker	10		1150	21	546	254	69	438	377	169	435	377	169	-	-	-	-	-	-
W.0008		Trackform	12 days		1150	1	254	56	13	377	145	24	377	145	24	539	254	69	289	80	17
W.0009		Trackform - Ballast Tamper	4 days		1150	16	458	195	36	547	289	97	545	289	97	309	453	231	245	492	257
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		1150	4	369	69	57	517	186	78	517	186	78	466	368	124	485	161	73
W.0011		Comms & Signalling Works	12		1150	4	369	69	57	517	186	78	517	186	78	466	368	124	516	184	78
W.0012		Segregation Fencing	6		1150	-	254	66	25	439	108	68	439	108	68	531	253	89	438	106	68
W.0013	Station Worksites	Site Establishment	3		1150	-	167	28	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		1150	-	246	73	4	437	148	19	436	148	19	530	244	77	435	148	19
W.0015		Demolition - Breaker & Saw	6		1150	7	527	231	63	458	382	140	454	381	140	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		1150	-	207	51	1	340	117	7	339	117	7	519	205	52	286	99	6
W.0017		Station Installation & Fitout	20		1150	-	167	28	-	265	86	4	265	86	4	466	166	28	205	51	1
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		1150	-	300	34	13	463	106	23	462	106	23	487	300	46	397	73	16
W.0019		Demolition	2		1150	-	223	25	11	398	74	16	397	74	16	466	223	35	335	42	13
W.0020		Demolition - Breaker & Saw	2		1150	20	508	300	47	405	463	129	392	462	129	-	-	-	-	-	-
W.0021		Construction & Installation	20		1150	-	106	21	2	300	33	13	300	33	13	463	105	23	259	29	12

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2]	Number of Receivers																
				%	Total	HNA[3]	With NML Exceedance[4]														
							Standard Daytime			Possession / Closedown Works [5]											
										Daytime OOH			Evening			Night-time			Sleep Disturbance		
				20 40 60 80			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		1150	-	9	-	-	70	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		1150	-	-	-	-	9	-	-	9	-	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

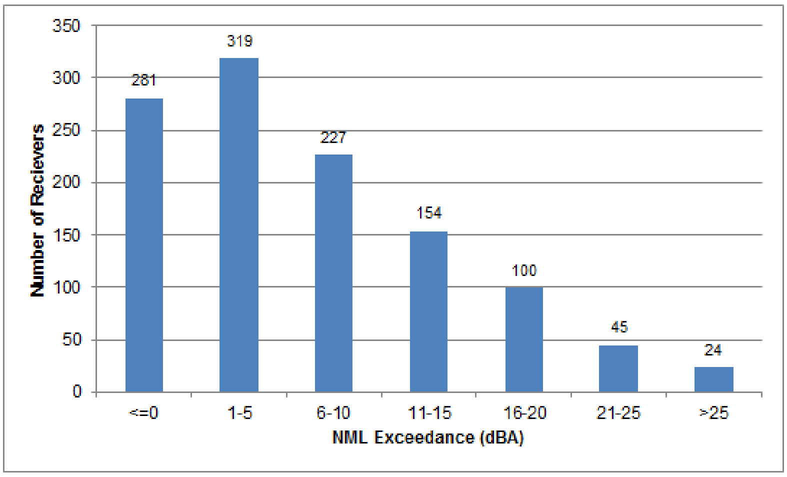
3.11.1.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 22** shows that activities which use noise intrusive plant items, such as a rockbreaker, diamond saw and/or ballast tamper, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0015 – Station Worksites, Demolition - Breaker & Saw
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'. **Figure 7** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 7 NML Exceedances Daytime – 'W.0007 – Corridor Works - Ground & Track, Earthworks – Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 69 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in 13 receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.1.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 22** shows that the highest numbers of night-time NML exceedances are apparent during the following works:

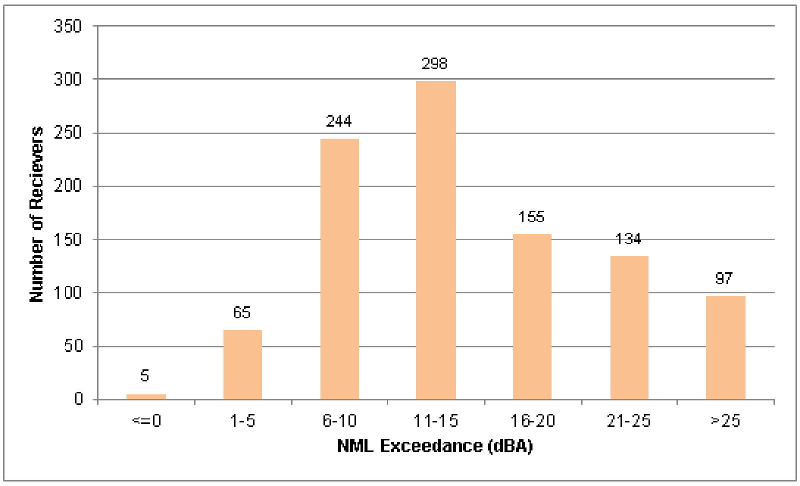
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works
- W.0014 – Station Worksites, Demolition

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems' activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 8** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

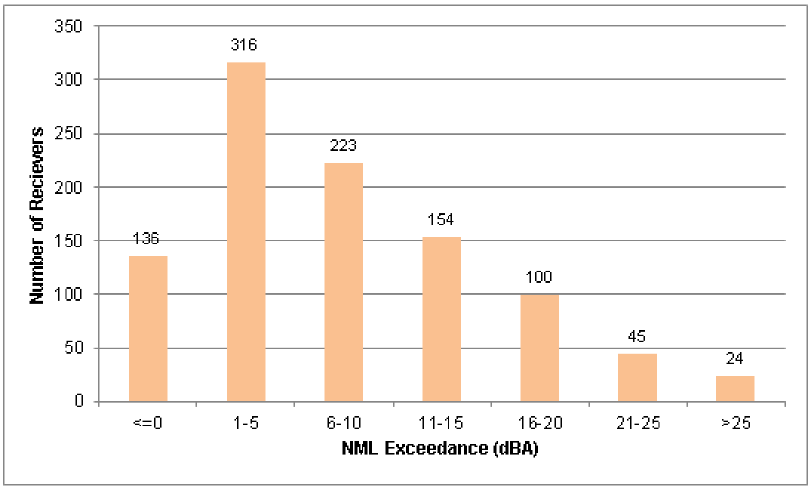
Figure 8 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 231 receivers, there are many receivers in this precinct that are subject to lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time, the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 69 receivers, as shown in **Figure 9**.

Figure 9 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track, Trackform'



3.11.1.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 23**. The table shows the number of residential receivers separated by works activity and NCA.

Table 23 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA01		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	1	-	-
W.0002		Earthworks - Breaker	4	-	-
W.0003		Piling	1	-	-
W.0004		Site Establishment	-	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	4	4	4
W.0007		Earthworks - Breaker	21	21	-
W.0008		Trackform	1	1	1
W.0009		Trackform - Ballast Tamper	16	16	16
W.0010	Corridor Works - Track Support Systems	OHW Modifications	4	4	4
W.0011		Comms & Signalling Works	4	4	4
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	7	7	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-

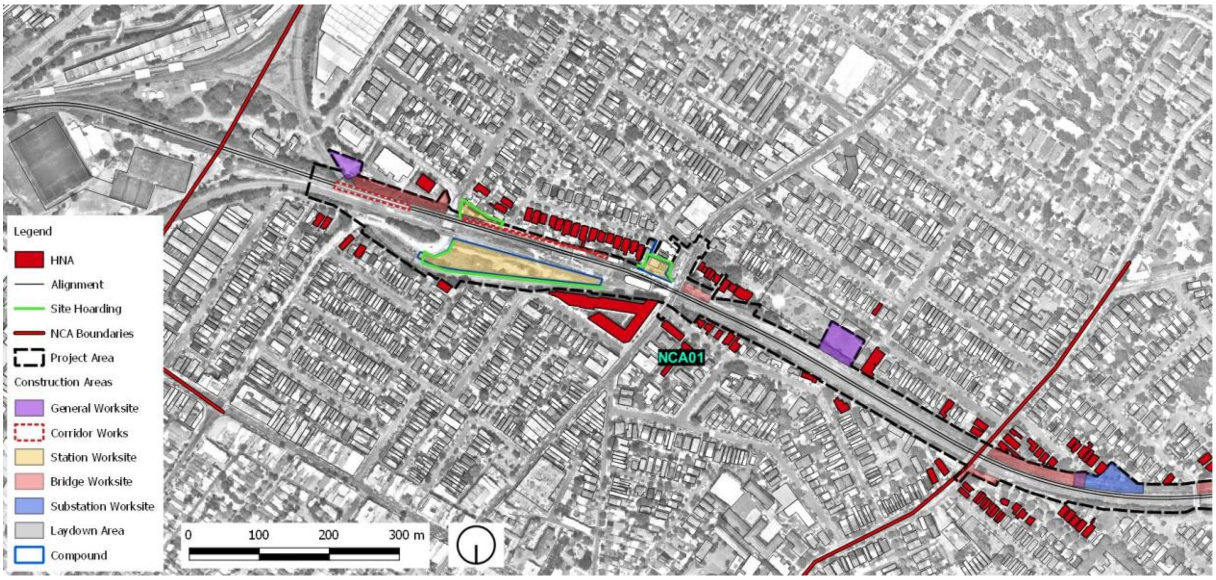
Works	Scenario	Activity	NCA01		
			Day	Eve	Night
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-
W.0019		Demolition	-	-	-
W.0020		Demolition - Breaker & Saw	20	20	-
W.0021		Construction & Installation	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 21 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 16 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to five receivers being Highly Noise Affected during this period.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 20 receivers are predicted to be Highly Noise Affected during the daytime and evening, which results from the large number of bridge worksites in this precinct. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 10**.

Figure 10 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Leofrene Avenue which is adjacent to Corridor Works and Station Worksites
- In the vicinity of Arthur Street, Illawarra Road and Warburton Street which is adjacent to a Bridge Worksite and Station Worksite.

3.11.1.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 24**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 24 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
W.0002		Earthworks - Breaker	4	-	-	1	-	-	3	-	-	1	-	-	-	3	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0007		Earthworks - Breaker	-	-	-	-	-	-	1	-	-	1	-	-	3	-	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0009		Trackform - Ballast Tamper	-	-	-	-	-	-	-	-	-	1	-	-	3	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-
W.0011		Comms & Signalling Works	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-
W.0012		Segregation Fencing	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0020		Demolition - Breaker & Saw	7	-	-	1	-	-	3	-	-	1	-	-	3	-	1
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Public building – 129-130 Meeks Road, Marrickville
  - Public building – 3-5 Carrington Road, Marrickville
  - Public building – McNeilly Park buildings
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Café/bar – 1 Warburton Street, Marrickville

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15**.

3.11.1.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 25** for works which have been found to potentially have the highest impacts.

Table 25 Works Activities and Indicative Durations

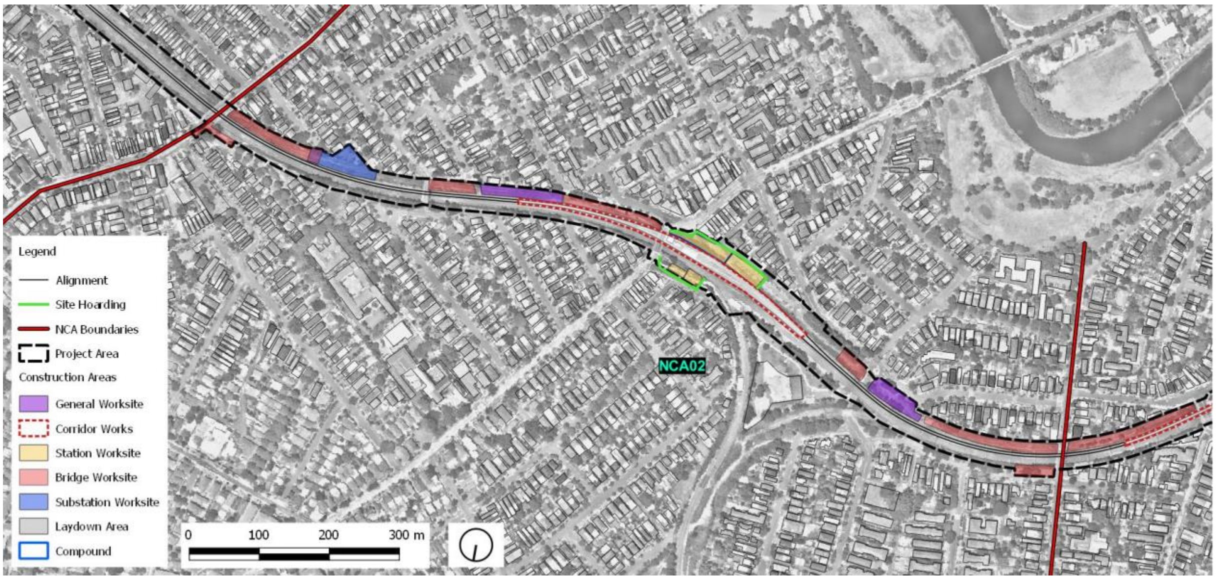
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.2 Dulwich Hill Precinct (NCA02)

The Dulwich Hill precinct is located near various construction worksites that are associated with station works, track works, bridges, lineside works, and substation works. The Dulwich Hill precinct is shown below in **Figure 11**.

Figure 11 Dulwich Hill Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.2.1 NCA Discussion

NCA02

- This precinct has numerous bridges that require modification, therefore there are many bridge worksites in this area. Residential receivers on Livingstone Road, Randall Street, Kays Avenue, School Parade, Ewart Street and The Parade are in proximity of works associated with the construction of the bridges.
- Corridor Works are required around Dulwich Hill Station to realign the tracks to meet metro requirements. Receivers surrounding this location are a mix of commercial and residential.
- There is a Substation Worksite to the east of the precinct, near to Randall Street, where residential receivers are in relatively close proximity.
- Station works are required at Dulwich Hill Station. Most of the surrounding receivers are residential adjacent to site on Ewart Lane and commercial facing Wardell Road.

3.11.2.2 Construction Activities

Table 26 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 26 Construction Activities and Period of Works – Dulwich Hill

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a six week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a six week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.2.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 27**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 27 Overview of NML Exceedances from Project – Dulwich Hill Precinct (NCA02) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works [5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		1279	9	306	74	18	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		1279	24	639	232	63	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		1279	6	259	60	18	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		1279	1	183	31	11	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		1279	-	109	20	6	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		1279	11	331	82	23	565	150	69	565	150	69	653	330	105	564	150	69
W.0007		Earthworks - Breaker	10		1279	36	675	232	88	541	489	160	534	489	160	-	-	-	-	-	-
W.0008		Trackform	12 days		1279	5	232	71	17	489	112	48	489	112	48	667	231	88	330	82	23
W.0009		Trackform - Ballast Tamper	4 days		1279	20	569	150	69	657	330	105	655	330	105	419	564	219	358	592	254
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		1279	5	268	164	31	506	187	101	505	187	101	601	265	195	448	177	82
W.0011		Comms & Signalling Works	12		1279	5	268	164	31	506	187	101	505	187	101	601	265	195	503	187	101
W.0012		Segregation Fencing	6		1279	-	206	120	17	331	176	51	331	176	51	561	206	137	331	176	51
W.0013	Station Worksites	Site Establishment	3		1279	-	62	15	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		1279	-	151	25	4	451	54	16	451	54	16	663	150	29	450	54	16
W.0015		Demolition - Breaker & Saw	6		1279	9	633	121	27	629	365	56	623	365	56	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		1279	-	100	20	1	302	43	9	302	43	9	589	99	21	227	39	6
W.0017		Station Installation & Fitout	20		1279	-	62	15	1	189	34	5	189	34	5	504	61	16	99	20	1
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		1279	13	373	130	57	581	186	117	581	186	117	574	369	187	497	155	96
W.0019		Demolition	2		1279	5	288	118	36	500	155	96	500	155	96	618	285	154	415	130	70
W.0020		Demolition - Breaker & Saw	2		1279	106	584	373	187	322	581	303	315	581	303	-	-	-	-	-	-
W.0021		Construction & Installation	20		1279	-	187	102	15	370	130	57	370	130	57	577	186	117	321	125	43
W.0022	Substation Worksites	Site Establishment	2		1279	1	129	26	3	267	40	17	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		1279	-	40	16	1	127	26	3	127	26	3	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.
Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.
Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).
Note 4: Based on worst case predicted noise levels.
Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

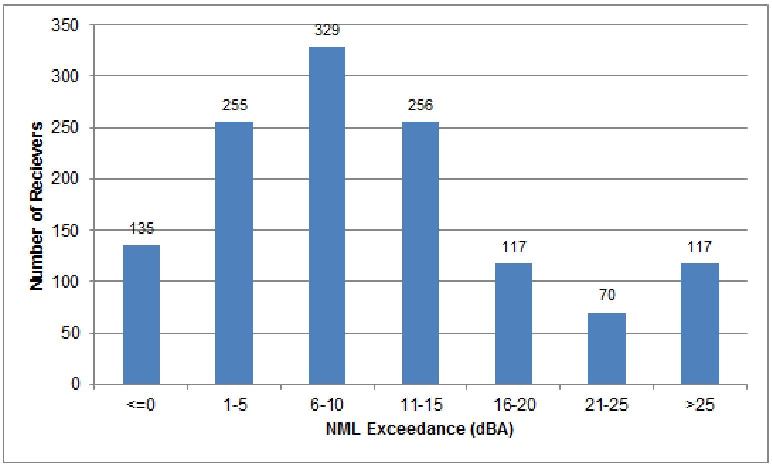
3.11.2.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 27** shows that activities which use noise intrusive plant items, such as a rockbreaker, diamond saw and/or ballast tamper, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', as a number of bridge worksites are in this precinct. **Figure 12** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 12 NML Exceedances Daytime – 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 187 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker/diamond saw in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately two weeks at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 12 dB, resulting in 36 receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.2.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases, this is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 27** shows that the highest numbers of night-time NML exceedances are apparent during the following works:

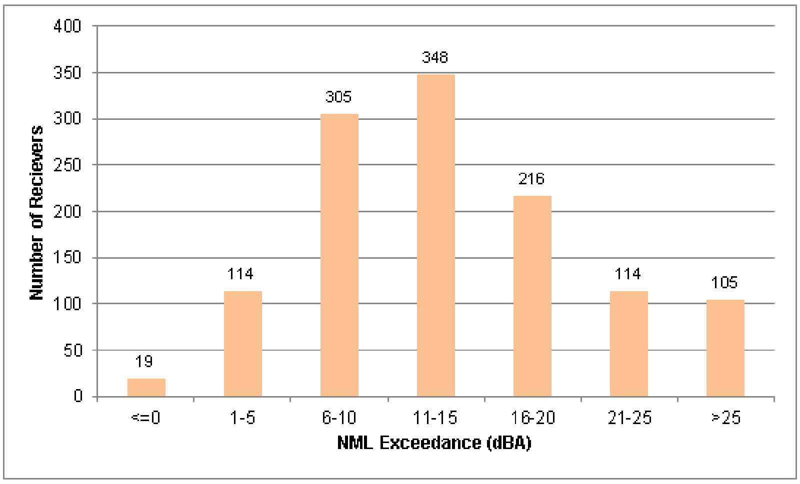
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works
- W.0018 – Bridge Worksites, Site Establish. & Impact Protection
- W.0019 – Bridge Worksites, Demolition

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems' activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 13** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

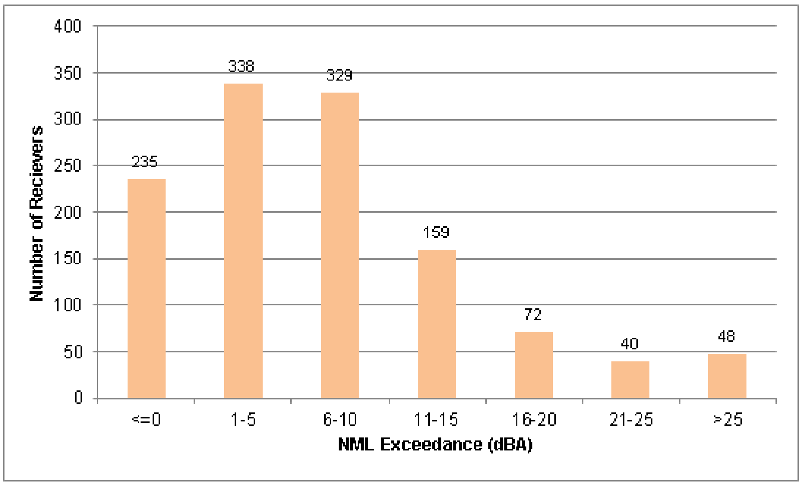
Figure 13 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 219 receivers, there are many receivers in this precinct that are subject to lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time, the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 88 receivers, as shown in **Figure 14**.

Figure 14 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track, Trackform'



3.11.2.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 28**. The table shows the number of residential receivers separated by works activity and NCA.

Table 28 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA02		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	9	-	-
W.0002		Earthworks - Breaker	24	-	-
W.0003		Piling	6	-	-
W.0004		Site Establishment	1	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	11	11	11
W.0007		Earthworks - Breaker	36	36	-
W.0008		Trackform	5	5	5
W.0009		Trackform - Ballast Tamper	20	20	20
W.0010	Corridor Works - Track Support Systems	OHW Modifications	5	5	5
W.0011		Comms & Signalling Works	5	5	5
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	9	9	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	13	13	13
W.0019		Demolition	5	5	5
W.0020		Demolition - Breaker & Saw	106	106	-
W.0021		Construction & Installation	-	-	-

Works	Scenario	Activity	NCA02		
			Day	Eve	Night
W.0022	Substation Worksites	Site Establishment	1	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0002 – General Worksites, Earthworks – Breaker', where 24 receivers are predicted to be Highly Noise Affected during the daytime only and would only be undertaken for approximately three days at any site.
- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 36 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 20 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to five receivers being Highly Noise Affected during this period.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 106 receivers are predicted to be Highly Noise Affected during the daytime and evening, which results from the large number of bridge worksites in this precinct. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 15**.

Figure 15 Highly Noise Affected Residential Receivers

The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to The Parade and Ewart Street which are adjacent to Bridge Worksites
- Wardell Road, Bedford Crescent and Ewart Lane which is adjacent to Station Worksites.
- In the vicinity of School Parade, Wilga Avenue and Kays Avenue which is adjacent to Bridge Worksites and a General Worksite.
- Near Livingstone Road, Marrickville Avenue and Randall Street which is adjacent to a Bridge Worksite and a Substation Worksite.

3.11.2.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 29**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 29 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	4	-	-	-	-	-	1	-	-	-	-	-	-	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0007		Earthworks - Breaker	3	-	-	-	-	-	-	-	-	-	-	-	1	1	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0009		Trackform - Ballast Tamper	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
W.0011		Comms & Signalling Works	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
W.0012		Segregation Fencing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	2	-	-	-	-	-	2	-	-
W.0019		Demolition	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-
W.0020		Demolition - Breaker & Saw	5	-	-	-	-	-	-	2	-	-	-	-	1	2	-
W.0021		Construction & Installation	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Place of worship – St Nicholas Greek Orthodox Church, 205 Livingstone Road, Marrickville
  - Public buildings – 209 Livingstone Road, Marrickville
  - Café/bar – 245 Wardell Road, Dulwich Hill

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15**.

- **Duration**

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 30** for works which have been found to potentially have the highest impacts.

Table 30 Works Activities and Indicative Durations

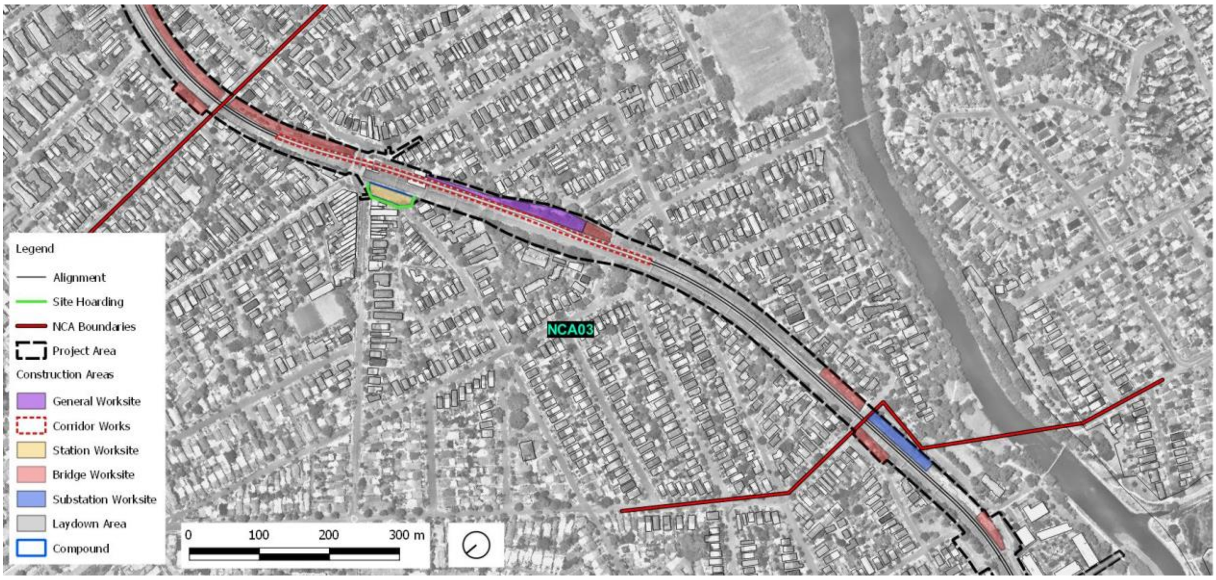
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.3 Hurlstone Park Precinct (NCA03)

The Hurlstone Park precinct is located near various construction worksites that are associated with station works, track works, bridges, substation works, and lineside works. The Hurlstone Park precinct is shown below in **Figure 16**.

Figure 16 Hurlstone Park Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.3.1 NCA Discussion

NCA03

- This precinct has a number of Bridge Worksites with residential receivers on Floss Street, Foord Avenue and Hurlstone Avenue being in close proximity to these worksites.
- Corridor Works are required around Hurlstone Park Station to realign the tracks to meet metro requirements. Receivers surrounding this location are a mix of commercial and residential.
- Station works are required at Hurlstone Park Station. The surrounding receivers are a mix of commercial and residential.

3.11.3.2 Construction Activities

Table 31 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**

Table 31 Construction Activities and Period of Works – Hurlstone Park

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.3.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 32**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 32 Overview of NML Exceedances from Project – Hurlstone Park Precinct (NCA03) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] %	Number of Receivers Total	HNA[3]	With NML Exceedance[4] Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5] Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		751	3	224	44	20	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		751	23	383	167	46	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		751	3	199	40	15	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		751	1	115	28	8	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		751	-	67	23	3	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		751	8	263	86	40	378	146	71	374	145	71	321	234	113	361	131	60
W.0007		Earthworks - Breaker	10		751	48	368	205	99	207	348	169	191	346	168	-	-	-	-	-	-
W.0008		Trackform	12 days		751	3	205	75	24	348	114	55	346	113	55	373	183	86	234	79	34
W.0009		Trackform - Ballast Tamper	4 days		751	34	384	147	71	298	261	125	288	259	125	156	361	191	120	374	216
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		751	2	243	101	41	364	152	84	363	152	83	342	229	128	337	129	64
W.0011		Comms & Signalling Works	12		751	2	243	101	41	364	152	84	363	152	83	342	229	128	351	135	72
W.0012		Segregation Fencing	6		751	-	191	86	15	303	116	55	302	116	54	368	161	92	278	107	46
W.0013	Station Worksites	Site Establishment	3		751	-	48	7	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		751	-	87	20	-	292	44	3	288	44	3	435	77	17	237	34	2
W.0015		Demolition - Breaker & Saw	6		751	1	446	80	17	376	240	36	366	237	36	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		751	-	62	16	-	190	33	1	188	33	1	395	52	12	112	25	-
W.0017		Station Installation & Fitout	20		751	-	48	7	-	114	25	-	112	25	-	288	44	3	52	12	-
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		751	2	282	52	24	386	124	43	384	124	42	372	243	65	330	76	30
W.0019		Demolition	2		751	2	219	42	18	359	83	35	359	83	34	401	184	50	280	52	23
W.0020		Demolition - Breaker & Saw	2		751	39	346	282	76	170	386	167	162	384	166	-	-	-	-	-	-
W.0021		Construction & Installation	20		751	-	124	40	3	280	52	24	280	52	23	368	107	39	219	42	17

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2]	Number of Receivers																
					Total	HNA[3]	With NML Exceedance[4]														
				%			Standard Daytime			Possession / Closedown Works[5]											
										Daytime OOH			Evening			Night-time			Sleep Disturbance		
				20 40 60 80			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		751	-	33	10	-	82	13	2	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		751	-	13	2	-	33	10	-	33	10	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

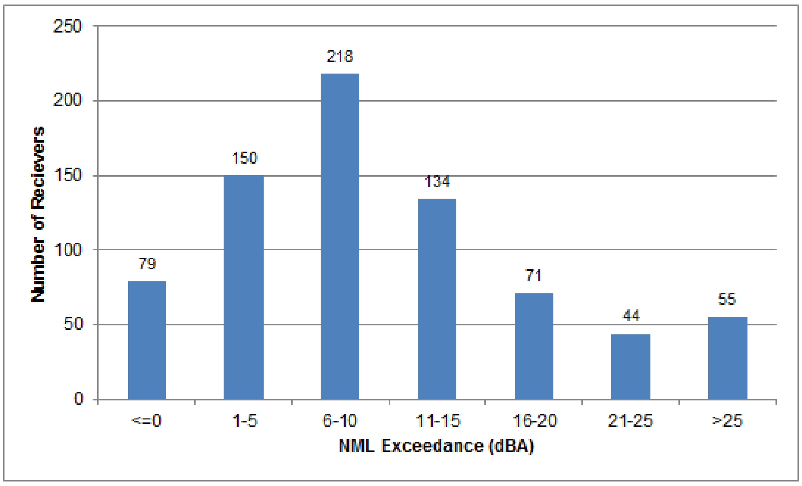
3.11.3.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 32** shows that activities which use noise intrusive plant items, such as a rockbreaker and/or diamond saw, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'. **Figure 17** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 17 NML Exceedances Daytime – 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 99 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in 40 receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.3.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain time in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 32** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

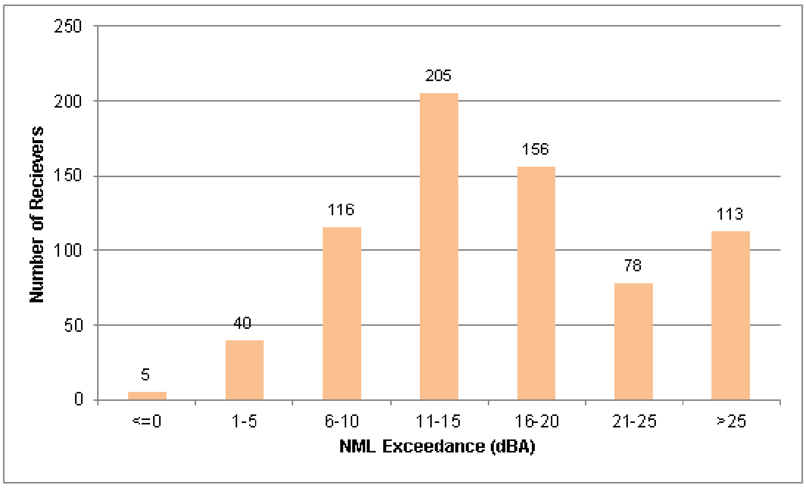
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems' activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 18** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

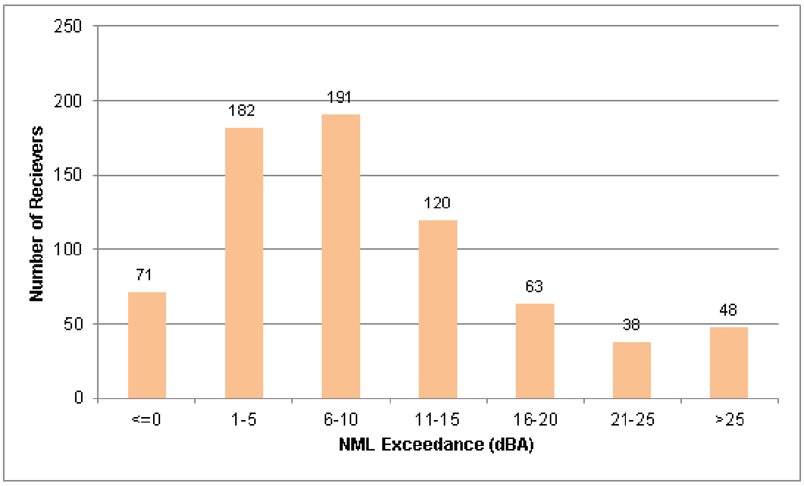
Figure 18 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 191 receivers, there are many receivers in this precinct that are subject to lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 86 receivers, as shown in **Figure 19**.

Figure 19 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track'



3.11.3.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 33**. The table shows the number of residential receivers separated by works activity and NCA.

Table 33 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA03		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	3	-	-
W.0002		Earthworks - Breaker	23	-	-
W.0003		Piling	3	-	-
W.0004		Site Establishment	1	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	8	8	8
W.0007		Earthworks - Breaker	48	48	-
W.0008		Trackform	3	3	3
W.0009		Trackform - Ballast Tamper	34	34	34
W.0010	Corridor Works - Track Support Systems	OHW Modifications	2	2	2
W.0011		Comms & Signalling Works	2	2	2
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	1	1	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	2	2	2
W.0019		Demolition	2	2	2
W.0020		Demolition - Breaker & Saw	39	39	-
W.0021		Construction & Installation	-	-	-

Works	Scenario	Activity	NCA03		
			Day	Eve	Night
W.0022	Substation Worksites	Site Establishment	-	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0002 – General Worksites, Earthworks – Breaker', where 23 receivers are predicted to be Highly Noise Affected during the daytime only and would only be undertaken for approximately three days at any site.
- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 48 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 34 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to three receivers being Highly Noise Affected during this period.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 39 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 20**.

Figure 20 Highly Noise Affected Residential Receivers

The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Duntroon Street, Floss Street and Hampden Street which is adjacent to Corridor Works and a Bridge Worksite.
- In the vicinity of Railway Street and Foord Avenue which is adjacent to Corridor Works, a Bridge Worksite and a General Worksite.
- Near Hurlstone Avenue and Melford Street which is adjacent to a Bridge Worksite.

3.11.3.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 34**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 34 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	-	-	-	-	-	-	1	-	-	3	-	-	-	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
W.0007		Earthworks - Breaker	5	-	-	-	-	-	1	-	-	1	1	1	-	-	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
W.0009		Trackform - Ballast Tamper	2	-	-	-	-	-	-	-	-	2	1	-	-	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
W.0011		Comms & Signalling Works	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
W.0012		Segregation Fencing	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
W.0020		Demolition - Breaker & Saw	4	-	-	-	-	-	-	-	-	1	1	1	-	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Childcare – Hurlstone Park Children's Centre, 12 Smith Avenue, Hurlstone Park
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Childcare – Dulwich Hill Child Care Centre, 66 Garnet Street, Hurlstone Park

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15**.

3.11.3.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 35** for works which have been found to potentially have the highest impacts.

Table 35 Works Activities and Indicative Durations

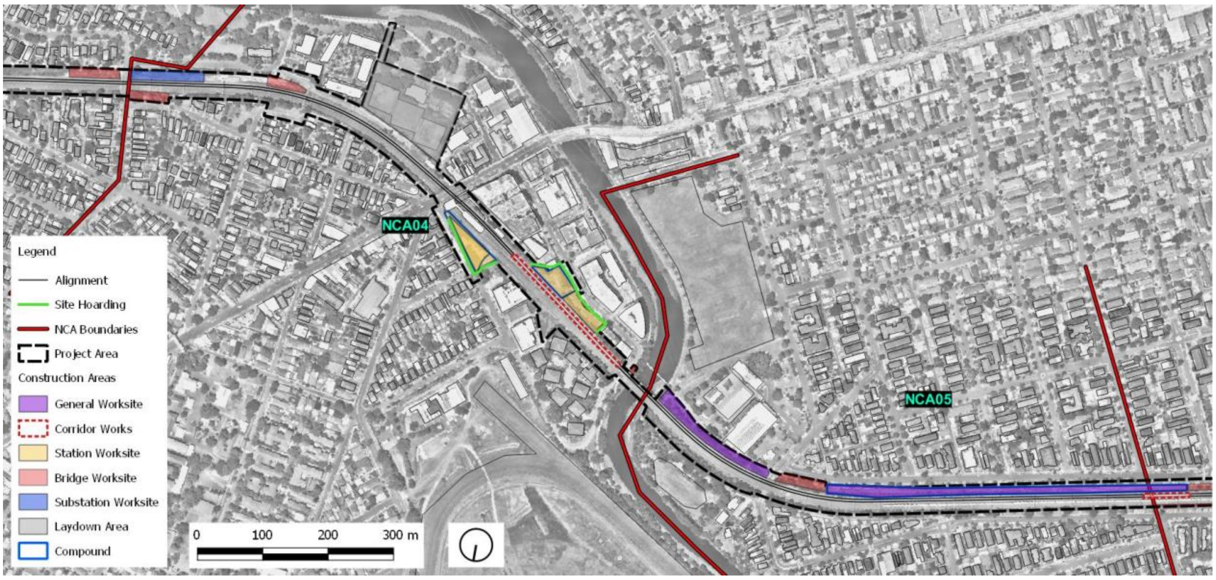
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.4 Canterbury Precinct (NCA04 and NCA05)

The Canterbury precinct is located near various construction worksites that are associated with station works, track works, bridges, lineside works, and substation works. The Canterbury precinct is shown below in **Figure 21**.

Figure 21 Canterbury Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.4.1 NCA Discussion

NCA04

- This precinct has a number of Bridge Worksites. Residential receivers on Canberra Street, Church Street and Hutton Street are in close proximity to these worksites in this catchment.
- Corridor Works are required around Canterbury Station to realign the tracks to meet metro requirements. Receivers surrounding this location are mainly commercial with some residential to the north.
- Station works are required at Canterbury Station. The surrounding receivers are a mix of commercial and residential.
- There is a Substation Worksite at the eastern end of the precinct adjacent Hutton Street, where residential receivers are relatively close by.

NCA05

- This precinct has a Bridge Worksite on the southern side of the rail corridor with residential receivers on South Parade and Wairoa Street being in proximity of these worksites in this catchment.
- Works associated with General Worksites are in close proximity to residential receivers on South Parade.

3.11.4.2 Construction Activities

Table 36 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 36 Construction Activities and Period of Works – Canterbury

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.4.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 37**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 37 Overview of NML Exceedances from Project – Canterbury Precinct (NCA04 and NCA05) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		708	-	212	52	30	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		708	30	232	186	55	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		708	-	197	45	25	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		708	-	147	41	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		708	-	78	34	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		708	4	187	29	6	366	75	14	362	75	14	389	158	34	342	65	11
W.0007		Earthworks - Breaker	10		708	7	370	135	24	277	304	67	274	300	67	-	-	-	-	-	-
W.0008		Trackform	12 days		708	1	135	19	5	304	58	9	300	58	9	383	116	20	158	28	6
W.0009		Trackform - Ballast Tamper	4 days		708	6	366	76	14	368	184	35	364	183	35	243	342	76	201	368	92
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		708	-	253	127	20	319	172	84	315	172	84	268	234	138	306	134	75
W.0011		Comms & Signalling Works	12		708	-	253	127	20	319	172	84	315	172	84	268	234	138	321	155	83
W.0012		Segregation Fencing	6		708	-	198	101	7	287	129	50	287	129	50	326	180	101	275	128	38
W.0013	Station Worksites	Site Establishment	3		708	-	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		708	-	37	15	1	159	20	8	159	20	8	381	30	16	123	20	8
W.0015		Demolition - Breaker & Saw	6		708	8	375	27	15	466	116	25	461	116	25	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		708	-	24	14	-	94	19	5	94	19	5	270	24	14	58	18	2
W.0017		Station Installation & Fitout	20		708	-	20	11	-	52	16	2	52	16	2	160	20	11	24	14	-
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		708	1	276	68	8	341	129	34	341	129	34	317	249	68	323	97	17
W.0019		Demolition	2		708	-	222	52	5	327	100	21	327	100	21	337	190	50	278	71	12
W.0020		Demolition - Breaker & Saw	2		708	22	290	276	76	166	341	163	164	341	163	-	-	-	-	-	-
W.0021		Construction & Installation	20		708	-	129	32	2	276	68	8	276	68	8	343	122	28	225	52	6

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime			Possession / Closedown Works [5]: Daytime OOH			Evening			Night-time			Sleep Disturbance		
							1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		708	-	26	8	-	42	16	2	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		708	-	16	2	-	26	8	-	26	8	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

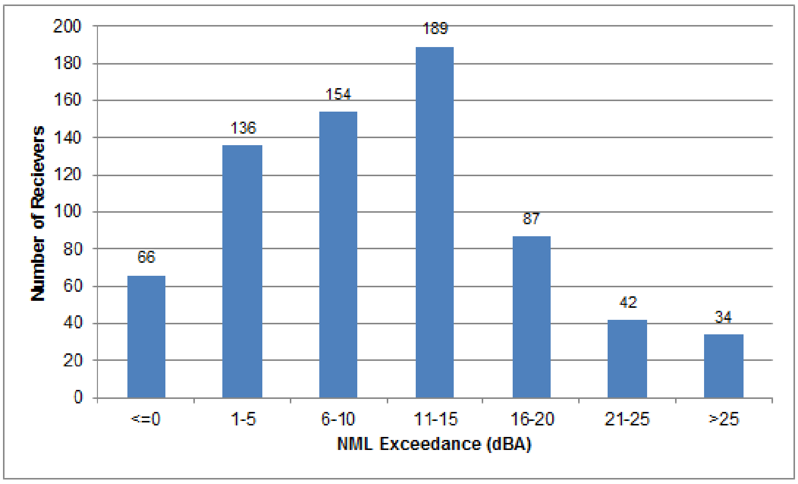
3.11.4.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 37** shows that activities which use noise intrusive plant items, such as a rockbreaker and/or diamond saw, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw'. **Figure 22** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 22 NML Exceedances Daytime – 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 76 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately two weeks at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 12 dB, resulting in eight receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.4.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain time in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 37** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

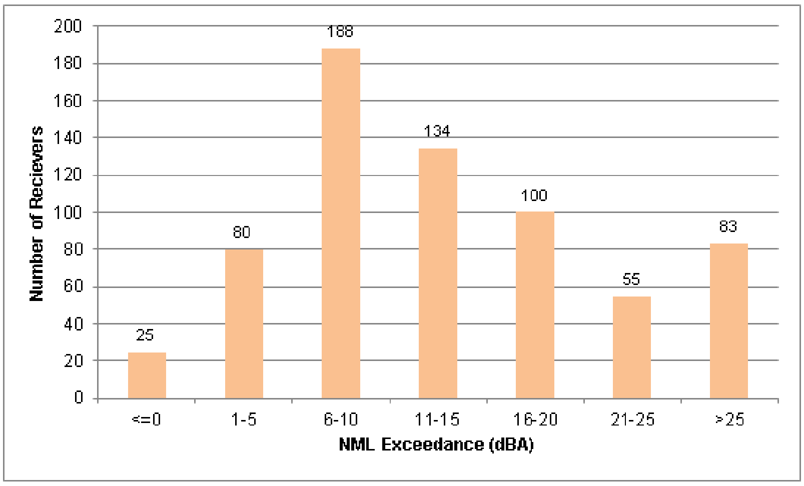
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works
- W.0012 – Corridor Works - Track Support Systems, Segregation Fencing

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010, W.0011 and W.0012. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'. **Figure 23** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

Figure 23 NML Exceedances Night-time – 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 138 receivers, there are many receivers in this precinct that are subject to lower impacts. It is noted that the duration of these works is likely to be relatively short as the works typically progress at a reasonably fast rate.

3.11.4.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 38**. The table shows the number of residential receivers separated by works activity and NCA.

Table 38 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA04			NCA05		
			Day	Eve	Night	Day	Eve	Night
W.0001	General Worksites	Earthworks	-	-	-	-	-	-
W.0002		Earthworks - Breaker	-	-	-	30	-	-
W.0003		Piling	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	4	4	4	-	-	-
W.0007		Earthworks - Breaker	6	6	-	1	1	-
W.0008		Trackform	1	1	1	-	-	-
W.0009		Trackform - Ballast Tamper	5	5	5	1	1	1
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	-	-	-
W.0011		Comms & Signalling Works	-	-	-	-	-	-
W.0012		Segregation Fencing	-	-	-	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-
W.0014		Demolition	-	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	8	8	-	-	-	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	1	1	1	-	-	-
W.0019		Demolition	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	14	14	-	8	8	-
W.0021		Construction & Installation	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-

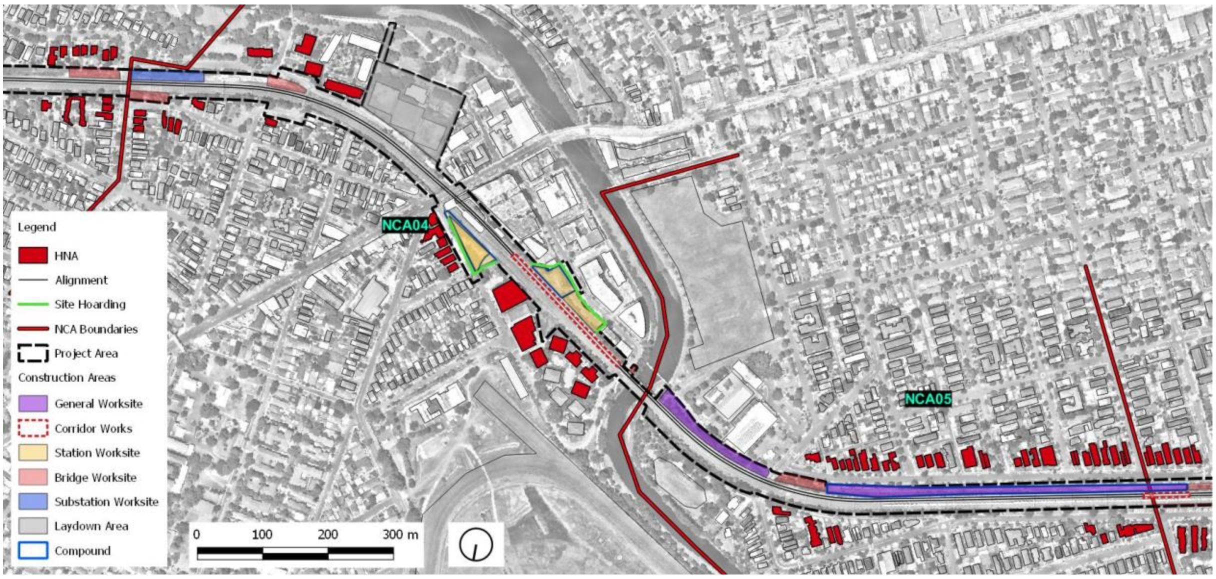
The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- ‘W.0002 – General Worksites, Earthworks – Breaker’, where 30 receivers are predicted to be Highly Noise Affected in NCA05 during the daytime only and would only be undertaken for approximately three days at any site.
- ‘W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker’, where six receivers in NCA04 and one receiver in NCA05 are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- ‘W.0015 – Station Worksites, Demolition - Breaker & Saw’, where eight receivers in NCA04 are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 14 receivers in NCA04 and eight receivers in NCA05 are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 24**.

Figure 24 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- In NCA04:
  - Near to Canberra Street and Hutton Street which is adjacent to a Substation Worksite and a Bridge Worksite.
  - Near to Broughton Street and Charles Street which is adjacent to a Station Worksite.
- In NCA05:
  - Near to South Parade, North Parade and Nowra Lane which is adjacent to a Bridge Worksite and General Worksites.

3.11.4.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 39**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 39 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0002		Earthworks - Breaker	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0007		Earthworks - Breaker	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0009		Trackform - Ballast Tamper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0011		Comms & Signalling Works	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0012		Segregation Fencing	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Café/bar – 208 Canterbury Road, Canterbury

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15.**

3.11.4.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 40** for works which have been found to potentially have the highest impacts.

Table 40 Works Activities and Indicative Durations

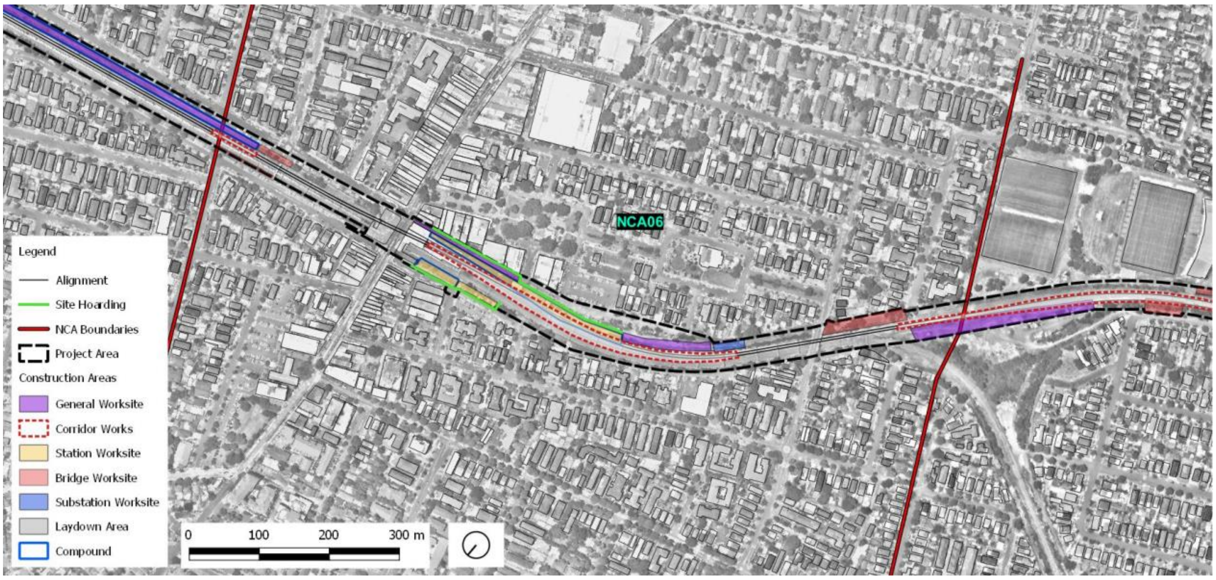
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0010	Corridor Works - Track Support Systems, OHW Modifications	3 weeks	n/a
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.5 Campsie Precinct (NCA06)

The Campsie precinct is located near various construction worksites that are associated with station works, track works, bridges, substation works, and lineside works. The Campsie precinct is shown below in **Figure 25**.

Figure 25 Campsie Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.5.1 NCA Discussion

NCA06

- This precinct has Bridge Worksites at the eastern and western ends of the precinct with residential receivers on South Parade and Lilian Lane being in close proximity to these worksites.
- Corridor Works are required around Campsie Station to realign the tracks to meet metro requirements. Receivers surrounding this location are a mix of commercial and residential.
- Station works are required at Campsie Station. The surrounding receivers are a mix of commercial and residential.
- There is a Substation Worksite towards the western end of the precinct, adjacent Lilian Lane, where residential receivers are relatively nearby.

3.11.5.2 Construction Activities

Table 41 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 41 Construction Activities and Period of Works – Campsie

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.5.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 42**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 42 Overview of NML Exceedances from Project – Campsie Precinct (NCA06) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works [5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		668	1	127	35	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		668	26	244	110	16	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		668	1	116	27	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		668	-	86	11	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		668	-	55	1	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		668	6	138	44	4	188	85	13	238	111	30	247	177	96	265	127	46
W.0007		Earthworks - Breaker	10		668	37	255	116	32	299	149	77	232	197	112	-	-	-	-	-	-
W.0008		Trackform	12 days		668	2	116	31	1	149	69	8	197	89	23	279	143	75	177	83	13
W.0009		Trackform - Ballast Tamper	4 days		668	23	193	87	13	281	131	46	282	145	75	111	265	173	88	276	184
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		668	1	99	43	-	144	71	9	172	91	17	287	139	77	193	97	20
W.0011		Comms & Signalling Works	12		668	1	99	43	-	144	71	9	172	91	17	287	139	77	216	94	40
W.0012		Segregation Fencing	6		668	-	88	14	-	111	58	1	143	68	9	263	105	59	151	82	14
W.0013	Station Worksites	Site Establishment	3		668	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		668	-	55	13	-	72	29	-	103	40	6	278	66	29	134	49	13
W.0015		Demolition - Breaker & Saw	6		668	13	132	47	11	261	66	27	325	78	41	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		668	-	45	6	-	70	19	-	74	35	-	198	65	19	78	37	4
W.0017		Station Installation & Fitout	20		668	-	40	-	-	56	16	-	60	27	-	157	51	16	65	19	-
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		668	3	52	17	2	82	33	6	135	44	13	283	79	39	132	44	13
W.0019		Demolition	2		668	1	47	12	1	60	28	3	93	38	6	255	57	31	90	38	6
W.0020		Demolition - Breaker & Saw	2		668	22	201	52	19	295	82	39	296	135	57	-	-	-	-	-	-
W.0021		Construction & Installation	20		668	-	34	6	-	50	17	2	58	28	3	188	49	19	65	30	5

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2]	Number of Receivers																
				%	Total	HNA[3]	With NML Exceedance[4]														
							Standard Daytime			Possession / Closedown Works [5]											
										Daytime OOH			Evening			Night-time			Sleep Disturbance		
				20 40 60 80			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		668	-	34	2	-	39	16	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		668	-	17	-	-	35	1	-	41	9	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

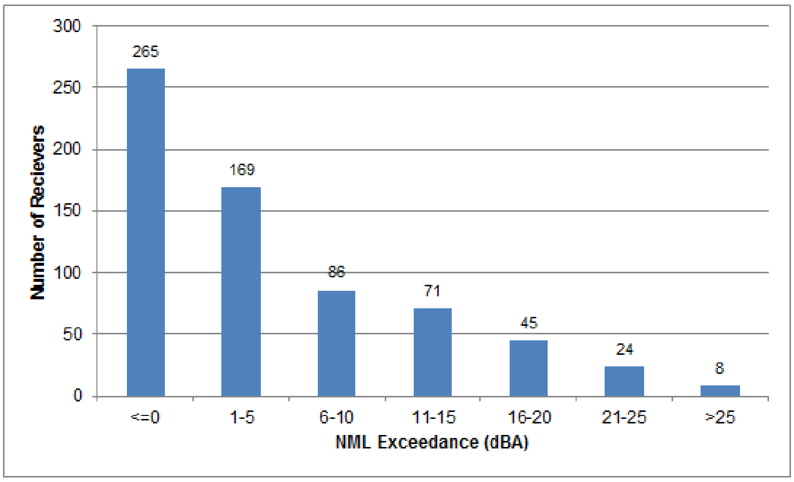
3.11.5.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 42** shows that activities which use noise intrusive plant items, such as a rockbreaker, diamond saw and/or ballast tamper, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0015 – Station Worksites, Demolition - Breaker & Saw
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'. **Figure 26** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 26 NML Exceedances Daytime – 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 32 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in four receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.5.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 42** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

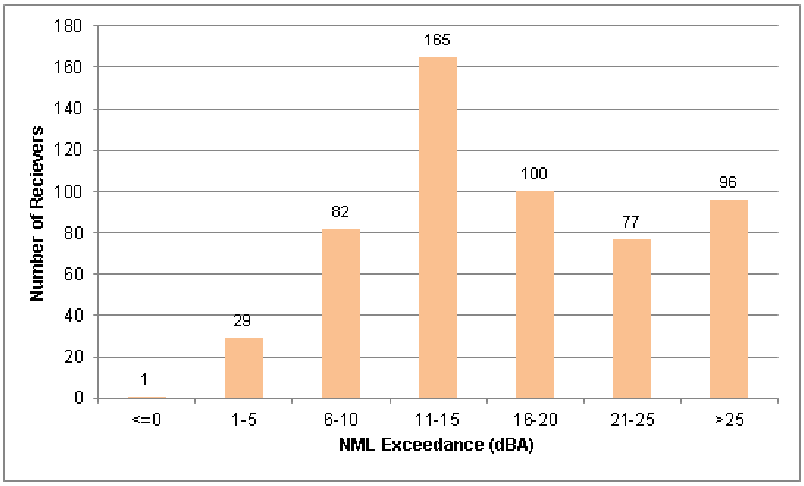
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 27** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

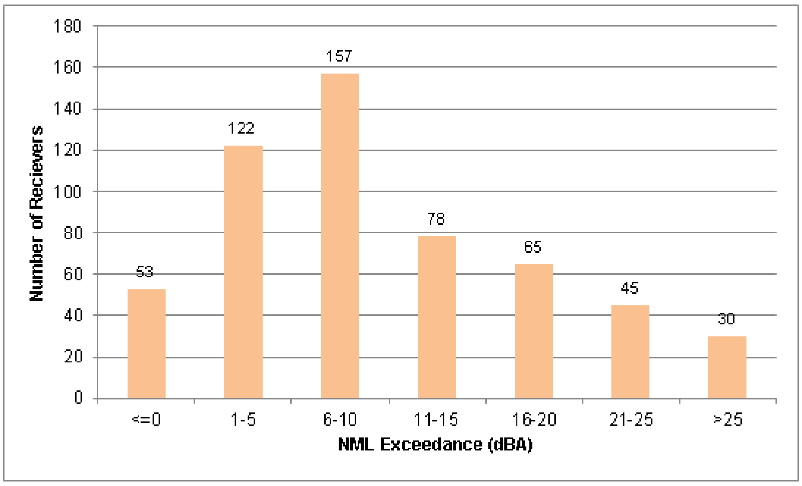
Figure 27 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 173 receivers, there are many receivers in this precinct that are subject to lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 75 receivers, as shown in **Figure 28**.

Figure 28 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track, Trackform'



3.11.5.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 43**. The table shows the number of residential receivers separated by works activity and NCA.

Table 43 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA06		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	1	-	-
W.0002		Earthworks - Breaker	26	-	-
W.0003		Piling	1	-	-
W.0004		Site Establishment	-	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	6	6	6
W.0007		Earthworks - Breaker	37	37	-
W.0008		Trackform	2	2	2
W.0009		Trackform - Ballast Tamper	23	23	23
W.0010	Corridor Works - Track Support Systems	OHW Modifications	1	1	1
W.0011		Comms & Signalling Works	1	1	1
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	13	13	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	3	3	3
W.0019		Demolition	1	1	1
W.0020		Demolition - Breaker & Saw	22	22	-
W.0021		Construction & Installation	-	-	-

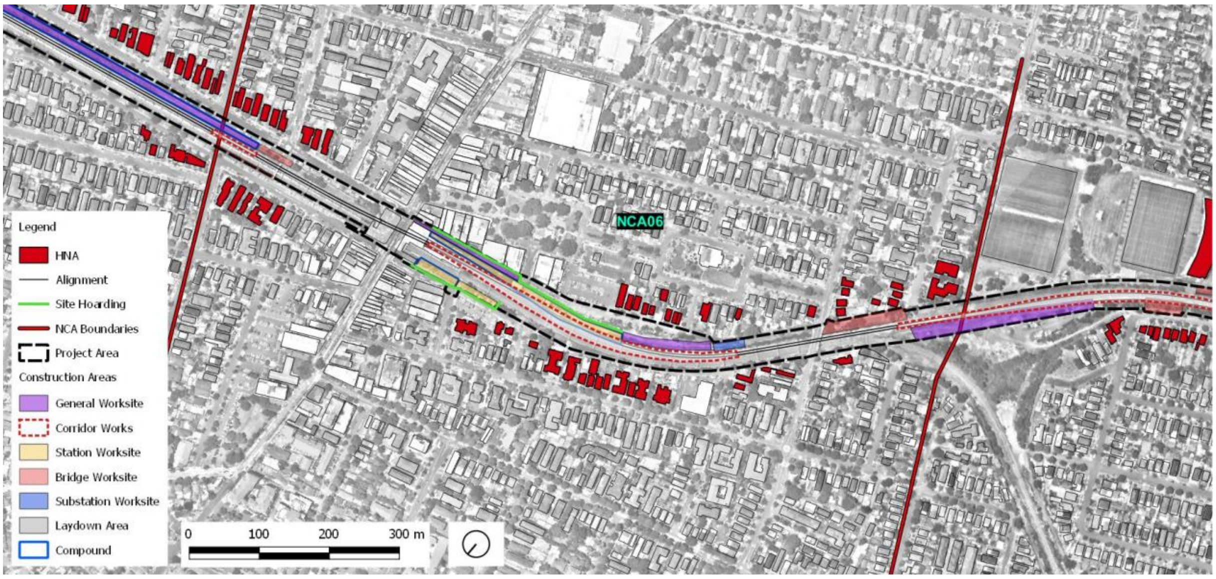
Works	Scenario	Activity	NCA06		
			Day	Eve	Night
W.0022	Substation Worksites	Site Establishment	-	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0002 – General Worksites, Earthworks – Breaker', where 26 receivers are predicted to be Highly Noise Affected during the daytime only and would only be undertaken for approximately three days at any site.
- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 37 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 23 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to two receivers being Highly Noise Affected during this period.
- 'W.0015 – Station Worksites, Demolition - Breaker & Saw', where 13 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 22 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 29**.

Figure 29 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to North Parade and South Parade which is adjacent to Corridor Works, a Bridge Worksite and a General Worksite.
- In the vicinity of Campsie Street, Lilian Street and Wilfred Avenue which is adjacent to Corridor Works, Station Worksites, a Substation Worksite and a General Worksite.
- Near to Lilian Lane and Loch Street which is adjacent to Corridor Works and a Bridge Worksite.

3.11.5.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 44**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 44 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	1	-	-	1	-	-	1	1	-	1	-	-
W.0002		Earthworks - Breaker	7	-	-	1	-	-	2	1	-	2	2	-	1	1	-
W.0003		Piling	-	-	-	-	-	-	1	-	-	1	1	-	1	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	1	-	-	1	-	-	1	1	-	-	1	-
W.0007		Earthworks - Breaker	6	-	-	1	-	-	2	1	-	2	1	1	1	-	1
W.0008		Trackform	-	-	-	-	-	-	1	-	-	1	1	-	-	1	-
W.0009		Trackform - Ballast Tamper	4	-	-	1	-	-	2	-	-	1	2	-	-	1	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	1	-	-	-	1	-	2	1	-	2	-	-
W.0011		Comms & Signalling Works	-	-	-	1	-	-	-	1	-	2	1	-	2	-	-
W.0012		Segregation Fencing	-	-	-	-	-	-	1	-	-	2	-	-	2	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	1	-	-	-	-	-	2	-	-	3	1	-	1	-	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
W.0019		Demolition	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	7	-	-	-	1	-	1	1	-	3	-	-	2	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-

Note 1: The ‘Remaining’ category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Medical – 7 Duke Street, Campsie
  - Place or worship – St John’s Anglican Church, Campsie
  - Childcare – 3 Harold Street, Campsie
  - Childcare – Carrington Occasional Child Care Centre, 2 Carrington Street, Campsie
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Childcare – 70 Campsie Street, Campsie
  - Public building – Campsie Police Station

The recommended ‘standard’ and ‘additional’ noise mitigation for the project is discussed in **Section 3.15.**

3.11.5.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 45** for works which have been found to potentially have the highest impacts.

Table 45 Works Activities and Indicative Durations

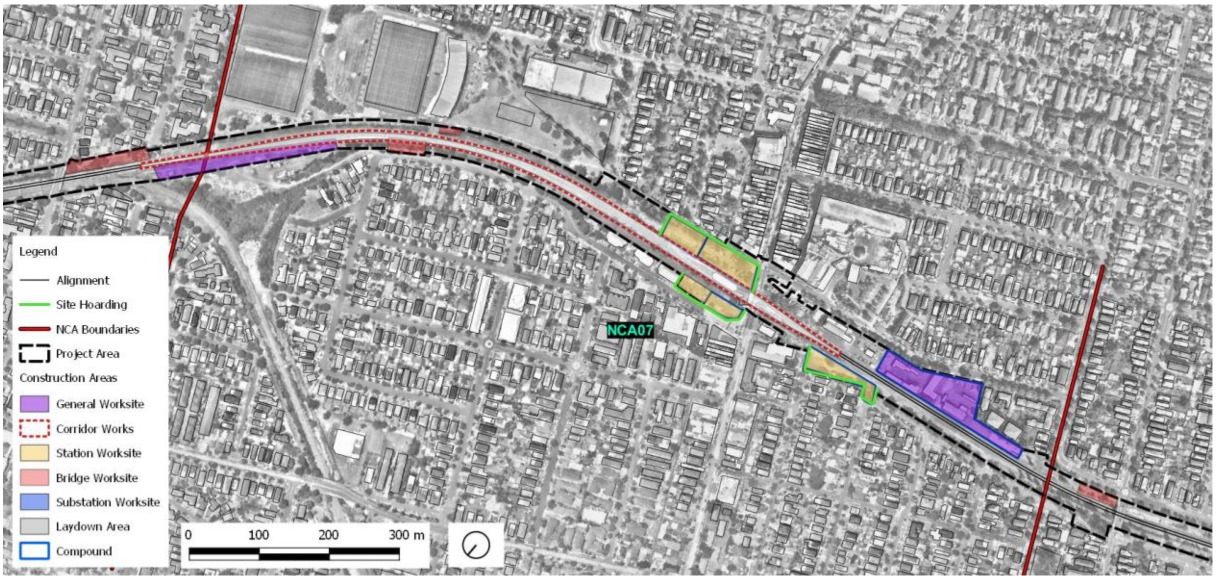
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.6 Belmore Precinct (NCA07)

The Belmore precinct is located near various construction worksites that are associated with station works, track works, bridges and lineside works. The Belmore precinct is shown below in **Figure 30**.

Figure 30 Belmore Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.6.1 NCA Discussion

NCA07

- Corridor Works are required for a large section of this precinct extending from the eastern precinct boundary to the western end of Belmore Station. The works are required to realign the tracks to meet metro requirements. Receivers surrounding this location are mainly commercial and residential.
- Station Works are required at Belmore Station. The surrounding receivers are a mix of commercial and residential.

- Bridge Works are required near to receivers on Redman Parade. The surrounding receivers are a mix residential and other sensitive (sports stadium) receivers.
- Works associated with General Worksites are located adjacent residential receivers on Bridge Road and Lark Street.

3.11.6.2 Construction Activities

Table 46 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 46 Construction Activities and Period of Works – Belmore

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1] Std. Day	Possession / Closedown Works[2] Day	Day OOH	Eve	Night	Comments
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.6.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 47**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 47 Overview of NML Exceedances from Project – Belmore Precinct (NCA07) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] %	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		1068	1	231	43	4	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		1068	22	523	131	38	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		1068	1	178	39	3	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		1068	-	103	25	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		1068	-	66	12	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		1068	-	273	53	6	464	100	25	457	99	24	479	306	62	500	110	28
W.0007		Earthworks - Breaker	10		1068	23	549	170	42	437	400	84	429	395	82	-	-	-	-	-	-
W.0008		Trackform	12 days		1068	-	170	40	2	400	63	21	395	62	20	512	216	44	306	53	8
W.0009		Trackform - Ballast Tamper	4 days		1068	12	468	101	27	510	266	59	502	263	57	309	500	139	268	514	170
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		1068	-	166	57	3	393	88	25	385	87	24	483	193	61	385	86	23
W.0011		Comms & Signalling Works	12		1068	-	166	57	3	393	88	25	385	87	24	483	193	61	431	94	29
W.0012		Segregation Fencing	6		1068	-	98	42	1	224	74	5	219	74	4	482	121	43	279	73	9
W.0013	Station Worksites	Site Establishment	3		1068	-	46	8	2	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		1068	1	94	14	2	227	38	4	226	37	3	514	108	18	257	44	8
W.0015		Demolition - Breaker & Saw	6		1068	8	401	70	15	611	202	36	598	201	34	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		1068	1	64	10	2	167	27	3	166	26	2	382	69	12	166	25	2
W.0017		Station Installation & Fitout	20		1068	-	46	8	2	109	18	2	107	18	1	292	51	9	68	11	1
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		1068	-	87	11	3	270	29	9	270	28	9	580	100	16	216	21	9
W.0019		Demolition	2		1068	-	47	11	-	183	16	8	182	16	8	476	67	12	138	13	7
W.0020		Demolition - Breaker & Saw	2		1068	10	516	87	14	600	270	38	597	270	37	-	-	-	-	-	-
W.0021		Construction & Installation	20		1068	-	29	9	-	88	10	3	87	10	3	325	29	9	87	10	3

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

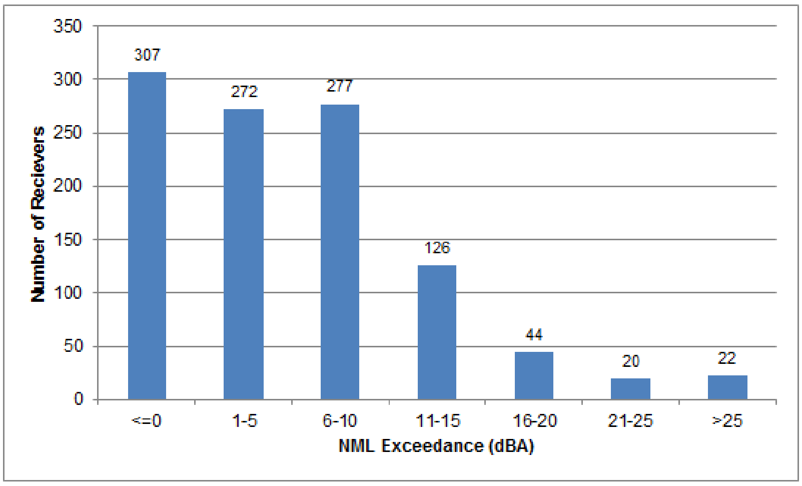
3.11.6.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 47** shows that activities which use noise intrusive plant items, such as a rockbreaker, diamond saw and/or ballast tamper, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0002 – General Worksites, Earthworks - Breaker
- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0015 – Station Worksites, Demolition - Breaker & Saw
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'. **Figure 31** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 31 NML Exceedances Daytime – 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 42 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in six receivers being subject to greater than 20 dB exceedance of the daytime NML.

3.11.6.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 47** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

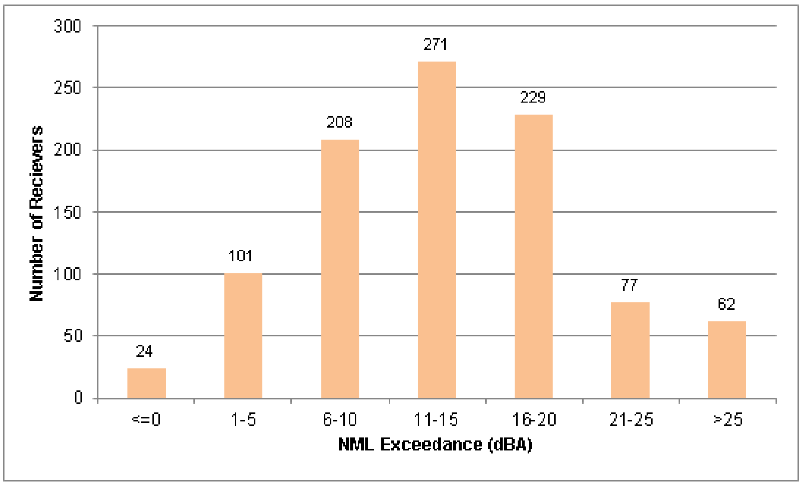
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 32** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

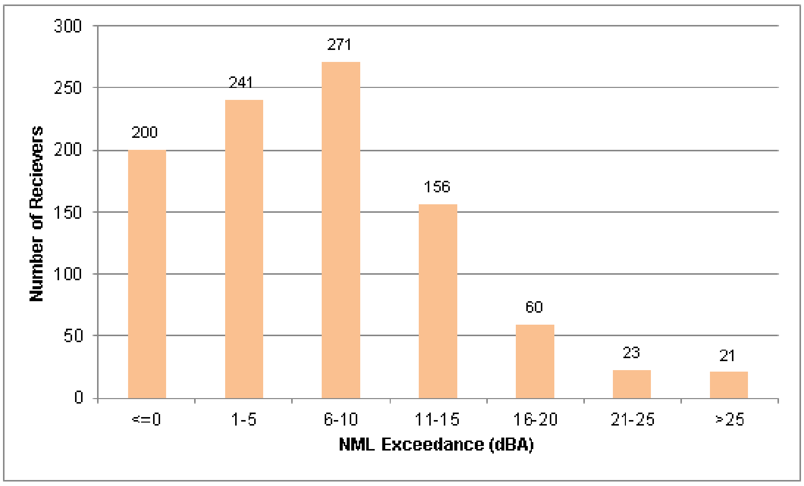
Figure 32 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 139 receivers, there are many receivers in this precinct that are subject to lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 44 receivers, as shown in **Figure 33**.

Figure 33 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track, Trackform'



3.11.6.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 48**. The table shows the number of residential receivers separated by works activity and NCA.

Table 48 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA07		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	1	-	-
W.0002		Earthworks - Breaker	22	-	-
W.0003		Piling	1	-	-
W.0004		Site Establishment	-	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-
W.0007		Earthworks - Breaker	23	23	-
W.0008		Trackform	-	-	-
W.0009		Trackform - Ballast Tamper	12	12	12
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-
W.0011		Comms & Signalling Works	-	-	-
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	1	1	1
W.0015		Demolition - Breaker & Saw	8	8	-
W.0016		Concrete & Structural Works	1	1	1
W.0017		Station Installation & Fitout	-	-	-

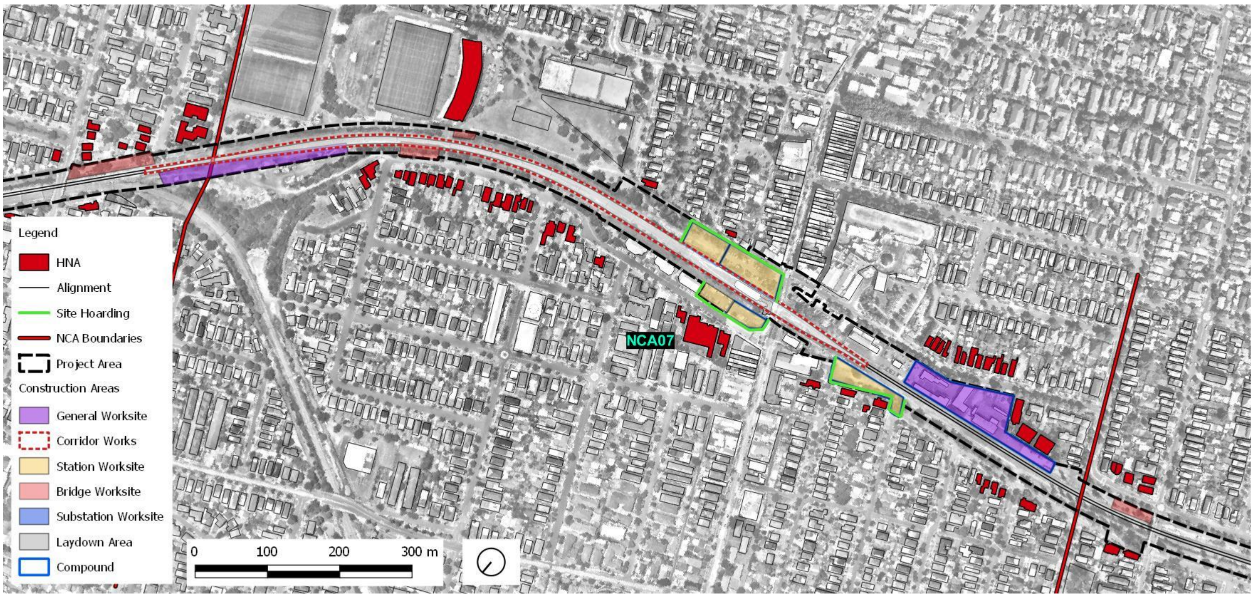
Works	Scenario	Activity	NCA07		
			Day	Eve	Night
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-
W.0019		Demolition	-	-	-
W.0020		Demolition - Breaker & Saw	10	10	-
W.0021		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0002 – General Worksites, Earthworks – Breaker', where 22 receivers are predicted to be Highly Noise Affected during the daytime only and would only be undertaken for approximately three days at any site.
- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 23 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 12 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be Highly Noise Affected during this period.
- 'W.0015 – Station Worksites, Demolition - Breaker & Saw', where eight receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 10 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 34**.

Figure 34 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Redman Parade which is adjacent to Corridor Works, Station Worksites and a Bridge Worksite.
- In the vicinity of Bridge Road and Railway Parade which is adjacent to a General Worksite.

3.11.6.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 49**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 49 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	2	-	-	-	-	-	2	-	-	3	-	-	-	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0006	Corridor Works - Ground & Track	Earthworks	2	1	-	-	-	1	1	-	-	2	-	1	-	1	-
W.0007		Earthworks - Breaker	2	1	1	-	-	1	4	-	-	1	1	1	1	-	1
W.0008		Trackform	1	1	-	-	-	1	-	-	-	1	-	1	-	1	-
W.0009		Trackform - Ballast Tamper	3	-	1	-	-	1	2	-	-	1	1	1	1	-	1
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	1	-	-	-	1	-	-	-	1	-	1	-	1	-
W.0011		Comms & Signalling Works	-	1	-	-	-	1	-	-	-	1	-	1	-	1	-
W.0012		Segregation Fencing	1	-	-	-	1	-	-	-	-	1	-	1	-	1	-
W.0013	Station Worksites	Site Establishment	1	-	-	-	1	-	-	-	-	1	-	1	-	-	-
W.0014		Demolition	1	-	-	-	1	-	-	-	-	-	1	1	1	-	-
W.0015		Demolition - Breaker & Saw	2	1	-	-	-	1	4	-	-	1	-	2	1	1	-
W.0016		Concrete & Structural Works	1	-	-	-	1	-	-	-	-	-	1	1	-	-	-
W.0017		Station Installation & Fitout	1	-	-	-	1	-	-	-	-	1	-	1	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0019		Demolition	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	1	-	1	1	-	-	1	-	-	2	-	-	1	-	-
W.0021		Construction & Installation	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The ‘Remaining’ category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Educational – Montessori Preschool, 24 Redman Parade, Belmore
  - Childcare – Montessori Child Care, 24 Redman Parade, Belmore
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Educational – 10 Redman Parade Belmore
  - Medical – 38-40 Redman Parade, Belmore
  - Childcare – 38 Redman Parade, Belmore
  - Public building – Belmore Community Centre

The recommended ‘standard’ and ‘additional’ noise mitigation for the project is discussed in **Section 3.15**.

3.11.6.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 50** for works which have been found to potentially have the highest impacts.

Table 50 Works Activities and Indicative Durations

Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.7 Lakemba Precinct (NCA08)

The Lakemba precinct is located near various construction worksites that are associated with station works, track works, bridges, substation works and lineside works. The Lakemba precinct is shown below in **Figure 35**.

Figure 35 Lakemba Precinct – Construction Areas

Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.7.1 NCA Discussion

NCA08

- This precinct has a number of Station Worksites with residential and commercial receivers on The Boulevarde and Railway Parade being in proximity to these worksites.
- Corridor Works are required around Lakemba Station to realign the tracks to meet metro requirements. Receivers surrounding this location are a mixture of commercial and residential.
- There is a Substation Worksite located to the east of Lakemba Station on The Boulevarde, where residential receivers are relatively close by.

3.11.7.2 Construction Activities

Table 51 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 51 Construction Activities and Period of Works – Lakemba

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.7.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 52**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 52 Overview of NML Exceedances from Project – Lakemba Precinct (NCA08) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers Total	HNA[3]	With NML Exceedance[4] Standard Daytime 1-10 dB	11-20 dB	>20 dB	Possession / Closedown Works[5] Daytime OOH 1-10 dB	11-20 dB	>20 dB	Evening 1-10 dB	11-20 dB	>20 dB	Night-time 1-10 dB	11-20 dB	>20 dB	Sleep Disturbance 1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	6		667	-	11	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		667	-	77	5	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		667	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		667	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		667	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		667	-	80	16	1	139	42	1	134	41	-	311	80	19	154	45	-
W.0007		Earthworks - Breaker	10		667	19	270	64	7	399	103	34	358	101	32	-	-	-	-	-	-
W.0008		Trackform	12 days		667	-	64	7	-	103	34	-	101	32	-	271	58	10	80	19	-
W.0009		Trackform - Ballast Tamper	4 days		667	4	164	44	3	322	76	17	295	74	15	339	155	45	301	187	52
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		667	-	99	4	-	126	63	-	124	61	-	298	98	6	122	60	-
W.0011		Comms & Signalling Works	12		667	-	99	4	-	126	63	-	124	61	-	298	98	6	143	69	-
W.0012		Segregation Fencing	6		667	-	77	1	-	111	20	-	108	19	-	196	79	-	105	30	-
W.0013	Station Worksites	Site Establishment	3		667	-	18	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		667	-	31	8	-	82	14	-	81	12	-	265	35	6	104	15	1
W.0015		Demolition - Breaker & Saw	6		667	8	220	26	6	399	70	14	362	69	12	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		667	-	26	4	-	55	12	-	54	10	-	177	25	2	53	9	-
W.0017		Station Installation & Fitout	20		667	-	18	2	-	38	7	-	37	6	-	118	19	1	25	2	-
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		667	-	24	5	-	38	18	-	37	16	-	112	29	2	32	12	-
W.0019		Demolition	2		667	-	20	3	-	34	9	-	33	7	-	77	20	2	30	3	-
W.0020		Demolition - Breaker & Saw	2		667	7	102	24	5	257	38	18	253	37	16	-	-	-	-	-	-
W.0021		Construction & Installation	20		667	-	17	1	-	25	3	-	24	2	-	41	15	-	23	2	-

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2]	Number of Receivers																
				%	Total	HNA[3]	With NML Exceedance[4]														
							Standard Daytime			Possession / Closedown Works[5]											
										Daytime OOH			Evening			Night-time			Sleep Disturbance		
				20 40 60 80			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		667	-	29	5	-	66	15	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		667	-	15	-	-	27	5	-	27	5	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

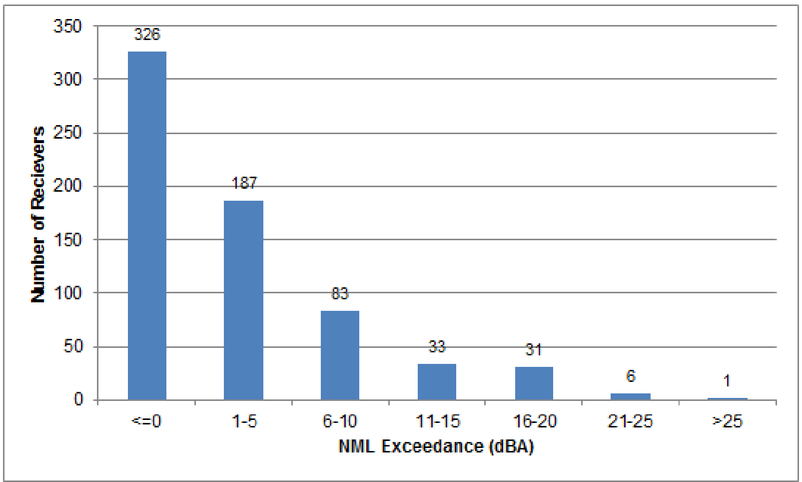
3.11.7.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 52** shows that activities which use noise intrusive plant items, such as a rockbreaker and/or diamond saw, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0015 – Station Worksites, Demolition - Breaker & Saw
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works, Ground & Track, Earthworks – Breaker'. **Table 61** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 36 NML Exceedances Daytime – 'W.0007 – Corridor Works, - Ground & Track, Earthworks – Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to only seven receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in one receiver being subject to greater than 20 dB exceedance of the daytime NML.

3.11.7.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

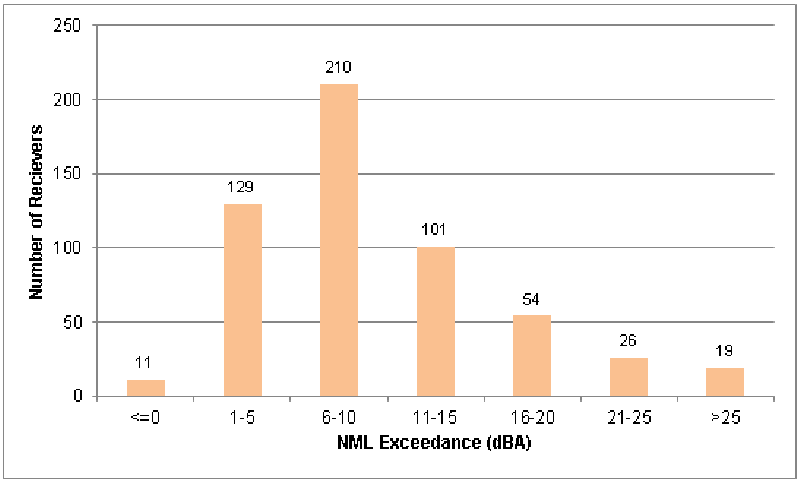
During out of hours construction works, **Table 52** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0008 – Corridor Works - Ground & Track - Trackform
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 37** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

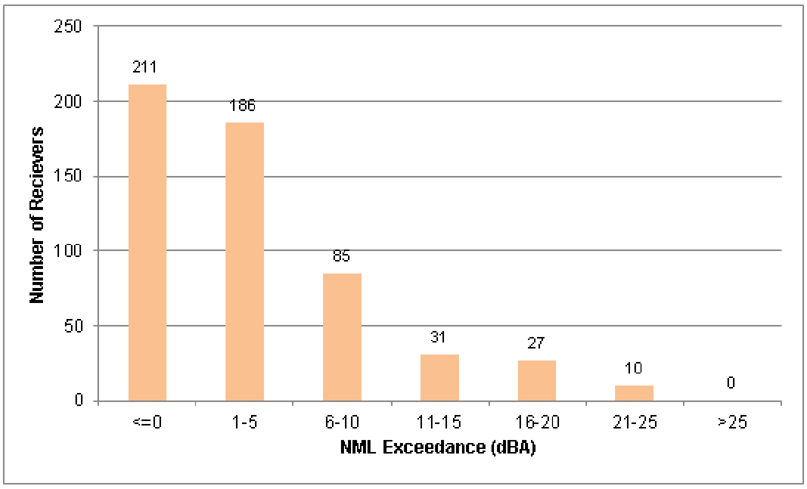
Figure 37 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs this is limited to 45 receivers, with the majority of the receivers in this precinct being subject to considerably lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 10 receivers, as shown in **Figure 38**.

Figure 38 NML Exceedances Night-time – 'W.0008 – Corridor Works - Ground & Track - Trackform'



3.11.7.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 53**. The table shows the number of residential receivers separated by works activity and NCA.

Table 53 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA08		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	-	-	-
W.0002		Earthworks - Breaker	-	-	-
W.0003		Piling	-	-	-
W.0004		Site Establishment	-	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-
W.0007		Earthworks - Breaker	19	19	-
W.0008		Trackform	-	-	-
W.0009		Trackform - Ballast Tamper	4	4	4
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-
W.0011		Comms & Signalling Works	-	-	-
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	8	8	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-
W.0019		Demolition	-	-	-
W.0020		Demolition - Breaker & Saw	7	7	-
W.0021		Construction & Installation	-	-	-

Works	Scenario	Activity	NCA08		
			Day	Eve	Night
W.0022	Substation Worksites	Site Establishment	-	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 19 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where four receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be Highly Noise Affected during this period.
- 'W.0015 – Station Worksites, Demolition - Breaker & Saw', where eight receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where seven receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 39**.

Figure 39 Highly Noise Affected Residential Receivers

The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Moreton Street, The Boulevarde and Railway Parade which is adjacent to a Bridge Worksite.
- Near to Quigg Street North and Railway Parade which is adjacent to Corridor Works and Station Worksites.
- In the vicinity of Sproule Street and The Boulevard which is adjacent to Corridor Works and Station Worksites.

3.11.7.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 24**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 54 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	1	1	-	2	-	-
W.0002		Earthworks - Breaker	-	-	-	1	-	-	1	-	-	1	2	-	1	1	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	2	-	-	1	-	-	1	-	-	1	1	1	1	1	-
W.0007		Earthworks - Breaker	11	-	-	1	1	-	4	1	-	4	-	2	-	1	1
W.0008		Trackform	-	-	-	1	-	-	1	-	-	-	2	-	1	1	-
W.0009		Trackform - Ballast Tamper	8	-	-	1	1	-	4	1	-	4	-	2	1	-	1
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	1	-	-	1	-	-	-	2	-	-	1	-
W.0011		Comms & Signalling Works	-	-	-	1	-	-	1	-	-	-	2	-	-	1	-
W.0012		Segregation Fencing	-	-	-	1	-	-	1	-	-	1	1	-	1	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	1	-	-	1	1	-	1	-	-
W.0014		Demolition	-	-	-	-	-	-	-	1	-	-	2	-	-	1	-
W.0015		Demolition - Breaker & Saw	9	-	-	2	-	-	3	-	1	4	-	2	1	-	1
W.0016		Concrete & Structural Works	-	-	-	-	-	-	1	-	-	-	2	-	-	1	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	1	-	-	1	1	-	1	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0020		Demolition - Breaker & Saw	1	-	-	-	-	-	2	-	1	2	1	1	1	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Medical – 10 Bellevue Avenue, Lakemba
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Place of worship – Lakemba Uniting Church, 69 Haldon Street, Lakemba
  - Childcare – 27 Railway Parade, Lakemba
  - Childcare – 44 Railway Parade, Lakemba
  - Public building – Canterbury City Community Centre, 130 Railway Parade, Lakemba

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15**.

3.11.7.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 55** for works which have been found to potentially have the highest impacts.

Table 55 Works Activities and Indicative Durations

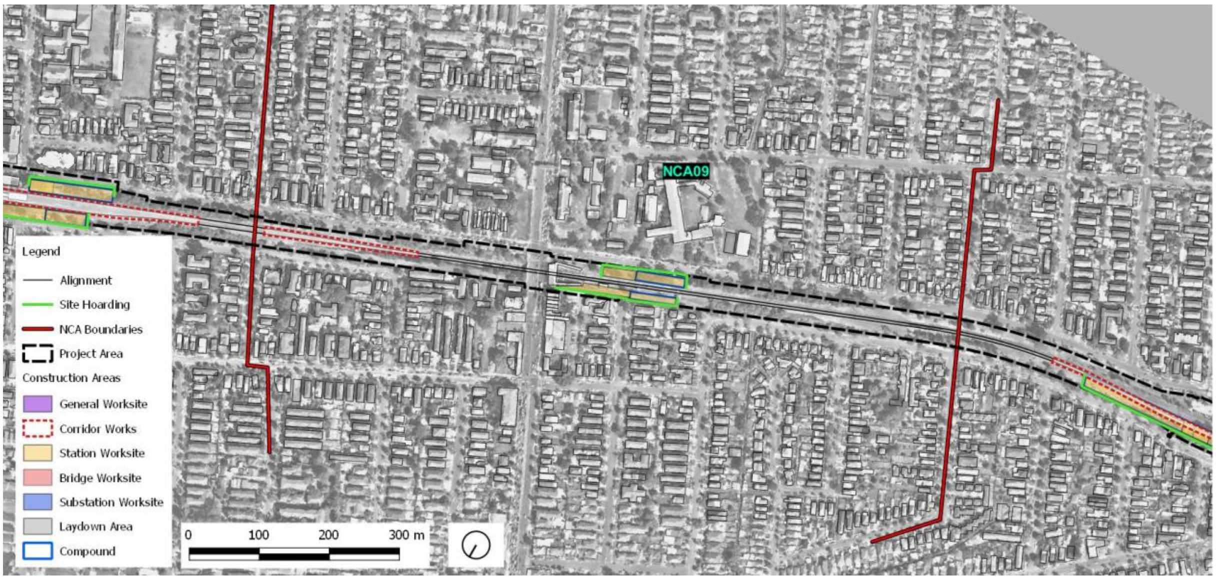
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.8 Wiley Park Precinct (NCA09)

The Wiley Park precinct is located near construction worksites that are associated with station works, track works, bridges and lineside works. The Wiley Park precinct is shown below in **Figure 40**.

Figure 40 Wiley Park Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.8.1 NCA Discussion

NCA09

- This precinct has Station Works around Willey Park Station with residential, educational and commercial receivers in proximity.
- Corridor Works are required to the east of Willey Park Station with residential receivers on The Boulevarde and Railway Parade being relatively close by.

3.11.8.2 Construction Activities

Table 56 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 56 Construction Activities and Period of Works – Wiley Park

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.8.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 57**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 57 Overview of NML Exceedances from Project – Wiley Park Precinct (NCA09) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 40 60 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0006	Corridor Works - Ground & Track	Earthworks	30		606	1	63	27	1	110	35	12	109	35	12	271	82	36	141	46	27
W.0007		Earthworks - Breaker	10		606	27	148	46	27	278	82	36	271	82	36	-	-	-	-	-	-
W.0008		Trackform	12 days		606	1	46	26	1	82	34	2	82	34	2	203	67	32	82	34	2
W.0009		Trackform - Ballast Tamper	4 days		606	12	112	35	12	171	62	28	168	62	28	334	141	73	322	153	82
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		606	-	92	60	-	154	93	4	147	93	4	312	113	88	211	95	11
W.0011		Comms & Signalling Works	12		606	-	92	60	-	154	93	4	147	93	4	312	113	88	233	99	19
W.0012		Segregation Fencing	6		606	-	98	11	-	106	80	1	103	80	1	280	84	60	146	93	4
W.0013	Station Worksites	Site Establishment	3		606	-	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		606	4	44	6	4	140	15	4	133	13	4	406	73	14	245	17	7
W.0015		Demolition - Breaker & Saw	6		606	7	329	35	8	422	109	16	399	101	15	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		606	1	24	6	1	80	10	4	73	10	4	373	47	8	133	13	4
W.0017		Station Installation & Fitout	20		606	-	20	5	-	54	4	4	47	4	4	303	27	7	47	4	4
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		606	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-
W.0019		Demolition	2		606	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	2		606	-	-	-	-	28	-	-	28	-	-	-	-	-	-	-	-
W.0021		Construction & Installation	20		606	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

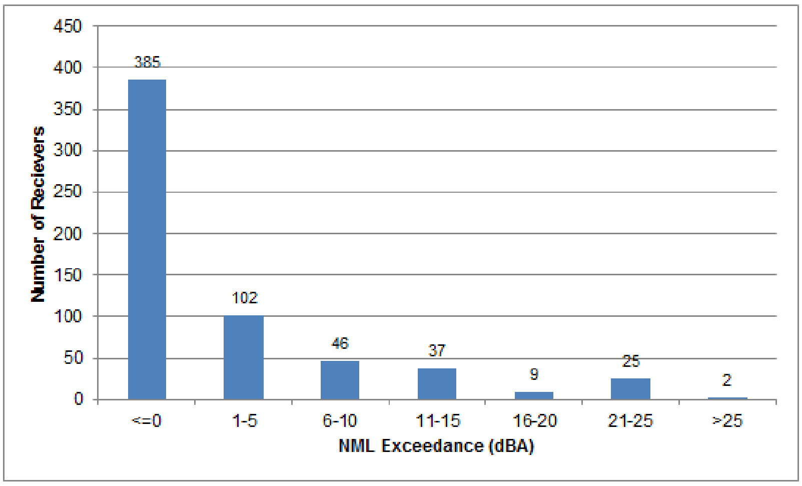
3.11.8.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 57** shows that activities which use noise intrusive plant items, such as a rockbreaker and/or diamond saw, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0015 – Station Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is ‘W.0007 – Corridor Works, Earthworks – Breaker’. **Figure 41** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 41 NML Exceedances Daytime – ‘W.0007 – Corridor Works, Earthworks – Breaker’



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 27 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in one receiver being subject to greater than 20 dB exceedance of the daytime NML.

3.11.8.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain times in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 57** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

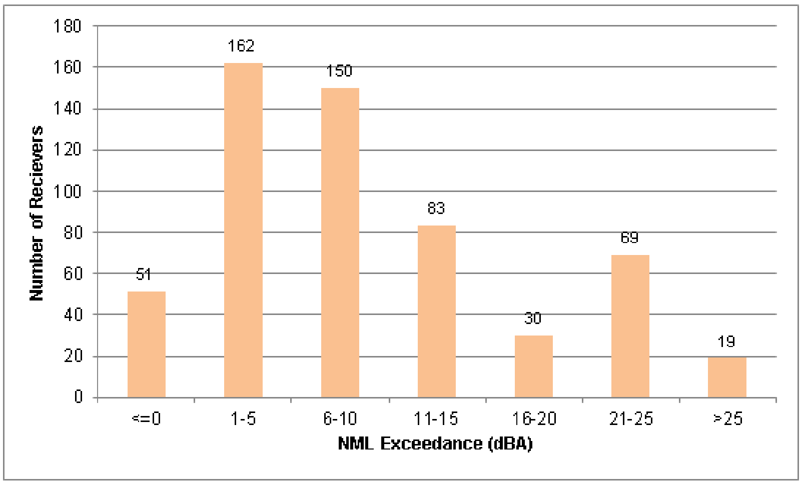
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works
- W.0012 – Corridor Works - Track Support Systems, Segregation Fencing

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010, W.0011 and W.0012. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'. **Figure 42** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

Figure 42 NML Exceedances Night-time – 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 88 receivers, there are many receivers in this precinct that are subject to lower impacts. It is noted that the duration of these impacts at a particular receiver are likely to be relatively short as the works typically progress at a reasonably fast rate.

3.11.8.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 58**. The table shows the number of residential receivers separated by works activity and NCA.

Table 58 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

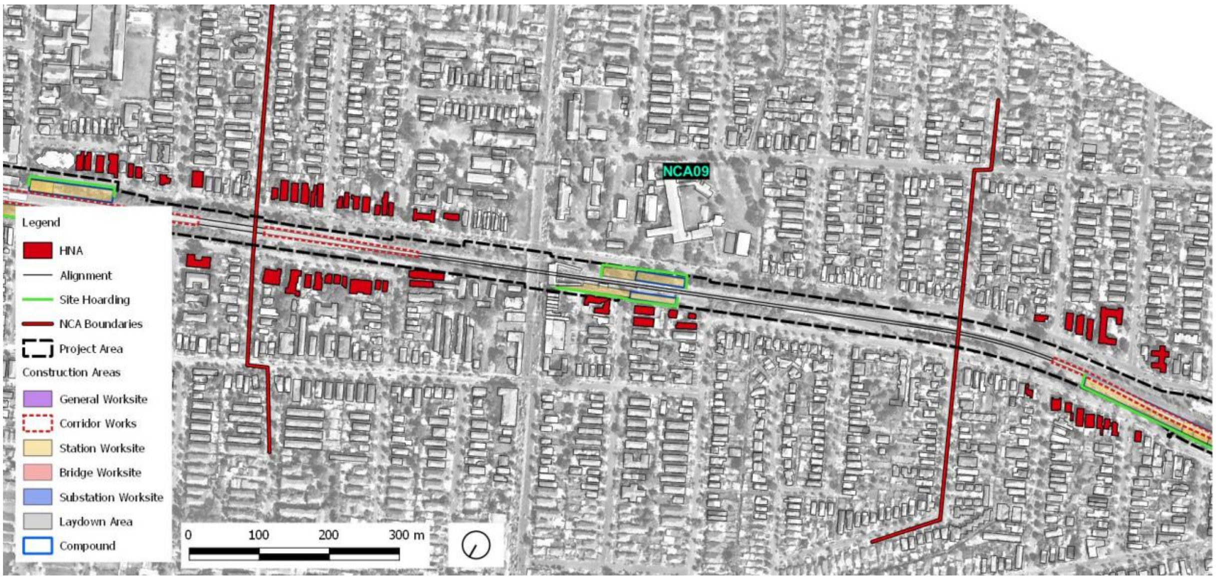
Works	Scenario	Activity	NCA09		
			Day	Eve	Night
W.0006	Corridor Works - Ground & Track	Earthworks	1	1	1
W.0007		Earthworks - Breaker	27	27	-
W.0008		Trackform	1	1	1
W.0009		Trackform - Ballast Tamper	12	12	12
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-
W.0011		Comms & Signalling Works	-	-	-
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	4	4	4
W.0015		Demolition - Breaker & Saw	7	7	-
W.0016		Concrete & Structural Works	1	1	1
W.0017		Station Installation & Fitout	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-
W.0019		Demolition	-	-	-
W.0020		Demolition - Breaker & Saw	-	-	-
W.0021		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 27 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where 12 receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, this would reduce to one receiver being Highly Noise Affected during this period.
- 'W.0015 – Station Worksites, Demolition - Breaker & Saw', where seven receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 43**.

Figure 43 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Alice Street North, Railway Parade and The Boulevarde which is adjacent to Corridor Works.
- In the vicinity of Stanlea Parade and Shadforth Street which is adjacent to Station Worksites.

3.11.8.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 59**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 59 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0007		Earthworks - Breaker	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0009		Trackform - Ballast Tamper	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	7	-	-	-	-	-	1	-	-	-	-	-	-	-	-
W.0011		Comms & Signalling Works	7	-	-	-	-	-	1	-	-	-	-	-	-	-	-
W.0012		Segregation Fencing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0013	Station Worksites	Site Establishment	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	7	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	16	8	1	-	-	-	2	-	-	2	-	-	-	-	-
W.0016		Concrete & Structural Works	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0017		Station Installation & Fitout	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The ‘Remaining’ category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Educational – Wiley Park Girls High School (buildings shielded from the rail corridor)
  - Educational – Lakemba Public School
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Educational – Wiley Park Girls High School (buildings fronting the rail corridor)

The recommended ‘standard’ and ‘additional’ noise mitigation for the project is discussed in **Section 3.15.**

3.11.8.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during Corridor Works where a rockbreaker may be required, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 60** for works which have been found to potentially have the highest impacts.

Table 60 Works Activities and Indicative Durations

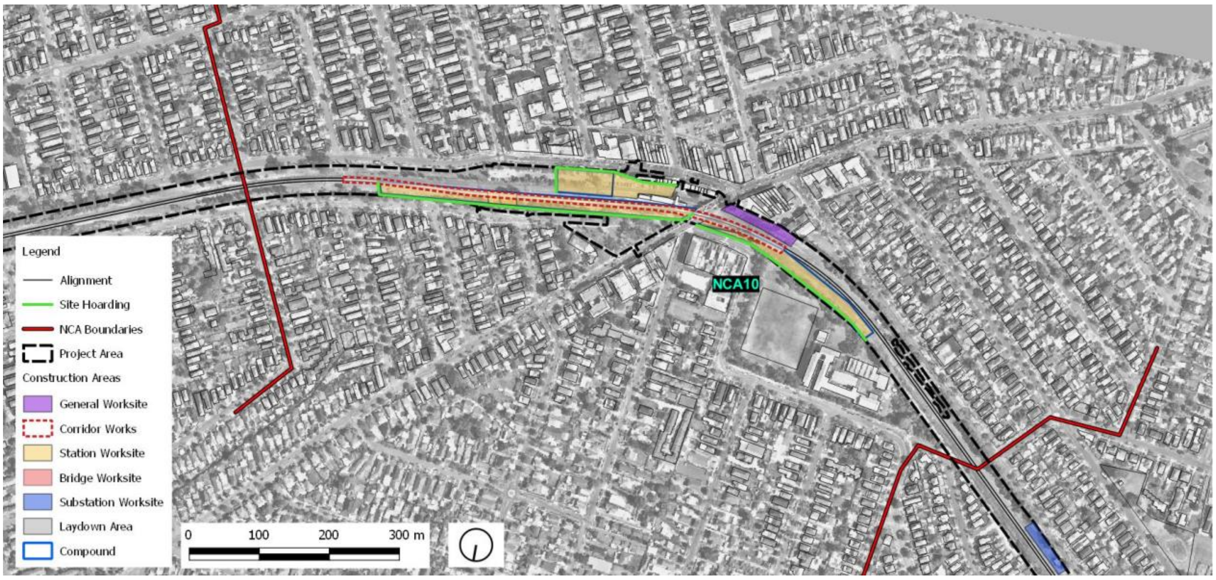
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.9 Punchbowl Precinct (NCA10)

The Punchbowl precinct is located near various construction worksites that are associated with station works, track works, and lineside works. The Punchbowl precinct is shown below in **Figure 44**.

Figure 44 Punchbowl Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.9.1 NCA Discussion

NCA10

- This precinct has a number of Station Worksites with residential receivers on Urunga Parade, The Boulevarde and South Terrace being in proximity of these worksites.
- Corridor Works are required around Punchbowl Station to realign the tracks to meet metro requirements. Receivers surrounding this location are a mixture of commercial and residential.
- Works associated with General Worksites are located adjacent residential and commercial receivers on South Terrace and Punchbowl Road.

3.11.9.2 Construction Activities

Table 61 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 61 Construction Activities and Period of Works – Punchbowl

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1] Std. Day	Possession / Closedown Works[2] Day	Day OOH	Eve	Night	Comments
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

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 (refer **Section 3.7.1**).

3.11.9.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 62**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 62 Overview of NML Exceedances from Project – Punchbowl Precinct (NCA10) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] %	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		718	-	16	1	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		718	-	91	7	2	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		718	-	10	1	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		718	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		718	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		718	-	103	16	1	183	38	1	156	37	-	318	90	15	186	44	-
W.0007		Earthworks - Breaker	10		718	15	281	74	10	373	143	27	342	123	25	-	-	-	-	-	-
W.0008		Trackform	12 days		718	-	74	9	1	143	26	1	123	25	-	271	62	11	89	15	-
W.0009		Trackform - Ballast Tamper	4 days		718	7	186	53	2	320	93	16	293	76	15	327	186	45	315	214	50
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		718	-	94	6	-	131	52	-	111	49	-	258	81	8	111	48	-
W.0011		Comms & Signalling Works	12		718	-	94	6	-	131	52	-	111	49	-	258	81	8	134	50	-
W.0012		Segregation Fencing	6		718	-	65	4	-	92	26	-	81	23	-	168	63	-	77	35	-
W.0013	Station Worksites	Site Establishment	3		718	-	34	2	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		718	-	60	5	-	116	26	-	109	22	-	254	62	-	112	28	-
W.0015		Demolition - Breaker & Saw	6		718	1	223	49	4	395	109	17	362	102	14	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		718	-	42	4	-	87	9	-	82	6	-	185	43	-	82	5	-
W.0017		Station Installation & Fitout	20		718	-	34	2	-	67	2	-	62	-	-	128	31	-	42	-	-
W.0022	Substation Worksites	Site Establishment	2		718	-	1	-	-	12	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		718	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

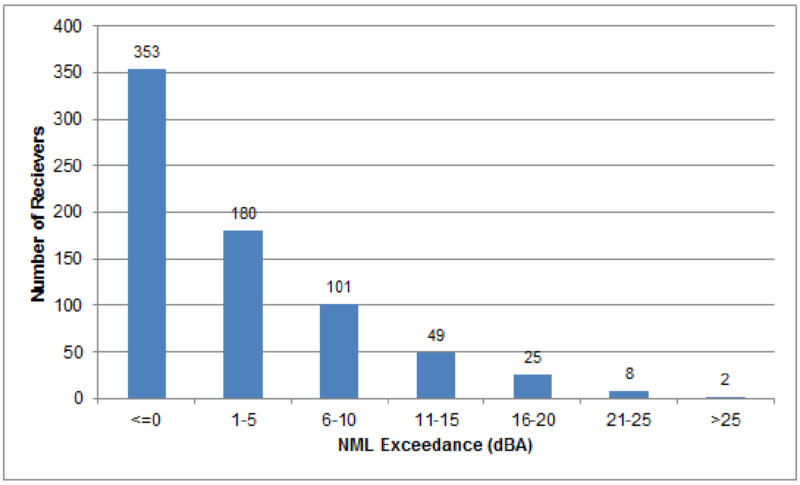
3.11.9.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 62** shows that activities which use noise intrusive plant items, such as a rockbreaker and/or diamond saw, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0015 – Station Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works, Earthworks – Breaker'. **Figure 44** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 45 NML Exceedances Daytime – 'W.0007 – Corridor Works, Earthworks – Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to only 10 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required intermittently during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in one receiver being subject to greater than 20 dB exceedance of the daytime NML.

3.11.9.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain time in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 62** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

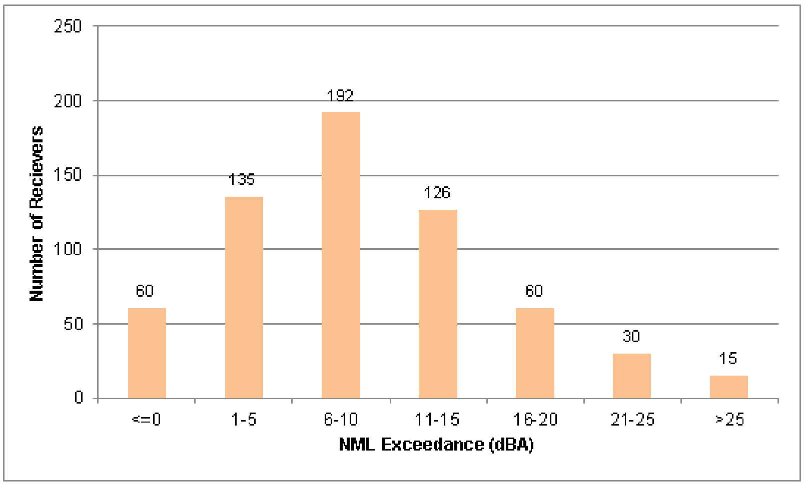
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'. **Figure 46** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

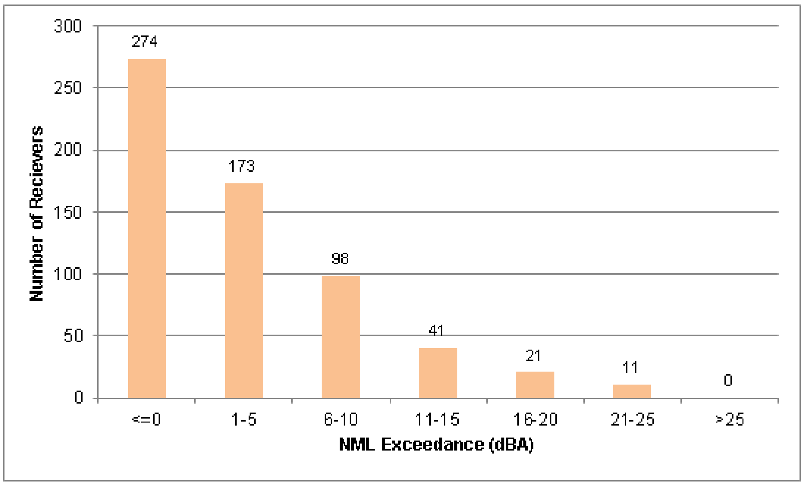
Figure 46 NML Exceedances Night-time – 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs this is limited to 45 receivers, with the majority of the receivers in this precinct being subject to considerably lower impacts.

The above impacts result from the use of a ballast tamper in this construction activity. When this noise intrusive plant item is not in use during the night-time the predicted noise levels and corresponding NML exceedances are expected to reduce by around 7 dB, with the number of night-time exceedances greater than 20 dB above NML reducing to 11 receivers, as shown in **Figure 47**.

Figure 47 NML Exceedances Night-time – 'W.0008 – Ground & Track, Trackform'



3.11.9.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 63**. The table shows the number of residential receivers separated by works activity and NCA.

Table 63 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

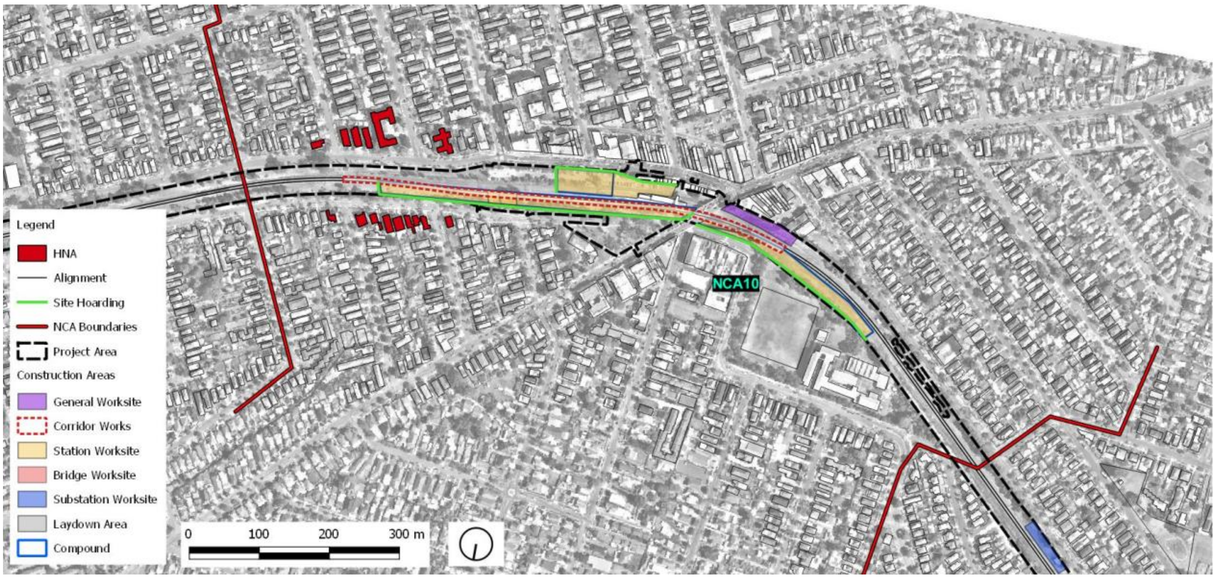
Works	Scenario	Activity	NCA10		
			Day	Eve	Night
W.0001	General Worksites	Earthworks	-	-	-
W.0002		Earthworks - Breaker	-	-	-
W.0003		Piling	-	-	-
W.0004		Site Establishment	-	-	-
W.0005		Operations	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	-	-	-
W.0007		Earthworks - Breaker	15	15	-
W.0008		Trackform	-	-	-
W.0009		Trackform - Ballast Tamper	7	7	7
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-
W.0011		Comms & Signalling Works	-	-	-
W.0012		Segregation Fencing	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-
W.0014		Demolition	-	-	-
W.0015		Demolition - Breaker & Saw	1	1	-
W.0016		Concrete & Structural Works	-	-	-
W.0017		Station Installation & Fitout	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-
W.0023		Construction & Installation	-	-	-

The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker', where 15 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', where seven receivers are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be Highly Noise Affected during this period.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 48**.

Figure 48 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- Near to Urunga Parade and The Boulevarde which is adjacent to Corridor Works and Station Worksites.

3.11.9.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 64**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 64 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	3	-	-	-	1	-	-	-	-	2	-	1	-	-	-
W.0002		Earthworks - Breaker	2	3	-	-	-	1	4	-	-	5	-	1	-	-	-
W.0003		Piling	3	-	-	-	1	-	-	-	-	1	-	1	-	-	-
W.0004		Site Establishment	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-
W.0005		Operations	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	4	-	-	-	1	-	-	-	-	3	1	1	-	-	-
W.0007		Earthworks - Breaker	2	3	-	-	-	1	4	-	-	3	2	2	-	-	-
W.0008		Trackform	3	-	-	-	1	-	-	-	-	2	1	1	-	-	-
W.0009		Trackform - Ballast Tamper	2	2	-	-	-	1	2	-	-	4	2	1	-	-	-
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3	1	-	-	1	-	-	-	-	3	2	-	-	-	-
W.0011		Comms & Signalling Works	3	1	-	-	1	-	-	-	-	3	2	-	-	-	-
W.0012		Segregation Fencing	3	1	-	-	1	-	-	-	-	2	2	-	-	-	-
W.0013	Station Worksites	Site Establishment	3	1	-	1	-	-	-	-	-	1	1	-	-	-	-
W.0014		Demolition	2	2	-	-	1	-	-	-	-	1	2	-	-	-	-
W.0015		Demolition - Breaker & Saw	3	3	1	-	-	1	4	-	-	5	1	2	-	-	-
W.0016		Concrete & Structural Works	3	1	-	-	1	-	-	-	-	1	2	-	-	-	-
W.0017		Station Installation & Fitout	3	1	-	1	-	-	-	-	-	1	1	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Educational – Punchbowl Boys High School (buildings shielded from the rail corridor)
  - Educational – Church of Jesus Christ of Latter Day Saints
  - Childcare – Long Day Pre-School, 21 Dudley Street, Punchbowl
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Educational – Punchbowl Boys High School (buildings fronting the rail corridor)
  - Medical – 15 South Terrace, Punchbowl

- Childcare – Baby Health Centre, 748 Punchbowl Road, Punchbowl
- Childcare – Breust Place, Punchbowl

The recommended ‘standard’ and ‘additional’ noise mitigation for the project is discussed in **Section 3.15.**

3.11.9.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 65** for works which have been found to potentially have the highest impacts.

Table 65 Works Activities and Indicative Durations

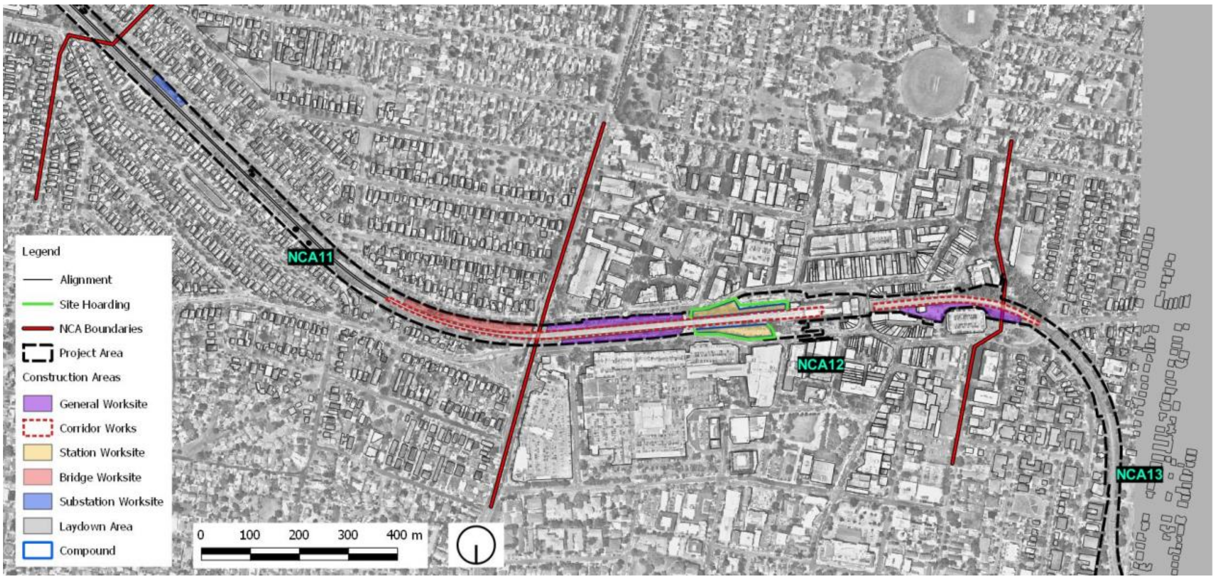
Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.11.10 Bankstown Precinct (NCA11, NCA12 and NCA13)

The Bankstown precinct is located near various construction worksites that are associated with station works, track works, bridges, substation works, and lineside works. The Bankstown precinct is shown below in **Figure 49**.

Figure 49 Bankstown Precinct – Construction Areas



Note: The assessment is based on categorising each construction area by the main activity that would occur within the boundary. Many construction areas would however likely have more than one usage.

Note: Refer to **Appendix E** for large format construction area figures

3.11.10.1 NCA Discussion

NCA11

- Bridge Worksites are situated in the north of this catchment with residential receivers on South Terrace and Wattle Street being in proximity of these worksites.
- Corridor Works are required at the northern end of the catchment with nearby residential receivers on South Terrace and Wattle Street.
- There is a Substation Worksite towards the southern end of the precinct on South Terrace with residential receivers directly adjacent.

NCA12

- The catchment is mainly of a commercial nature, with some residential receivers in the eastern section.
- Corridor Works are required throughout this catchment with commercial receivers adjacent to the rail corridor being the likely most affected.
- Station works are required at Bankstown Station. Most of the surrounding receivers are of a commercial nature, with some residential adjacent on South Terrace.

NCA13

- This catchment is the western end of the project and minimal construction works are required in this area.
- Corridor Works are required in the eastern end of the catchment with some commercial and residential receivers adjacent on Olympic Parade.

3.11.10.2 Construction Activities

Table 66 outlines the construction scenarios and corresponding activities proposed within or directly adjacent this precinct, as well as noting the assessed periods for each activity. The estimated durations of activities are also summarised, noting that the activities would be intermittent during this period and would not be expected to be undertaken every day during the scheduled activity. Further information on project scheduling is presented in **Section 3.7.2** and **Section 3.7.3**.

Table 66 Construction Activities and Period of Works – Bankstown

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works [2]				
					Day	Day OOH	Eve	Night	
General Worksites	W.0001	6	Earthworks	✓	✓	-	-	-	-
	W.0002	6	Earthworks - Breaker	✓	✓	-	-	-	Breaking works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 3 days.
	W.0003	6	Piling	✓	✓	-	-	-	Piling works will only occur intermittently during a 6 week period between 7am – 6pm. Total duration of works will be approximately 2 weeks.
	W.0004	4	Site Establishment	✓	✓	-	-	-	-
	W.0005	52	Operations	✓	✓	-	-	-	-
Corridor Works - Ground & Track	W.0006	30	Earthworks	✓	✓	✓	✓	✓	-
	W.0007	10	Earthworks - Breaker	✓	✓	✓	✓	-	Breaking works will only occur intermittently during 10 weeks of possession. Total duration of works will be approximately 3 days. Works are proposed to be undertaken between 7am – 10pm, unless unforeseen site conditions are encountered which may require night work.
	W.0008	12 days	Trackform	✓	✓	✓	✓	✓	-
	W.0009	4 days	Trackform - Ballast Tamper	✓	✓	✓	✓	✓	-
Corridor Works - Track Support Systems	W.0010	3	OHW Modifications	✓	✓	✓	✓	✓	Works will only occur intermittently during 3 weeks of possession over the total construction program.
	W.0011	12	Comms & Signalling Works	✓	✓	✓	✓	✓	Works will only occur intermittently during 12 weeks of possession over the total construction program.
	W.0012	6	Segregation Fencing	✓	✓	✓	✓	✓	Works will only occur intermittently during 6 weeks of possession over the total construction program.

Scenario	Works ID	Total Indicative Duration (Weeks)[3]	Activity	Hours of Works[1]					Comments
				Std. Day	Possession / Closedown Works[2]				
					Day	Day OOH	Eve	Night	
Station Worksites	W.0013	3	Site Establishment	✓	✓	-	-	-	-
	W.0014	6	Demolition	✓	✓	✓	✓	✓	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0015	6	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Demolition works will only occur for a total duration of approximately 2 weeks during a 6 week possession. Works are proposed to be undertaken between 7am – 10pm unless unforeseen site conditions are encountered which may require night work.
	W.0016	8	Concrete & Structural Works	✓	✓	✓	✓	✓	This includes construction of platform canopy structures and platform re-surfacing
	W.0017	20	Station Installation & Fitout	✓	✓	✓	✓	✓	This includes construction of station canopies, lift shafts and concourse works
Bridge Worksites	W.0018	2	Site Establish. & Impact Protection	✓	✓	✓	✓	✓	Works will be carried out intermittently over a two year period during possessions.
	W.0019	2	Demolition	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0020	2	Demolition - Breaker & Saw	✓	✓	✓	✓	-	Works will be carried out intermittently over a 2 year period during possessions. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.
	W.0021	20	Construction & Installation	✓	✓	✓	✓	✓	Works will be carried out intermittently over a 2 year period during possessions.
Substation Worksites	W.0022	2	Site Establishment	✓	✓	✓	-	-	-
	W.0023	6	Construction & Installation	✓	✓	✓	✓	-	-

Note 1: Noise intrusive works outside of standard construction hours would typically only be undertaken during possessions/closedowns.

Note 2: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm

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 (refer **Section 3.7.1**).

3.11.10.3 NML Exceedances

The predicted NML exceedances in this precinct are summarised in **Table 67**. The assessment presented takes into consideration all construction scenarios associated with the project in this area. 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.

Table 67 Overview of NML Exceedances from Project – Bankstown Precinct (NCA11, NCA12 and NCA13) – All Receiver Types

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 40 60 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime 1-10 dB	Standard Daytime 11-20 dB	Standard Daytime >20 dB	Possession / Closedown Works[5]: Daytime OOH 1-10 dB	Daytime OOH 11-20 dB	Daytime OOH >20 dB	Evening 1-10 dB	Evening 11-20 dB	Evening >20 dB	Night-time 1-10 dB	Night-time 11-20 dB	Night-time >20 dB	Sleep Disturbance 1-10 dB	Sleep Disturbance 11-20 dB	Sleep Disturbance >20 dB
W.0001	General Worksites	Earthworks	6		1223	-	81	5	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	6		1223	6	281	54	3	-	-	-	-	-	-	-	-	-	-	-	-
W.0003		Piling	6		1223	-	68	3	1	-	-	-	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	4		1223	-	32	3	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0005		Operations	52		1223	-	11	1	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	30		1223	1	166	48	1	288	67	6	262	66	5	475	133	43	306	71	21
W.0007		Earthworks - Breaker	10		1223	40	411	127	28	505	238	59	455	215	60	-	-	-	-	-	-
W.0008		Trackform	12 days		1223	-	127	28	-	238	56	3	215	57	3	412	93	38	129	42	1
W.0009		Trackform - Ballast Tamper	4 days		1223	24	309	79	9	434	156	45	399	138	45	551	307	95	526	344	102
W.0010	Corridor Works - Track Support Systems	OHW Modifications	3		1223	-	226	68	4	350	172	11	325	171	11	540	162	132	299	156	16
W.0011		Comms & Signalling Works	12		1223	-	226	68	4	350	172	11	325	171	11	540	162	132	362	159	20
W.0012		Segregation Fencing	6		1223	-	202	31	-	244	127	8	227	125	8	461	155	46	220	146	5
W.0013	Station Worksites	Site Establishment	3		1223	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0014		Demolition	6		1223	-	8	1	-	9	2	-	4	2	-	63	1	2	10	2	-
W.0015		Demolition - Breaker & Saw	6		1223	2	22	8	1	214	9	1	213	3	2	-	-	-	-	-	-
W.0016		Concrete & Structural Works	8		1223	-	8	-	-	9	-	-	4	1	-	27	2	1	2	2	-
W.0017		Station Installation & Fitout	20		1223	-	5	-	-	6	-	-	5	-	-	13	3	-	2	1	-
W.0018	Bridge Worksites	Site Establish. & Impact Protection	2		1223	1	44	26	-	82	31	1	82	31	1	271	63	30	98	31	2
W.0019		Demolition	2		1223	-	35	10	-	63	29	1	63	29	1	211	47	29	73	30	1
W.0020		Demolition - Breaker & Saw	2		1223	30	193	44	26	315	82	32	310	82	32	-	-	-	-	-	-
W.0021		Construction & Installation	20		1223	-	31	1	-	43	26	-	43	26	-	137	34	10	55	29	-

Activity ID	Scenario	Activity	No. Weeks[1]	Activity Duration within Overall Project Program[2] % (20 / 40 / 60 / 80)	Number of Receivers: Total	HNA[3]	With NML Exceedance[4]: Standard Daytime			Possession / Closedown Works [5]: Daytime OOH			Evening			Night-time			Sleep Disturbance		
							1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0022	Substation Worksites	Site Establishment	2		1223	-	29	17	-	51	33	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	6		1223	-	33	-	-	29	17	-	29	17	-	-	-	-	-	-	-

Note 1: Durations should be regarded as indicative and represent a typical worksite. There would be sites within each category that require works to be shorter or longer than shown. The duration of these impacts is less than the overall duration, and depends on the rate of progress in the works areas.

Note 2: Approximate percentage (rounded to the nearest 10%) of activity duration within overall project program.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 4: Based on worst case predicted noise levels.

Note 5: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

The above shows that relatively high noise impacts at many receivers are predicted during some of the higher noise generating construction activities. It is however noted that during most activities, it is expected that the construction noise levels would frequently be lower than the worst-case levels predicted above for significant periods of time.

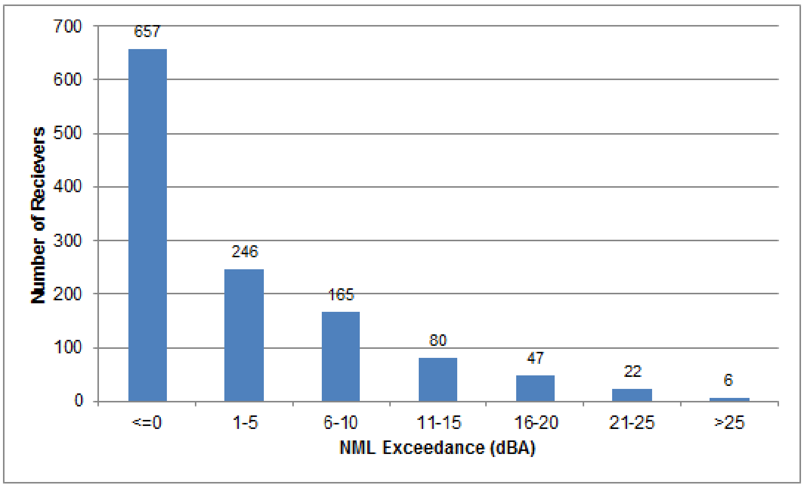
3.11.10.4 Worst-case Impacts during Standard Daytime Construction Hours

During standard daytime construction hours, **Table 67** shows that activities which use noise intrusive plant items, such as a rockbreaker, diamond saw and/or ballast tamper, result in the most receivers with NML exceedances. The highest impacts are predicted during the following works in this precinct:

- W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0020 – Bridge Worksites, Demolition - Breaker & Saw

The activity with potential for the highest number of NML exceedances is 'W.0007 – Corridor Works, Earthworks – Breaker'. **Figure 50** indicates the distribution of exceedances for this activity for receivers within this precinct during the daytime.

Figure 50 NML Exceedances Daytime – 'W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the daytime NML, this is limited to 28 receivers, with the majority of the receivers in this precinct being subject to considerably lower, or no impacts.

The above impacts result from the use of a rockbreaker in this construction activity, which would likely only be required sporadically during the works and would only be undertaken for approximately three days at any site. When this noise intrusive plant item is not in use the predicted noise levels and corresponding NML exceedances are predicted to reduce by around 8 dB, resulting in one receiver being subject to greater than 20 dB exceedance of the daytime NML.

3.11.10.5 Worst-case Impacts during Out-of-Hours Works

Out of Hours works would only be required during possessions/closedowns. Possessions and closedowns are periods that would be required at certain time in the project, during which the rail lines would be shut down so that construction works can be undertaken on a 24/7 basis. These periods are discussed further in **Section 3.7.4**.

To minimise the potential impacts, rockbreakers and other similarly noise intensive plant items would only be used during the 7 am to 10 pm in the majority of cases. This is discussed further in **Section 3.7.2.1**.

During out of hours construction works, **Table 67** shows that the highest numbers of night-time NML exceedances are apparent for the following works:

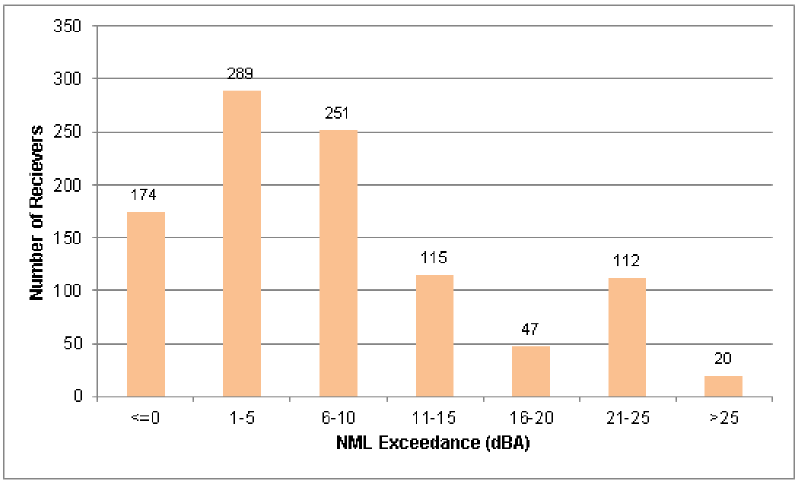
- W.0006 – Corridor Works - Ground & Track, Earthworks
- W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
- W.0010 – Corridor Works - Track Support Systems, OHW Modifications
- W.0011 – Corridor Works - Track Support Systems, Comms & Signalling Works
- W.0012 – Corridor Works - Track Support Systems, Segregation Fencing

Ballast tamping as part of 'W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper', may be required to be undertaken during all periods. This item of plant can produce relatively high noise levels, however the works typically progress at a reasonably fast rate, with individual receivers only likely to be affected for a short duration (ie one or two days).

Relatively large numbers of receivers are predicted to be affected during the 'Track Support Systems" activities W.0010 and W.0011. Whilst these works are not particularly noise intensive, they would be required along the length of corridor in this precinct with many receivers potentially being affected.

The activity with potential for the highest number of NML exceedances during the night-time is 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'. **Figure 51** indicates the distribution of exceedances for this activity for receivers within this precinct during the night-time.

Figure 51 NML Exceedances Night-time – 'W.0010 – Corridor Works - Track Support Systems, OHW Modifications'



The above graph shows that whilst the worst-case impacts may result in a greater than 20 dB exceedance of the night-time NMLs at 132 receivers, there are many receivers in this precinct that are subject to lower impacts. It is noted that the duration of these impacts at a particular receiver are likely to be relatively short as the works typically progress at a reasonably fast rate.

3.11.10.6 Highly Noise Affected Residential Receivers

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of Highly Noise Affected receivers in this precinct has been determined and is summarised in **Table 68**. The table shows the number of residential receivers separated by works activity and NCA.

Table 68 Predicted Number of Highly Noise Affected Residential Receivers by Works and NCA

Works	Scenario	Activity	NCA11			NCA12			NCA13		
			Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
W.0001	General Worksites	Earthworks	-	-	-	-	-	-	-	-	-
W.0002		Earthworks - Breaker	1	-	-	5	-	-	-	-	-
W.0003		Piling	-	-	-	-	-	-	-	-	-
W.0004		Site Establishment	-	-	-	-	-	-	-	-	-
W.0005		Operations	-	-	-	-	-	-	-	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	1	1	1	-	-	-	-	-	-
W.0007		Earthworks - Breaker	32	32	-	5	5	-	3	3	-
W.0008		Trackform	-	-	-	-	-	-	-	-	-
W.0009		Trackform - Ballast Tamper	19	19	19	3	3	3	2	2	2
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	-	-	-	-	-	-	-	-
W.0011		Comms & Signalling Works	-	-	-	-	-	-	-	-	-
W.0012		Segregation Fencing	-	-	-	-	-	-	-	-	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	-	-	-
W.0014		Demolition	-	-	-	-	-	-	-	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	2	2	-	-	-	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	-	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	-	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	1	1	1	-	-	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	30	30	-	-	-	-	-	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-

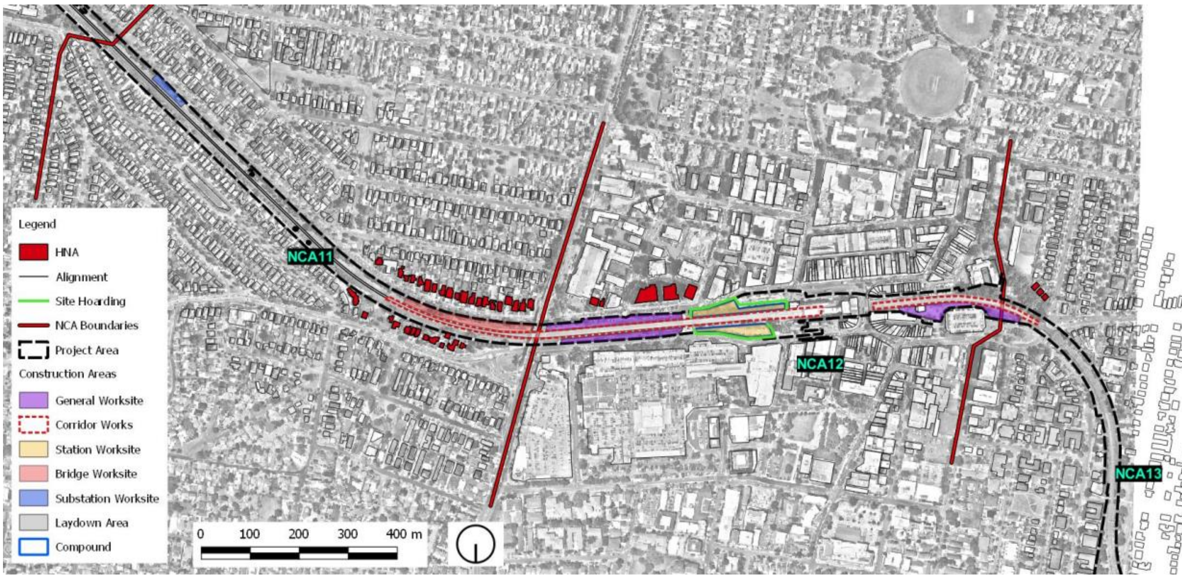
The above table shows that receivers are predicted to be Highly Noise Affected in this catchment during certain works activities. The highest numbers are apparent during:

- ‘W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker’, where 32 receivers are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time and would only be undertaken for approximately three days at any site.
- ‘W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper’, where 19 receivers in NCA11, three receivers in NCA12 and two receivers in NCA13 are predicted to be Highly Noise Affected during the daytime, evening and night-time periods. If the ballast tamper were to not be used during the night-time, no receivers would be Highly Noise Affected during this period.

- 'W.0020 – Bridge Worksites, Demolition - Breaker & Saw', where 30 receivers in NCA11 are predicted to be Highly Noise Affected during the daytime and evening. No rockbreaking would however be undertaken during the night-time. Demolition works will only occur for a total duration of approximately 2 weeks during these possessions.

The location of the Highly Noise Affected residential receivers in this precinct, from all works and in any time period, are shown in **Figure 52**.

Figure 52 Highly Noise Affected Residential Receivers



The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Many of the first row receivers in this area are predicted to be Highly Noise Affected, however this would only be expected to be apparent when high noise generating works are being carried out immediately adjacent to nearby residential receivers. The potentially most affected areas are:

- In NCA11:
  - Near to Wattle Street and South Terrace which is adjacent to Corridor Works and a Bridge Worksite.
- In NCA12:
  - Near to South Terrace and East Terrace which is adjacent to a General Worksite and Station Worksites.
- In NCA13:
  - In the vicinity of Olympic Parade which is adjacent to Corridor Works and a General Worksite.

3.11.10.7 Other Sensitive Receivers

Other sensitive receivers, such as educational facilities, hospitals and childcare centres, which are potentially affected by construction works in this precinct have been assessed against the various criteria detailed in **Section 3.3**.

The predicted daytime NML exceedances for other sensitive receivers are summarised in **Table 69**. The assessment takes into consideration all construction scenarios associated with the project and presents the number of receivers predicted to experience exceedances of the daytime NMLs, summarised in bands of 10 dB, separated by receiver type.

Table 69 Overview of Sensitive Receiver NML Exceedances in Precinct – Daytime

Works	Scenario	Activity	Education			Medical			Place of Worship			Childcare			Remaining[1]		
			1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
W.0001	General Worksites	Earthworks	-	-	1	-	-	-	2	-	-	2	1	-	1	3	-
W.0002		Earthworks - Breaker	8	-	1	-	-	-	1	2	-	2	2	1	5	3	1
W.0003		Piling	-	-	1	-	-	-	2	-	-	2	1	-	2	2	-
W.0004		Site Establishment	-	1	-	-	-	-	2	-	-	1	1	-	3	1	-
W.0005		Operations	-	1	-	-	-	-	-	-	-	1	-	-	3	-	-
W.0006	Corridor Works - Ground & Track	Earthworks	1	-	1	-	-	-	2	-	-	3	2	-	3	4	-
W.0007		Earthworks - Breaker	8	-	1	1	-	-	2	2	-	2	3	1	8	2	3
W.0008		Trackform	-	1	-	-	-	-	2	-	-	3	1	-	2	3	-
W.0009		Trackform - Ballast Tamper	7	-	1	1	-	-	3	1	-	4	2	-	6	1	3
W.0010	Corridor Works - Track Support Systems	OHW Modifications	-	2	-	-	-	-	3	1	-	2	1	-	2	3	-
W.0011		Comms & Signalling Works	-	2	-	-	-	-	3	1	-	2	1	-	2	3	-
W.0012		Segregation Fencing	-	2	-	-	-	-	2	1	-	2	-	-	2	2	-
W.0013	Station Worksites	Site Establishment	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-
W.0014		Demolition	-	-	-	-	-	-	1	-	-	2	1	-	1	-	-
W.0015		Demolition - Breaker & Saw	-	-	-	-	-	-	1	1	-	2	2	1	4	1	-
W.0016		Concrete & Structural Works	-	-	-	-	-	-	1	-	-	2	-	-	1	-	-
W.0017		Station Installation & Fitout	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-
W.0018	Bridge Worksites	Site Estab. & Impact Protection	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0019		Demolition	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
W.0020		Demolition - Breaker & Saw	3	-	-	-	-	-	1	-	-	3	1	-	1	-	-
W.0021		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0022	Substation Worksites	Site Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W.0023		Construction & Installation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: The 'Remaining' category includes public buildings, libraries, café/bars, etc.

The above table shows the following:

- The other sensitive receivers in this precinct are predicted to generally be subject to relatively minor impacts, with many receiver types and works activities not resulting in any exceedances of NMLs.
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of 11 to 20 dB above NML during the higher noise generating activities are:
  - Educational – Al Amanah College, 4 Winspear Avenue, Bankstown
  - Place of worship – St Euphemia Greek Orthodox Church, 6 East Terrace, Bankstown
  - Childcare – Roly Poly Education Child Care, 9 East Terrace, Bankstown
  - Café/bar – three receivers on Bankstown City Plaza, Bankstown
- Other sensitive receivers in this area which are predicted to be subject to worst-case exceedances of >20 dB above NML during the higher noise generating activities are:
  - Educational – Bankstown Arts Centre, 5 Olympic Parade, Bankstown
  - Café/bar – three receivers on Chapel Road, Bankstown

The recommended 'standard' and 'additional' noise mitigation for the project is discussed in **Section 3.15.**

3.11.10.8 Duration

Whilst impacts during noise intensive works are likely to affect a substantial number of the surrounding receivers, it is noted that the use of rockbreakers and similarly noise intensive plant items would be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which may require these night-time works to happen occasionally.

Furthermore, noise intensive activities would typically only be required to be undertaken for relatively short periods of the total project duration. For example, during general earthworks where a rockbreaker may be required to remove existing concrete slabs, the rockbreaker plant would only be in operation for approximately three days of the six week total works activity. The indicative durations for the total works activities, and the noise intensive plant operation durations are shown below in **Table 70** for works which have been found to potentially have the highest impacts.

Table 70 Works Activities and Indicative Durations

Works ID	Activity	Indicative Works Activity Duration	Indicative Noise Intensive Works Duration
W.0002	General Worksites, Earthworks - Breaker	6 weeks	3 days
W.0007	Corridor Works - Ground & Track, Earthworks - Breaker	10 weeks	3 days
W.0009	Corridor Works - Ground & Track, Trackform - Ballast Tamper	4 days	4 days
W.0015	Station Worksites, Demolition - Breaker & Saw	6 weeks	2 weeks
W.0020	Bridge Worksites, Demolition - Breaker & Saw	2 weeks	2 weeks

Noise intensive works would be required on an intermittent basis during the above activities and would not be expected to operate continuously every day during the scheduled activity.

3.12 Summary of Potential Construction Impacts

The following provides a summary of the potential construction impacts from the project:

- Relatively high noise levels are predicted from the construction works in most catchments along the alignment. Noise levels are typically higher for front row receivers which have line of sight to the works, and where construction works are situated in close proximity to receivers.
- The highest noise levels and greatest impacts are associated with activities that have noise intensive plant items, including:
  - Rockbreaker
  - Diamond saw
  - Ballast tamper
- Scenarios with noise intensive plant items include:
  - W.0002 – General Worksites, Earthworks - Breaker
  - W.0007 – Corridor Works - Ground & Track, Earthworks - Breaker
  - W.0009 – Corridor Works - Ground & Track, Trackform - Ballast Tamper
  - W.0015 – Station Worksites, Demolition - Breaker & Saw
  - W.0020 – Bridge Worksites, Demolition - Breaker & Saw

- Receivers are considered to be highly noise affected if construction noise levels exceed 75 dBA L_{Aeq}. Due to the close vicinity of the works, the assessment has identified worst-case construction works are likely to result in noise levels above 75 dBA during construction activities which are adjacent to receivers.
- During standard daytime construction hours, the highest impacts are generally predicted to be at receivers which are adjacent to worksites during the use of noise intensive plant items such as rockbreakers. Receivers which are further back from the works generally have lower predicted noise levels and correspondingly lower NML exceedances.
- Works outside of standard construction hours have the potential for greater impacts throughout the study area, especially during the most sensitive night-time period. This results from more stringent NMLs during these periods than the less sensitive daytime.
- Work outside of standard daytime construction hours would however only be undertaken as part of possessions/closedowns, during which time the rail lines would be shut down so construction works can be undertaken on a 24/7 basis. As the project would be staged, not all areas of the project would have construction works during every possession/closedown (refer to **Section 3.7.4**).
- The potential impacts during the night-time have been controlled to some extent due to rockbreakers and other similarly noise intensive plant items being restricted to 7 am to 10 pm, in the majority of cases. This is discussed further in **Section 3.7.2.1**.
- Restricting the use of noise intensive plant items to outside of the night-time period provides a large benefit in reducing the predicted noise levels and similarly reduces the extent and magnitude of the NML exceedances.

3.13 Sleep Disturbance

Review of the predicted $L_{A1(1minute)}$ exceedances at the nearest noise sensitive receivers provided in the preceding sections indicates that the sleep disturbance screening criterion is likely to be exceeded when night works are occurring adjacent to residential receivers for the majority of works scenarios.

At this early stage in the project, the assessment has included predictions of maximum noise impacts for assessment of potential sleep disturbance, however, it is noted that Section 4.3 of the ICNG only requires the project to consider maximum noise levels where construction works are planned to extend over more than two consecutive nights.

The Sydney Metro CNVS contains further details relating to potential sleep disturbance impacts in Section 5.10 and Section 6.4. The CNVS contains procedures on how to assess these impacts in Construction Noise Impact Statements (CNIS), which are site specific assessments of the potential impacts that would be undertake at a later stage in the project, prior to undertaking any construction works.

It is anticipated that the finalised requirements for OOHWs would be determined at a later design stage.

3.14 Cumulative Noise Impacts

The indicative construction program includes a number of overlapping construction phases, however these are representative of the works phase rather than the specific location of the works within each area at any given time.

Cumulative noise impacts warrant assessment where more than one works scenario operates at the same time and in the same location such that the same receiver is impacted by noise from more than one works. The assessment presented in **Section 3.10** to **Section 3.11.10.8** includes concurrent operation of multiple plant items within the same construction scenario.

The prediction of cumulative noise levels from more than one construction scenario within the project area is a complex matter given the number of sources and possible locations of a particular combination of construction works. In practice, it is not always possible to specify the precise location of more than one works scenario for the same 15-minute period and the assessment becomes overly conservative to calculate the cumulative impacts based on all nearby works operating on a worst-case basis at the same time.

Since the works are anticipated to be of a similar nature, the effect of concurrent construction works would likely have a minimal effect on the worst-case predictions presented in **Section 3.10** to **Section 3.11.10.8**, but may however increase the number of 15-minute periods during construction where the predicted worst-case noise impacts are apparent.

In practice, the noise levels would vary due to the fact that plant and equipment would move about the worksites and would not all be operating concurrently.

Given the number of work sites associated with the project it is likely that receivers would, occasionally, be subject to potential cumulative noise impacts from worksites operating concurrently in the same area. This would most likely be apparent during possessions/closedown periods, where multiple worksites would likely be operating in a particular section of the project, potentially on a 24/7 basis.

3.15 Mitigation

The ICNG acknowledges that due to the nature of construction activities in urban areas it is inevitable that there would be noise impacts from construction sites. The NMLs identified in this report have been applied to determine measures for the control of potential construction noise impacts at sensitive receivers.

The project should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and contact details during construction. Works should be undertaken during daytime periods where possible, as noise impacts are generally more intrusive during the more sensitive evening and night-time periods.

A Construction Environmental Management Plan (CEMP) should be prepared during the detailed design phase and implemented through all construction activities. A Construction Noise and Vibration Management Plan (CNVMP) would be included in the CEMP to provide the framework and mechanisms for the management and mitigation of all potential noise and vibration impacts from the project. The CNVMP would be expected to include procedures for dealing with potential impacts during possessions/closedown periods.

All sensitive receivers expected to be exposed to contruction noise levels above NMLs would be consulted with prior to and during construction. To inform this consultation, the CNVMP would:

- Detail any community relation programs that are planned including prior notification for particularly noisy activities, letter box drops regarding out of hours construction work to be undertaken, and ongoing consultation with the community affected by extended hours.
- Include a 24 hour hotline and complaints management process.
- Outline procedures to enter into negotiated agreements for extended hours or out of hours activities, where applicable.

Information that would be provided to residents would include:

- Programmed times and locations of construction work.
- Construction noise and vibration predictions.
- Construction noise and vibration mitigation measures being implemented on site.

Specific details of all out of hours work required would be provided to the relevant authorities as part of the CNVMP.

3.15.1 Standard Mitigation

Particular effort should be directed towards the implementation of all feasible and reasonable noise mitigation and management strategies as per the standard mitigation measures detailed in the ICNG.

Reference is made to the TfNSW CNVS for the Sydney Metro project, which details a number of standard mitigation measures for construction activities that can be applied to reduce construction noise and vibration impacts.

Where identified in the impact assessment, particular effort should be directed towards the implementation of all feasible and reasonable noise mitigation and management strategies, noting that additional site specific measures may also be recommended. Identification of all feasible and reasonable noise mitigation and management strategies would be documented in the projects' Out of Hours Works Strategy and executed as part of the projects' Out of Hours Works Plans.

Standard mitigation measures which may be considered appropriate for the project are shown in **Table 71**.

Table 71 Recommended Standard Noise Mitigation Measures

Action Required	Applies To	Details
Recommended Management Measures		
Implementation of any project specific mitigation measures required.	Airborne noise. Ground-borne noise and vibration.	In addition to the measures set out in this table, any *project specific* mitigation measures identified in the environmental assessment documentation (eg Environmental Impact Statement, Review of Environmental Factors, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures.	Airborne noise. Ground-borne noise and vibration.	Periodic Notification (monthly letterbox drop)[1]. Website. Project information and construction response telephone line. Email distribution list. Place Managers.
Register of Noise Sensitive Receivers.	Airborne noise Ground-borne noise and vibration.	A register of all noise and vibration sensitive receivers (NSRs) would be kept on site. The register would include the following details for each NSR: · Address of receiver. · Category of receiver (eg Residential, Commercial etc.). · Contact name and phone number.

Action Required	Applies To	Details
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction should at least include: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height; throwing of metal items; and slamming of doors. No excessive revving of plant and vehicle engines Controlled release of compressed air. The use of 'engine braking' or 'compression braking' should be avoided wherever feasible.
Monitoring	Airborne noise Ground-borne noise and vibration	A noise and vibration monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Dilapidation survey	Construction vibration	If construction activities have the potential to cause damage through vibration to nearby public utilities, structures, buildings and their contents, an Existing Condition Inspection should be undertaken in accordance with the requirements of the CNVS.
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.
Recommended Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise and vibration Airborne noise	High noise and vibration generating activities[2] may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block[3].

Action Required	Applies To	Details
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment are to have operating Sound Power Levels compliant with the criteria in Table 11 (of the CNVS).
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 11 (of the CNVS).
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) to be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Air brake silencers	Airborne noise	Air brake silencers to be correctly installed and fully operational for any heavy vehicle that approaches and uses any Sydney Metro construction site.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from NSRs Select site access points and roads as far as possible away from NSRs Dedicated loading/unloading areas to be shielded if close to NSRs Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable
Recommended Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources would be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

Note 1 Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works.

Note 2 Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

Note 3 "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

3.15.2 Project Specific Mitigation Measures

Where feasible and reasonable, mitigating impacts via means of source and or path control are preferred when determining appropriate mitigation.

Based on the noise impact assessment of the construction works, the recommended project-specific mitigation measures (in addition to the standard suite of measures in **Table 71**) are summarised in **Table 72**.

Table 72 Recommended Project Specific Noise Mitigation Measures

Activity	Mitigation Description	Reason	Recommendations
All	Noise intensive plant items (such as rockbreaking) has been restricted to the 7:00 am to 10:00 pm period, unless unforeseen site conditions are encountered which may require night work. Ballast tamping may however be required to be undertaken during all periods. Whilst impacts from tamping are likely to be of short duration, the project should consider also restricting the use of this plant item during the night-time period when operating near to receivers.	The assessment has identified that the use of a ballast tamper during the night-time period is likely to result in substantial impacts.	Limit the use of noise the ballast tamper to daytime and evening periods, where feasible.
All	Where feasible, all pilling works should be performed with non-noise intensive bored piling plant.	Bored pilling is significantly less noise intensive than impact pilling.	Constructability studies to accommodate the requirements of bored pilling for all pilling activities wherever feasible.
All worksites near to receivers	At this stage, 3 m hoarding has been included in the assessment at station sites. Hoarding should be used at all long term noise generating sites where receivers are located close by.	Hoarding around all worksites where receivers are nearby would provide mitigation to construction noise levels. Barriers can provide around 5 – 10 dB benefit where the adequately break line of sight to receivers.	Use 3 m hoarding around at all long term noise generating sites where receivers are located close by.

3.15.3 Additional Noise Mitigation Measures

Additional noise mitigation measures to be explored in the CNVMPs in the event of predicted exceedances of the noise goals (particularly during OOHWs) are described in the TfNSW CNVS and *Construction Noise Strategy* (CNS).

Where there is a potential exceedance of the construction noise and vibration management levels a number of additional measures to mitigate such exceedances – primarily aimed at pro-active engagement with affected sensitive receivers – would be considered. The additional mitigation measures to be applied are outlined in **Table 73**.

Table 73 Additional Management Measures

Measure	Description	Abbreviation[1]
Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis.	AA
Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented.	M
Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.	IB
Letter box drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and inform and provide project-specific messages. Advanced warning of potential disruptions (eg traffic changes or noisy works) can assist in reducing the impact on the community. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.	LB
Project specific respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.	RO
Phone calls and emails	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.	PC
Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.	SN

Note 1: Abbreviations reference **Table 74** and **Appendix F**.

In circumstances where, after application of the standard mitigation measures, the $L_{Aeq(15minute)}$ construction noise and vibration levels are still predicted to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (refer to **Table 74**) is to be used to determine the additional measures to be implemented. This requirement is supplemental to the basic requirements in the ICNG.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures to be implemented:

- Determine the duration (time period) when the work is to be undertaken.
- Determine the level of exceedance.
- From the relevant AMMM table, identify the additional mitigation measures to be implemented.

Table 74 Additional Mitigation Measures Matrix – Airborne Construction Noise

Time Period		**Mitigation Measure**			
		$L_{Aeq(15minute)}$ Noise Level above Background (RBL)			
		0 to 10 dBA Noticeable	**10 to 20 dBA Clearly Audible**	**20 to 30 dBA Moderately Intrusive**	**>30 dBA Highly Intrusive**
Standard	Mon-Fri (7am - 6pm)	-	-	LB, M	LB, M
	Sat (8am - 1pm)				
	Sun/Pub Hol. (Nil)				
OOHW Period 1	Mon-Fri (6pm - 10pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN
	Sat (7am - 8am) & (1pm - 10pm)				
	Sun/Pub Hol. (8am - 6pm)				
OOHW Period 2	Mon-Fri (10pm - 7am)	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
	Sat (10pm - 8am)				
	Sun/Pub Hol. (6pm - 7am)				

Note: The following abbreviations are used: Alternative accommodation (AA), Monitoring (M), Individual briefings (IB), Letter box drops (LB), Project specific respite offer (RO), Phone calls (PC), Specific notifications (SN).

Table 75 presents the summary of receiver types that are predicted to be subject to noise impacts greater than 25 dBA above the NML (ie corresponds to the '>30 dBA Highly Intrusive' category above).

As previously discussed, the use of noise intensive plant items (ie rockbreakers, saws, etc) will, in most cases, be restricted to daytime and evening periods. The ballast tamper may however be required during all periods. As such, impacts during the night-time have been provided both with and without the ballast tamper to illustrate the effect that this plant item has on the impacts.

Table 75 Number of Receivers Predicted to be Subject to >25 dBA above NML Noise Levels

NCA	Residential					Commercial					Other Sensitive					HNA[3]	
	Standard Day	Day OOH[1]	Evening	Night-time (with Ballast Tamper)	Night-time (without Ballast Tamper)	Standard Day	Day OOH	Evening	Night-time (with Ballast Tamper)	Night-time (without Ballast Tamper)	Standard Day	Day OOH[1]	Evening	Night-time (with Ballast Tamper)	Night-time (without Ballast Tamper)	Night-time (with Ballast Tamper)	Night-time (without Ballast Tamper)
NCA01	64	139	139	152	99	-	-	-	-	-	-	-	-	-	-	20	8
NCA02	147	224	223	191	164	-	-	-	-	-	-	-	-	-	-	31	23
NCA03	76	138	138	140	94	-	-	-	-	-	1	1	-	-	-	34	9
NCA04	21	42	42	38	32	-	-	-	-	-	-	-	-	-	-	6	5
NCA05	50	56	56	73	65	-	-	-	-	-	-	-	-	-	-	1	-
NCA06	13	45	66	101	65	-	-	-	-	-	-	-	-	-	-	25	9
NCA07	33	45	45	79	50	-	-	-	-	-	3	3	2	1	-	12	1
NCA08	-	7	7	19	1	-	-	-	-	-	2	2	-	-	-	4	-
NCA09	6	34	34	46	40	-	-	-	-	-	-	-	-	-	-	16	5
NCA10	-	7	7	15	-	-	-	-	-	-	3	3	1	-	-	7	-
NCA11	1	26	26	43	29	-	-	-	-	-	-	-	-	-	-	19	1
NCA12	-	-	-	5	-	-	-	-	-	-	3	3	2	-	-	3	-
NCA13	2	8	8	12	11	-	-	-	-	-	-	-	-	-	-	2	-

Note 1: OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am, and 1pm – 10pm.

Note 2: 'Other Sensitive' receiver definitions provided in **Section 2.2** and **Section 3.3.2.4**.

Note 3: Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

The above table shows that the most potentially affected catchment is NCA02. This is due to the large number of residential receivers in this area and the close proximity of the works. A number of other NCAs are also predicted to be subject to highly intrusive and highly noise affected impacts at many receivers.

It is noted that the potential impacts during the night-time period have been controlled by restricting the use of noise intensive plant items (such as rockbreaking) to the 7:00 am to 10:00 pm period, unless unforeseen site conditions are encountered which may require night work.

Ballast tamping may however be required during all periods. If this item of plant were to also be restricted to outside of night-time hours this is predicted to have a substantial effect on reducing the number of receivers predicted to be subject to noise levels of >25 dBA above the NML (and highly noise affected) in all catchments during the night-time.

No commercial receivers are predicted to be subject to noise levels of >25 dBA above the NML.

3.15.3.1 Summary of Additional Mitigation

Based on the predicted noise levels in **Section 3.10**, additional mitigation measures as per the requirements of **Table 74** have been determined for works during standard daytime construction hours and for works at night-time during possessions/closedowns.

The numbers take into consideration all works at all sites, and assume that noise intensive plant items are in use during the daytime and night-time periods. For the night-time period, impacts both with and without the ballast tamper have been presented.

Maps showing the location of the receivers identified for additional mitigation in the daytime and night-time period are provided in **Appendix F**. For the night-time period, impacts both with and without the ballast tamper have been presented.

Table 76 Receivers Identified for Additional Mitigation

NCA	Number of Receivers						
	Standard Daytime	Possession / Closedown Works					
		Night-time (OOHW2)					
		With Ballast Tamping				Without Ballast Tamping	
	LB, M	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
NCA01	565	29	452	363	152	277	99
NCA02	594	67	620	334	191	213	164
NCA03	462	6	306	260	140	181	94
NCA04	121	25	150	74	38	65	32
NCA05	291	-	168	136	73	99	65
NCA06	161	27	245	175	101	115	65
NCA07	291	120	457	312	79	134	50
NCA08	88	122	295	111	19	83	1
NCA09	126	86	300	132	46	105	40
NCA10	73	172	326	102	15	71	-
NCA11	116	169	316	153	43	129	29
NCA12	5	-	11	-	5	5	-
NCA13	72	35	178	71	12	42	11

The information presented in **Table 76** indicates that restricting noise intensive plant items to outside of night-time periods substantially reduces the number of receivers identified for additional mitigation measures.

The additional noise mitigation requirements outlined in the TfNSW CNS and CNVS are based on predicted exceedance of RBLs assuming sensitivity to noise increases for the receivers outside standard construction hours. The NMLs for other sensitive receiver types are specific to the type of use rather than the time of operation in accordance with the ICNG.

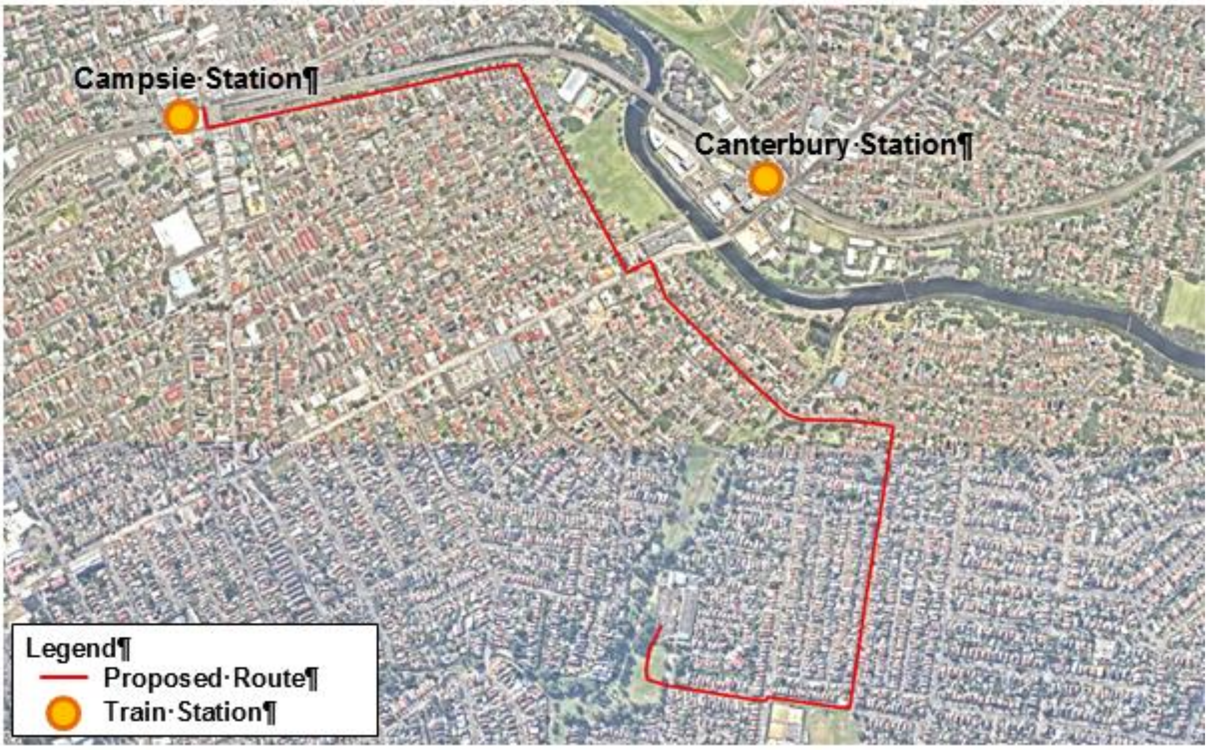
Notwithstanding, due to the potential noise impacts at adjacent other sensitive receiver types, it is recommended that letterbox drops also be undertaken at other sensitive receivers immediately adjacent the works to inform these receivers of the construction works.

3.16 Utilities Works

Construction works associated with utility relocation and diversion would likely be required at a number of work sites. Provision of a high voltage feeder cable would likely be required to provide power to the project. Works would be required along various streets along the chosen routes to allow access and modification to existing underground utilities.

At this stage in the project the exact location and equipment required to undertake the works are unknown, but would likely comprise of typical ground excavation items, such as excavators, concrete saws, rockbreakers, etc. An indicative route for the feeder cable is provided in **Figure 53**.

Figure 53 Indicative Feeder Cable Route



3.16.1 Assessment

An assessment of the potential noise levels from the likely plant items associated with utilities and feeder cable works is provided in **Table 77**. Noise levels have been predicted at various offset distances to give an indication of the possible impacts.

Table 77 Potential Noise Levels from Utilities and Feeder Cable Works

Scenario	Equipment	Predicted Noise Level at Distance ($L_{Aeq(15minute)}$ dBA)			
		10 m	15 m	30 m	50 m
Excavation	Excavator (breaker)[1]	88	85	82	77
	Concrete saw[1]				
	12T Excavator				
	Truck and Dog				
Drilling	Light vehicles	70	67	63	59
	HDD Drill Rig				
Cable Laying	Cable trailer and Truck[2]	72	70	66	62
	Franna/crane				
	Cable Winch[2]				
	Jointing hut[2]				

Scenario	Equipment	Predicted Noise Level at Distance ($L_{Aeq(15minute)}$ dBA)			
		10 m	15 m	30 m	50 m
Cleaning	Cleaning System	73	70	67	62
	Skid Steer				
	Field Services truck				

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

Note 2: SWL assumed for this plant item based on typical similar plant.

The above table shows that relatively high noise impacts are likely where noise intensive plant items are required near to adjacent receivers. On typical streets surrounding the worksites, the closest residential receivers are likely to be situated around 15 m from road. In this situation, noise levels in the region of 85 dBA are possible when noise intensive plant items are in use.

Night-time NMLs in the vicinity of most worksites would be expected to be in the region of 40 dBA. As such, exceedances of greater than 30 dB above NML are possible where noise intensive plant items are in use during the night-time.

3.16.2 Mitigation

Mitigation measures for the works would be determined at a later stage in the project when further information regarding the extent of the works is known. It is however recommended that the following measures are considered:

- Use of localised hoarding around noise generating plant items, where feasible.
- Limiting use of noise intensive plant items to daytime or evening periods, where possible.

In managing the works, reference should be made to the mitigation measures detailed in **Section 3.15**, including the Sydney Metro CNVS.

3.17 Construction Ground-borne Noise

The ICNG defines internal ground-borne noise goals for residential receivers during the evening (6:00 pm to 10:00 pm) and night-time (10:00 pm to 7:00 am) construction periods and are only applicable when ground-borne noise levels are higher than airborne noise levels.

Construction airborne noise levels for evening and night-time possession works (refer **Section 3.10**) are predicted to be higher than the corresponding ground-borne noise levels and are therefore not considered further in this assessment.

3.18 Construction Road Traffic Noise Assessment

Temporary additional road traffic associated with the project generally falls into two categories:

- Construction related traffic – This includes heavy vehicle movements to/from the construction compounds transporting construction materials and spoil along defined haulage routes, as well as vehicles of construction personnel travelling to/from the construction compounds.
- Temporary Transport Strategy (TTS) and associated Temporary Transport Management Plans (TTMP) – During periods of extended track possession associated with construction works, train replacement bus services would be required. This would introduce additional heavy vehicles (buses) onto the public road network during these periods. More information on the TTS and TTMPs can be found in Appendix G of the EIS.

It is appropriate to assess the noise impacts from each of the temporary construction road traffic categories individually, as these may occur during separate periods of construction works, and to also differentiate between predicted noise impacts from each of the road traffic noise sources.

A cumulative noise assessment has also been undertaken to identify the potential impacts where these vehicle movements occur concurrently in the same location.

Existing traffic volumes on the roads along construction routes and TTMP scenario routes were provided by the project team and are shown in **Table 78**.

Table 78 Existing Road Traffic Volumes along Construction and TTMP Routes

Construction Precinct	Roads along Construction & TTMP Routes	Existing Road Traffic Volumes							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Marrickville	Myrtle St	867	82	84	8	79	7	9	1
	Carrington Rd (Between Schwebel St and Myrtle St)	7290	693	706	67	661	63	78	7
	Richardson Cres	15849	1129	1535	107	1438	100	171	12
	Illawarra Rd (between Marrickville Rd and Calvert St)	10158	769	983	73	922	68	109	8
	Marrickville Rd (Between Illawarra Rd and Silver St)	12853	1807	1244	183	1166	171	138	20
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	9348	1116	905	111	848	104	101	12
	Warren Rd (Between Illawarra Rd and Moyes St)	8776	1233	850	125	796	117	94	14
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	10732	352	1021	32	952	29	113	4
	Marrickville Rd (Between Darley St and Wardell Rd)	10249	1222	975	119	909	111	108	13
	Dudley St (Between School Pde and Wardell Rd)	3728	199	355	18	331	17	39	2
	Bayley St (Between Ewart St and Dudley St)	604	109	58	10	89	9	6	1
	Ewart St (Between Bayley St and Wicks Ave)	6504	349	619	32	577	30	69	4
	Beauchamp St (Between School Pde and Ewart St)	6504	349	619	32	577	30	69	4
	Wardell Rd (Between Marrickville Rd and Pine St)	12788	363	1217	32	1134	30	135	4
	Terrace Rd (Between New Canterbury Rd and Consett St)	1184	12	113	1	174	2	13	0
	New Canterbury Rd (Between Kintore St and Terrace Rd)	25396	996	2417	90	2253	84	269	10
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	10970	1091	1062	106	995	99	118	12
	Illawarra Rd (between Marrickville Rd and Calvert St)	10158	769	983	73	922	68	109	8
	Ewart St (between Wardell and Ness Ave)	171	0	16	0	15	0	2	0
	Warren Rd (Between Illawarra Rd and Moyes St)	8776	1233	850	125	796	117	94	14

Construction Precinct	Roads along Construction & TTMP Routes	Existing Road Traffic Volumes							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	2002	28	191	2	178	2	21	0
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	21892	1019	2084	92	1942	86	232	10
	Duntroon St	1728	60	164	6	173	5	18	1
	Crinan St (Between Floss St and Fernhil St)	7163	617	682	58	635	54	76	6
	Dunstaffenage St (Between Crinan St and Floss st)	229	0	22	0	20	0	2	0
	Crinan St (Between Melford St and Dunstaffenage St)	5455	601	519	58	484	54	58	6
	Canterbury Rd (Between Queen St and Wattle Ln)	21496	1788	2046	168	1907	157	227	19
	Canterbury Rd (Between Queen St and Princess St)	25195	2017	2398	189	2235	176	266	21
	Floss St (Between Garnet St and Crinan St)	6973	615	664	58	619	54	74	6
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	6698	782	1068	120	545	61	119	13
	Canterbury Rd (Between Close St and Broughton St)	41257	3283	6580	485	3356	247	731	54
	Close St	529	144	100	27	51	11	11	3
	Broughton St (Between Canterbury Rd and Robert St)	2891	408	275	39	236	26	31	4
	Canterbury Rd (Between Jeffrey St and Minter St)	28431	2558	4534	381	2313	195	504	42
	Charles St (Between Canterbury Rd and Broughton St)	691	157	66	15	69	10	7	2
	Canterbury Rd (Between Charles St and Close St)	40784	3127	6549	470	3305	241	728	52
	Wonga St	11015	151	1757	21	896	11	195	2
	Canterbury Rd (Between Wonga St and Cooks Avenue)	29794	2686	5645	509	2753	228	627	57
	Canterbury Rd (Between Fore St and Charles St)	41475	3284	6615	485	3374	247	735	54
	Canterbury Rd (Between Wonga St and Fore St)	34645	2740	6565	519	3196	234	729	58
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	26398	2325	4210	346	2147	177	468	38

Construction Precinct	Roads along Construction & TTMP Routes	Existing Road Traffic Volumes							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	32920	2774	5250	411	2678	210	583	46
	South Parade (Between Beamish St and Harold St)	5856	459	557	44	376	26	62	5
	Beamish St (Between Ninth Ave and Campsie St)	12783	364	1336	35	1071	28	148	4
	Beamish St (Between South Parade and Amy St)	16711	392	1747	38	1400	30	194	4
	Brighton Ave (Between Browning St and Shakespeare St)	11369	74	1188	7	952	6	132	1
	Ninth Ave (Between Beamish St and Fifth Ave)	13695	383	2184	54	1114	28	243	6
	Loch St (Between Evaline St and Lillian St)	12977	1154	1356	119	1087	95	151	13
	Evaline St (Between Loch St and Beamish St)	4548	159	725	23	370	12	81	3
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	6875	566	719	58	576	46	80	6
	Canterbury Rd (Between Northcote St and Beamish St)	32920	2774	5250	411	2678	210	583	46
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	34454	2860	5495	424	2803	216	611	47
	Gould St (Between Canterbury Rd and Redman St)	2336	215	222	20	191	5	25	2
	Albert St (Between Lincoln St and Baltimore St)	10577	363	1106	35	886	28	123	4
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	15101	1887	2527	303	1077	129	281	34
	Bridge Rd (Between Marie Ln and Burwood Ave)	8583	498	1436	75	612	32	160	8
	Burwood Rd (Between Bridge Rd and Collins St)	16560	1943	2772	310	1181	132	308	34
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	33212	3247	5297	488	2702	249	589	54

Construction Precinct	Roads along Construction & TTMP Routes	Existing Road Traffic Volumes							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	6788	170	1136	25	484	11	126	3
	Moreton St (Between Lakemba St and The Boulevarde)	13335	1086	2232	167	951	71	248	19
	Lakemba St (Between King Georges Rd and Shadforth St)	2974	69	498	10	212	4	55	1
	Burwood Rd (Between Redman Parade and Bridge Rd)	15101	1887	2527	303	1077	129	281	34
	Railway Pde (Between Haldon St and Croydon St)	4059	93	386	9	328	9	43	1
	Haldon St (Between Railway Parade and The Boulevarde)	12054	846	2017	129	860	55	224	14
	Haldon St (Between The Boulevarde and Oneata St)	7622	777	1276	122	544	52	142	14
	Canterbury Rd (Between Haldon St and Legge St)	34257	3512	5733	552	2443	235	637	61
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	11540	410	1931	61	823	26	215	7
	King Georges Rd (Between The Boulevarde and Mary St)	66898	8791	11196	1420	4770	605	1244	158
	Lakemba St (Between King Georges Rd and Shadforth St)	2974	69	498	10	212	4	55	1
	King Georges Rd (Between Lakemba St and The Boulevarde)	74269	9027	12430	1445	5296	615	1381	161
Punchbowl	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	40229	3270	6733	504	2869	215	748	56
	The Boulevarde (Between Punchbowl Rd and Arthur St)	20024	1351	3351	206	1428	88	372	23
	South Terrace (Between Loder Ln and Punchbowl Rd)	11676	400	1954	59	833	25	217	7
	Punchbowl Rd (Between South Terrace and The Boulevarde)	48495	3845	8116	591	3458	252	902	66
	Wattle St (Between Highclere Ave and Acacia Ave)	15500	293	2594	43	1105	18	288	5

Construction Precinct	Roads along Construction & TTMP Routes	Existing Road Traffic Volumes							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Bankstown	South Terrace (Between West Terrace and East Terrace)	10168	236	1609	33	863	18	179	4
	Stacey St (Between Verbena Ave and Stanley St)	48597	8303	7692	1331	4124	714	855	148
	Restwell St (Between Stewart Ln and Raymond St)	7347	275	1163	39	623	21	129	4
	Raymond St (Between Restwell St and West Terrace)	2594	217	411	32	220	17	46	4
	South Terrace (Between West Terrace and Restwell St)	5192	271	822	39	441	21	91	4
	North Terrace (Between The Appian Way and Fetherstone St)	7790	42	1233	6	661	3	137	1
	Wattle St (Between Stacey St and North Terrace)	10414	321	1648	45	884	24	183	5
	South Terrace (between Punchbowl Rd and Stacey St)	10168	236	1609	33	863	18	179	4
	South Terrace (Between Stacey St and Bankstown City Plaza)	5192	271	822	39	441	21	91	4
	Raymond St (Between Restwell St and Lopez Ln)	2594	217	411	32	220	17	46	4
	Bankstown City Plaza	7790	42	1233	6	661	3	137	1

3.18.1 Construction Traffic

It is understood that the additional road vehicle movements associated with construction vehicles on public roads would be predominantly required during daytime hours, although some vehicle movements would be required at night to support night-time construction works. Night-time construction vehicle activities would be required for safety reasons, during possession periods, or to minimise disruption to the road network. The proposed construction road traffic movements per precinct are provided in **Table 79** for all roads within the study area that are anticipated to carry either construction or TTMP scenario road traffic.

Table 79 Construction Traffic Movements

Construction Precinct	Roads along Construction & TTMP Routes	Construction Road Traffic Volumes[1]							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Marrickville	Myrtle St	90	52	20	58	10	10	5	9
	Carrington Rd (Between Schwebel St and Myrtle St)	90	52	20	58	10	10	5	9
	Richardson Cres	90	52	20	58	10	10	5	9
	Illawarra Rd (between Marrickville Rd and Calvert St)	90	103	20	117	10	20	5	9
	Marrickville Rd (Between Illawarra Rd and Silver St)	-	-	-	-	-	-	-	-
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	-	-	-	-	-	-	-	-
	Warren Rd (Between Illawarra Rd and Moyes St)	90	52	20	58	10	10	5	9
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	0	21	0	23	0	4	0	4
	Marrickville Rd (Between Darley St and Wardell Rd)	90	62	20	70	10	12	5	9
	Dudley St (Between School Pde and Wardell Rd)	-	-	-	-	-	-	-	-
	Bayley St (Between Ewart St and Dudley St)	0	21	0	23	0	4	0	4
	Ewart St (Between Bayley St and Wicks Ave)	0	21	0	23	0	4	0	4
	Beauchamp St (Between School Pde and Ewart St)	0	21	0	23	0	4	0	4
	Wardell Rd (Between Marrickville Rd and Pine St)	90	62	20	70	10	12	5	9
	Terrace Rd (Between New Canterbury Rd and Consett St)	200	125	20	117	20	22	5	9
	New Canterbury Rd (Between Kintore St and Terrace Rd)	200	125	20	117	20	22	5	9
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	90	62	20	70	10	12	5	9
	Illawarra Rd (between Marrickville Rd and Calvert St)	90	103	20	117	10	20	5	9
	Ewart St (between Wardell and Ness Ave)	0	21	0	23	0	4	0	4
	Warren Rd (Between Illawarra Rd and Moyes St)	90	52	20	58	10	10	5	9

Construction Precinct	**Roads along Construction & TTMP Routes**	**Construction Road Traffic Volumes**[1]							
		Day (7:00 am to 10:00 pm)		**Night (10:00 pm to 7:00 am)**		**Day Peak 1 Hour**		**Night Peak 1 Hour**	
		Light	**Heavy**	**Light**	**Heavy**	**Light**	**Heavy**	**Light**	**Heavy**
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	0	21	0	23	0	4	0	4
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	200	125	20	117	20	22	5	9
	Duntroon St	90	52	20	58	10	10	5	9
	Crinan St (Between Floss St and Fernhil St)	200	65	20	73	20	13	5	9
	Dunstaffenage St (Between Crinan St and Floss st)	0	31	0	35	0	6	0	6
	Crinan St (Between Melford St and Dunstaffenage St)	200	147	20	117	20	24	5	9
	Canterbury Rd (Between Queen St and Wattle Ln)	200	147	20	117	20	24	5	9
	Canterbury Rd (Between Queen St and Princess St)	200	147	20	117	10	24	5	9
	Floss St (Between Garnet St and Crinan St)	-	-	-	-	-	-	-	-
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	200	147	20	117	20	24	5	9
	Canterbury Rd (Between Close St and Broughton St)	90	125	20	117	10	22	5	9
	Close St	222	83	20	93	22	16	5	9
	Broughton St (Between Canterbury Rd and Robert St)	2	103	20	117	2	20	2	9
	Canterbury Rd (Between Jeffrey St and Minter St)	90	125	20	117	10	22	5	9
	Charles St (Between Canterbury Rd and Broughton St)	10	10	12	12	2	2	2	2
	Canterbury Rd (Between Charles St and Close St)	90	125	20	117	10	22	5	9
	Wonga St	-	-	-	-	-	-	-	-
	Canterbury Rd (Between Wonga St and Cooks Avenue)	90	125	20	117	10	22	5	9
	Canterbury Rd (Between Fore St and Charles St)	90	125	20	117	10	22	5	9
	Canterbury Rd (Between Wonga St and Fore St)	90	125	20	117	10	22	5	9
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	200	147	20	117	20	24	5	9

Construction Precinct	Roads along Construction & TTMP Routes	Construction Road Traffic Volumes[1]							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	35	26	20	29	5	5	5	5
	South Parade (Between Beamish St and Harold St)	0	10	0	12	0	2	0	2
	Beamish St (Between Ninth Ave and Campsie St)	35	26	20	29	5	5	5	5
	Beamish St (Between South Parade and Amy St)	35	26	20	29	5	5	5	5
	Brighton Ave (Between Browning St and Shakespeare St)	35	26	20	29	5	5	5	5
	Ninth Ave (Between Beamish St and Fifth Ave)	0	10	0	12	0	2	0	2
	Loch St (Between Evaline St and Lillian St)	0	10	0	12	0	2	0	2
	Evaline St (Between Loch St and Beamish St)	0	10	0	12	0	2	0	2
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	0	10	0	12	0	2	0	2
	Canterbury Rd (Between Northcote St and Beamish St)	200	147	20	117	20	24	5	9
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	200	147	20	117	20	24	5	9
	Gould St (Between Canterbury Rd and Redman St)	-	-	-	-	-	-	-	-
	Albert St (Between Lincoln St and Baltimore St)	0	10	0	12	0	2	0	2
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	200	103	20	117	20	20	5	9
	Bridge Rd (Between Marie Ln and Burwood Ave)	-	-	-	-	-	-	-	-
	Burwood Rd (Between Bridge Rd and Collins St)	200	147	20	117	20	24	5	9
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	200	147	20	117	20	24	5	9

Construction Precinct	Roads along Construction & TTMP Routes	Construction Road Traffic Volumes[1]							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	35	26	20	29	5	5	5	5
	Moreton St (Between Lakemba St and The Boulevarde)	0	41	0	47	0	8	0	8
	Lakemba St (Between King Georges Rd and Shadforth St)	90	52	20	58	10	10	5	9
	Burwood Rd (Between Redman Parade and Bridge Rd)	200	103	20	117	20	20	5	9
	Railway Pde (Between Haldon St and Croydon St)	24	21	20	23	4	4	4	4
	Haldon St (Between Railway Parade and The Boulevarde)	90	52	20	58	10	10	5	9
	Haldon St (Between The Boulevarde and Oneata St)	145	213	20	117	15	30	5	9
	Canterbury Rd (Between Haldon St and Legge St)	0	21	0	23	0	4	0	4
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	90	52	20	58	10	10	5	9
	King Georges Rd (Between The Boulevarde and Mary St)	90	62	20	70	10	12	5	9
	Lakemba St (Between King Georges Rd and Shadforth St)	90	52	20	58	10	10	5	9
	King Georges Rd (Between Lakemba St and The Boulevarde)	90	52	20	58	10	10	5	9
Punchbowl	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	68	41	20	47	8	8	5	8
	The Boulevarde (Between Punchbowl Rd and Arthur St)	24	21	20	23	4	4	4	4
	South Terrace (Between Loder Ln and Punchbowl Rd)	24	21	20	23	4	4	4	4
	Punchbowl Rd (Between South Terrace and The Boulevarde)	24	21	20	23	4	4	4	4
	Wattle St (Between Highclere Ave and Acacia Ave)	24	21	20	23	4	4	4	4

Construction Precinct	Roads along Construction & TTMP Routes	Construction Road Traffic Volumes[1]							
		Day (7:00 am to 10:00 pm)		Night (10:00 pm to 7:00 am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Bankstown	South Terrace (Between West Terrace and East Terrace)	35	26	20	29	5	5	5	5
	Stacey St (Between Verbena Ave and Stanley St)	112	257	20	117	12	34	5	9
	Restwell St (Between Stewart Ln and Raymond St)	35	26	20	29	5	5	5	5
	Raymond St (Between Restwell St and West Terrace)	35	26	20	29	5	5	5	5
	South Terrace (Between West Terrace and Restwell St)	35	26	20	29	5	5	5	5
	North Terrace (Between The Appian Way and Fetherstone St)	35	26	20	29	5	5	5	5
	Wattle St (Between Stacey St and North Terrace)	35	26	20	29	5	5	5	5
	South Terrace (between Punchbowl Rd and Stacey St)	-	-	-	-	-	-	-	-
	South Terrace (Between Stacey St and Bankstown City Plaza)	-	-	-	-	-	-	-	-
	Raymond St (Between Restwell St and Lopez Ln)	-	-	-	-	-	-	-	-
	Bankstown City Plaza	-	-	-	-	-	-	-	-

Note 1: Results marked with a "-" represent roads without regular designated construction haulage traffic.

Table 80 presents the assessment of predicted daytime and night-time noise impacts from construction road traffic and is based on the construction road traffic volumes presented in **Table 79** and the existing road traffic volumes presented in **Table 78**. Predicted daytime and night-time construction road traffic noise impacts in **Table 80** are presented for all roads within the study area that are anticipated to carry either construction or TTMP scenario road traffic.

Table 80 Construction Road Traffic Noise Assessment

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Road Traffic Noise Day / Night $L_{Aeq(period)}$[2]	Combined Road Traffic Noise Level Day / Night	
Marrickville	Myrtle St	60 / 55	61 / 53	55 / 57	62 / 59	N / **Y**
	Carrington Rd (Between Schwebel St and Myrtle St)	60 / 55	70 / 62	55 / 57	71 / 64	N / N
	Richardson Cres	60 / 55	73 / 65	55 / 57	73 / 66	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	58 / 60	72 / 65	N / N
	Marrickville Rd (Between Illawarra Rd and Silver St)	60 / 55	76 / 68	-	76 / 68	N / N
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	60 / 55	74 / 66	-	74 / 66	N / N
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	55 / 57	72 / 65	N / N
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	60 / 55	71 / 63	50 / 53	71 / 63	N / N
	Marrickville Rd (Between Darley St and Wardell Rd)	60 / 55	75 / 67	58 / 60	75 / 68	N / N
	Dudley St (Between School Pde and Wardell Rd)	55 / 50	66 / 57	-	66 / 57	N / N
	Bayley St (Between Ewart St and Dudley St)	55 / 50	62 / 51	54 / 54	62 / 56	N / **Y**
	Ewart St (Between Bayley St and Wicks Ave)	60 / 55	69 / 61	50 / 53	69 / 62	N / N
	Beauchamp St (Between School Pde and Ewart St)	60 / 55	69 / 61	50 / 53	69 / 62	N / N
	Wardell Rd (Between Marrickville Rd and Pine St)	60 / 55	72 / 64	56 / 58	72 / 65	N / N
	Terrace Rd (Between New Canterbury Rd and Consett St)	60 / 55	61 / 53	59 / 60	63 / 61	N / **Y**
	New Canterbury Rd (Between Kintore St and Terrace Rd)	60 / 55	78 / 69	62 / 62	78 / 70	N / N
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	60 / 55	75 / 67	58 / 60	75 / 68	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	58 / 60	72 / 65	N / N
	Ewart St (between Wardell and Ness Ave)	60 / 55	52 / 44	50 / 53	54 / 54	N / N
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	55 / 57	72 / 65	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Road Traffic Noise Day / Night $L_{Aeq(period)}$[2]	Combined Road Traffic Noise Level Day / Night	
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	55 / 50	63 / 53	54 / 54	63 / 57	N / **Y**
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	60 / 55	77 / 69	62 / 62	77 / 70	N / N
	Duntroon St	60 / 55	62 / 54	55 / 56	62 / 58	N / **Y**
	Crinan St (Between Floss St and Fernhil St)	60 / 55	70 / 62	57 / 58	70 / 64	N / N
	Dunstaffenage St (Between Crinan St and Floss st)	60 / 55	54 / 46	52 / 55	56 / 55	N / N
	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	69 / 61	60 / 60	70 / 64	N / **Y**
	Canterbury Rd (Between Queen St and Wattle Ln)	60 / 55	77 / 69	62 / 62	78 / 70	N / N
	Canterbury Rd (Between Queen St and Princess St)	60 / 55	78 / 70	62 / 62	78 / 71	N / N
	Floss St (Between Garnet St and Crinan St)	60 / 55	70 / 62	-	70 / 62	N / N
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	70 / 64	60 / 60	71 / 66	N / N
	Canterbury Rd (Between Close St and Broughton St)	60 / 55	80 / 74	61 / 62	80 / 75	N / N
	Close St	55 / 50	61 / 55	61 / 58	64 / 60	**Y** / **Y**
	Broughton St (Between Canterbury Rd and Robert St)	60 / 55	67 / 59	57 / 60	67 / 63	N / **Y**
	Canterbury Rd (Between Jeffrey St and Minter St)	60 / 55	79 / 73	61 / 62	79 / 73	N / N
	Charles St (Between Canterbury Rd and Broughton St)	60 / 55	62 / 54	48 / 51	62 / 56	N / N
	Canterbury Rd (Between Charles St and Close St)	60 / 55	80 / 74	61 / 62	80 / 75	N / N
	Wonga St	55 / 50	72 / 65	-	72 / 65	N / N
	Canterbury Rd (Between Wonga St and Cooks Avenue)	60 / 55	79 / 74	61 / 62	79 / 74	N / N
	Canterbury Rd (Between Fore St and Charles St)	60 / 55	80 / 74	61 / 62	80 / 75	N / N
	Canterbury Rd (Between Wonga St and Fore St)	60 / 55	79 / 74	61 / 62	80 / 75	N / N
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	60 / 55	78 / 73	62 / 62	79 / 73	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Road Traffic Noise Day / Night $L_{Aeq(period)}$[2]	Combined Road Traffic Noise Level Day / Night	
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	60 / 55	79 / 74	55 / 57	79 / 74	N / N
	South Parade (Between Beamish St and Harold St)	60 / 55	69 / 61	47 / 50	69 / 61	N / N
	Beamish St (Between Ninth Ave and Campsie St)	60 / 55	72 / 64	52 / 54	72 / 65	N / N
	Beamish St (Between South Parade and Amy St)	60 / 55	73 / 65	52 / 54	73 / 65	N / N
	Brighton Ave (Between Browning St and Shakespeare St)	60 / 55	71 / 63	52 / 54	71 / 64	N / N
	Ninth Ave (Between Beamish St and Fifth Ave)	60 / 55	72 / 66	47 / 50	72 / 66	N / N
	Loch St (Between Evaline St and Lillian St)	60 / 55	73 / 65	47 / 50	73 / 65	N / N
	Evaline St (Between Loch St and Beamish St)	60 / 55	66 / 60	46 / 49	66 / 60	N / N
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	55 / 50	73 / 65	54 / 54	74 / 65	N / N
	Canterbury Rd (Between Northcote St and Beamish St)	60 / 55	79 / 74	62 / 62	79 / 74	N / N
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	60 / 55	80 / 74	62 / 62	80 / 74	N / N
	Gould St (Between Canterbury Rd and Redman St)	60 / 55	65 / 57	-	65 / 57	N / N
	Albert St (Between Lincoln St and Baltimore St)	60 / 55	71 / 63	47 / 50	71 / 64	N / N
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	59 / 60	74 / 69	N / N
	Bridge Rd (Between Marie Ln and Burwood Ave)	60 / 55	70 / 65	-	70 / 65	N / N
	Burwood Rd (Between Bridge Rd and Collins St)	60 / 55	74 / 69	60 / 60	74 / 69	N / N
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	60 / 55	80 / 74	62 / 62	80 / 74	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Road Traffic Noise Day / Night $L_{Aeq(period)}$[2]	Combined Road Traffic Noise Level Day / Night	
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	60 / 55	69 / 63	52 / 54	69 / 64	N / N
	Moreton St (Between Lakemba St and The Boulevarde)	60 / 55	73 / 67	53 / 56	73 / 67	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	55 / 57	66 / 62	N / N
	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	59 / 60	74 / 69	N / N
	Railway Pde (Between Haldon St and Croydon St)	60 / 55	67 / 59	51 / 54	67 / 60	N / N
	Haldon St (Between Railway Parade and The Boulevarde)	60 / 55	72 / 67	55 / 57	72 / 67	N / N
	Haldon St (Between The Boulevarde and Oneata St)	60 / 55	71 / 65	61 / 60	71 / 66	N / N
	Canterbury Rd (Between Haldon St and Legge St)	60 / 55	80 / 74	52 / 55	80 / 74	N / N
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	60 / 55	71 / 66	55 / 57	71 / 66	N / N
	King Georges Rd (Between The Boulevarde and Mary St)	60 / 55	83 / 77	58 / 60	83 / 78	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	55 / 57	66 / 62	N / N
	King Georges Rd (Between Lakemba St and The Boulevarde)	60 / 55	83 / 78	58 / 60	83 / 78	N / N
Punchbowl	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	60 / 55	80 / 75	57 / 59	80 / 75	N / N
	The Boulevarde (Between Punchbowl Rd and Arthur St)	60 / 55	74 / 69	51 / 54	74 / 69	N / N
	South Terrace (Between Loder Ln and Punchbowl Rd)	60 / 55	70 / 64	50 / 53	70 / 64	N / N
	Punchbowl Rd (Between South Terrace and The Boulevarde)	60 / 55	81 / 75	53 / 56	81 / 75	N / N
	Wattle St (Between Highclere Ave and Acacia Ave)	60 / 55	72 / 67	51 / 54	72 / 67	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise Day / Night LAeq(period)	Predicted Road Traffic Noise Day / Night LAeq(period)[2]	Combined Road Traffic Noise Level Day / Night	
Bankstown	South Terrace (Between West Terrace and East Terrace)	60 / 55	71 / 65	52 / 54	71 / 65	N / N
	Stacey St (Between Verbena Ave and Stanley St)	60 / 55	80 / 74	62 / 60	80 / 74	N / N
	Restwell St (Between Stewart Ln and Raymond St)	60 / 55	69 / 64	52 / 54	70 / 64	N / N
	Raymond St (Between Restwell St and West Terrace)	60 / 55	66 / 60	52 / 54	66 / 61	N / N
	South Terrace (Between West Terrace and Restwell St)	60 / 55	68 / 62	52 / 54	68 / 63	N / N
	North Terrace (Between The Appian Way and Fetherstone St)	60 / 55	69 / 63	52 / 54	69 / 64	N / N
	Wattle St (Between Stacey St and North Terrace)	60 / 55	69 / 63	51 / 54	69 / 64	N / N
	South Terrace (between Punchbowl Rd and Stacey St)	60 / 55	71 / 65	-	71 / 65	N / N
	South Terrace (Between Stacey St and Bankstown City Plaza)	60 / 55	68 / 62	-	68 / 62	N / N
	Raymond St (Between Restwell St and Lopez Ln)	60 / 55	66 / 60	-	66 / 60	N / N
	Bankstown City Plaza	60 / 55	69 / 63	-	69 / 63	N / N

Note 1: Road traffic noise criteria (refer to **Section 3.4**).

Note 2: Results marked with a "-" represent roads without regular designated construction haulage traffic.

The above results indicate that construction road traffic is predicted to result in an increase in road traffic noise levels of less than 2 dB on the majority of roads along the construction routes.

Construction road traffic is however predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on eight roads. These roads are:

- Marrickville – Myrtle St – during the night.
- Dulwich Hill – Bayley St (Btwn Ewart St & Dudley St) – during the night.
- Dulwich Hill – Terrace Rd (Btwn New Canterbury Rd & Consett St) – during the night.
- Hurlstone Park – Garnet St (Between Canterbury Rd and Hampden St) – during the night.
- Hurlstone Park – Duntroon St – during the night.
- Hurlstone Park – Crinan St (Btwn Melford St & Dunstaffenage St) – during the night.
- Canterbury – Close St – during the day and night.
- Canterbury – Broughton St (Btwn Canterbury Rd & Robert St) – during the night.

Construction routes and traffic volumes would be confirmed at a later design stage of the project to determine if mitigation should be considered for the roads outlined above. Where compliance with the criteria is unable to be achieved, feasible and reasonable noise mitigation should be considered. The measures could comprise of alternate construction traffic routes, reducing the maximum number of daily movements, or rescheduling some or all of the night-time movements to the daytime period.

3.18.2 Temporary Transport Arrangements during Possessions

A Temporary Transport Strategy (TTS) has been developed (presented in EIS Appendix G) which outlines the process for planning and delivery of a temporary, integrated, multi-modal transport network that would operate during each of the possession periods. For each possession period, a Temporary Transport Management Plan (TTMP) would be developed to enable customers to continue to reach their destinations while trains are not operating.

For the purposes of the EIS, a Baseline Temporary Transport Management Plan (Baseline TTMP) was developed and assessed consisting of full rail capacity replacement by buses only, similar to what currently occurs during weekend possession periods for Sydney Trains maintenance works. As a result of the much larger volume of passengers required to be moved during the weekday peak period, the EIS identified extensive impacts as a result of this solution. As such, a Refined Baseline TTMP was developed which took the learnings from the Baseline TTMP and includes an option to convey passengers west of Campsie to parallel rail lines to reduce the potential traffic and other impacts at Dulwich Hill and Marrickville.

Both the Baseline and Refined Baseline TTMP traffic movements are outlined in **Table 81** for all roads within the study area that are anticipated to carry either construction or TTMP scenario road traffic.

Table 81 Baseline TTMP and Refined Baseline TTMP Traffic Movements

Construction Precinct	Roads along Construction & TTMP Routes	Baseline TTMP and Refined Baseline TTMP Heavy Road Traffic Volumes[1,2]							
		Day (7:00am to 10:00pm)		Night (10:00pm to 7:00am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline
Marrickville	Myrtle St	-	-	-	-	-	-	-	-
	Carrington Rd (Between Schwebel St and Myrtle St)	-	-	-	-	-	-	-	-
	Richardson Cres	-	-	-	-	-	-	-	-
	Illawarra Rd (between Marrickville Rd and Calvert St)	495	225	0	0	33	15	0	0
	Marrickville Rd (Between Illawarra Rd and Silver St)	1515	825	70	35	101	55	10	5
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	1020	600	0	0	68	40	0	0
	Warren Rd (Between Illawarra Rd and Moyes St)	495	225	70	35	33	15	10	5
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	-	-	-	-	-	-	-	-
	Marrickville Rd (Between Darley St and Wardell Rd)	1020	600	0	0	68	40	0	0
	Dudley St (Between School Pde and Wardell Rd)	495	0	70	35	33	0	10	5
	Bayley St (Between Ewart St and Dudley St)	495	0	70	35	33	0	10	5
	Ewart St (Between Bayley St and Wicks Ave)	495	450	70	35	33	30	10	5
	Beauchamp St (Between School Pde and Ewart St)	495	225	70	35	33	15	10	5
	Wardell Rd (Between Marrickville Rd and Pine St)	0	225	0	0	0	15	0	0
	Terrace Rd (Between New Canterbury Rd and Consett St)	-	-	-	-	-	-	-	-
	New Canterbury Rd (Between Kintore St and Terrace Rd)	1020	375	0	0	68	25	0	0
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	1020	375	0	0	68	25	0	0
	Illawarra Rd (between Marrickville Rd and Calvert St)	495	225	70	35	33	15	10	5
	Ewart St (between Wardell and Ness Ave)	495	450	70	35	33	30	10	5
	Warren Rd (Between Illawarra Rd and Moyes St)	495	225	70	35	33	15	10	5

Construction Precinct	Roads along Construction & TTMP Routes	Baseline TTMP and Refined Baseline TTMP Heavy Road Traffic Volumes[1,2]							
		Day (7:00am to 10:00pm)		Night (10:00pm to 7:00am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	-	-	-	-	-	-	-	-
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	1020	375	0	0	68	25	0	0
	Duntroon St	-	-	-	-	-	-	-	-
	Crinan St (Between Floss St and Fernhil St)	165	225	70	35	11	15	10	5
	Dunstaffenage St (Between Crinan St and Floss st)	-	-	-	-	-	-	-	-
	Crinan St (Between Melford St and Dunstaffenage St)	165	225	70	35	11	15	10	5
	Canterbury Rd (Between Queen St and Wattle Ln)	1020	600	0	0	68	40	0	0
	Canterbury Rd (Between Queen St and Princess St)	1185	600	70	35	79	40	10	5
	Floss St (Between Garnet St and Crinan St)	495	450	70	35	33	30	10	5
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	165	225	70	35	11	15	10	5
	Canterbury Rd (Between Close St and Broughton St)	1185	600	70	35	79	40	10	5
	Close St	-	-	-	-	-	-	-	-
	Broughton St (Between Canterbury Rd and Robert St)	-	-	-	-	-	-	-	-
	Canterbury Rd (Between Jeffrey St and Minter St)	1185	600	70	35	79	40	10	5
	Charles St (Between Canterbury Rd and Broughton St)	-	-	-	-	-	-	-	-
	Canterbury Rd (Between Charles St and Close St)	1185	600	70	35	79	40	10	5
	Wonga St	690	600	70	35	46	40	10	5
	Canterbury Rd (Between Wonga St and Cooks Avenue)	495	0	0	0	33	0	0	0
	Canterbury Rd (Between Fore St and Charles St)	1185	600	70	35	79	40	10	5
	Canterbury Rd (Between Wonga St and Fore St)	495	0	0	0	33	0	0	0
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	1185	600	70	35	79	40	10	5

Construction Precinct	Roads along Construction & TTMP Routes	Baseline TTMP and Refined Baseline TTMP Heavy Road Traffic Volumes[1,2]							
		Day (7:00am to 10:00pm)		Night (10:00pm to 7:00am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	495	0	0	0	33	0	0	0
	South Parade (Between Beamish St and Harold St)	690	600	70	35	46	40	10	5
	Beamish St (Between Ninth Ave and Campsie St)	690	600	70	35	46	40	10	5
	Beamish St (Between South Parade and Amy St)	-	-	-	-	-	-	-	-
	Brighton Ave (Between Browning St and Shakespeare St)	-	-	-	-	-	-	-	-
	Ninth Ave (Between Beamish St and Fifth Ave)	690	225	70	35	46	15	10	5
	Loch St (Between Evaline St and Lillian St)	-	-	-	-	-	-	-	-
	Evaline St (Between Loch St and Beamish St)	-	-	-	-	-	-	-	-
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	-	-	-	-	-	-	-	-
	Canterbury Rd (Between Northcote St and Beamish St)	495	0	0	0	33	0	0	0
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	495	0	0	0	33	0	0	0
	Gould St (Between Canterbury Rd and Redman St)	690	600	70	35	46	40	10	5
	Albert St (Between Lincoln St and Baltimore St)	690	225	70	35	46	15	10	5
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	690	225	70	35	46	15	10	5
	Bridge Rd (Between Marie Ln and Burwood Ave)	690	225	70	35	46	15	10	5
	Burwood Rd (Between Bridge Rd and Collins St)	-	-	-	-	-	-	-	-
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	495	0	0	0	33	0	0	0

Construction Precinct	Roads along Construction & TTMP Routes	Baseline TTMP and Refined Baseline TTMP Heavy Road Traffic Volumes[1,2]							
		Day (7:00am to 10:00pm)		Night (10:00pm to 7:00am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	660	225	70	35	44	15	10	5
	Moreton St (Between Lakemba St and The Boulevarde)	-	-	-	-	-	-	-	-
	Lakemba St (Between King Georges Rd and Shadforth St)	-	-	-	-	-	-	-	-
	Burwood Rd (Between Redman Parade and Bridge Rd)	690	225	70	35	46	15	10	5
	Railway Pde (Between Haldon St and Croydon St)	-	-	-	-	-	-	-	-
	Haldon St (Between Railway Parade and The Boulevarde)	-	-	-	-	-	-	-	-
	Haldon St (Between The Boulevarde and Oneata St)	495	0	0	0	33	0	0	0
	Canterbury Rd (Between Haldon St and Legge St)	495	0	0	0	33	0	0	0
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	660	225	70	35	44	15	10	5
	King Georges Rd (Between The Boulevarde and Mary St)	-	-	-	-	-	-	-	-
	Lakemba St (Between King Georges Rd and Shadforth St)	-	-	-	-	-	-	-	-
	King Georges Rd (Between Lakemba St and The Boulevarde)	-	-	-	-	-	-	-	-
Punchbowl	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	-	-	-	-	-	-	-	-
	The Boulevarde (Between Punchbowl Rd and Arthur St)	660	225	70	35	44	15	10	5
	South Terrace (Between Loder Ln and Punchbowl Rd)	660	225	70	35	44	15	10	5
	Punchbowl Rd (Between South Terrace and The Boulevarde)	-	-	-	-	-	-	-	-
	Wattle St (Between Highclere Ave and Acacia Ave)	-	-	-	-	-	-	-	-

Construction Precinct	Roads along Construction & TTMP Routes	Baseline TTMP and Refined Baseline TTMP Heavy Road Traffic Volumes[1,2]							
		Day (7:00am to 10:00pm)		Night (10:00pm to 7:00am)		Day Peak 1 Hour		Night Peak 1 Hour	
		Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline	Baseline	Refined Baseline
Bankstown	South Terrace (Between West Terrace and East Terrace)	660	225	70	35	44	15	10	5
	Stacey St (Between Verbena Ave and Stanley St)	-	-	-	-	-	-	-	-
	Restwell St (Between Stewart Ln and Raymond St)	660	225	70	35	44	15	10	5
	Raymond St (Between Restwell St and West Terrace)	660	225	70	35	44	15	10	5
	South Terrace (Between West Terrace and Restwell St)	660	225	70	35	44	15	10	5
	North Terrace (Between The Appian Way and Fetherstone St)	82.5	112.5	70	35	5.5	7.5	10	5
	Wattle St (Between Stacey St and North Terrace)	-	-	-	-	-	-	-	-
	South Terrace (between Punchbowl Rd and Stacey St)	660	225	70	35	44	15	10	5
	South Terrace (Between Stacey St and Bankstown City Plaza)	660	225	70	35	44	15	10	5
	Raymond St (Between Restwell St and Lopez Ln)	660	225	70	35	44	15	10	5
	Bankstown City Plaza	660	225	70	35	44	15	10	5

Note 1: TTMP heavy vehicle traffic refers to train replacement buses.

Note 2: Results marked with a "-" represent roads without designated TTMP traffic.

Table 82 presents the assessment of predicted daytime and night-time noise impacts from road traffic associated with the Baseline TTMP and Refined Baseline TTMP based on the TTMP traffic volumes presented in **Table 81** and the existing road traffic volumes presented in **Table 78**.

Table 82 Baseline TTMP and Refined Baseline TTMP Road Traffic Noise Assessment

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)							
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise LAeq(period)	Baseline TTMP[1]			Refined Baseline TTMP[1]		
				Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night	Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night
Marrickville	Myrtle St	60 / 55	61 / 53	-	61 / 53	N / N	-	61 / 53	N / N
	Carrington Rd (Between Schwebel St and Myrtle St)	60 / 55	70 / 62	-	70 / 62	N / N	-	70 / 62	N / N
	Richardson Cres	60 / 55	73 / 65	-	73 / 65	N / N	-	73 / 65	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	64 / 0	72 / 64	N / N	61 / 0	72 / 64	N / N
	Marrickville Rd (Between Illawarra Rd and Silver St)	60 / 55	76 / 68	71 / 60	77 / 69	N / N	68 / 57	77 / 68	N / N
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	60 / 55	74 / 66	69 / 0	76 / 66	N / N	67 / 0	75 / 66	N / N
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	64 / 58	72 / 65	N / N	61 / 55	72 / 64	N / N
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	60 / 55	71 / 63	-	71 / 63	N / N	-	71 / 63	N / N
	Marrickville Rd (Between Darley St and Wardell Rd)	60 / 55	75 / 67	69 / 0	76 / 67	N / N	67 / 0	75 / 67	N / N
	Dudley St (Between School Pde and Wardell Rd)	55 / 50	66 / 57	63 / 58	68 / 61	N / **Y**	0 / 55	66 / 59	N / N
	Bayley St (Between Ewart St and Dudley St)	55 / 50	62 / 51	63 / 58	66 / 59	**Y** / **Y**	0 / 55	62 / 57	N / **Y**
	Ewart St (Between Bayley St and Wicks Ave)	60 / 55	69 / 61	64 / 58	70 / 63	N / N	64 / 55	70 / 62	N / N
	Beauchamp St (Between School Pde and Ewart St)	60 / 55	69 / 61	64 / 58	70 / 63	N / N	61 / 55	70 / 62	N / N
	Wardell Rd (Between Marrickville Rd and Pine St)	60 / 55	72 / 64	-	72 / 64	N / N	61 / 0	72 / 64	N / N
	Terrace Rd (Between New Canterbury Rd and Consett St)	60 / 55	61 / 53	-	61 / 53	N / N	-	61 / 53	N / N
	New Canterbury Rd (Between Kintore St and Terrace Rd)	60 / 55	78 / 69	69 / 0	78 / 69	N / N	65 / 0	78 / 69	N / N
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	60 / 55	75 / 67	69 / 0	76 / 67	N / N	65 / 0	75 / 67	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	64 / 58	72 / 65	N / N	61 / 55	72 / 64	N / N
	Ewart St (between Wardell and Ness Ave)	60 / 55	52 / 44	64 / 58	64 / 58	**Y** / **Y**	64 / 55	64 / 55	**Y** / N
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	64 / 58	72 / 65	N / N	61 / 55	72 / 64	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)							
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise LAeq(period)	Baseline TTMP[1]			Refined Baseline TTMP[1]		
				Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night	Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	55 / 50	63 / 53	-	63 / 53	N / N	-	63 / 53	N / N
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	60 / 55	77 / 69	69 / 0	78 / 69	N / N	65 / 0	77 / 69	N / N
	Duntroon St	60 / 55	62 / 54	-	62 / 54	N / N	-	62 / 54	N / N
	Crinan St (Between Floss St and Fernhil St)	60 / 55	70 / 62	59 / 58	70 / 63	N / N	61 / 55	71 / 63	N / N
	Dunstaffenage St (Between Crinan St and Floss st)	60 / 55	54 / 46	-	54 / 46	N / N	-	54 / 46	N / N
	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	69 / 61	59 / 58	70 / 63	N / N	61 / 55	70 / 62	N / N
	Canterbury Rd (Between Queen St and Wattle Ln)	60 / 55	77 / 69	69 / 0	78 / 69	N / N	67 / 0	78 / 69	N / N
	Canterbury Rd (Between Queen St and Princess St)	60 / 55	78 / 70	70 / 60	79 / 71	N / N	67 / 57	78 / 70	N / N
	Floss St (Between Garnet St and Crinan St)	60 / 55	70 / 62	64 / 58	71 / 63	N / N	64 / 55	71 / 63	N / N
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	70 / 64	59 / 58	71 / 65	N / N	61 / 55	71 / 65	N / N
	Canterbury Rd (Between Close St and Broughton St)	60 / 55	80 / 74	70 / 60	81 / 75	N / N	67 / 57	80 / 74	N / N
	Close St	55 / 50	61 / 55	-	61 / 55	N / N	-	61 / 55	N / N
	Broughton St (Between Canterbury Rd and Robert St)	60 / 55	67 / 59	-	67 / 59	N / N	-	67 / 59	N / N
	Canterbury Rd (Between Jeffrey St and Minter St)	60 / 55	79 / 73	70 / 60	79 / 73	N / N	67 / 57	79 / 73	N / N
	Charles St (Between Canterbury Rd and Broughton St)	60 / 55	62 / 54	-	62 / 54	N / N	-	62 / 54	N / N
	Canterbury Rd (Between Charles St and Close St)	60 / 55	80 / 74	70 / 60	81 / 75	N / N	67 / 57	80 / 74	N / N
	Wonga St	55 / 50	72 / 65	65 / 59	73 / 66	N / N	65 / 56	72 / 65	N / N
	Canterbury Rd (Between Wonga St and Cooks Avenue)	60 / 55	79 / 74	66 / 0	79 / 74	N / N	-	79 / 74	N / N
	Canterbury Rd (Between Fore St and Charles St)	60 / 55	80 / 74	70 / 60	81 / 75	N / N	67 / 57	80 / 75	N / N
	Canterbury Rd (Between Wonga St and Fore St)	60 / 55	79 / 74	66 / 0	80 / 74	N / N	-	79 / 74	N / N
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	60 / 55	78 / 73	70 / 60	79 / 73	N / N	67 / 57	79 / 73	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)							
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise LAeq(period)	Baseline TTMP[1]			Refined Baseline TTMP[1]		
				Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night	Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	60 / 55	79 / 74	66 / 0	80 / 74	N / N	-	79 / 74	N / N
	South Parade (Between Beamish St and Harold St)	60 / 55	69 / 61	65 / 58	71 / 63	N / N	65 / 55	71 / 62	N / N
	Beamish St (Between Ninth Ave and Campsie St)	60 / 55	72 / 64	65 / 58	73 / 65	N / N	65 / 55	73 / 65	N / N
	Beamish St (Between South Parade and Amy St)	60 / 55	73 / 65	-	73 / 65	N / N	-	73 / 65	N / N
	Brighton Ave (Between Browning St and Shakespeare St)	60 / 55	71 / 63	-	71 / 63	N / N	-	71 / 63	N / N
	Ninth Ave (Between Beamish St and Fifth Ave)	60 / 55	72 / 66	65 / 58	73 / 67	N / N	61 / 55	72 / 66	N / N
	Loch St (Between Evaline St and Lillian St)	60 / 55	73 / 65	-	73 / 65	N / N	-	73 / 65	N / N
	Evaline St (Between Loch St and Beamish St)	60 / 55	66 / 60	-	66 / 60	N / N	-	66 / 60	N / N
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	55 / 50	73 / 65	-	73 / 65	N / N	-	73 / 65	N / N
	Canterbury Rd (Between Northcote St and Beamish St)	60 / 55	79 / 74	66 / 0	80 / 74	N / N	-	79 / 74	N / N
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	60 / 55	80 / 74	66 / 0	80 / 74	N / N	-	80 / 74	N / N
	Gould St (Between Canterbury Rd and Redman St)	60 / 55	65 / 57	65 / 58	68 / 61	**Y** / **Y**	65 / 55	68 / 59	**Y** / N
	Albert St (Between Lincoln St and Baltimore St)	60 / 55	71 / 63	65 / 58	72 / 64	N / N	61 / 55	71 / 64	N / N
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	65 / 58	75 / 69	N / N	61 / 55	74 / 69	N / N
	Bridge Rd (Between Marie Ln and Burwood Ave)	60 / 55	70 / 65	65 / 58	72 / 66	N / N	61 / 55	71 / 65	N / N
	Burwood Rd (Between Bridge Rd and Collins St)	60 / 55	74 / 69	-	74 / 69	N / N	-	74 / 69	N / N
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	60 / 55	80 / 74	66 / 0	80 / 74	N / N	-	80 / 74	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)							
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise LAeq(period)	Baseline TTMP[1]			Refined Baseline TTMP[1]		
				Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night	Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	60 / 55	69 / 63	65 / 58	70 / 64	N / N	61 / 55	69 / 64	N / N
	Moreton St (Between Lakemba St and The Boulevarde)	60 / 55	73 / 67	-	73 / 67	N / N	-	73 / 67	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	-	65 / 60	N / N	-	65 / 60	N / N
	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	65 / 58	75 / 69	N / N	61 / 55	74 / 69	N / N
	Railway Pde (Between Haldon St and Croydon St)	60 / 55	67 / 59	-	67 / 59	N / N	-	67 / 59	N / N
	Haldon St (Between Railway Parade and The Boulevarde)	60 / 55	72 / 67	-	72 / 67	N / N	-	72 / 67	N / N
	Haldon St (Between The Boulevarde and Oneata St)	60 / 55	71 / 65	64 / 0	72 / 65	N / N	-	71 / 65	N / N
	Canterbury Rd (Between Haldon St and Legge St)	60 / 55	80 / 74	66 / 0	80 / 74	N / N	-	80 / 74	N / N
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	60 / 55	71 / 66	65 / 58	72 / 66	N / N	61 / 55	72 / 66	N / N
	King Georges Rd (Between The Boulevarde and Mary St)	60 / 55	83 / 77	-	83 / 77	N / N	-	83 / 77	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	-	65 / 60	N / N	-	65 / 60	N / N
	King Georges Rd (Between Lakemba St and The Boulevarde)	60 / 55	83 / 78	-	83 / 78	N / N	-	83 / 78	N / N
Punchbowl	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	60 / 55	80 / 75	-	80 / 75	N / N	-	80 / 75	N / N
	The Boulevarde (Between Punchbowl Rd and Arthur St)	60 / 55	74 / 69	65 / 58	75 / 69	N / N	61 / 55	75 / 69	N / N
	South Terrace (Between Loder Ln and Punchbowl Rd)	60 / 55	70 / 64	65 / 57	71 / 65	N / N	60 / 54	70 / 65	N / N
	Punchbowl Rd (Between South Terrace and The Boulevarde)	60 / 55	81 / 75	-	81 / 75	N / N	-	81 / 75	N / N
	Wattle St (Between Highclere Ave and Acacia Ave)	60 / 55	72 / 67	-	72 / 67	N / N	-	72 / 67	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)							
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise LAeq(period)	Baseline TTMP[1]			Refined Baseline TTMP[1]		
				Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night	Predicted TTMP Noise Day / Night LAeq(period)[2]	Combined TTMP Noise Level Day / Night	Exceedance of Criteria and 2 dB Increase? Day / Night
Bankstown	South Terrace (Between West Terrace and East Terrace)	60 / 55	71 / 65	65 / 58	72 / 66	N / N	61 / 55	71 / 65	N / N
	Stacey St (Between Verbena Ave and Stanley St)	60 / 55	80 / 74	-	80 / 74	N / N	-	80 / 74	N / N
	Restwell St (Between Stewart Ln and Raymond St)	60 / 55	69 / 64	65 / 58	71 / 65	N / N	61 / 55	70 / 64	N / N
	Raymond St (Between Restwell St and West Terrace)	60 / 55	66 / 60	65 / 58	69 / 62	**Y** / N	61 / 55	67 / 61	N / N
	South Terrace (Between West Terrace and Restwell St)	60 / 55	68 / 62	65 / 58	70 / 64	N / N	61 / 55	69 / 63	N / N
	North Terrace (Between The Appian Way and Fetherstone St)	60 / 55	69 / 63	56 / 58	69 / 64	N / N	58 / 55	69 / 64	N / N
	Wattle St (Between Stacey St and North Terrace)	60 / 55	69 / 63	-	69 / 63	N / N	-	69 / 63	N / N
	South Terrace (between Punchbowl Rd and Stacey St)	60 / 55	71 / 65	65 / 58	72 / 66	N / N	61 / 55	71 / 65	N / N
	South Terrace (Between Stacey St and Bankstown City Plaza)	60 / 55	68 / 62	65 / 58	70 / 64	N / N	61 / 55	69 / 63	N / N
	Raymond St (Between Restwell St and Lopez Ln)	60 / 55	66 / 60	65 / 58	69 / 62	**Y** / N	61 / 55	67 / 61	N / N
	Bankstown City Plaza	60 / 55	69 / 63	65 / 58	71 / 64	N / N	61 / 55	70 / 64	N / N

Note 1: Results marked with a "-" represent roads without designated TTMP traffic.

Note 1: Road traffic noise criteria (refer to **Section 3.4**).

The above predictions indicate that the Baseline TTMP and Refined Baseline TTMP road traffic would result in an increase in road traffic noise levels of less than 2 dB on the majority of roads along the TTMP routes.

TTMP road traffic is however predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on six and three roads for the Baseline TTMP and Refined Baseline TTMP scenarios, respectively. These roads are:

- Dulwich Hill – Dudley St (Between School Pde and Wardell Rd) – Baseline TTMP during the night.
- Dulwich Hill – Bayley St (Btwn Ewart St & Dudley St) – Baseline TTMP during the day and night, and Refined Baseline TTMP during the night.
- Dulwich Hill – Ewart St (Btwn Wardell Rd & Ness Ave) – Baseline TTMP during the day and night, and Refined Baseline TTMP during the day..
- Campsie – Gould St (Btwn Canterbury Rd & Redman St) – Baseline TTMP during the day and night, and Refined Baseline TTMP during the day.
- Bankstown – Raymond St (Btwn Restwell St & West Terrace) – Baseline TTMP during the day.
- Bankstown – Raymond St (Btwn Restwell St & Lopez Ln) – Baseline TTMP during the day.

The predictions indicate that the Refined Baseline TTMP would result in lower noise impacts compared to the Baseline TTMP due to the lower traffic volumes.

As described in **Section 3.18.2**, the Baseline TTMP solution and the associated noise impacts are representative of the potential worst-case noise impacts from train replacement bus services if all T3 Bankstown Line train services were to be replaced with buses. At this stage in the assessment, it is considered unlikely the Baseline TTMP would be implemented. The results of the assessment are presented in this technical paper as an indication of potential worst-case noise impacts only.

TTMP routes and traffic volumes should be confirmed at a later design stage of the project. Where compliance with the criteria is unable to be achieved, feasible and reasonable noise mitigation should be considered. The measures could comprise of alternate TTMP routes or reducing the frequency of movements.

3.18.3 Cumulative Construction Road Traffic

A cumulative assessment of temporary additional road traffic noise from vehicles associated with the project has been undertaken to identify the potential for impacts where both the construction traffic and the Refined Baseline TTMP vehicle movements occur concurrently in the same location.

Table 83 presents the assessment of predicted daytime and night-time cumulative noise impacts from road traffic associated with both the construction traffic and the Refined Baseline TTMP traffic. This comparison includes the Refined Baseline TTMP traffic for the reasons discussed in **Section 3.18.2**

Table 83 Cumulative Construction Road Traffic Noise Assessment (Construction Traffic and Refined Baseline TTMP)

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Cumulative Road Traffic Noise Day / Night $L_{Aeq(period)}$	Combined Road Traffic Noise Level Day / Night	
Marrickville	Myrtle St	60 / 55	61 / 53	55 / 57	62 / 59	N / **Y**
	Carrington Rd (Between Schwebel St and Myrtle St)	60 / 55	70 / 62	55 / 57	71 / 64	N / N
	Richardson Cres	60 / 55	73 / 65	55 / 57	73 / 66	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	62 / 60	72 / 65	N / N
	Marrickville Rd (Between Illawarra Rd and Silver St)	60 / 55	76 / 68	68 / 57	77 / 68	N / N
	Marrickville Rd (Between Livingstone Rd and Wardell Rd)	60 / 55	74 / 66	67 / 0	75 / 66	N / N
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	62 / 59	72 / 65	N / N
Dulwich Hill	Livingstone Rd (between Warren Rd and Jersey St)	60 / 55	71 / 63	50 / 53	71 / 63	N / N
	Marrickville Rd (Between Darley St and Wardell Rd)	60 / 55	75 / 67	68 / 60	76 / 68	N / N
	Dudley St (Between School Pde and Wardell Rd)	55 / 50	66 / 57	66 / 59	66 / 59	N / N
	Bayley St (Between Ewart St and Dudley St)	55 / 50	62 / 51	54 / 58	62 / 58	N / **Y**
	Ewart St (Between Bayley St and Wicks Ave)	60 / 55	69 / 61	64 / 57	70 / 63	N / N
	Beauchamp St (Between School Pde and Ewart St)	60 / 55	69 / 61	61 / 57	70 / 63	N / N
	Wardell Rd (Between Marrickville Rd and Pine St)	60 / 55	72 / 64	62 / 58	72 / 65	N / N
	Terrace Rd (Between New Canterbury Rd and Consett St)	60 / 55	61 / 53	59 / 60	63 / 61	N / **Y**
	New Canterbury Rd (Between Kintore St and Terrace Rd)	60 / 55	78 / 69	67 / 62	78 / 70	N / N
	Marrickville Rd (Between Wardell Rd and New Canterbury Rd)	60 / 55	75 / 67	66 / 60	75 / 68	N / N
	Illawarra Rd (between Marrickville Rd and Calvert St)	60 / 55	72 / 64	62 / 61	72 / 66	N / N
	Ewart St (between Wardell and Ness Ave)	60 / 55	52 / 44	64 / 57	64 / 57	**Y** / **Y**
	Warren Rd (Between Illawarra Rd and Moyes St)	60 / 55	72 / 64	62 / 59	72 / 65	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Cumulative Road Traffic Noise Day / Night $L_{Aeq(period)}$	Combined Road Traffic Noise Level Day / Night	
Hurlstone Park	Garnet St (Between Canterbury Rd and Hampden St)	55 / 50	63 / 53	54 / 54	63 / 57	N / **Y**
	New Canterbury Rd (Between Wattle Ln and Old Canterbury Rd)	60 / 55	77 / 69	67 / 62	77 / 70	N / N
	Duntroon St	60 / 55	62 / 54	55 / 56	62 / 58	N / **Y**
	Crinan St (Between Floss St and Fernhil St)	60 / 55	70 / 62	62 / 60	71 / 64	N / N
	Dunstaffenage St (Between Crinan St and Floss st)	60 / 55	54 / 46	52 / 55	56 / 55	N / N
	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	69 / 61	63 / 61	70 / 64	N / **Y**
	Canterbury Rd (Between Queen St and Wattle Ln)	60 / 55	77 / 69	68 / 62	78 / 70	N / N
	Canterbury Rd (Between Queen St and Princess St)	60 / 55	78 / 70	68 / 63	79 / 71	N / N
	Floss St (Between Garnet St and Crinan St)	60 / 55	70 / 62	64 / 55	71 / 63	N / N
Canterbury	Crinan St (Between Melford St and Dunstaffenage St)	60 / 55	70 / 64	63 / 61	71 / 66	N / N
	Canterbury Rd (Between Close St and Broughton St)	60 / 55	80 / 74	68 / 63	81 / 75	N / N
	Close St	55 / 50	61 / 55	61 / 58	64 / 60	**Y** / **Y**
	Broughton St (Between Canterbury Rd and Robert St)	60 / 55	67 / 59	57 / 60	67 / 63	N / **Y**
	Canterbury Rd (Between Jeffrey St and Minter St)	60 / 55	79 / 73	68 / 63	79 / 73	N / N
	Charles St (Between Canterbury Rd and Broughton St)	60 / 55	62 / 54	48 / 51	62 / 56	N / N
	Canterbury Rd (Between Charles St and Close St)	60 / 55	80 / 74	68 / 63	80 / 75	N / N
	Wonga St	55 / 50	72 / 65	65 / 56	72 / 65	N / N
	Canterbury Rd (Between Wonga St and Cooks Avenue)	60 / 55	79 / 74	61 / 62	79 / 74	N / N
	Canterbury Rd (Between Fore St and Charles St)	60 / 55	80 / 74	68 / 63	81 / 75	N / N
	Canterbury Rd (Between Wonga St and Fore St)	60 / 55	79 / 74	61 / 62	80 / 75	N / N
	Canterbury Rd (Between New Canterbury Rd and Broughton St)	60 / 55	78 / 73	68 / 63	79 / 73	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Cumulative Road Traffic Noise Day / Night $L_{Aeq(period)}$	Combined Road Traffic Noise Level Day / Night	
Campsie	Canterbury Rd (Between Beamish St and Scahill St)	60 / 55	79 / 74	55 / 57	79 / 74	N / N
	South Parade (Between Beamish St and Harold St)	60 / 55	69 / 61	65 / 56	71 / 62	N / N
	Beamish St (Between Ninth Ave and Campsie St)	60 / 55	72 / 64	65 / 58	73 / 65	N / N
	Beamish St (Between South Parade and Amy St)	60 / 55	73 / 65	52 / 54	73 / 65	N / N
	Brighton Ave (Between Browning St and Shakespeare St)	60 / 55	71 / 63	52 / 54	71 / 64	N / N
	Ninth Ave (Between Beamish St and Fifth Ave)	60 / 55	72 / 66	61 / 56	72 / 67	N / N
	Loch St (Between Evaline St and Lillian St)	60 / 55	73 / 65	47 / 50	73 / 65	N / N
	Evaline St (Between Loch St and Beamish St)	60 / 55	66 / 60	46 / 49	66 / 60	N / N
	Thorncraft Pde (Between Canterbury Rd and Claremont St)	55 / 50	73 / 65	54 / 54	74 / 65	N / N
	Canterbury Rd (Between Northcote St and Beamish St)	60 / 55	79 / 74	62 / 62	79 / 74	N / N
	Canterbury Rd (Between Beamish St and Kingsgrove Rd)	60 / 55	80 / 74	62 / 62	80 / 74	N / N
	Gould St (Between Canterbury Rd and Redman St)	60 / 55	65 / 57	65 / 55	68 / 59	**Y** / N
	Albert St (Between Lincoln St and Baltimore St)	60 / 55	71 / 63	61 / 56	71 / 64	N / N
Belmore	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	63 / 61	74 / 69	N / N
	Bridge Rd (Between Marie Ln and Burwood Ave)	60 / 55	70 / 65	61 / 55	71 / 65	N / N
	Burwood Rd (Between Bridge Rd and Collins St)	60 / 55	74 / 69	60 / 60	74 / 69	N / N
	Canterbury Rd (Between Kingsgrove Rd and Haldon St)	60 / 55	80 / 74	62 / 62	80 / 74	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night LAeq(period)[1]	Estimated Existing Road Traffic Noise Day / Night LAeq(period)	Predicted Cumulative Road Traffic Noise Day / Night LAeq(period)	Combined Road Traffic Noise Level Day / Night	
Lakemba	The Boulevarde (Between Haldon St and Croydon St)	60 / 55	69 / 63	61 / 58	70 / 64	N / N
	Moreton St (Between Lakemba St and The Boulevarde)	60 / 55	73 / 67	53 / 56	73 / 67	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	55 / 57	66 / 62	N / N
	Burwood Rd (Between Redman Parade and Bridge Rd)	60 / 55	74 / 68	63 / 61	74 / 69	N / N
	Railway Pde (Between Haldon St and Croydon St)	60 / 55	67 / 59	51 / 54	67 / 60	N / N
	Haldon St (Between Railway Parade and The Boulevarde)	60 / 55	72 / 67	55 / 57	72 / 67	N / N
	Haldon St (Between The Boulevarde and Oneata St)	60 / 55	71 / 65	61 / 60	71 / 66	N / N
	Canterbury Rd (Between Haldon St and Legge St)	60 / 55	80 / 74	52 / 55	80 / 74	N / N
Wiley Park	The Boulevarde (Between Renown Ave and King Georges Rd)	60 / 55	71 / 66	62 / 59	72 / 67	N / N
	King Georges Rd (Between The Boulevarde and Mary St)	60 / 55	83 / 77	58 / 60	83 / 78	N / N
	Lakemba St (Between King Georges Rd and Shadforth St)	60 / 55	65 / 60	55 / 57	66 / 62	N / N
	King Georges Rd (Between Lakemba St and The Boulevarde)	60 / 55	83 / 78	58 / 60	83 / 78	N / N
Punchbowl	Dudley St (Between School Pde and Wardell Rd)	55 / 50	66 / 60	54 / 58	67 / 62	N / N
	Punchbowl Rd (Between The Boulevarde and Acacia Ave)	60 / 55	80 / 75	57 / 59	80 / 75	N / N
	The Boulevarde (Between Punchbowl Rd and Arthur St)	60 / 55	74 / 69	61 / 57	75 / 69	N / N
	South Terrace (Between Loder Ln and Punchbowl Rd)	60 / 55	70 / 64	60 / 56	70 / 65	N / N
	Punchbowl Rd (Between South Terrace and The Boulevarde)	60 / 55	81 / 75	53 / 56	81 / 75	N / N
	Wattle St (Between Highclere Ave and Acacia Ave)	60 / 55	72 / 67	51 / 54	72 / 67	N / N

Construction Precinct	Roads along Construction & TTMP Routes	Noise Level (dBA)				Exceedance of Criteria and 2 dB Increase? Day / Night
		Base Criteria Day / Night $L_{Aeq(period)}$[1]	Estimated Existing Road Traffic Noise Day / Night $L_{Aeq(period)}$	Predicted Cumulative Road Traffic Noise Day / Night $L_{Aeq(period)}$	Combined Road Traffic Noise Level Day / Night	
Bankstown	South Terrace (Between West Terrace and East Terrace)	60 / 55	71 / 65	61 / 58	71 / 66	N / N
	Stacey St (Between Verbena Ave and Stanley St)	60 / 55	80 / 74	62 / 60	80 / 74	N / N
	Restwell St (Between Stewart Ln and Raymond St)	60 / 55	69 / 64	61 / 58	70 / 65	N / N
	Raymond St (Between Restwell St and West Terrace)	60 / 55	66 / 60	61 / 58	67 / 62	N / N
	South Terrace (Between West Terrace and Restwell St)	60 / 55	68 / 62	61 / 58	69 / 64	N / N
	North Terrace (Between The Appian Way and Fetherstone St)	60 / 55	69 / 63	59 / 58	69 / 64	N / N
	Wattle St (Between Stacey St and North Terrace)	60 / 55	69 / 63	51 / 54	69 / 64	N / N
	South Terrace (between Punchbowl Rd and Stacey St)	60 / 55	71 / 65	61 / 55	71 / 65	N / N
	South Terrace (Between Stacey St and Bankstown City Plaza)	60 / 55	68 / 62	61 / 55	69 / 63	N / N
	Raymond St (Between Restwell St and Lopez Ln)	60 / 55	66 / 60	61 / 55	67 / 61	N / N
	Bankstown City Plaza	60 / 55	69 / 63	61 / 55	70 / 64	N / N

Note 1: Road traffic noise criteria (refer to **Section 3.4**).

The above results indicate that concurrent construction traffic and Refined Baseline TTMP traffic is predicted to result in an increase in road traffic noise levels of less than 2 dB on the majority of roads along the construction and TTMP scenario routes.

Cumulative construction road traffic is predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on 10 roads. These roads are:

- Marrickville – Myrtle St – during the night.
- Dulwich Hill – Bayley St (Btwn Ewart St & Dudley St) – during the night.
- Dulwich Hill – Terrace Rd (Btwn New Canterbury Rd & Consett St) – during the night.
- Dulwich Hill – Ewart St (Btwn Wardell Rd & Ness Ave) – during the day and night.
- Hurlstone Park – Garnet St (Between Canterbury Rd and Hampden St) – during the night.
- Hurlstone Park – Duntroon St – during the night.
- Hurlstone Park – Crinan St (Btwn Melford St & Dunstaffenage St) – during the night.
- Canterbury – Close St – during the day and night.
- Canterbury – Broughton St (Btwn Canterbury Rd & Robert St) – during the night.
- Campsie – Gould St (Btwn Canterbury Rd & Redman St) – during the day.

Construction and TTMP traffic volumes should be confirmed at a later design stage of the project to confirm if mitigation should be considered for the roads outlined above. Where compliance with the criteria is unable to be achieved, feasible and reasonable noise mitigation should be considered. The measures could comprise of alternate routes or reducing the maximum number of daily movements.

Construction traffic volumes and haul routes are subject to change as work plans and work sequencing are developed by the contractor. As part of the iterative process of determining the best design outcome, a number of potential alternative haul routes have been identified to address a range of matters including ease of constructability, project construction duration, and safety. While many of the alternative routes would only include infrequent use by construction vehicles, roads on some routes with construction traffic modifications may result in significant levels of additional construction traffic.

Further modelling of these routes would be carried out during the detailed design stage of the project when construction volumes and haulage routes are confirmed. Where compliance with the criteria is unable to be achieved, feasible and reasonable noise mitigation should be considered. The measures could comprise of alternate construction traffic routes or reducing the maximum number of daily movements.

3.19 Construction Vibration Assessment

As a guide, safe working distances for the proposed items of vibration intensive plant are provided in the TfNSW *Construction Noise Strategy* (CNS) and are reproduced below in **Table 84**.

Table 84 Recommended Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (NSW EPA Vibration Guideline)
Vibratory Roller	< 50 kN (Typically 1-2t)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4t)	6 m	20 m
	< 200 kN (Typically 4-6t)	12 m	40 m
	< 300 kN (Typically 7-13t)	15 m	100 m
	> 300 kN (Typically 13-18t)	20 m	100 m
	> 300 kN (Typically > 18t)	25 m	100 m
Small Hydraulic Hammer	300 kg - 5 to 12t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg - 12 to 18t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg - 18 to 34t excavator	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Note: More stringent conditions may apply to heritage or other sensitive structures.

The safe working distances presented in **Table 84** are quoted for both cosmetic damage (refer to BS7385:2 *Evaluation and Measurement for Vibration in Buildings Part 2: Guide to Damage Levels from Ground-borne Vibration*, 1993) and human comfort (refer to NSW EPA *Assessing Vibration: a technical guideline*, 2006).

The safe working distances for building damage should be complied with at all times. The distances are noted as being indicative and would vary depending on the particular item of plant and local geotechnical conditions. They apply to addressing the risk of cosmetic (minor - easily reparable) damage of typical buildings under typical geotechnical conditions.

Where vibration intensive works are required to be undertaken within the specified safe working distances, vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied.

In relation to human comfort, the safe working distances relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed.

3.19.1 Cosmetic Damage Assessment

For most sources of intermittent vibration during construction, such as rockbreakers, the predominant vibration energy occurs at frequencies usually in the 10 Hz to 100 Hz range. On this basis, and with reference to BS7385:2 and **Section 3.5.2** , a vibration damage screening level of 7.5 mm/s has been adopted for the purpose of assessing potential impacts from continuous vibration.

BS7385:2 sets guide values for vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk is usually taken as 95 per cent probability of no effect.

Proposed vibration intensive construction plant is listed in **Table 19** and compared to the general vibration screening criteria detailed in **Section 3.5.2,** and the safe working distances detailed in **Table 84** in order to determine potential vibration impacts. Based on the equipment and activities presented in **Table 19**, large rock breakers have been identified as having the highest potential for vibration impacts across the project.

Table 85 provides a summary of the number of buildings that exceed the cosmetic damage screening criteria 7.5 mm/s with the use of a large rock breaker. A**ppendix G** illustrates the potential cosmetic damage vibration impacts due to construction activities in this area.

3.19.2 Human Response

In relation to human comfort (response), the safe working distances in **Table 84** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in *Assessing Vibration – a technical guideline*. Given information regarding the operating duration of construction equipment is unknown at this stage, the human response safe working distances as presented in **Table 84** have been used to conservatively estimate the number of dwellings which may perceive vibration. **Table 85** provides a summary of the number of buildings which are within the human response safe working distance for a large rock breaker.

3.19.3 Vibration Assessment Summary

Based on the safe working distances presented in the CNS, indicative vibration levels at the representative receivers are shown in **Table 85**.

Table 85 Construction Vibration Assessment Summary

Work Scenario	Vibration Intensive Equipment	NCA	Number of buildings within minimum working distance for highest vibration plant item	
			7.5mm /s	**Human Response**
Various	Rockbreaker [1]	NCA01	40	185
		NCA02	74	249
		NCA03	45	150
		NCA04	18	55
		NCA05	5	83
		NCA06	29	110
		NCA07	41	116
		NCA08	36	77
		NCA09	12	50
		NCA10	25	60
		NCA11	3	37
		NCA12	32	5
		NCA13	0	7
		Total	**360**	**1184**

Note 1: Proposed highest vibration plant item for these works.

3.19.3.1 Cosmetic Damage Assessment Summary

The separation distance(s) between the construction works and the nearest sensitive receivers would generally be sufficient so that nearby buildings are unlikely to suffer 'cosmetic damage' for most of the construction equipment. However, based on the arrangement of the work zones, some items of construction equipment have the potential to be operated closer to sensitive receivers than the recommended minimum working distances. Operation of large rockbreakers has the potential to generate some of the highest construction vibration impacts due to the high vibration characteristics of the plant.

The assessment presented in **Table 85** indicates that during surface works, up to 360 buildings (including stations) in the vicinity of the works may be within the screening criteria distances (7.5mm/s) should a large rockbreaker be used at the outer extents of each works area. In practice, it is unlikely that a rockbreaker would be required at all areas and therefore the vibration impacts presented in this assessment should be considered a worst-case. The required locations for vibration intensive equipment should be reviewed during detailed design to account for finalised information relating to the ground propagation characteristics, equipment type and specific works location.

3.19.4 Human Comfort Vibration Assessment

The assessment presented in **Table 85** indicates the surface works using a large rockbreaker may result in a large number of receivers (around 1184) within the nominated minimum working distance for human comfort vibration.

Receivers adjacent to the construction areas have been identified as likely to perceive vibration impacts at times during construction works. This is expected to be primarily due to works associated with rockbreakers and other high vibration plant items. In practice vibration impacts from most construction activities would be intermittent within the duration of the project. The required locations for vibration intensive equipment should be reviewed during detailed design when finalised information relating to the works is available.

3.19.4.1 Heritage Structures

Heritage buildings are to be considered on a case by case basis, and detailed inspections of heritage listed structures should be undertaken for all potentially affected heritage structures (including stations) prior to the commencement of works. Where a historic building/structure is deemed to be sensitive to damage from vibration (following inspection), it is recommended to reduce the vibration criteria. It is however noted that BS 7385 states that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" and therefore the building should not automatically be assumed to be sensitive to vibration on the basis of being a heritage item.

Heritage listed buildings identified within the cosmetic damage screening criteria minimum working distances are listed in **Table 86**.

Table 86 Heritage and Conservation Listed Buildings within Cosmetic Damage Minimum Working Distance

NCA	Address	Building Occupancy	Construction Type[1]
NCA01	Carrington Road, Marrickville	Public Building	Masonry (Brick)
NCA01	1 Myrtle Street, Marrickville	Residential	Masonry (Brick)
NCA01	Marrickville Station	Commercial	Masonry
NCA02	217 Livingstone Road, Marrickville	Residential	Masonry (Brick)
NCA02	219 Livingstone Road, Marrickville	Residential	Masonry (Brick)
NCA02	2 Hollands Avenue, Marrickville	Residential	Masonry (Brick)

NCA	Address	Building Occupancy	Construction Type[1]
NCA02	4 Hollands Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	6 Hollands Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	242 Wardell Road, Dulwich Hill	Residential	Masonry (Brick)
NCA02	240 Wardell Road, Dulwich Hill	Residential	Masonry (Brick/Rendered)
NCA02	5 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	7 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	14 Wilga Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	47 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	43 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	41 School Parade, Marrickville	Residential	Masonry (Brick)
NCA02	22 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	26 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	28 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	37 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	39 Kays Avenue, Marrickville	Residential	Masonry (Brick)
NCA02	34 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	36 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	35 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick)
NCA02	39 Challis Avenue, Dulwich Hill	Residential	Masonry (Brick/Rendered)
NCA02	Dulwich Hill Station	Commercial	Weatherboard
NCA02	116 Ewart Street, Dulwich Hill	Residential	Masonry
NCA03	Hurlstone Park Railway Station	Commercial	Masonry (Brick)
NCA04	2 Sugar House Road, Canterbury	Residential	Masonry
NCA04	Canterbury Station	Commercial	Masonry (Brick)
NCA04	193 Canterbury Road, Canterbury	Residential	Masonry (Brick)
NCA04	3 Broughton Street, Canterbury	Residential	Masonry (Brick)
NCA06	203 Beamish Street, Campsie	Commercial	Masonry (Brick/Rendered)
NCA06	Campsie Station	Commercial	Masonry
NCA07	Belmore Station	Commercial	Weatherboard
NCA08	60 The Boulevarde, Lakemba	Commercial	Masonry (Brick)
NCA08	Lakemba Station	Commercial	Masonry (Brick)
NCA09	Wiley Park Station	Commercial	Weatherboard
NCA10	Punchbowl Station	Commercial	Weatherboard

Note 1: Estimated from photographic information only and should be confirmed onsite. The inclusion of items is not a reflection of the heritage significance of the item. Refer to the Technical Paper No 3 Non Aboriginal Heritage Impact Assessment for discussion on heritage items

The construction type classifications and structural integrity of all the listed heritage buildings should be confirmed at detailed design by a suitably qualified structural engineer. This information can then be used to verify the applicable vibration criteria and associated impacts, and potentially reasonable and feasible mitigation options.

4 OPERATIONAL NOISE AND VIBRATION ASSESSMENT

4.1 Airborne Noise - Rail Operations

4.1.1 Introduction

The primary source of airborne noise from rail operations is the wheel-rail interface, as a result of surface irregularities on the wheel and/or rail running surfaces and interaction forces. During a train passby the wheel, bogies, rail and rail support system vibrate and transfer this energy to the surrounding environment as airborne noise.

The key influencers of airborne noise are the train speed, the condition of the wheel and rail, the train length, number of train passby events and the design of the train and track. The level of airborne noise experienced at a receiver is dependent upon the distance to the track and the presence of natural or man-made barriers between the rail and the receiver which can impede the propagation of noise.

4.1.2 Operational Noise Metrics

The primary noise metrics used to describe airborne railway noise emissions in the modelling and assessments are:

$L_{Amax,95\%}$ The *"typical maximum noise level"* for a train passby event. In RING, L_{Amax} refers to the maximum noise level not exceeded for 95% of rail passby events and is measured using the 'fast' response setting on a sound level meter.

$L_{Aeq(24hour)}$ The *"energy average noise level"* evaluated over a 24 hour period. The $L_{Aeq(24hour)}$ represents the cumulative effects of all the train noise events occurring in one day.

$L_{Aeq(15hour)}$ The $L_{Aeq(15hour)}$ represents the cumulative effects of all the train noise events occurring in the daytime period from 7:00 am to 10:00 pm.

$L_{Aeq(9hour)}$ The $L_{Aeq(9hour)}$ represents the cumulative effects of all the train noise events occurring in the night-time period from 10:00 pm to 7:00 am.

$L_{Aeq(1hour)}$ The busiest 1-hour "*energy average noise level*" The $L_{Aeq(1hour)}$ represents the typical L_{Aeq} noise level from all the train noise events during the busiest 1-hour of the assessment period.

L_{AE} The "*Sound Exposure Level*", which is used to indicate the total acoustic energy of an individual noise event. This parameter is used in the calculation of L_{Aeq} values from individual noise events.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

4.1.3 Operational Noise Trigger Levels

The NSW EPA provides guidance for the assessment and management of potential airborne noise from railways in the RING. To assess and manage potential noise from rail proposals, the guideline provides non-mandatory airborne noise triggers for residential and other sensitive receivers.

Where the project results in rail noise levels exceeding the noise triggers, the noise assessment is to identify feasible and reasonable mitigation to achieve a desired objective of airborne noise within the trigger levels.

The RING requires noise to be assessed at project opening and for a future design year typically ten years or more after opening. For this project two timeframes are assessed. These are based on forecasts for the operations in the at-opening scenario (2024) and a future scenario (2034).

The project is a redevelopment of an existing rail line development. The relevant airborne noise trigger levels for residential land uses are presented in **Table 87**.

Table 87 Airborne Rail Noise Triggers for Residential Land Use

Sensitive Land Use	Noise Trigger Level (dBA)	
	Day time 7:00 am to 10:00 pm	**Night-time 10:00 pm to 7:00 am**
Residential	Development increases existing LAeq(period)[1] rail noise levels by 2 dB or more, or existing LAmax rail noise levels by 3 dB or more ***and*** predicted rail noise levels exceed:	
	65 LAeq(15hour) or 85 LAmax[2]	60 LAeq(9hour) or 85 LAmax[2]

Note 1: LAeq(period) means the LAeq(15hour) for the daytime and LAeq(9hour) for the night-time.

Note 2: LAmax refers to the maximum noise level not exceeded for 95 per cent of rail pass-by events and is measured using the 'fast' response setting on a sound level meter.

In assessing noise levels emitted by the project at residential receiver locations, the outdoor noise level to be addressed is that prevailing at a location 1 m in front of the most affected building facade. Any "internal noise level" refers to the noise level at the centre of the habitable room that is most exposed to the noise source and applies with windows open sufficiently to provide adequate ventilation.

For redeveloped rail projects, the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period (ten years or similar) into the future to represent the expected future level of rail traffic usage. For this assessment, the future scenario represents rail operations approximately 10 years after project opening.

The RING acknowledges the need to protect the community from rail-noise related sleep disturbance at night and therefore encourages a greater volume of rail movements to take place during daytime as reflected by the airborne rail noise trigger levels presented in **Table 87**.

The RING noise triggers for non-residential sensitive receivers in **Table 88** are applicable when the building or premise is in use. All noise trigger levels are external levels except where otherwise stated. Sensitive receivers in the project area (other than residential) are listed in **Table 88**. Commercial and industrial receivers are not considered sensitive to operational airborne noise impacts. The receiver types assessed are shown in **Appendix B**.

Table 88 Airborne Rail Noise Triggers for Sensitive Land Uses Other Than Residential (Redeveloped)

Sensitive Land Use	Noise Trigger Level dBA (when in use)
Schools, educational institutions and child care centres	45 $L_{Aeq(1hour)}$ Internal
Places of worship	45 $L_{Aeq(1hour)}$ Internal
Hospital wards	40 $L_{Aeq(1hour)}$ Internal
Hospital other uses	65 $L_{Aeq(1hour)}$
Open space – passive use (eg parkland, bush reserves)	65 $L_{Aeq(15hour)}$
Open space – active use (eg sports field, golf course)	65 $L_{Aeq(15hour)}$

For sensitive receivers such as schools, child care centres and places of worship, the trigger levels presented in **Table 88** are based on internal noise levels. Any 'internal noise level' refers to the noise level at the centre of the habitable room that is most exposed to the noise source. Depending on the location and existing noise sources in the area (i.e. road, rail, commercial or industry), the building may be fitted with ventilation or air-conditioning to allow for closed windows and indoor acoustic amenity. In other situations open windows may be relied upon to provide adequate ventilation. Depending on building facade and openings, the outside-to-inside attenuation would typically be between 10 and 20 dB, but could also be substantially more.

Operational noise impacts presented in this assessment consider all rail noise sources within the study area as depicted in **Appendix B** in accordance with the requirements of the RING.

4.1.4 Operational Noise Modelling

4.1.4.1 Introduction to Noise Modelling

SoundPLAN Version 7.1 has been used to calculate rail noise emission levels for this project. Of the train noise prediction models available within SoundPLAN, the Nordic Rail Traffic Noise Prediction Method (Kilde 1984) has been used.

Noise emissions from suburban electric passenger trains on surface track are predominantly caused by the rolling contact of steel wheels on steel rails. Even under ideal conditions with "smooth" rail and wheels, noise would occur as a result of the elastic deformation at the rolling contact point and due to the finite residual roughness of typical wheel and rail running surfaces. Other noise sources on electric passenger trains (such as air-conditioning plant and air compressors) are generally insignificant in noise level when compared with the wheel rail interaction, unless the train is travelling at very low speed or is stationary. Where track is located on bridges or viaducts, vibration is transmitted to the structure resulting in structure-radiated noise in addition to the direct rolling noise from the track and wheels of the trains.

Predicted noise levels in previous rail modelling projects have shown good correlation with the values measured at the completion of the projects, once operations began.

4.1.4.2 Source Noise Levels

The reference noise levels used for the noise modelling are shown in **Table 89**. The input data used in the noise modelling for this project has been chosen so that the calculated noise levels for the future Metro operations reflect the likely future Metro train fleet of new single-deck trains. The calculated noise levels for the Sydney Trains operations are based on modern Sydney Trains electric double-deck suburban passenger trains as defined in the NSW rail noise database. The calculated noise levels for freight operations are based on reference noise levels for diesel-electric locomotives and general freight wagon arrangements presented in the NSW rail noise database.

Freight operations are present within the shared rail corridor in the eastern half of the project area between Marrickville and Belmore. The future track form consists of ballast track on concrete sleepers. The source noise levels used in the noise modelling are typical of noise levels in the NSW rail noise database for existing double-deck Sydney trains. This approach is consistent with previous EIS assessment stages of the Sydney Metro Project and is considered conservative, since at this stage the rail roughness in the project area is unknown; there is no measured noise data available for the new Sydney Metro single-deck trains; the unsprung mass of the new Sydney Metro single-deck trains is understood to be the same or lower than the existing double-deck Sydney trains; and the mix of rolling stock on the existing lines may vary. In the event that the new Sydney Metro rolling stock has lower noise emissions than assumed here, the impacts of the project would be less than predicted in this report (both the overall wayside noise levels, and the increase due to the project).

Table 89 Rolling Stock Reference Noise Levels

Train Types	Reference Conditions	LAmax, 95%	LAE
Double-deck Sydney Trains	15 m, 80 km/h	85 dBA	88 dBA
Single-deck Sydney Metro Trains	15 m, 80 km/h	85 dBA	88 dBA
Freight Locomotives	15 m, 80 km/h	94 dBA	88 dBA
Freight Wagons	15 m, 80 km/h	90 dBA	100 dBA

The passby noise levels used in the noise modelling assume track in good condition and that the running surface of the rail head is free of defects. Wheel tread condition is also assumed to be in good to fair condition.

4.1.4.3 Track Feature Corrections

Impact noise from rail discontinuities such as turnouts, crossovers, expansion joints or rail defects increase the level of wheel-rail noise as each wheel of the train passes over the discontinuity. **Table 90** identifies the locations of the turnouts in the future alignment designs.

The project would result in the removal of some turnouts on the existing T3 Bankstown Line tracks, and the installation of new turnouts on the Metro tracks. Where turnouts are removed from the existing T3 Bankstown Line tracks and not replaced as part of the project, the noise generated by the existing turnout would be eliminated from the with-project operations. Conversely, turnouts associated with the project that are installed in locations where the T3 Bankstown Line tracks did not have turnouts would result in the introduction of a new noise source at that location.

Table 90 Rail Track Turnouts

Line	Track	Chainage
Goods Line (Port Botany to Enfield)	Goods Up	4.940 km
		5.050 km
		6.220 km
		6.500 km
		6.570 km
		6.600 km
	Goods Down	4.970 km
		5.030 km
		6.250 km
		6.480 km
		6.600 km

Line	Track	Chainage
Goods Line (Illawarra Line)	Goods Up	5.590 km
		5.620 km
		5.820 km
		5.850 km
		6.050 km
		6.080 km
		6.590 km
	Goods Down	5.660 km
		5.750 km
		5.830 km
		6.020 km
		6.050 km
		6.100 km
		6.570 km
		6.600 km
T3 Bankstown Line	Main Up	5.450 km
		11.460 km
		18.510 km
		18.860 km
	Main Down	5.480 km
		5.530 km
		5.590 km
		5.690 km
		11.420 km
		18.580 km
		18.840 km
		19.140 km

Line	Track	Chainage
Metro	Main Up	5.580 km
		5.620 km
		5.670 km
		5.710 km
		6.300 km
		11.980 km
		13.120 km
		13.690 km
		18.850 km
		18.980 km
		19.460 km
		19.690 km
	Main Down	5.670 km
		5.710 km
		6.100 km
		6.300 km
		6.380 km
		11.930 km
		13.090 km
		13.690 km
		18.850 km
		18.980 km
		19.520 km
		19.650 km
T4 Illawarra Line	Local Up	5.010 km
		5.120 km
		5.160 km
		5.550 km
		5.640 km
		5.760 km
	Local Down	4.990 km
		5.020 km
		5.140 km
		5.670 km
		5.730 km
		5.760 km
	Main Up	4.960 km
		4.990 km
		5.690 km
		5.720 km
	Main Down	4.960 km
		5.690 km

Line	Track	Chainage
Light Rail	Main Up	9.790 km
	Main Down	9.790 km

The modelling includes allowances for localised increases in noise emission from turnouts. A correction of +6 dB for turnouts has been applied in the noise model over a 20 m track distance.

In areas where there are tight radius curves, flanging noise or curve squeal may increase the levels of noise emission. The increased noise emissions generated from train operating on curves is generally referred to as ‘curve gain’. Many of the rail lines within the study area include curve radii that have the potential to result in curve gain under general operating conditions. **Table 91** lists the curve gain corrections adopted in the noise modelling for this assessment.

Passenger train curve gain values presented in **Table 91** are derived from curving noise studies performed on Australian electric passenger trains.

Freight train curve gain values presented in **Table 91** are based on the typical best case modern freight wagon steering performance and rail track maintenance practices which is considered conservative for this assessment.

Table 91 Curve Gain Corrections

Radius	Passenger Adjustment[1]		Freight Adjustment	
	LAeq	LAmax	LAeq	LAmax
Greater than 500m	0	0	0	0
400m to 500m	3	3	3	3
300m to 400m	8	16	5	5
200m to 300m	8	17	8	8
Less than 200m	8	17	8	8

4.1.4.4 Bridge Noise

Structure-radiated noise from some types of rail bridges (especially open-transom steel bridges) may also increase the overall levels of track noise. Corrections applied to rail bridges within the project area are listed in **Table 92**.

[1] Basutu, L., Hanson, D., Schulten, C.: Modelling Curve Gain in NSW. Acoustics Australia (2015) 43:245-250

Table 92 Rail Bridge Corrections

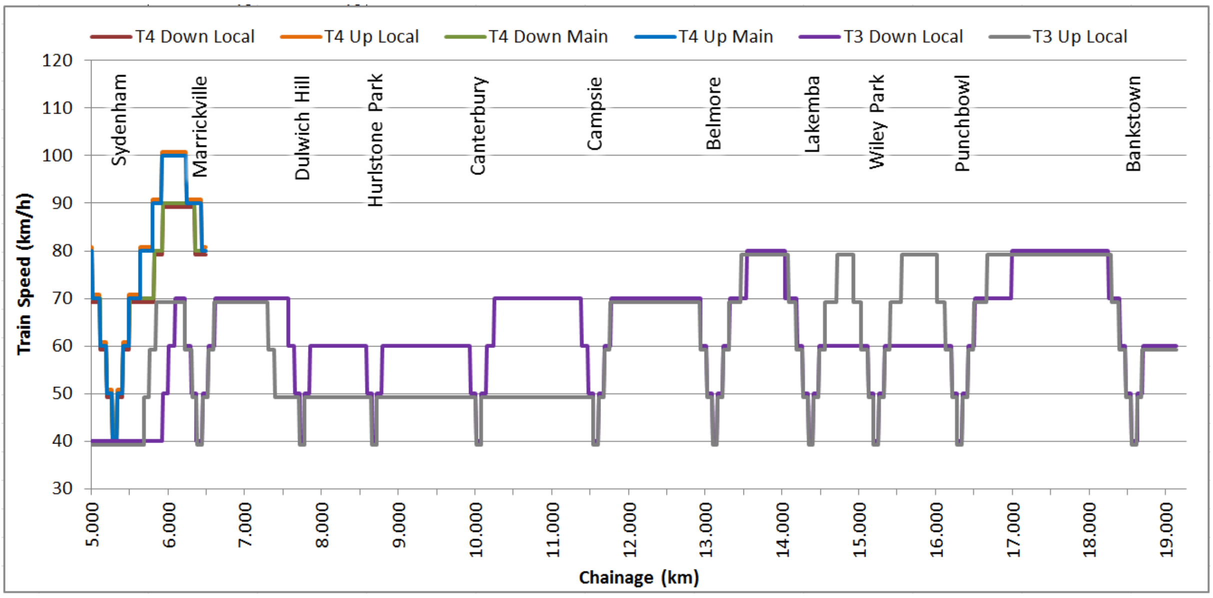
Bridge	Approx. Chainage[1]	Rail Line	Bridge	
			Construction Description	Correction
Unwins Bridge Road	5.300 – 5.340 km	Goods Line	Ballasted, concrete span, no side screens	0 dB
Illawarra Line Overpass	5.470 – 5.520 km	Goods Line	Open transom, fabricated steel web, no side screens	+10 dB
Frasier Park Bridge	5.680 – 5.700 km	Goods Line	Ballasted, concrete span, no side screens	0 dB
Victoria Road Bridge	6.310 – 6.340 km	Goods Line T3 Bankstown Line Metro Line	Open transom, fabricated web forming side screens	+8 dB
Ness Avenue Bridge	8.160 – 8.190 km	Goods Line T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB
Foord Avenue Bridge	9.070 – 9.100 km	Goods Line T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB
Cooks River Passenger Train Bridge	10.420 – 10.520 km	Goods Line	Ballasted, steel box girder, no side screens	+4 dB
Cooks River Freight Train Bridge	10.420 – 10.520 km	T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB
Nowra Street Bridge	10.700 – 10.740 km	T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB
Belmore Sportsground Pedestrian Overpass	12.770 – 12.790 km	T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB
West Terrace Road Bridge	18.430 – 18.460 km	T3 Bankstown Line Metro Line	Ballasted, concrete span, no side screens	0 dB

Note 1: Chainage refers to T3 Bankstown Line

4.1.4.5 Speed Profile

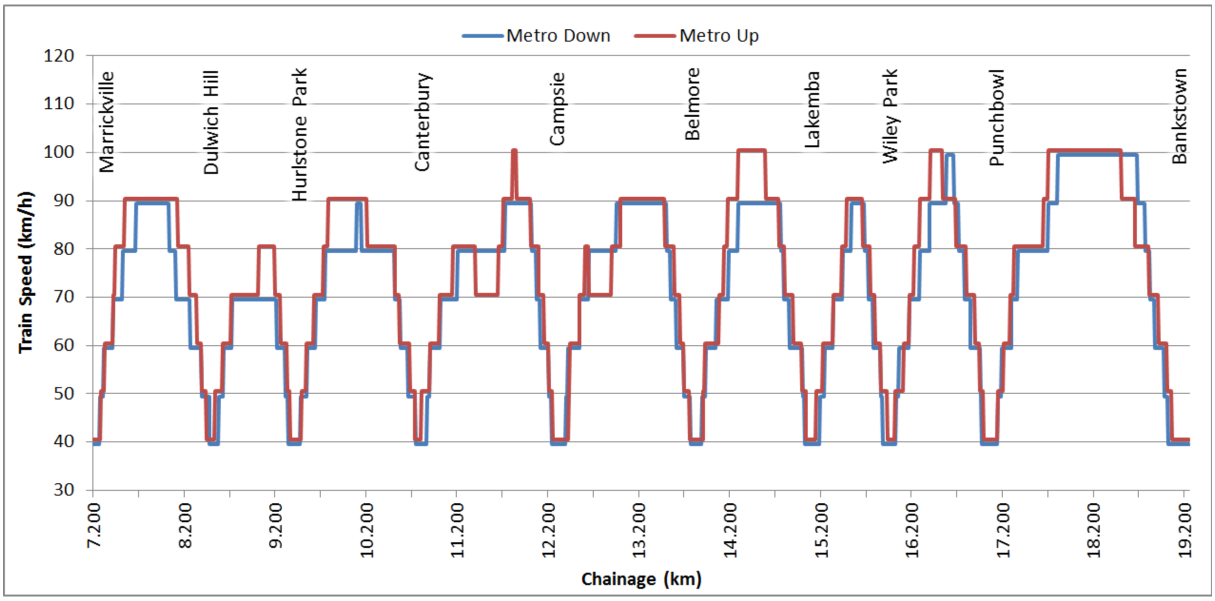
The speed profile for noise and vibration assessment purposes for Sydney Trains services on the T3 Bankstown Line and T4 Illawarra Line are show in **Figure 54**.

Figure 54 Sydney Trains Speed Profile for Noise and Vibration Assessment



The speed profile for noise and vibration assessment purposes through the proposed Metro track is shown in **Figure 55**. The maximum Metro train speeds are up to 100 km/h.

Figure 55 Metro Speed Profile for Noise and Vibration Assessment



As shown in **Figure 54** and **Figure 55**, the minimum modelled train speed through stations for all passenger services is 40 km/h.

It is noted that the speed profile adopted in this assessment would be reviewed as part of the detailed design and may be subject to change. Further assessment of the noise and vibration impacts resulting from speed profile modifications would be undertaken during the detail design stage if required.

4.1.4.6 Track Alignment and Ground Terrain

The track alignments for the project were provided by the project team in the form of three dimensional track strings in AutoCAD drawing format.

The ground terrain was based on light detection and ranging (LiDAR) data of the project area, modified to incorporate the project alignments and realignment of existing tracks, including cuttings or embankments where necessary.

4.1.4.7 Rail Traffic Data

The RING specifies that the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period into the future to represent the expected typical maximum level of train usage. In order to support the noise modelling predictions, estimated train numbers for the at year of opening and ten years after opening operating scenarios have been provided.

The rail traffic estimates provided by the project team and used in the modelling scenarios are summarised in **Table 93**. The train numbers in **Table 93** are indicative only, with consideration given to the estimated passenger demand, minimum service levels and the upper design limit of Sydney Metro service frequencies for future peak times.

Table 93 Rail Traffic Scenarios for Noise Assessment Purposes

Rail Line	Scenario	Train Type	Trains Per Weekday Period			
			Day 7:00 am to 10:00 pm		Night 10:00 pm to 7:00 am	
			Up	Down	Up	Down
T2 Airport Line	Existing 2017	Double-deck Sydney Trains	6	8	0	1
	Prior to Opening 2024	Double-deck Sydney Trains	26	23	6	6
	After Opening 2024	Double-deck Sydney Trains	26	23	6	6
	Future 2034	Double-deck Sydney Trains	26	23	6	6
	Future 2034 Without Project ('no build option')	Double-deck Sydney Trains	26	23	6	6
T3 Bankstown Line including future Metro Services	Existing 2017	Double-deck Sydney Trains	78	84	17	20
	Prior to Opening 2024	Double-deck Sydney Trains	96	94	21	23
	After Opening 2024	Single-deck Metro Trains	184	184	27	27
	Future 2034	Single-deck Metro Trains	202	202	30	30
	Future 2034 Without Project ('no build option')	Double-deck Sydney Trains	96	94	21	23

Rail Line	Scenario	Train Type	Trains Per Weekday Period			
			Day 7:00 am to 10:00 pm		Night 10:00 pm to 7:00 am	
			Up	Down	Up	Down
T4 Eastern Suburbs and Illawarra Line	Existing 2017	Double-deck Sydney Trains	96	85	26	23
	Prior to Opening 2024	Double-deck Sydney Trains	111	101	28	26
	After Opening 2024	Double-deck Sydney Trains	111	101	28	26
	Future 2034	Double-deck Sydney Trains	111	101	28	26
	Future 2034 Without Project ('no build option')	Double-deck Sydney Trains	111	101	28	26
Goods Line	Existing 2017	Freight Trains	27	27	9	9
	Prior to Opening 2024	Freight Trains	44	44	15	15
	After Opening 2024	Freight Trains	44	44	15	15
	Future 2034	Freight Trains	63	63	21	21
	Future 2034 Without Project ('no build option')	Freight Trains	63	63	21	21

Once the project is operating, Sydney Trains services would no longer operate along the T3 Bankstown Line from Sydenham to Bankstown. At opening, the project would operate six car Metro trains at least every four minutes during the peak periods (15 trains per hour) and at least every ten minutes in the off peak periods.

This assessment assumes that metro train services could operate at least every three minutes during the peak periods (20 trains per hour) at opening, and the number of metro services could grow by up to 10% ten years after opening (22 trains per hour). This assessment approach is considered conservative.

4.1.4.8 Noise Modelling Outputs and Assessment Parameters

The operational noise model predicts noise levels at each façade on each floor for every identified sensitive receiver building. The most exposed floor is commonly the upper storey, for buildings with two or more levels, as lower floors receive more shielding from the intervening terrain. Where exceedances of the noise trigger levels are identified for an individual receiver at any floor level, the predicted noise levels are described in this report.

In terms of the $L_{Amax,95\%}$ assessment parameter, the noise emission trigger levels at residential receiver locations are the same during the daytime and night-time periods. This is on the basis that the maximum train speeds are the same during the daytime and night-time periods.

The $L_{Aeq(period)}$ noise parameter is determined by the number of trains during the relevant daytime or night-time period. The night-time $L_{Aeq(9hour)}$ noise trigger levels are 5 dB lower (i.e. more stringent) than the daytime $L_{Aeq(15hour)}$ noise trigger levels.

For other sensitive receivers with noise trigger levels defined on the basis of the $L_{Aeq(1hour)}$ assessment parameter, the maximum number of services per hour within the project area has been used to calculate the $L_{Aeq(1hour)}$ using the values in **Table 94**. Service frequencies in **Table 94** represent the combination of both Up and Down rail traffic per line.

It is noted that the passenger train services on rail lines presented in **Table 93** and **Table 94** do not include continuous operations during the entire night-time period.

Table 94 Maximum Service Frequencies - Trains per Hour

Line	2024 Maximum Trains Per Hour		2034 Maximum Trains Per Hour	
	Day	Night	Day	Night
T3 Bankstown Line Main	17	9	17	9
T4 Illawarra Line Local	4	3	4	3
T4 Illawarra Line Main	14	11	14	11
Sydney Light Rail	15	8	15	8
Sydney Metro	40	12	44	13
Goods Line	12	7	16	9

4.1.5 Noise Model Validation

To validate the noise model, receiver points representing the measurement locations described in **Section 2.4** were established in the model. The model was then used to calculate noise levels at these locations. **Table 95** presents the comparison between the model results and the attended noise measurements at the five locations described in **Section 2.4**.

Noise model validation outputs include L_{Aeq} noise levels and L_{Amax} noise levels. The L_{Aeq} noise levels provide a validation of the assumed L_{AE} train source levels and the number of trains assumed for a given period. The L_{Amax} noise levels provide a validation of the assumed maximum train source levels.

Table 95 Modelling Predictions and Measured Noise Levels

Location	Noise Level (dBA)					
	$L_{Aeq(24hour)}$			L_{Amax}		
	Measured	Modelled	Difference	Measured	Modelled	Difference
OP01.N1	63	64	+0.6	103	102	-0.7
OP02.N1	68	68	+0.4	98	100	+1.4
OP03.N1	59	57	-2.0	83	83	-0.4
OP04.N1	65	66	+0.6	104	104	0

The results presented in **Table 95** indicate the agreement between the model results and the measurements is within 2 dB for $L_{Aeq(24hour)}$ and L_{Amax} noise levels for most locations.

As discussed in **Appendix D**, train passby measurements performed at location OP03.N1 indicated the T3 Bankstown Line track was observed to exhibit significant levels of track whine at this location with passbys on the down track suggesting excessive rail head roughness. As a result, the $L_{Aeq(24hour)}$ noise levels derived from measurements at this location are higher than noise levels typically observed across the wider network, and higher than the modelled noise levels. Rail roughness levels at this location have not been investigated in detail at this stage, but it is highly likely that the measured noise levels would decrease following regular track maintenance including rail grinding.

Overall the model is considered to be suitable for predicting the rail noise levels from the project.

The modelling process inherently requires a number of assumptions to be made. Whilst every effort has been made to correlate predicted noise levels with measured noise data, it is important to regard the overall absolute predicted noise levels within the generally accepted modelling accuracy of ± 2 dB, with the accuracy of noise level comparative increase being more precise.

4.1.6 Predicted Operational Airborne Rail Noise Levels

To assist the understanding of operational noise impacts, noise level contours have been calculated with a grid spacing of 20 m and are presented in **Appendix H**. The contour plots for the daytime, night-time and maximum noise levels are calculated for the 2034 with project scenario, at a height of 4.5 m above the local ground level.

The second floor noise levels are representative of the typically most exposed floor level for the existing receivers. Noise levels at single-storey buildings would typically be lower than shown in the noise contour plots. Noise levels at the upper floors of buildings with three or more storeys may be higher than shown in the noise contour plots where line of sight to the rail tracks is less obstructed than lower levels. Note that noise contours are indicative only. To determine compliance with the applicable noise criteria, results in **Section 4.1.6.1** and **Section 4.1.6.2** should be referenced.

A detailed presentation of the airborne noise predictions is provided by precinct area in **Section 4.1.6.4** through **Section 4.1.6.13** for each NCA as defined in **Appendix B**.

Where exceedances of the noise trigger levels are identified, the RING requires additional noise mitigation to be considered. Noise mitigation options for triggered NCAs are discussed in **Section 4.1.8**.

4.1.6.1 Residential Receivers

A summary of the predicted rail noise levels for residential receivers are presented in **Table 96** for receivers with a predicted exceedance of the RING noise trigger levels. The results are shown as the worst-case impact for the receiver potentially most affected by the project in each NCA. Where exceedance of the RING trigger levels was not predicted within a NCA, the highest overall residential rail noise levels are displayed for non-triggered residential receivers.

Table 96 Summary of With-Project Most Affected Residential Receivers

NCA	Side	Most Affected Predicted Noise Level (dBA)																					
		Scenario Year 2024										Scenario Year 2034											
		Without Project			With Project			Noise Level Increase			RING Triggers	Without Project			With Project			Noise Level Increase			RING Triggers
		LAeq Day	LAeq Night	LAmax	LAeq Day	LAeq Night	LAmax	LAeq Day	LAeq Night	LAmax		LAeq Day	LAeq Night	LAmax	LAeq Day	LAeq Night	LAmax	LAeq Day	LAeq Night	LAmax	
NCA01	Up	**76**	**73**	**105**	**76**	**73**	**105**	0.0	0.0	0.0	0	**77**	**75**	**105**	**77**	**75**	**105**	0.0	0.0	0.0	0
	Down	63	**67**	**96**	**66**	**68**	**96**	3.0	0.5	0.0	1	64	**69**	**96**	**67**	**69**	**96**	2.6	0.5	0.0	1
NCA02	Up	**73**	**70**	**101**	**73**	**70**	**101**	0.2	0.0	0.0	0	**74**	**71**	**101**	**74**	**71**	**101**	0.2	0.0	0.0	0
	Down	**70**	**67**	**96**	**71**	**68**	**96**	1.2	0.5	0.0	0	**71**	**68**	**96**	**72**	**69**	**96**	1.0	0.4	0.0	0
NCA03	Up	**73**	**71**	**102**	**74**	**71**	**102**	1.2	0.5	0.0	0	**75**	**72**	**102**	**76**	**72**	**102**	1.0	0.4	0.0	0
	Down	**69**	**67**	**96**	**71**	**67**	**96**	1.8	0.8	0.0	0	**71**	**68**	**96**	**72**	**69**	**96**	1.6	0.7	0.0	0
NCA04	Up	**74**	**71**	**102**	**75**	**72**	**102**	1.2	0.5	0.0	0	**75**	**73**	**102**	**76**	**73**	**102**	1.0	0.4	0.0	0
	Down	**70**	**67**	**95**	**72**	**68**	**95**	2.0	0.9	0.0	1	**71**	**69**	**95**	**73**	**69**	**95**	1.7	0.8	0.0	0
NCA05	Up	**66**	**68**	**97**	**68**	**68**	**97**	2.1	0.3	0.0	1	**72**	**69**	**97**	**73**	**69**	**97**	0.7	0.2	0.0	0
	Down	**67**	65	**91**	**69**	**65**	**91**	2.1	0.7	0.0	6	**69**	**66**	**91**	**70**	**66**	**91**	1.6	0.6	0.0	0
NCA06	Up	**67**	**71**	**99**	**69**	**71**	**99**	2.2	0.1	0.0	2	**68**	**72**	**99**	**70**	**72**	**99**	2.1	0.1	0.0	1
	Down	**67**	61	**95**	**69**	**63**	**95**	2.3	2.0	0.1	4	65	**69**	**95**	**69**	**69**	**95**	3.5	0.2	0.1	3
NCA07	Up	61	**69**	83	**66**	**69**	**86**	4.7	0.0	3.0	4	61	**71**	83	**66**	**71**	**86**	5.1	0.0	3.0	7
	Down	63	59	82	**68**	**62**	**86**	4.6	2.7	3.3	2	63	59	82	**68**	**62**	**86**	5.0	3.1	3.3	2
NCA08	Up	61	57	82	65	59	83	3.7	1.8	1.3	0	61	57	82	65	59	83	4.1	2.3	1.3	0
	Down	60	56	82	64	58	83	3.5	1.5	1.2	0	60	56	82	64	58	83	3.9	2.0	1.2	0
NCA09	Up	61	58	84	**66**	**61**	**86**	4.9	2.8	1.4	1	61	57	84	**67**	**61**	**86**	5.3	3.5	1.4	2
	Down	60	56	81	65	59	84	5.3	3.4	2.4	0	60	56	81	**66**	60	84	5.7	3.9	2.4	1
NCA10	Up	60	56	82	**66**	60	85	5.5	3.6	2.7	2	60	56	82	**66**	60	85	5.9	4.0	2.7	6
	Down	64	61	**86**	**66**	**61**	85	2.8	-0.2	0.0	4	64	61	**86**	**67**	**62**	85	3.2	0.3	0.0	9
NCA11	Up	63	61	**86**	**68**	**64**	**89**	5.1	2.6	3.0	34	63	60	**86**	**69**	**64**	**89**	5.5	3.7	3.0	37
	Down	62	57	82	**67**	60	**85**	5.1	3.0	2.9	23	62	57	82	**67**	**61**	**85**	5.5	3.5	2.9	38
NCA12	Up	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0
	Down	60	56	81	63	57	81	2.8	0.8	0.0	0	60	56	81	63	57	81	3.2	1.3	0.0	0

Note 1: **Bold** indicates exceedances of the RING residential absolute noise trigger levels.

Note 2: "RING Triggers" refers to the number of locations where the RING noise trigger levels are predicted to be exceeded. For reference, the RING noise trigger levels are: Development increases existing LAeq(period) rail noise levels by 2 dB or more, or existing LAmax rail noise levels by 3 dB or more ***and*** Predicted rail noise levels exceed: daytime: 65 LAeq(15hour) or 85 LAmax, night-time: 60 LAeq(9hour) or 85 LAmax.

Note 3: Results presented with a "-" indicate residential receivers are not located within close proximity of the rail corridor in this catchment.

The results presented in **Table 96** indicate that operational noise levels in 2024 and 2034 without the project are generally already close to, or exceeding, the RING L_{Aeq} and L_{Amax} overall noise trigger levels due to the existing rail operations within the rail corridor. Therefore where the project is seen to increase noise levels by 2 dB or more in these areas, an exceedance of the RING trigger levels occurs.

Reference to the ‘without project’ predictions shows that there is essentially no change in impacts between the 2024 and 2034 timeframes except in sections of the study area where freight services are present (NCA01 through NCA07). This is because the ‘without project’ passenger rail service noise impacts are not anticipated to change over time as these lines are already operating at capacity (refer **Section 4.1.4.7**).

‘Without project’ predictions for sections of the study area where freight services are present show noticeable differences between the 2024 and 2034 timeframes. This is because the freight rail daytime and night-time L_{Aeq} noise levels are predicted to increase in the 2034 scenario driven by increased freight train service volumes (refer **Section 4.1.4.7**).

‘With Project’ L_{Aeq} noise levels are typically higher in the 2034 timeframe due to the increased Metro service volumes during this period. Further information on the controlling noise influences are presented in **Section 4.1.6.3**.

A detailed presentation of the residential airborne noise predictions is provided by precinct area in **Section 4.1.6.4** through **Section 4.1.6.13**.

4.1.6.2 Other Sensitive Receivers

A summary of the highest overall rail noise levels for the 2024 and 2034 scenarios are presented in **Table 97** for other sensitive receivers where a noise level increase trigger is predicted. The results are shown as the worst-case prediction in each NCA. Where a RING trigger is not predicted within a NCA, the highest overall rail noise levels are displayed for non-triggered other sensitive receivers.

Table 97 Summary of With-Project Most Affected Other Sensitive Noise Triggers

NCA	Side	Worst-case Predicted Noise Level (dBA)													
		Scenario Year 2024							Scenario Year 2034						
		Without Project		With Project		Noise Level Increase		RING Triggers	Without Project		With Project		Noise Level Increase		RING Triggers
		LAeq Day	LAeq Night	LAeq Day	LAeq Night	LAeq Day	LAeq Night		LAeq Day	LAeq Night	LAeq Day	LAeq Night	LAeq Day	LAeq Night	
NCA01	Up	-	-	-	-	-	-	0	-	-	-	-	-	-	0
	Down	68	66	70	66	1.5	0.4	0	69	67	71	67	1.3	0.4	0
NCA02	Up	68	66	69	66	0.6	0.2	0	70	67	70	67	0.5	0.2	0
	Down	-	-	-	-	-	-	0	-	-	-	-	-	-	0
NCA03	Up	50	47	50	48	0.3	0.1	0	51	49	52	49	0.3	0.1	0
	Down	-	-	-	-	-	-	0	-	-	-	-	-	-	0
NCA04	Up	-	-	-	-	-	-	0	-	-	-	-	-	-	0
	Down	68	66	70	66	1.6	0.7	0	70	67	71	68	1.3	0.6	0
NCA05	Up	67	65	68	65	1.0	0.4	0	68	66	69	66	0.8	0.3	0
	Down	65	62	67	63	1.9	0.7	0	66	63	68	64	1.7	0.7	0
NCA06	Up	78	75	78	75	0.3	0.1	0	79	77	80	77	0.3	0.1	0
	Down	58	56	59	56	0.3	0.1	0	60	57	60	57	0.2	0.1	0
NCA07	Up	47	44	49	44	2.8	0.3	0	47	44	50	45	3.2	0.7	0
	Down	65	62	69	64	4.5	2.1	2	65	62	70	65	4.6	2.4	2
NCA08	Up	55	52	58	53	3.0	0.4	1	55	52	59	53	3.4	0.9	1
	Down	54	51	57	52	2.9	0.4	1	54	51	57	52	3.3	0.8	1
NCA09	Up	47	44	52	47	5.0	2.6	0	47	44	52	47	5.4	2.9	0
	Down	59	56	62	57	3.7	1.2	5	59	56	63	58	4.1	1.7	5
NCA10	Up	65	62	69	63	3.6	1.1	5	65	62	69	64	4.0	1.5	5
	Down	47	44	50	45	3.6	1.0	0	47	44	50	45	4.0	1.5	0
NCA11	Up	42	40	47	42	5.0	2.6	0	42	40	48	43	5.5	2.9	0
	Down	45	43	50	45	4.9	2.4	0	45	43	51	45	5.3	2.8	0
NCA12	Up	51	49	50	45	0.0	0.0	0	52	49	51	46	0.0	0.0	0
	Down	57	54	54	49	3.7	1.2	0	57	54	54	49	4.1	1.6	0

Note 1: Noise predictions are external. A conservative outside-to-inside attenuation of 10 dB has been applied.

Note 2: Results presented with a “-“ indicate other sensitive receivers are not located within close proximity of the rail corridor in this catchment.

4.1.6.3 Controlling Scenarios

The noise modelling inputs presented in **Section 4.1.4** identify that future freight service frequencies for the design year (2034) are anticipated to increase by approximately 40% during the daytime and night-time periods compared to the at-opening (2024) scenario. By comparison, the future Metro service frequencies for the design year (2034) are anticipated to increase by 10% during the daytime and night-time periods compared to the at-opening (2024) scenario.

This disproportionate increase in freight service volumes for the 2034 scenario produces an increase in predicted freight rail L_{Aeq} noise level dominance in areas of the project where freight operations are present. As a result, the influence of the assessed project noise sources (Metro tracks) at nearby sensitive receivers is diminished for the design year (2034) scenario as rail noise levels are dominated by freight operations, thus resulting in fewer RING triggers in areas where freight noise is present. For this reason, the at-opening (2024) scenario is considered the critical period for assessment of the requirement for noise mitigation in this section of the study area. Further discussion on the influence of future freight operations on predicted RING triggers and the sensitivity of the assessment outcomes to these operational forecasts is presented in **Section 4.1.10**.

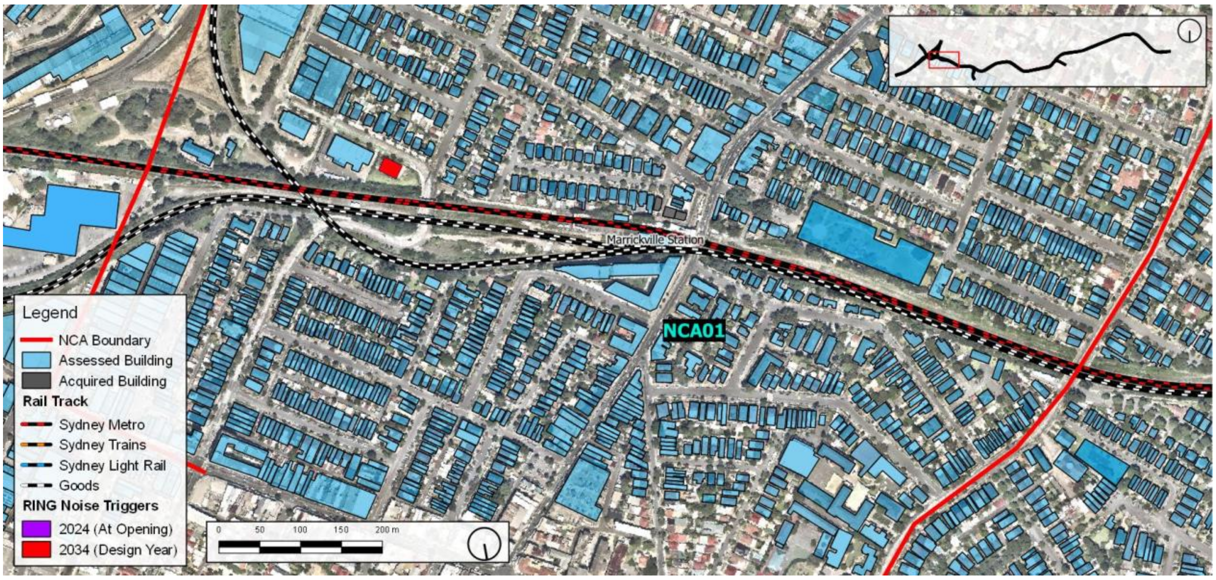
Freight operations are present within the shared rail corridor in the eastern half of the project area between Marrickville and Belmore. However, there are no freight operations in the section of the study area between Belmore and Bankstown. In this section of the study area, the increase in future Metro service frequencies for the design year (2034) results in a greater number of predicted RING triggers for the design year (2034) scenario compared to the at-opening (2024) scenario. For this reason, the design year (2034) scenario is considered the critical period for assessment of the requirement for noise mitigation in this section of the study area.

The position of the proposed Metro rail tracks and existing non-project rail tracks is depicted in **Appendix B**.

4.1.6.4 Predicted Noise Impacts - Marrickville Precinct (NCA01)

The sensitive receivers in the Marrickville Precinct (NCA01) that exceed the RING noise trigger levels are shown below in **Figure 56**.

Figure 56 NCA01 Locations Triggered for Consideration of Noise Mitigation



Predicted operational rail noise impacts within the Marrickville Precinct, include predicted exceedances of the noise trigger levels at one residential building on the Down side of the alignment in NCA01. This location is:

- 1 Myrtle Street, Marrickville (single-storey residential building)

The triggered receiver building located on the down side of NCA01 is a single storey residential building. The predicted rail noise increase for this receiver is influenced by the adjacent Victoria Road Bridge (refer **Section 4.1.4.4**), and its close proximity to the Metro tracks. This receiver is also located below rail level and is partially shielded from freight rail noise sources.

4.1.6.5 Predicted Noise Impacts - Dulwich Hill Precinct (NCA02)

A Map of the Dulwich Hill Precinct (NCA02) is presented in **Figure 57**.

Figure 57 NCA02 Locations Triggered for Consideration of Noise Mitigation

From the results presented in **Table 96**, **Table 97**, and **Figure 57,** it can be seen that there are no exceedances of the operational noise trigger levels in NCA02 and hence no requirement to consider additional noise mitigation in this catchment. Throughout the catchment area both L_{Aeq} and L_{Amax} noise levels are controlled by freight operations of the Goods Line.

4.1.6.6 Predicted Noise Impacts - Hurlstone Park Precinct (NCA03)

A Map of the Hurlstone Park Precinct (NCA03) is presented in **Figure 58**.

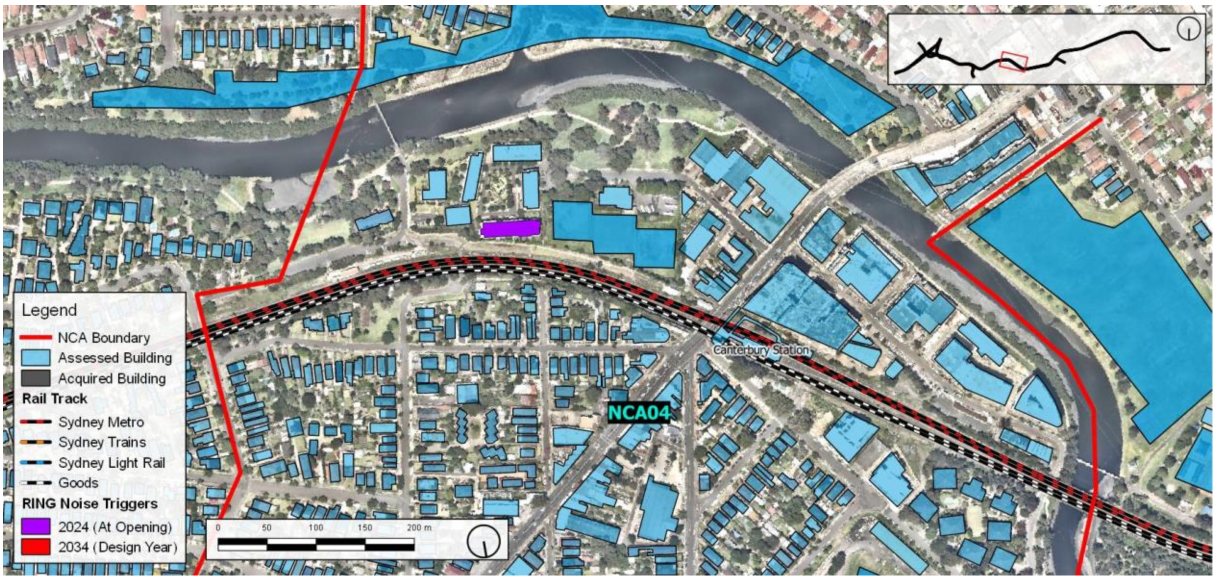
Figure 58 NCA03 Locations Triggered for Consideration of Noise Mitigation

From the results presented in **Table 96**, **Table 97**, and **Figure 58** it can be seen that there are no exceedances of the operational noise trigger levels in NCA03 and hence no requirement to consider additional noise mitigation in this catchment. Throughout the catchment area both LAeq and LAmax noise levels are controlled by freight operations of the Goods Line.

4.1.6.7 Predicted Noise Impacts - Canterbury Precinct (NCA04)

The sensitive receivers in the Canterbury Precinct (NCA04) that exceed the RING noise trigger levels are shown below in **Figure 59**.

Figure 59 NCA04 Locations Triggered for Consideration of Noise Mitigation



Predicted operational rail noise impacts within the Canterbury Precinct, include exceedances of the noise trigger levels at one residential building on the Down side of the alignment in NCA04. This location is:

- 20 Close Street, Canterbury (multistorey-storey residential apartment building)

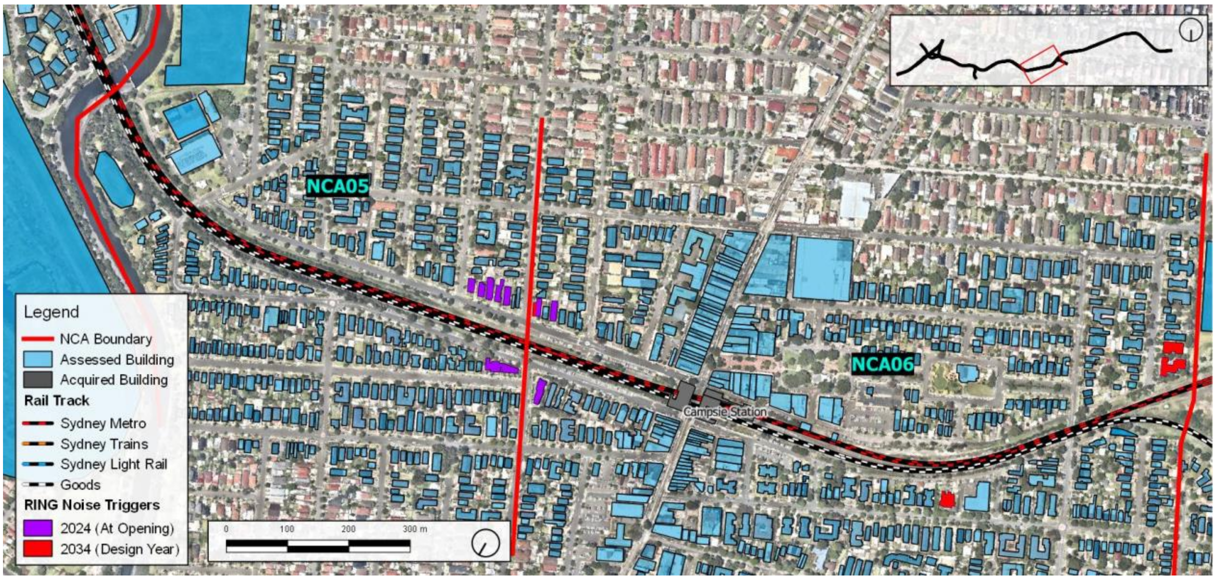
The triggered residential building on the Down side of the corridor in NCA04 is a three storey apartment building (plus roof level); as such this building would consist of several dwellings. RING triggers are only predicted at this receiver building during the daytime at-opening (2024) scenario. Increased freight train volumes on the Goods Line during the design year (2034) scenario dominate the rail noise environment during this scenario and eliminate the RING trigger.

The receivers on upper floors of this building are likely to have an unobstructed view of the rail tracks and are unlikely to be effectively mitigated by traditional noise barriers due to their increased elevation and close proximity to the tracks.

4.1.6.8 Predicted Noise Impacts - Campsie Precinct (NCA05 - NCA06)

The Campsie Precinct is divided into two noise catchment areas as displayed in **Figure 60**. NCA05 is located at the eastern end of the precinct (city-end) and NCA06 is located at the western end of the precinct (country-end).

Figure 60 Campsie Precinct: NCA05 - NCA06



Predicted operational rail noise impacts within the Campsie Precinct, including NCA05 and NCA06, are presented below.

4.1.6.8.1 NCA05 Predicted Noise Impacts

The sensitive receivers in NCA05 that exceed the RING noise trigger levels are shown below in **Figure 61**.

Figure 61 NCA05 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at six residential receiver buildings on the Down side of the alignment in NCA05. These locations are:

- Between 26 and 30 South Parade, Campsie (six residential buildings)

Exceedances of the noise trigger levels are predicted at one residential receiver building on the Up side of the alignment. This location is:

- 84-86 Frederick Street, Campsie (two storey residential townhouse complex)

The triggered residential receivers located on South Parade, Campsie, are typically two storey residential apartment buildings with one two-storey residential building and one single storey residential building. The triggered residential receiver building on Frederick Street, Campsie, is a two storey residential townhouse complex. Both the multistorey apartment buildings and town house buildings on each side of the alignment would likely consist of several dwellings.

Receivers on both sides of the alignment are triggered due to predicted 2024 daytime L_{Aeq} noise levels. Increased freight train volumes on the Goods Line during the 2034 scenario dominate the rail noise environment during this scenario ensuring the RING noise trigger levels are not exceeded.

4.1.6.8.2 NCA06 Predicted Noise Impacts

The sensitive receivers in NCA06 that exceed the RING noise trigger levels are shown below in **Figure 62**.

Figure 62 NCA06 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at five residential receiver buildings on the Down side of the alignment in NCA06. These locations are:

- 33 and 34 South Parade, Campsie (residential duplex)
- 36 South Parade, Campsie (two storey residential apartment building)
- 25-29 and 33 Loftus Street, Campsie (three storey residential apartment buildings)

Exceedances of the noise trigger levels are predicted at two residential receiver buildings on the Up side of the alignment. These locations are:

- 24-25 North Parade, Campsie (three storey residential apartment building)
- 56-58 Campsie Street, Campsie (split level multipurpose building including residential sleeping areas)

The triggered multistorey residential receivers located on both sides of the alignment in this NCA would likely consist of several dwellings. Only some of the dwellings with habitable spaces facing the rail alignment exceed the noise trigger levels and require consideration of noise mitigation.

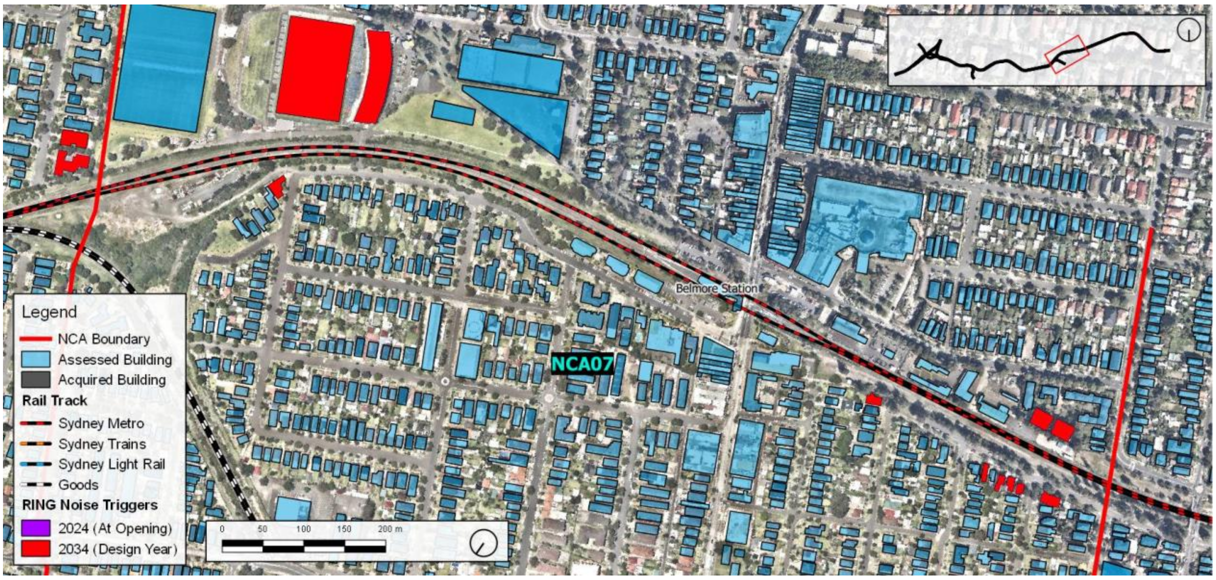
Receivers on both sides of the alignment at the eastern end of NCA06 are triggered due to predicted 2024 daytime $L_{Aeq(15hour)}$ noise levels. Increased freight train volumes on the Goods Line during the 2034 daytime scenario dominate the rail noise environment, ensuring only a single sensitive receiver exceeds the RING noise trigger levels.

Year 2034 daytime $L_{Aeq(15hour)}$ triggers at the two multi-storey residential receivers on Loftus Street in the western end of NCA06 are primarily influenced by the new Metro track crossovers located immediately adjacent these receivers.

4.1.6.9 Predicted Noise Impacts - Belmore Precinct (NCA07)

The sensitive receivers in the Belmore Precinct (NCA07) that exceed the RING noise trigger levels are shown below in **Figure 63**.

Figure 63 NCA07 Locations Triggered for Consideration of Noise Mitigation



Exceedances of the noise trigger levels are predicted at two residential receiver buildings and one other sensitive receiver area on the Down side of the alignment in NCA07. These locations are:

- 101-105 Bridge Road, Belmore (two four-storey residential apartment buildings)
- Belmore Sportsground (outdoor recreation area - sports field and spectator areas)

Exceedances of the noise trigger levels are predicted at seven residential receiver buildings on the Up side of the alignment. These locations are:

- 2 Brande Street, Belmore (single storey residential building)
- 7 to 9 Railway Parade, Belmore (mix of single and two storey residential buildings)
- 5 Railway Parade, Belmore (two storey residential building)
- 1 Belmore Avenue, Belmore (single storey residential building)
- 1 Hall Street, Belmore (single storey residential building)

The triggered multistorey residential apartment buildings located on the Down side of the alignment in this NCA would likely consist of several dwellings. Only dwellings with habitable spaces facing the rail alignment would be triggered for consideration of noise mitigation.

Exceedances of the RING noise trigger levels predicted at the residential receiver on Hall Street are influenced by the alignment of the future Metro Up track which is up to 8 metres closer to this receiver compared to the T3 Bankstown Line tracks. Additionally, exceedances of the RING noise trigger levels are also influenced by the increased metro train speeds which are up to 20 km/h faster than the T3 Bankstown Line train speeds in this region.

Exceedances at the western end of NCA07 are influenced by the increased metro train volumes and speeds. The train speeds throughout this area are between 10 km/h and 20 km/h faster than the T3 Bankstown Line train speeds in this region.

The active recreation receiver located on the Down side of the Metro alignment (Belmore Sportsground) includes both playing field areas and dedicated spectator areas. The areas of the sports field with exceedances of the RING noise trigger levels include the most northern extents of the main field including the northern extents of the spectator area. Exceedances are generated in these areas as a result of increased service volumes associated with the project and increased metro train speeds compared with the T3 Bankstown Line train speeds.

4.1.6.10 Predicted Noise Impacts - Lakemba Precinct (NCA08)

The sensitive receivers in the Lakemba Precinct (NCA08) that exceed the RING noise trigger levels are shown below in **Figure 64**.

Figure 64 NCA08 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at one other sensitive receiver building on the Down side of the alignment in NCA08. This location is:

- 69-75 Haldon Street, Lakemba (Place of Worship: Lakemba Uniting Church)

Exceedances of the noise trigger levels are predicted at one other sensitive receiver building on the Up side of the alignment in NCA08. This location is:

- 10-12 Belleview Avenue, Lakemba (Medical, Day Surgery: Anowara Medical Centre)

A place of worship (Lakemba Uniting Church) is located on the Down side of the corridor, approximately 35 metres from the corridor boundary. Exceedances of the noise trigger levels at this receiver are influenced by increased service volumes and the alignment of the future Metro Down track. The alignment moves up to 5 metres closer to this receiver compared to the T3 Bankstown Line tracks. The church was constructed adjacent to an existing rail line, arterial road, and in the Lakemba central business district, so it is highly likely the facade has an upgraded performance facade (further information on facade corrections presented in **Section 4.1.3**).

A medical facility with noise sensitive medical areas (day surgery) is located approximately 70 metres from the rail corridor boundary on the Up side of the alignment. Exceedances of the noise trigger levels predicted at this receiver are influenced by increased service volumes associated with the Metro Line compared to the T3 Bankstown Line tracks.

4.1.6.11 Predicted Noise Impacts - Wiley Park Precinct (NCA09)

The sensitive receivers in the Wiley Park Precinct (NCA09) that exceed the RING noise trigger levels are shown below in **Figure 65**.

Figure 65 NCA09 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at one residential receiver building and five other sensitive receiver buildings on the Down side of the alignment. These locations are:

- 132 The Boulevarde, Wiley Park (single storey residential building)
- 1A Hillcrest Street, Wiley Park (educational: Wiley Park Girls High School)

Exceedances of the noise trigger levels are predicted at two residential receiver buildings on the Up side of the alignment. These locations are:

- 17 Alice Street North, Wiley Park (three storey residential apartment building)
- 12B Urunga Parade, Wiley Park (single storey residential building)

The multistorey residential apartment building located on the Up side of the alignment in this NCA would likely consist of several dwellings. Only dwellings with habitable spaces facing the rail alignment would be eligible for the consideration of noise mitigation.

Exceedances of the noise trigger levels at residential receivers on the western end of this NCA are influenced by the increased metro train volumes and speeds. Speeds throughout this area are up to 30 km/h faster than the T3 Bankstown Line train speeds.

An educational facility (Wiley Park Girls High School) is located approximately 40 metres from the rail corridor boundary on the Down side of the alignment. Exceedances of the noise trigger levels are influenced by increased service volumes which are primarily associated with the Metro Line compared to the T3 Bankstown Line tracks.

4.1.6.12 Predicted Noise Impacts - Punchbowl Precinct (NCA10)

The sensitive receivers in the Punchbowl Precinct (NCA10) that exceed the RING noise trigger levels are shown below in **Figure 66**.

Figure 66 NCA10 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at nine residential receiver buildings on the Down side of the alignment. These locations are:

- 140 The Boulevarde, Wiley Park (two storey residential building)
- 32 Rosemont Street South, Punchbowl (single storey residential building)
- 147 to 149 The Boulevarde, Wiley Park (three, three-storey residential apartment buildings)
- 15 South Terrace, Punchbowl (three-storey residential apartment building)
- 36 and 38 South Terrace, Punchbowl (two, single storey residential buildings)
- 42 South Terrace, Punchbowl (single storey residential building)

Exceedances of the noise trigger levels are predicted at six residential receiver buildings and five other sensitive receiver buildings on the Up side of the alignment. These locations are:

- 18 Urunga Parade, Wiley Park (single storey residential building)
- 22 Urunga Parade, Wiley Park (single storey residential building)
- 24 to 27 Urunga Parade, Wiley Park (mix of single storey and two storey residential buildings)
- 25 Kelly Street, Punchbowl (Place or Worship: Church)
- 54 Kelly Street, Punchbowl (Educational: Punchbowl Boys High School buildings and outdoor active recreation area)

The multistorey residential apartment buildings located on the Down side of the alignment in this NCA would likely consist of several dwellings. Only dwellings with habitable spaces facing the rail alignment would be eligible for consideration of noise mitigation.

Exceedances of the RING noise trigger levels at receivers at the eastern end of this NCA are primarily influenced by the increased metro train volumes and speeds. Train speeds throughout this area would be up to 40 km/h faster than the T3 Bankstown Line train speeds in this region.

Exceedances of the RING noise trigger levels at receivers at the western end of this NCA including at residential, educational and place of worship receivers are primarily influenced by the increased metro train volumes and speeds. Train speeds throughout this area would be approximately 10 km/h faster than the T3 Bankstown Line train speeds.

4.1.6.13 Predicted Noise Impacts - Bankstown Precinct (NCA11 - NCA12)

The Bankstown Precinct is divided into two noise catchment areas as displayed in **Figure 67**. NCA11 is located at the eastern end of the precinct (city-end) and NCA12 is located at the western end of the precinct (country-end).

Figure 67 Bankstown Precinct: NCA11 - NCA12

Predicted operational rail noise impacts within the Bankstown Precinct, including NCA11 and NCA12, are presented below.

4.1.6.13.1 NCA11 Predicted Noise Impacts

The sensitive receivers in NCA11 that exceed the RING noise trigger levels are shown below in **Figure 68**.

Figure 68 NCA11 Locations Triggered for Consideration of Noise Mitigation

Exceedances of the noise trigger levels are predicted at 38 residential receivers on the Down side of the alignment. These locations are:

- 74 and 76 South Terrace, Bankstown (two single storey residential buildings)
- 80 South Terrace, Bankstown (single storey residential building)
- 86 to 124 South Terrace, Bankstown (17 residential buildings, mix of single and two-storey)
- 128 to 154 South Terrace, Bankstown (12 residential buildings, mix of single and two-storey)
- 162 to 172 South Terrace, Bankstown (six residential buildings, mix of single and two-storey)

Exceedances of the noise trigger levels are predicted at 37 residential receivers on the Up side of the alignment. These locations are:

- 150 to 166 Wattle Street, Bankstown (11 residential buildings, mix of single and two-storey)
- 1 Stansfield Avenue, Bankstown (two two-storey residential townhouse building)
- 3 to 17 Stansfield Avenue, Bankstown (eight two-storey residential buildings)
- 43 Stansfield Avenue, Bankstown (one two-storey residential building)
- 47 Stansfield Avenue, Bankstown (one two-storey residential building)
- 51 Stansfield Avenue, Bankstown (one two-storey residential building)
- 57 to 61 Stansfield Avenue, Bankstown (three two-storey residential buildings)
- 65 to 69 Stansfield Avenue, Bankstown (three two-storey residential buildings)
- 79 Stansfield Avenue, Bankstown (one two-storey residential building)
- 83 Stansfield Avenue, Bankstown (one two-storey residential building)
- 97 to 105 Stansfield Avenue, Bankstown (five two-storey residential buildings)

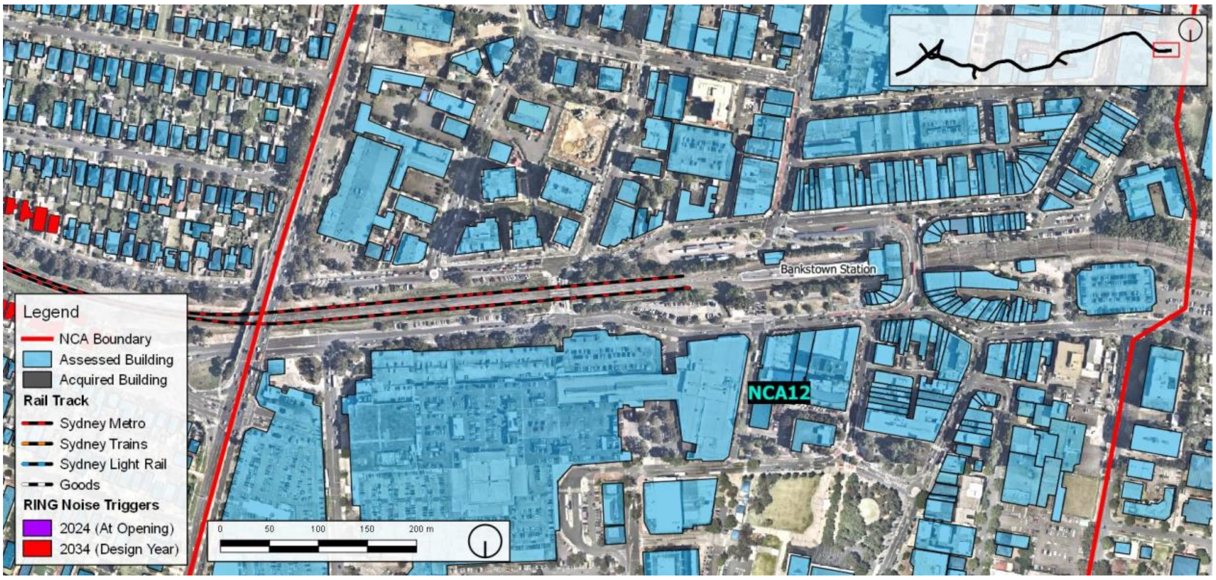
The multistorey residential townhouse buildings located on the Up side of the alignment in this NCA would likely consist of several dwellings. Only dwellings with habitable spaces facing the rail alignment would be eligible for consideration of noise mitigation.

Exceedances of RING noise trigger levels at receivers in this NCA are primarily influenced by the increased metro train volumes and speeds. Trains speeds throughout the area would be up to 20 km/h faster than the T3 Bankstown Line train speeds for the majority of the alignment in this NCA.

4.1.6.13.2 NCA12 Predicted Noise Impacts

A Map of the NCA12 is presented in **Figure 69**.

Figure 69 NCA12 Locations Triggered for Consideration of Noise Mitigation



From the results presented in **Table 96**, **Table 97**, and **Figure 69** it can be seen that there are no exceedances of the operational noise trigger levels in NCA12 and hence no requirement to consider additional noise mitigation in this catchment. This results from rail operations in the large distance between sensitive receivers and the Metro rail tracks.

4.1.7 Summary of Locations Triggered for Consideration of Noise Mitigation

Table 98 provides a summary of the locations where exceedances of the RING noise trigger levels are predicted.

Table 98 Summary of Locations Triggered for Consideration of Noise Mitigation

Project Precinct	NCA	SIDE	Number of Exceedances of RING Noise Trigger Levels[1]				Comments
			Residential Receivers		Other Sensitive Receivers		
			2024	2034	2024	2034	
Marrickville	NCA01	Up	0	0	0	0	n/a
		Down	1	1	0	0	Residential receiver building
Dulwich Hill	NCA02	Up	0	0	0	0	n/a
		Down	0	0	0	0	n/a
Hurlstone Park	NCA03	Up	0	0	0	0	n/a
		Down	0	0	0	0	n/a
Canterbury	NCA04	Up	0	0	0	0	n/a
		Down	1	0	0	0	Residential receiver building
Campsie	NCA05	Up	1	0	0	0	Residential receiver building
		Down	6	0	0	0	Residential receiver buildings
	NCA06	Up	2	1	0	0	Residential receiver buildings
		Down	4	3	0	0	Residential receiver buildings
Belmore	NCA07	Up	4	7	0	0	Residential receiver buildings
		Down	2	2	2	2	Residential receiver buildings and other sensitive receivers (active recreation)
Lakemba	NCA08	Up	0	0	1	1	Other sensitive receiver (medical)
		Down	0	0	1	1	Other sensitive receiver (place of worship)
Wiley Park	NCA09	Up	1	2	0	0	Residential receiver buildings
		Down	0	1	5	5	Residential receiver building and other sensitive buildings (educational)
Punchbowl	NCA10	Up	2	6	5	5	Residential receiver buildings and other sensitive buildings (educational and place of worship)
		Down	4	9	0	0	Residential receiver buildings
Bankstown	NCA11	Up	34	37	0	0	Residential receiver buildings
		Down	23	38	0	0	Residential receiver buildings
	NCA12	Up	0	0	0	0	n/a
		Down	0	0	0	0	n/a
	TOTAL		**85**	**107**	**14**	**14**	

Note 1: The number of locations identified counts buildings once only, in the event that more than one facade or floor of the building is triggered. This number may be less than the number of individual dwellings triggered, for example where buildings contain multiple apartments.

4.1.8 Airborne Noise Mitigation Options

The noise modelling results (for the future scenario) indicate at some locations the RING noise trigger levels are exceeded at existing receivers. Further assessment of feasible and reasonable noise mitigation measures is therefore required to be undertaken.

Appendix 6 of the RING provides the following guidance in relation to determining feasible and reasonable mitigation measures:

> *"A **feasible** mitigation measure is a noise-abatement measure that can be engineered and is practical to build, given proposal constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (e.g. changing timetable schedules) to achieve noise reduction.*
>
> *Selecting **reasonable** measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the abatement measure. To make such a judgement, consider the following.*
>
> - *Noise impacts*
> - *Noise mitigation benefits*
> - *Cost effectiveness of noise mitigation*
> - *Community views"*

A summary of airborne operational noise mitigation options considered for existing receivers along the project corridor is provided in **Table 99**, along with comments on their feasibility and reasonableness.

Source control measures are typically more cost effective to implement in terms of the resulting noise benefit compared with path and receivers controls respectively. On this basis, the hierarchy of noise control is to give preference to source control measures, then to path control measures and finally receiver controls.

Table 99 Summary of Additional Operational Noise Mitigation Options

Description	Estimated Noise Reduction	Comments on Feasibility and Reasonableness
Source Control Measures		
Reduce speeds	A 20% reduction in maximum speed would reduce L_{Amax} noise levels by 2.5 dB and L_{Aeq} noise levels by 1.5 dB.	The speeds as proposed are required to meet service frequency demands during peak periods. Potentially feasible and reasonable outside of peak periods, for example at night however, daytime is the critical period for RING triggers so a reduction in night-time speeds would not reduce the controlling daytime triggers.
Reduce overall number of train passbys	No change in L_{Amax}. 1 dB in L_{Aeq} for 20% reduction. 2 dB in L_{Aeq} for 35% reduction.	Not feasible as train numbers are required to meet service frequency demands.
Reduce train lengths	Negligible change in L_{Amax} 1.3 dB reduction in L_{Aeq} for 25% reduction in train length. 3 dB reduction in L_{Aeq} for 50%reductoin in train length.	Not feasible as train lengths are required to meet capacity demand.

Description	Estimated Noise Reduction	Comments on Feasibility and Reasonableness
Minimise wheel and rail roughness	Limited by whether rail roughness or wheel roughness dominates the combined system.	The specifications for the Sydney Metro operations include requirements for maintaining the rail surface (via rail grinding) and train wheel condition (via wheel lathe) in accordance with defined acceptance standards.
Minimise train source noise levels via specifications	N/A.	Trains specifications are locked in consistent with those specified for the Sydney Metro Northwest.
Track design measures – rail dampers	No significant benefit on typical ballast track.	Rail dampers are most suited to resiliently mounted track such as slab-track. No significant noise benefit is achievable for ballast track on concrete sleepers.
Exclude “noisy” individual trains from Sydney Metro	Negligible.	The base case operation of the Sydney Metro proposes to use the quietest available train types, and would include a maintenance strategy to identify and repair noisy trains.
Path Control Measures		
Conventional noise barriers – near rail corridor boundary	Significant noise reduction possible (ie >5 dB) where source to receiver line-of-sight is broken by barrier.	New noise barriers and increase in height of existing noise barriers where appropriate.
Noise barriers – low profile “platform barriers”	Up to 8 dB reduction in L_{Aeq} and L_{Amax} over unmitigated case. Benefit depends on the gap remaining between the low barrier and the train.	Could result in high noise reduction with low visual impact. Design would need to consider rollingstock loading gauge and track maintenance requirements.
Receiver Control Options		
Ventilation in accordance with Building Code requirements to allow windows to be closed (if desired)	10 dB to 15 dB reduction in internal noise levels compared with windows open for standard glazing. Higher noise reductions possible for laminated and double glazing with acoustic seals. No benefit for outdoor areas or if windows are opened.	This option could be applicable as a final measure for existing residences predicted to exceed the trigger levels. Several receivers triggered for mitigation are modern constructions which likely include facades with high acoustic performance in line with the requirements of the SEPP.

4.1.8.1 Potentially Reasonable and Feasible Mitigation Options

Of the additional noise mitigation options listed in **Table 99**, those which may be feasible and reasonable for reducing the impact of operational noise at existing receivers with identified exceedances of the trigger levels are discussed below.

4.1.8.1.1 Low Profile Noise Barriers

Noise from the wheel-rail interface is the dominant Metro rail noise source and can be targeted directly by screening of the noise source in close proximity to the source through use of low profile noise barriers. Low-profile barriers would need to be installed as close as possible to the tracks, but outside the zone in which there is the potential for them to be struck by a train or by maintenance equipment such as automated ballast cleaning machines. Some low-profile barrier designs allow for the partition to be located close to the tracks and removed from the maintenance envelope when required.

There are many potential designs for low-height barriers in various situations. Some examples are shown in **Figure 70**. The low barrier examples in **Figure 70** are installed on only one side of the tracks in all cases. The example with another barrier on the far side incorporates gaps in the low concrete barrier to permit a refuge or egress point.

Low profile noise barriers would likely be effective in significantly reducing noise from metro services at adjacent receivers by approximately 8 dB to 10 dB if correctly implemented. Low profile barriers installed to target noise from the metro tracks are unlikely to effectively address noise from the neighbouring Goods Line tracks. As such this mitigation option targets noise from the new Metro tracks only and does not address the total noise from all rail noise services in the corridor and for this reason may not be considered a reasonable mitigation option in areas with significant rail noise from non-metro tracks.

From an acoustic perspective, a barrier with an absorptive facing is preferred. Otherwise, safety and maintenance considerations control the detail of the design of a low-height barrier close to the track. Generally safety and maintenance risks determine the feasibility of low profile noise barriers and can be considered in greater detail during the detailed design stage of the project when specific details regarding safety and maintenance requirements are better determined.

Figure 70 Examples of Low-Height Barriers

4.1.8.1.2 Conventional Noise Barriers

Unlike low profile noise barriers which only mitigate noise from directly adjacent rail track sources, well designed conventional noise barriers can potentially mitigate noise emissions originating from all sources within the rail corridor.

Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. In circumstances where multi-storey apartments or other forms of multi-unit dwelling buildings are triggered, the density of individual dwellings is considered when judging the potential suitability of noise barriers.

A benefit of noise barriers (conventional and low profile) is that they maximise the noise mitigation benefits to all residents in the area, including those that have noise impacts below the RING noise trigger levels. Barriers also improve external amenity for both residential and other sensitive receivers such as backyards, parks and playing fields. Conventional barriers can be constructed to greater heights than low barriers close to the tracks.

Conventional noise barriers do not necessarily satisfy all expectations. Residents may also possibly be affected by negative aspects of conventional barriers such as:

- Loss of open aspect and breezes
- Potential for vandalism and need for graffiti removal
- Reduction in visual amenity of urban landscape and potential for overshadowing
- Loss of views and vistas
- Removal of vegetation

Conventional noise barriers are typically well suited to mitigating the mid to high frequency noise emissions of wheel rail dominant train noise.

The primary limitation on conventional noise barriers is the requirement to break line of sight between the noise source and receiver. In the case of a multi-storey residential receiver directly adjacent the rail corridor boundary, the height of the noise barrier required to break line of sight at the upper floors of the building is often almost as high as the multistorey building resulting in many of the above listed negative aspects and making the overall barrier height unfeasible to construct.

In some circumstances there is potential for noise barrier reflected noise to increase noise levels on the opposite side of the tracks. Reflected noise from noise barriers can be addressed through barrier design and surface finishes and would be considered in greater detail during the detailed design stage.

This assessment identifies where consideration of noise mitigation is required in accordance with the requirements of the RING. The recommended potentially reasonable and feasible noise barrier mitigation presented in this assessment would be considered in greater detail during the detailed design stage of the project and is subject to change.

It is noted that in some locations the noise barrier alignment may be discontinuous to accommodate future design elements such as station buildings. Noise barrier alignments and heights presented in this assessment may require modification during detailed design to accommodate changes to various design elements.

4.1.8.1.3 Property Treatments

Treatments to building facades usually involve higher performance windows, doors and seals to keep noise out. Facade treatments effectively require occupants to keep their windows and doors closed and hence mechanical ventilation is usually required to maintain adequate air flow.

Building treatments are generally considered as a noise mitigation option only as a final measure. If windows are closed as a noise mitigation measure, the resulting noise reductions are likely to be clearly beneficial from a quantitative and subjective perspective. If heavier glazing, laminated glazing or double glazing is provided, the additional noise benefit (quantitative and subjective) could be beneficial in some circumstances, depending on the overall facade construction of individual dwellings.

The scope and suitability of property facade treatments would depend on the existing conditions at each property and consultation with the affected receivers.

This assessment identifies where consideration of noise mitigation is required in accordance with the requirements of the RING. The recommended potentially reasonable and feasible property treatments would be considered in greater detail during the detailed design stage of the project and are subject to change.

4.1.9 Recommended Airborne Noise Mitigation

Airborne noise triggers at sensitive receivers are dominated by wheel rail noise from Metro rail operations. Treatment of acutely dominant rail noise sources should be prioritised when addressing noise mitigation options.

Recommended potentially reasonable and feasible noise mitigation options are presented in the following sections for project precincts with predicted exceedances of the RING trigger levels presented in **Section 4.1.6**.

Noise mitigation optimisation has been performed where conventional noise barriers have been considered. The conventional noise barrier optimisation included consideration of various noise barrier heights ranging between 1 m and 6 m above local ground elevation, the number of RING triggers eliminated by the noise barrier, the reduction in noise level for all receivers located behind the noise barrier, the number of residual impacts, and the approximate cost of the noise barrier. Figures presented in the following sections represent post-mitigation noise impacts.

The feasibility of these options requires further investigation of issues including detailed cost effectiveness assessment, constructability, visual impact, overshadowing, ecological impact, impact on maintenance and safety requirements, etc. The recommended potentially reasonable and feasible noise mitigation presented in this assessment are subject to change and would be considered in greater detail during the detailed design stage of the project when the specific design and operational details are confirmed.

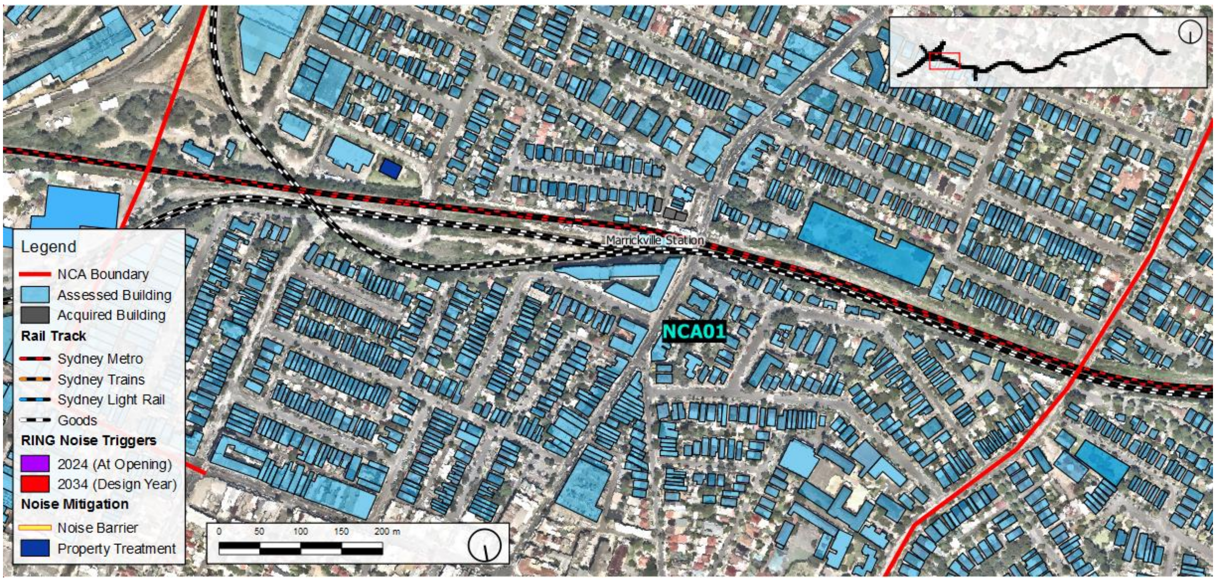
4.1.9.1 Recommended Airborne Noise Mitigation - Marrickville Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate a RING noise trigger levels exceedance is predicted at one receiver in the Marrickville Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 100**. The recommended noise mitigation options are displayed in **Figure 71**.

Table 100 Recommended Airborne Noise Mitigation - Marrickville Precinct

NCA	Side	Mitigation	Description
NCA01	Down	At property treatments *- One building*	The Victoria Road rail bridge is located adjacent the receiver eligible for consideration of noise mitigation and is contributing to the exceedance. Augmentation of the bridge with a noise barrier is unlikely to reduce noise impacts as the bridge itself is radiating the dominant source of noise (structure-borne noise). Construction of a conventional noise barrier between the triggered receiver in NCA01 and the rail track does not result in feasible or reasonable noise mitigation solution due to: • The height of the noise barrier required to break line of sight between the sensitive receiver and the elevated rail track would be unreasonable to construct. • The barrier alignment would have a large gap in the middle due to the Victoria Road rail bridge which would severely limit noise barrier performance Therefore, property treatment is considered the most viable mitigation option.

Figure 71 Recommended Airborne Noise Mitigation - Marrickville Precinct



4.1.9.2 Recommended Airborne Noise Mitigation - Dulwich Hill Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate that no RING noise trigger level exceedances are predicted at receivers within the Dulwich Hill Precinct. Therefore further consideration of rail noise mitigation is not required in this precinct.

4.1.9.3 Recommended Airborne Noise Mitigation - Hurlstone Park Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate that no RING noise trigger level exceedances are predicted at receivers within the Hurlstone Park Precinct. Therefore further consideration of rail noise mitigation is not required in this precinct.

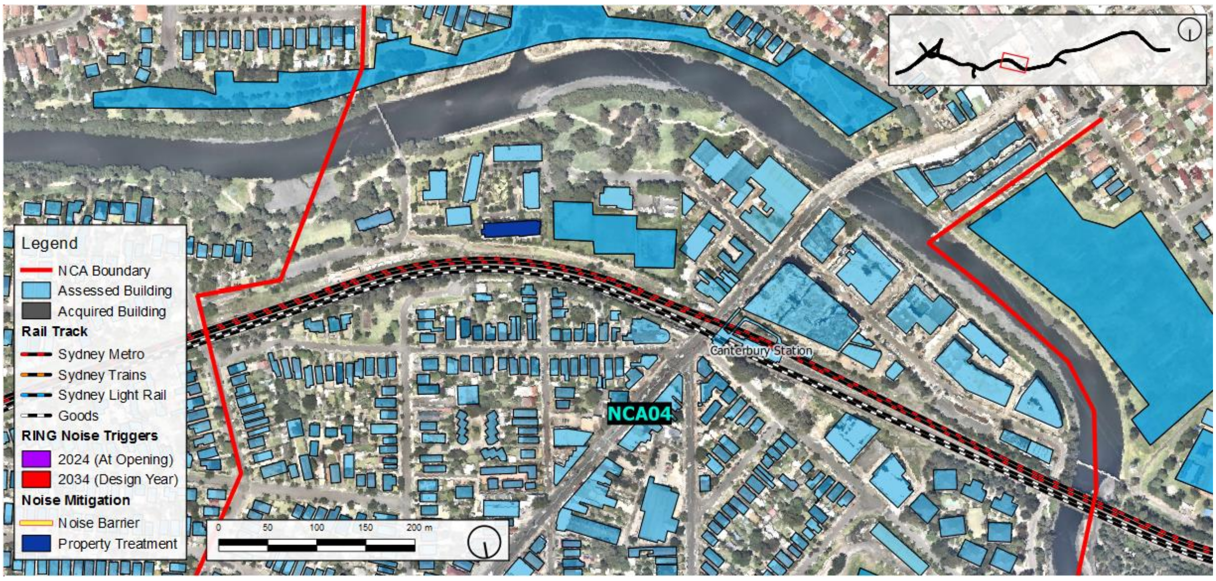
4.1.9.4 Recommended Airborne Noise Mitigation - Canterbury Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at one receiver within the Canterbury Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 101**. The recommended noise mitigation options are displayed in **Figure 72**.

Table 101 Recommended Airborne Noise Mitigation - Canterbury Precinct

NCA	Side	Mitigation	Description
NCA04	Down	At property treatments *- One building*	One three storey multi-storey residential receiver located directly adjacent the rail corridor boundary is triggered for consideration of noise mitigation in NCA04. The height of a conventional noise barrier required to break line of sight at the upper floors of the building would be almost as high as the multistorey building. This height of conventional noise barrier is considered unreasonable and unfeasible for construction. Therefore, property treatments are considered the most potentially viable recommended mitigation option at this location. Only some of the dwellings with habitable spaces facing the rail alignment are eligible for consideration of noise mitigation.

Figure 72 Recommended Airborne Noise Mitigation - Canterbury Precinct



4.1.9.5 Recommended Airborne Noise Mitigation - Campsie Precinct

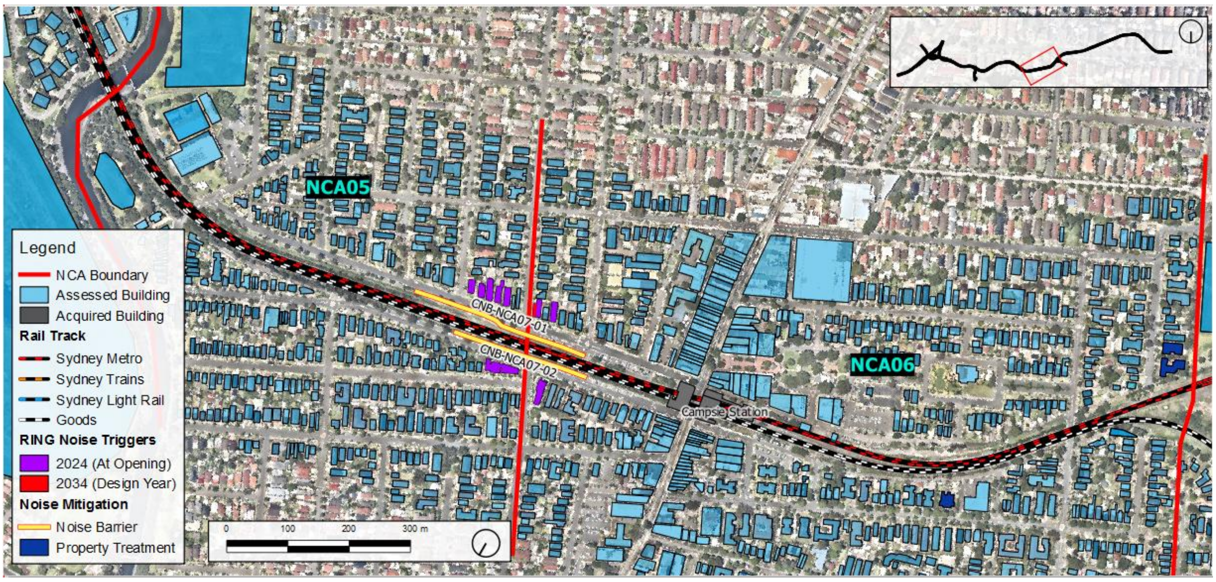
The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Campsie Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 102**. The recommended noise mitigation options are displayed in **Figure 73**.

Table 102 Recommended Airborne Noise Mitigation - Campsie Precinct

NCA	Side	Mitigation	Description
NCA05 and NCA06	Down	2m high conventional noise barrier. - *CNB-NCA05-01*	Noise barrier to address predicted RING triggers at six residential receivers on South Parade, Campsie, in NCA05, and three residential receivers on South Parade, Campsie, in NCA06. 2m high conventional noise barrier located on the down-side rail corridor boundary. Noise barrier to extend from 12 South Parade, Campsie to the pedestrian rail overpass at Duke Street (approximately 290m).
	Up	2m high conventional noise barrier. - *CNB-NCA05-02*	Noise barrier to address predicted RING triggers at one multi-dwelling residential receivers on North Parade, Campsie, in NCA05, and one multi-dwelling residential receivers on North Parade, Campsie, in NCA06. 2m high conventional noise barrier located on the up-side rail corridor boundary. Noise barrier to extend from 20 North Parade, Campsie to the pedestrian rail overpass adjacent 28-29 North Parade, Campsie (approximately 220m).
NCA06	Down	At property treatments - *Two buildings*	Two three storey residential receivers located adjacent the rail corridor boundary are triggered for consideration of noise mitigation in NCA06. The height of a conventional noise barrier required to break line of sight at the upper floors of the building would be almost as high as the multistorey building. This height of conventional noise barrier is considered unreasonable and unfeasible for construction. Therefore, property treatments are considered the most potentially viable recommended mitigation option at these locations. Only some of the dwellings with habitable spaces facing the rail alignment are eligible for consideration of noise mitigation.

NCA	Side	Mitigation	Description
	Up	At property treatments *- One building*	Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the RING triggers at 56-58 Campsie Street, Campsie.

Figure 73 Recommended Airborne Noise Mitigation - Campsie Precinct



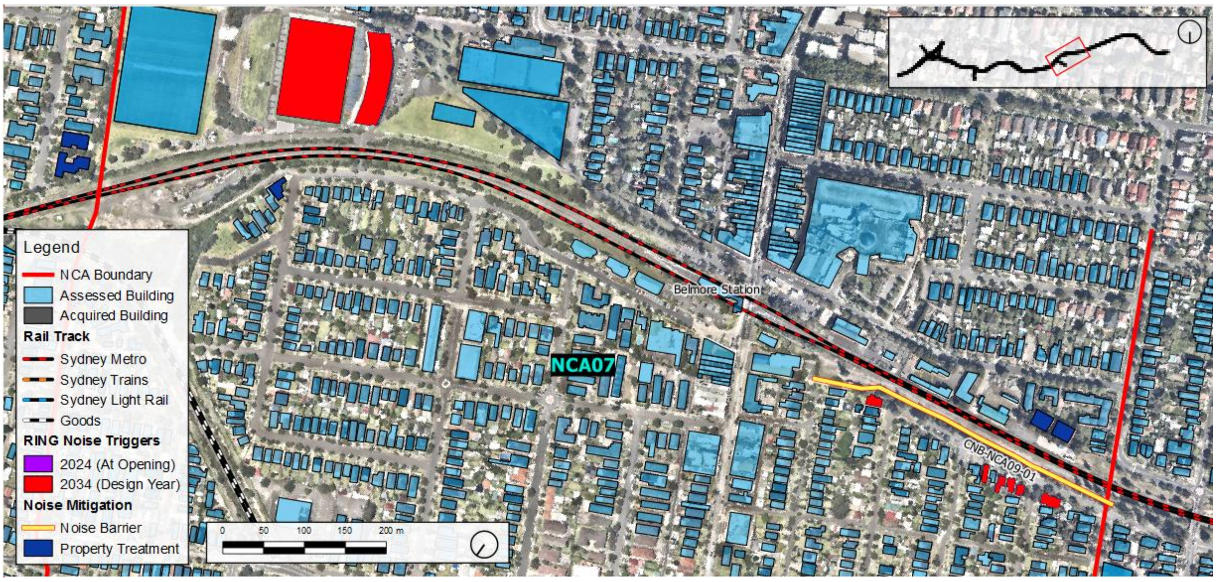
4.1.9.6 Recommended Airborne Noise Mitigation - Belmore Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Belmore Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 103**. The recommended noise mitigation options are displayed in **Figure 74**.

Table 103 Recommended Airborne Noise Mitigation - Belmore Precinct

NCA	Side	Mitigation	Description
NCA07	Down	At property treatments *- Two buildings*	Two four-storey multi-storey residential receiver buildings located directly adjacent the rail corridor boundary are triggered for consideration of noise mitigation in NCA07. The height of a conventional noise barrier required to break line of sight at the upper floors of the building would be almost as high as the multistorey buildings. This height of conventional noise barrier is considered unreasonable and unfeasible for construction. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the RING triggers at 101-105 Bridge Road, Belmore. Only some of the dwellings with habitable spaces facing the rail alignment are triggered for consideration of noise mitigation.
	Up	2m high conventional noise barrier. *- CNB-NCA07-01*	Noise barrier to address predicted RING triggers at seven residential receivers on the up-side of the corridor at the western end of NCA07. 2m high conventional noise barrier located at the corridor boundary between 2 Cleary Avenue, Belmore, and 21 Peel Street, Belmore (approximately 400m).
		At property treatments *- One buildings*	Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the isolated exceedance at 1 Hall Street, Belmore.
	Down	Residual impacts	Exceedances of the RING noise trigger levels are predicted at the Belmore Sportsground other sensitive receiver (outdoor active receiver area). Construction of a conventional noise barrier between the Belmore Sportsground receivers in NCA07 and the rail track does not result in reasonable or feasible noise mitigation solution because: • A conventional noise barrier could not feasibly be constructed at this location as there is insufficient space at the top of the batter. • The barrier alignment would have a large gap in the middle due to the Belmore Stadium pedestrian bridge which would severely limit noise barrier performance Low profile noise barriers may potentially be effective at mitigating noise impacts at these receivers and should be considered in greater detail during the detailed design stage of the project when specific details regarding constructability, safety, and maintenance requirements are better determined. It is noted however that the gap in the barrier alignment at the bridge would limit the potential effectiveness of this mitigation option unless barriers may be incorporated into the bridge design.

Figure 74 Recommended Airborne Noise Mitigation - Belmore Precinct



4.1.9.7 Recommended Airborne Noise Mitigation - Lakemba Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Lakemba Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 104**. The recommended noise mitigation options are displayed in **Figure 75**.

Table 104 Recommended Airborne Noise Mitigation - Lakemba Precinct

NCA	Side	Mitigation	Description
NCA008	Down	At property treatments *- One building*	Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the isolated RING trigger at 69-75 Haldon Street, Lakemba.
	Up	At property treatments *- One building*	Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the isolated RING trigger at 10-12 Belleview Avenue, Lakemba.

Figure 75 Recommended Airborne Noise Mitigation - Lakemba Precinct

4.1.9.8 Recommended Airborne Noise Mitigation - Wiley Park Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Wiley Park Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 105**. The recommended noise mitigation options are displayed in **Figure 76**.

Table 105 Recommended Airborne Noise Mitigation - Wiley Park Precinct

NCA	Side	Mitigation	Description
NCA09	Down	4m high conventional noise barrier. - *CNB-NCA09-01*	Noise barrier to address predicted RING triggers at five buildings at educational receiver on The Boulevarde, Wiley Park (Wiley Park Girls High School). A 4m high conventional noise barrier located on the down side of the rail corridor. Noise barrier to extend from rail station buildings near King Georges Road, Wiley Park to Renown Avenue (approximately 350m). The location of rail station structures may interrupt the noise barrier alignment where the noise barrier would likely require interface with the station structures. The noise barrier alignment and height would be reviewed during the detailed design stage when the layout of Wiley Park Station is confirmed.
	Up	At property treatments - *One building*	One three storey residential receiver located adjacent the rail corridor boundary is eligible for consideration of noise mitigation in NCA09. The height of a conventional noise barrier required to break line of sight at the upper floors of the building would be almost as high as the multistorey building. This height of conventional noise barrier is considered unreasonable and unfeasible for construction. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the RING triggers at 17 Alice Street North, Wiley Park. Only some of the dwellings with habitable spaces facing the rail alignment are triggered for consideration of noise mitigation.

NCA	Side	Mitigation	Description
NCA09 and NCA10	Down	3m high conventional noise barrier. - *CNB-NCA09-01*	Noise barrier to address predicted RING noise trigger levels at residential receivers between 132 The Boulevarde and 150 The Boulevarde. 3m high conventional noise barrier located on the down-side rail corridor boundary. Noise barrier to extend from Faux Street, Wiley Park, to Dudley Street, Punchbowl (approximately 360m). This noise barrier alignment also addresses noise impacts at receivers in the Punchbowl Precinct and extends into NCA10 (refer **Section 4.1.9.9**)
	Up	2m high conventional noise barrier. - *CNB-NCA09-02*	Noise barrier to address predicted RING noise trigger levels at residential receivers between 12B Urunga Parade, Wiley Park and 27 Urunga Parade, Punchbowl. 2m high conventional noise barrier located on the up-side rail corridor boundary. Noise barrier to extend from Defoe Street, Wiley Park, to Dudley Street, Punchbowl (approximately 420m). This noise barrier alignment also addresses noise impacts at receivers in the Punchbowl Precinct and extends into NCA10 (refer **Section 4.1.9.9**)

Figure 76 Recommended Airborne Noise Mitigation - Wiley Park Precinct

4.1.9.9 Recommended Airborne Noise Mitigation - Punchbowl Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Punchbowl Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 106**. The recommended noise mitigation options are displayed in **Figure 77**.

Table 106 Recommended Airborne Noise Mitigation - Punchbowl Precinct

NCA	Side	Mitigation	Description
NCA09 and NCA10	Down	3m high conventional noise barrier. *- CNB-NCA09-01*	Noise barrier to address predicted RING noise trigger level exceedances at residential receivers between 132 The Boulevarde and 150 The Boulevarde. 3m high conventional noise barrier located on the down-side rail corridor boundary. Noise barrier to extend from Faux Street, Wiley Park, to Dudley Street, Punchbowl (approximately 360m). This noise barrier alignment also addresses noise impacts at receivers in the Wiley Park Precinct and extends into NCA09 (refer **Section 4.1.9.8**)
	Up	2m high conventional noise barrier. *- CNB-NCA09-02*	Noise barrier to address predicted RING noise trigger level exceedances at residential receivers between 12B Urunga Parade, Wiley Park and 27 Urunga Parade, Punchbowl. 2m high conventional noise barrier located on the up-side rail corridor boundary. Noise barrier to extend from Defoe Street, Wiley Park, to Dudley Street, Punchbowl (approximately 420m). This noise barrier alignment also addresses noise impacts at receivers in the Wiley Park Precinct and extends into NCA09 (refer **Section 4.1.9.8**)
NCA10	Up	2m - 4m high conventional noise barrier. *- CNB-NCA09-01*	Noise barrier to address predicted RING noise trigger level exceedances at five educational receiver buildings and one place of worship building on the Up side of the rail corridor in NCA10 (Punchbowl Boys High School). A varying height conventional noise barrier of between 2 m height in the east and rising to 4 m in the west would be required to mitigate all of the other sensitive triggers on the Up side. This barrier height would completely eliminate all sensitive receiver building triggers, and provide amenity for outdoor areas also, including the schools playing fields. Low profile noise barriers may potentially be effective at mitigating noise impacts at these receivers and should be considered in greater detail during the detailed design stage of the project when specific details regarding safety and maintenance requirements are better determined.
	Down	At property treatments *- Four buildings*	Conventional noise barriers are generally only considered where more than three closely grouped properties are triggered for consideration of noise mitigation. Therefore, property treatments are considered the most potentially viable recommended mitigation option for the spaced out residential receivers at the western end NCA10.
	Down	At property treatments *- One building*	One three storey residential building at 148 The Boulevarde, Punchbowl, includes RING noise trigger level exceedances at receivers on the top floor of the building that are not predicted to be eliminated through the implementation of noise barrier CNB-NCA09-01. While increasing the height of the noise barrier to 4m is predicted to eliminate this trigger, the most reasonable and feasible approach to addressing this residual impact would be the consideration of at property treatments for these receivers.

Figure 77 Recommended Airborne Noise Mitigation - Punchbowl Precinct

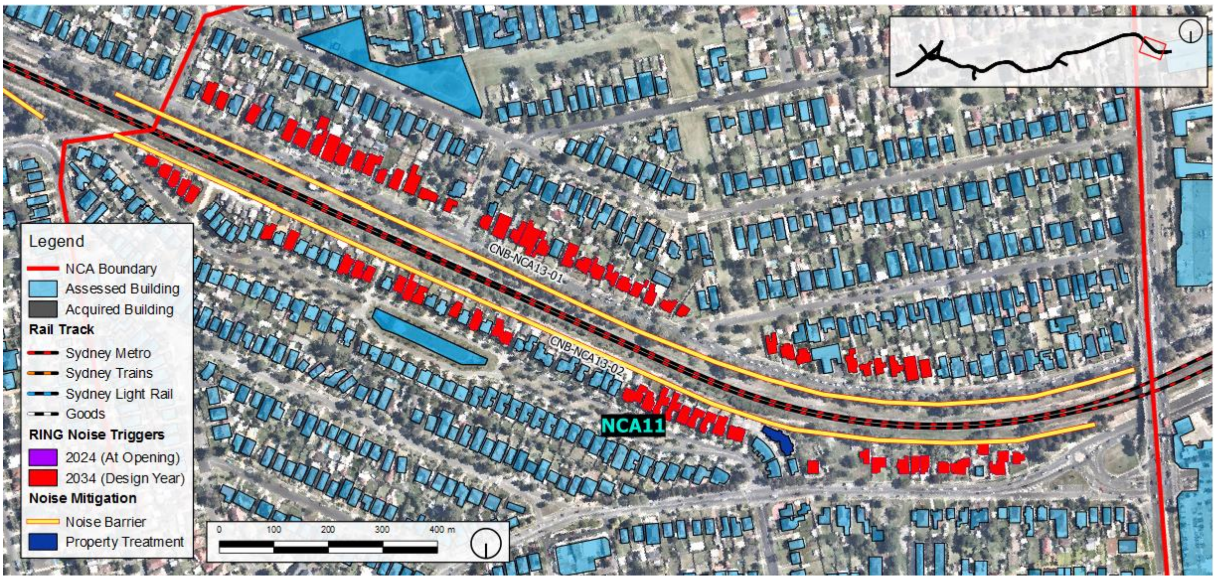
4.1.9.10 Recommended Airborne Noise Mitigation - Bankstown Precinct

The rail noise levels for the 2024 and 2034 scenarios presented in **Section 4.1.6** indicate RING noise trigger levels exceedance are predicted at receivers within the Bankstown Precinct. Abatement of the predicted noise impacts may include the recommended noise mitigation options in **Table 107**. The recommended noise mitigation options are displayed in **Figure 78**.

Table 107 Recommended Airborne Noise Mitigation - Bankstown Precinct

NCA	Side	Mitigation	Description
NCA11	Down	3m high conventional noise barrier. - *CNB-NCA11-01*	Noise barrier to address predicted RING noise trigger level exceedances at residential receivers between 74 South Terrace, Bankstown, and 172 South Terrace, Bankstown. 3m high conventional noise barrier located on the down-side rail corridor boundary. Noise barrier to extend from rail corridor entry gate adjacent 74 South Terrace, Bankstown, to Stacey Street, Bankstown (approximately 1,100m). Low profile noise barriers may potentially be effective at mitigating noise impacts at these receivers and should be considered in greater detail during the detailed design stage of the project when specific details regarding safety and maintenance requirements are better determined.
	Up	2m-4m high conventional noise barrier. - *CNB-NCA11-02*	Noise barrier to address predicted RING noise trigger level exceedances at residential receivers between 166 Wattle Street, Bankstown, and 105 Stansfield Avenue, Bankstown. A varying height conventional noise barrier of between 2 m and 4 m height located on the up-side rail corridor boundary would be required to mitigate most of the RING noise trigger level exceedances on the Up side. Noise barrier to extend from rail corridor entry gate adjacent 104 Stansfield Avenue, Bankstown, to Stacey Street, Bankstown (approximately 1,060m). It is noted that there is an existing noise barrier of approximately 2.4 m height for the majority of this alignment. Therefore, future noise barrier designs of a lower height have no effect on rail noise levels With the 4m noise barrier described above, there are residual impacts predicted at the upper floors of one multi-storey receiver buildings. Mitigation of residual impacts with property treatments at this receiver building are described below Low profile noise barriers may potentially be effective at mitigating noise impacts at these receivers and should be considered in greater detail during the detailed design stage of the project when specific details regarding safety and maintenance requirements are better determined.
	Up	Property Treatments - *Residential building*	One two storey residential townhouse receiver located directly adjacent the rail corridor boundary is triggered for consideration of noise mitigation in NCA011 with the recommended 4m high noise barrier. The height of a conventional noise barrier required to break line of sight at the upper floors of this building would be almost as high as the multistorey building itself. This height of conventional noise barrier is considered unreasonable and unfeasible for construction. Therefore, property treatments are considered the most potentially viable recommended mitigation option at this location. Only some of the dwellings with habitable spaces on the top floor facing the rail alignment are triggered for consideration of noise mitigation.

Figure 78 Recommended Airborne Noise Mitigation - Bankstown Precinct



4.1.10 Operational Noise from Commissioning

During the commissioning stage of the project, prior to the commencement of revenue services, test vehicle operations would be performed on the Metro tracks as part of the rail track and vehicle systems testing procedures.

There is a possibility that the commencement of revenue services would be phased such that the Metro train network and service frequencies are developed in stages over a project opening period. This may include Metro trains running from Cudgegong Station to Sydenham Station before the Sydenham to Bankstown upgrade is operational. At the time of this assessment phased opening operations were still being assessed and are not confirmed as a project feature.

It is understood that test vehicle movements and potential phased opening operations within the project area would not be more frequent than the proposed revenue services assessed in this report. Additionally, the test vehicle and phased opening speeds are not anticipated to be significantly higher than the vehicle speeds presented in this report. Therefore, it is reasonable to assume that the operational noise impacts resulting from these activities would be less than or similar to the L_{Aeq} and L_{Amax} noise levels presented within this report.

However, in the event that vehicle testing would require the operation of test vehicles in a significantly different configuration to that assumed for general operation, then an assessment of the proposed commissioning operations should be undertaken. If exceedances of the operational noise criteria are identified for commissioning operations, then feasible and reasonable mitigation measures should be investigated. Such measures may include:

- Scheduling fewer commissioning operations in the same region during the daytime or night-time period.
- Rescheduling commissioning operations from the night-time period to the less sensitive daytime period.
- Scheduling unusually high noise events (such as traction, acceleration and brake testing) to less sensitive periods of the day in consultation with the potentially affected community, and/or away from receivers.

4.1.11 Airborne Noise Sensitivity Analysis – Rail Operations

Future freight traffic operating within the study area would have an impact on the noise assessment outcomes for the project undertaken in accordance with the RING which requires noise from all rail traffic to be considered in the noise impact assessment. Where noise from freight traffic dominates the rail noise environment, the influence of passenger train noise emissions is reduced to a point where increases in movements and speeds do not result in an exceedance of the increase in noise trigger level. The high freight noise levels ensures overall noises levels do not increase which controls the projects impact on sensitive receivers.

At this stage in the project it is not possible to forecast future freight operational conditions with absolute certainty. In the event that future freight operations result in increased noise emissions than those assumed for this assessment, noise mitigation requirements may reduce in areas with freight movements. Conversely, in the event that future freight operations result in decreased noise emissions than those assumed for this assessment, noise mitigation requirements may increase in the future.

A sensitivity analysis of the potential maximum range in exceedances of the noise trigger levels has been undertaken with the results presented in **Table 108**.

Table 108 Airborne Noise Prediction Sensitivity Analysis - Change in Quantity of RING Trigger Prediction

Freight Noise Emission Scenario	Receiver Type	At Opening (2024)				Design Year (2034)			
		Day	Night	Max	TOTAL	Day	Night	Max	TOTAL
Increased Freight Noise Emissions	Residential	-11	-1	-8	-18	-1	-1	-8	-7
	Other Sensitive	+/-0	+/-0	-	+/-0	+/-0	+/-0	-	+/-0
Decreased Freight Noise Emissions	Residential	+41	+/-0	+2	+41	+56	+1	+2	+57
	Other Sensitive	+1	+/-0	-	+1	+2	+/-0	-	+2

From the results presented in **Table 108** it can be seen that the quantity of predicted exceedances of the RING noise trigger levels may decrease by up to seven sensitive receivers if freight noise impacts are greater than anticipated. Likewise, the quantity of predicted RING triggers may increase by up to 59 sensitive receivers if freight noise impacts are lower than anticipated.

Where the quantity of predicted RING triggers has the potential to increase as a result of lower freight noise impacts, the additional receivers triggered for consideration of noise mitigation measures would generally be in areas close to the RING trigger levels identified in **Section 4.1.6**. Hence, an extension of mitigation measures to address impact over a wide area may be required.

Forecast freight traffic operating conditions would be considered further during the detailed design stage of the project when more information pertaining to freight operating conditions is available. The recommended reasonable and feasible noise mitigation presented in this assessment would be considered in greater detail during the detailed design stage of the project and is subject to change.

4.2 Ground-borne Noise and Vibration

4.2.1 Introduction

Rail vibration is generated by dynamic forces at the wheel-rail interface and occurs due to surface irregularities at the point of contact. The vibration generated propagates through the rail mounts into the trackform, which then propagates through the surrounding soil. The vibration continues to propagate up into surrounding structures. This study considers the impact on people within buildings where the occupants may be annoyed by the generation of vibration.

Inside structures there are two components of vibration that are of specific concern. Tactile vibration (perceptible by touch) can be a concern dependant on the length of exposure. Vibration can also cause the floors and walls to vibrate which generates a low-frequency rumble which is commonly referred to ground-borne noise. Rattling or visible movement of loose objects (crockery, plants, etc) may also occur.

The integrity of building foundations are very unlikely to be comprised by the passby of operational trains. Compliance with tactile vibration and ground-borne noise indicates that the assessment of building damage is not required.

4.2.2 Operational Ground-borne Noise Objectives

4.2.2.1 Ground-borne Noise

The RING provides ground-borne noise vibration criteria for train movements. Provided below is a summary of the applicable ground-borne noise trigger levels.

Table 109 Ground-borne Noise Trigger Levels for Heavy or Light Rail Projects

Sensitive land use	Time of day	Internal noise trigger level dBA
		Development increases existing rail noise levels by 3 dBA or more ***and*** resulting rail noise levels exceed:
Residential	Day (7am to 10pm)	40 L_{ASmax}
	Night (10pm to 7am)	35 L_{ASmax}
Schools, educational institutions, places of worship	When in use	40 - 45 L_{ASmax}

The RING acknowledges that the World Health Organisation recommends avoiding individual noise events exceeding 45 dB L_{Amax} indoors. This is reflected in the triggers for ground-borne noise listed in **Table 109**.

4.2.2.2 Human Perception of Vibration

The level of vibration which annoys an individual is highly dependent on the circumstances surrounding the vibration and the individual's expectations in that scenario. For example a highly level of vibration is generally considered to be acceptable on transport infrastructure than would be experienced in the persons own home. Short term vibration such as construction is also often considered to be less annoying due to the transient nature of the vibration.

The thresholds of perception for continuous whole-body vibration vary widely among individuals. Approximately half the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015 m/s^2 as stated in Annex C of AS 2670.1:2001 '*Evaluation of human exposure to whole-body vibration - Part 1: General requirements*[viii] (AS2670.1). Converted to vibration velocity, the perception threshold is approximately 0.1 mm/s Root Mean Square (RMS).

The *Assessing Vibration: a technical guideline* (DEC, 2006) notes that:

> *"vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time)."*

Examples of continuous vibration include generators, compressors and other continuous operating plant. Examples of impulsive vibration events include the vibration generated by blasting, or dropping of heavy equipment. Examples of intermittent vibration events include vibration generated by train passbys, vibratory roller passbys, drilling and materials handling.

Where vibration is intermittent or impulsive in character, the DEC vibration guideline recognises that higher vibration levels are tolerable to building occupants than is the case for continuous vibration. As such, higher vibration goals are usually applicable for short term, intermittent and impulsive vibration activities than for continuous sources.

Although people are able to perceive relatively low vibration levels, it is not appropriate to set vibration emission limits requiring 'no vibration' since there will always be some measurable vibration in any environment. Realistic design objectives should therefore be set to minimise disturbance and adverse impacts on occupants' amenity.

4.2.2.3 Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment. As such, the controlling vibration design objectives are the human comfort criteria. It is therefore not necessary to set separate design objectives for this environmental impact statement in relation to the effect of rail vibration on common building contents.

Some scientific equipment (eg electron microscopes and microelectronics manufacturing equipment) can however require more stringent design goals than those applicable to human comfort. In such cases, vibration design objectives should be obtained from the specific equipment manufacturers or if unavailable, from generic vibration criteria within commonly referenced sources in the literature[2].

4.2.2.4 Effects of Vibration on Structures

The levels of vibration required to cause damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive or disturbing. It is therefore not necessary to set separate design objectives for this project in relation to building damage from rail vibration, as compliance with the human comfort design objectives would ensure compliance with any criteria related to potential structural damage.

4.2.3 Vibration Design Objectives

The applicable criteria for transient vibration are provided by *Assessing Vibration: A Technical Guideline* (DEC, 2006)[ix] (AVATG), which is based on the guidelines contained in BS 6472. For vibration associated with train passbys, the guideline indicates that vibration levels should be assessed on the basis of the vibration dose value (VDV).

The VDV considers the vibration generated by a train passby, and includes the length of exposure over the given time period.

The criteria provides both preferred and maximum criteria values. AVATG states *"Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if they can be justified"*.

[2] *ANC Guidelines - Measurement and Assessment of Ground-borne Noise & Vibration,* Association of Noise Consultants (2012) and *Vibration Control Design of High Technology Facilities*, Journal of S & V, Ungar, Sturtz & Amick (1990).

This project involves the modification to an existing railway corridor. Sensitive receivers adjacent to the project are already exposed to vibration generated from the railway corridor. Mitigation for vibration is generally limited to moving the source further from the receivers or using an alternate trackform. There is little opportunity to move the proposed alignment and it would not be reasonable to change the trackform without significant impacts being identified. As such the maximum VDV values are considered to be appropriate criteria to be used for this project.

Table 110 Acceptable Maximum Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime	Night-time
Critical working areas (eg hospital operating theatres, precision laboratories)	0.2	0.2
Residences	0.4	0.26
Offices, schools, educational institutions and places of worship	0.8	0.8
Workshops	1.6	1.6

Where particularly sensitive equipment is identified, the generic vibration criterion curve C (Colin G. Gordon - 28 September 1999) is used as a trigger level for further investigation for identified receivers likely to have highly vibration sensitive equipment. The VC-C curve specifies a design objective of 82 dB_V per 1/3 octave band for frequencies between 8 Hz and 80 Hz and is appropriate for most lithography and inspection equipment down to 1 micron detail size. Sensitive equipment has not been identified within the vicinity of this project.

4.2.4 Ground-borne Noise and Vibration Modelling Methodology

International Standard ISO 14837-1 2005 *Mechanical vibration - Ground-borne noise and vibration arising from rail systems - Part 1: General Guidance*[x] provides relevant guidance in relation to the extent of assessment that is normally required for new rail systems. A brief description of the modelling options from this document is provided below.

> *"A single model may be used for all stages with appropriate selection of input parameters (e.g. worst case for scoping assessment). Otherwise, three types of ground-borne vibration and/or ground-borne noise prediction model should be considered, as follows.*
>
> *a)* ***Scoping model****: to be used at the very earliest stages of development of a rail system to identify whether ground-borne vibration and/or ground-borne noise is an issue and, if so, where the areas of higher impact along the length of the system's alignment are located. This type of model should be used to generate input to either environmental comparative frameworks (as part of the selection of a mode of transport) or the scoping stage of an environmental assessment.*
>
> *b)* ***Environmental assessment model****: to be used to quantify more accurately the location and severity of ground-borne vibration and/or ground-borne noise effects for a rail system. The report should outline the generic form and extent of mitigation required to mitigate predicted impacts. This type of model should form part of the planning process and environmental documentation of a project.*
>
> *c)* ***Detailed design model****: to be used to support the detailed design and specification of the generic mitigation identified as being required by the environmental assessment model. This type of model should form part of the design and construction stages of a scheme, with particular focus on the rolling stock and permanent-way design."*

At this stage of the project, a combined environmental assessment/detailed design model has been adopted to assess the potential impacts from ground-borne noise and vibration levels and identify the extent of the likely in-principle mitigation measures.

In accordance with the ISO standard, the model considers all of the parameters that are critical in determining the absolute levels of ground-borne noise and vibration, and the benefits (or otherwise) of different design and mitigation options.

The key parameters of the project modelling algorithms are described in the following section under the headings:

- **Source** - route alignment, rolling stock design, rail type, track form design, tunnel design, turnouts, construction tolerances, operations and maintenance
- **Propagation Path** - ground type and vibration propagation wave types
- **Receivers** - building construction.

4.2.4.1 Modelling Approach

The prediction of ground-borne noise and vibration from rail systems is a complex and developing technical field. Whilst much research has been undertaken into various aspects associated with ground-borne impacts from rail systems, there are currently no commercially available modelling software packages.

The modelling for the project has been carried out using a modelling process for the core calculations developed by SLR. The algorithms incorporated into the SLR model are provided in **Section 4.2.4.2** and are widely used within the acoustical consulting profession, both in Australia and internationally. The model used has been successfully incorporated and validated in many previous rail projects undertaken by SLR over the past ten years.

Provided below is a summary of the model calculations methodology.

4.2.4.2 Source Vibration Levels

The source vibration levels used have been based on attended vibration measurements undertaken by this project. The measurements were all undertaken on ballast track with concrete sleepers, the same trackform as the proposed design see **Section 2.4.3**.

Attended measurements found that the measured freight levels were consistent with vibration generated by the heavy passenger rail movements. As such they were included in the dataset and only a single source level has been included in the study.

The proposed metro fleet has not been field tested at this stage. As such it is unclear what the potential vibration levels would be. It can be assumed that both the wheel and rail profile would be somewhat consistent with the existing situation. Additionally a metro system is likely to have a relatively lower unsprung mass than a heavy rail system. This would result in a lower vibration emission level from the rollingstock. However for the purposes of providing a conservative assessment it has been assumed the vibration emission levels would remain consistent with the existing levels.

Provided below is a summary of the vibration source level used in this assessment. This level is the 95^{th} percentile $L_{max(slow)}$ of all measured passbys. Rather than choose the passby movement which represents the 95^{th} percentile and choosing that passby frequency spectrum, a 95^{th} percentile of each one-third octave band has been used. This method results in a vibration level approximately 1 dB higher than the actual 95^{th} percentile. This method has been used to reduce the likelihood of overlooking potential vibration generation in all frequency bands.

Table 111 Reference Source Vibration Levels (7.5 m, 80 km/h)

Track Type	Vibration Levels (dB_V re 1 nm/s) in 1/3 Octave Bands (Hz) – $L_{max,slow,95\%}$																Overall Level
	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	
Ballast	78	80	88	97	102	106	106	105	103	102	101	95	88	85	80	75	112

4.2.4.3 Speed Adjustment

Vibration measurements undertaken by SLR throughout the Sydney network have consistently shown that vibration increases by about 6 dB per doubling of train speed. To account for the speed changes throughout the network the following formula has been incorporated in the assessment:

$$A_{corr} = 20log_{10}(\frac{V_0}{80})$$

The potential impact of simultaneously passing trains at particular receiver locations on a regular basis has not been evaluated in detail as part of the assessment. The maximum increase in vibration levels in the event of two trains passing at the same time is 3 dB. Since ground-borne noise and vibration levels from trains are variable, any increase in noise levels would likely be limited to 1 dB or 2 dB and is not likely to be noticeable.

4.2.4.4 Maintenance

The maintenance of the track and rolling stock can have a significant influence on the ground-borne noise and vibration levels. The source vibration levels which form the starting point of the modelling assume that the track is maintained in a reasonable condition consistent with that observed and measured on ECRL. In the case of poor track condition, it is assumed that rail grinding would be undertaken if appreciable increases in rail related noise impacts are reported (this process would be outlined in the project maintenance strategy). Furthermore, it is also assumed that the condition of the track would be monitored on a regular basis using on-car or hand-held monitoring equipment. Additional information on rail roughness management as applied to the ECRL may be found in Vegh et. al. *Acoustic rail grinding - measures of long term effectiveness: Epping to Chatswood Rail Link case study*[xi].

The source vibration levels are also based on the 95th percentile (highest 5%) of train vibration levels observed, as required by the RING. The project would include wheel condition monitoring systems and a wheel lathe at the Sydney Metro Trains Facility (part of Sydney Metro Northwest). On this basis, it is reasonable to assume that the condition of the wheels would remain steady over time.

In the case of poor wheel condition, it is assumed that the potential for wheel flats would be minimised through incorporation of anti-skid braking systems in the design. If wheel flats or other wheel defects do occur, it is assumed that these would be identified by a permanent monitoring station and rectified using the wheel lathe or other measures to return the wheel condition to an acceptable degree of smoothness.

4.2.4.5 Propagation Path

The propagation of vibration through the ground is a complex phenomenon. The received vibration at any point includes the combined effects of several different wave types, plus reflections and refractions caused by changes in ground conditions along the propagation path.

Attenuation with distance occurs due to the geometric spreading of the wave front and due to other losses within the ground material known as damping. The attenuation due to geometric spreading occurs equally for all frequencies, whereas the damping component is frequency dependent, with greater loss per metre occurring at high frequencies than at low frequencies.

4.2.4.6 Calculation Methodology

Provided below is a summary of the ground-borne noise and vibration calculation equations incorporated in this assessment.

4.2.4.6.1 Vibration Attenuation due to Geometric Spreading

For geometric spreading, a 160 m long train was modelled as a source located at the base of the ballast, midway between the track centreline.

$$A_{div} = 10log_{10}(\frac{1}{d})$$

Where d is the offset distance between the source and receiver.

4.2.4.6.2 Material Damping

Material damping has been included in the calculation of propagation. The formula used to calculate material damping is provided below:

$$A_{damping} = 10log_{10}(e^{-2\pi fnd}/_{c})$$

Where f is the frequency band, d is the offset distance, n is the loss factor, and c is the wave speed. For this assessment the loss factor of 0.4 and a wave speed of 1500 m/s have been incorporated in the assessment. These values are based on the local soil condition and SLRs experience with vibration propagation through rail corridors.

4.2.4.6.3 Angle of View Correction

The formula for geometric spreading assumes that the source is an infinite line source. While in close proximity to the source this may be essentially true, as the receiver moves further away the source changes to a finite line source, and eventually a point source. To account for this differential an angle of view correction has been included in the calculation. Provided below is the formula to account for the finite line source correction.

$$AOV = 10log_{10}(\frac{\theta}{180})$$

4.2.4.7 Receivers

4.2.4.7.1 Propagation of Vibration into Buildings

When vibration waves propagate from one material to another, an impedance loss (or reduction in energy) occurs. For the propagation of vibration through soil and rock, this corresponds to a reduction in vibration. A reduction in vibration from the impedance loss is commonly called a coupling loss. The magnitude of the coupling loss is dependent on a range of factors which varies based on building size, construction, and ground type.

A conservative coupling loss has been chosen, assuming the buildings are all single residential. This is detailed in **Table 112** together with typical coupling loss data for common building structures.

At this stage of the project only limited information regarding basements is available. Ground-borne noise and vibration modelling would be refined during the detailed design to incorporate basement levels for potentially impacted buildings.

Table 112 Coupling Loss Values (dB)

Type	Coupling Loss (dB) in 1/3 Octave Bands (Hz)																		
	5	6.3	8	10	12	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315
Values adopted for the project	3	3	4	4	5	5	6	6	6	6	6	6	6	5	5	5	4	4	4
Large Masonry on Piles	6	6	6	6	7	7	7	8	9	10	11	12	13	13	14	14	15	15	15
Large Masonry on Spread Footings	11	11	11	11	12	13	14	14	15	15	15	15	14	14	14	14	13	12	11
2-4 Storey Masonry on Spread Footings	5	6	6	7	9	11	11	12	13	13	13	13	13	12	12	11	10	9	8
1-2 Storey Commercial	4	5	5	6	7	8	8	9	9	9	9	9	9	8	8	8	7	6	5
Single Residential	3	3	4	4	5	5	6	6	6	6	6	6	6	5	5	5	4	4	4

Note: Coupling loss values have been obtained from Nelson[3] and have been extrapolated to include frequency bands below 16 Hz.

4.2.4.7.2 Conversion from Vibration to Noise

The Kurzweil approach is the most common method to convert vibration energy to noise. While the approach is largely based in theory, it has been used extensively and shown to be an effective empirical approach to ground-borne noise predictions.

The average sound pressure in the room can be calculated using the following equation:

$$\langle \overline{p^2} \rangle = \frac{p_0 c_0^2 T_{60} W}{13.81 V}$$

Where V is the volume of the room, T_{60} is the reverberation time, W is the sound power radiated by the vibration of the floor. This formula can be simplified to and expressed in terms of sound pressure level:

$$L_p = L_v + 10log_{10}(\sigma) - 10log_{10}(H) - 20 + 10log_{10}(T_{60})$$

Where L_v is the vibration velocity in dB re 10^{-9} m/s and H = V/S is the height of the room. Assuming that the radiation ratio $\sigma = 1$, H = 2.8 metres and T_{60} = 0.5 seconds, it is found that

$$L_p \approx L_v - 27\ dB$$

This assessment has used the vibration velocity calculated on the first floor of the building, subtracted 27 to each one-third octave frequency band, and finally A-weighted the results. This level yields the overall A-weighted noise level expected in a room.

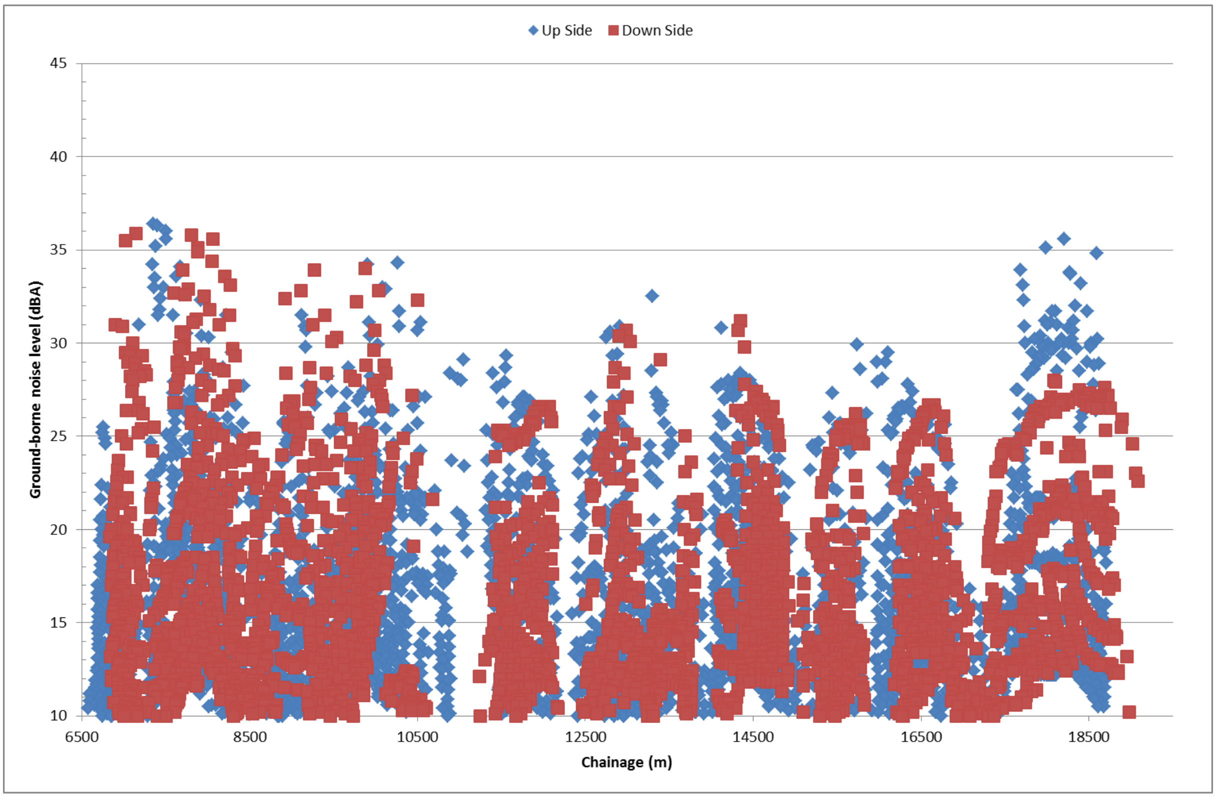
4.2.5 Ground-borne Noise Assessment

The project involves the removal of the existing heavy passenger rail alignment, with a new metro rail alignment to be built in approximately the same location. Freight operations are present within the shared rail corridor in the eastern half of the project area between Marrickville and Belmore. Sensitive receivers are currently exposed to vibration throughout the area. There is the potential that sensitive receivers are also exposed to ground-borne noise, however this is typically unlikely on above ground ballasted alignments where development is located outside the rail corridor.

[3] *Transportation Noise Reference Book*, Nelson, J (1987).

A summary of the predicted ground-borne noise levels are show below in **Figure 79**.

Figure 79 Predicted Ground-borne Noise Levels



The results above illustrate a small number of exceedances on both sides of the track between chainages 7000 to 8200 and 17500 to 18600. The results provided below in **Figure 80** and **Figure 81** show these areas in more detail. Range bars have also been included to show the change in noise levels from the existing passenger system.

Figure 80 Ground-borne Noise Levels – Change in Noise from Passenger Rail - Chainage 7000 to 8200

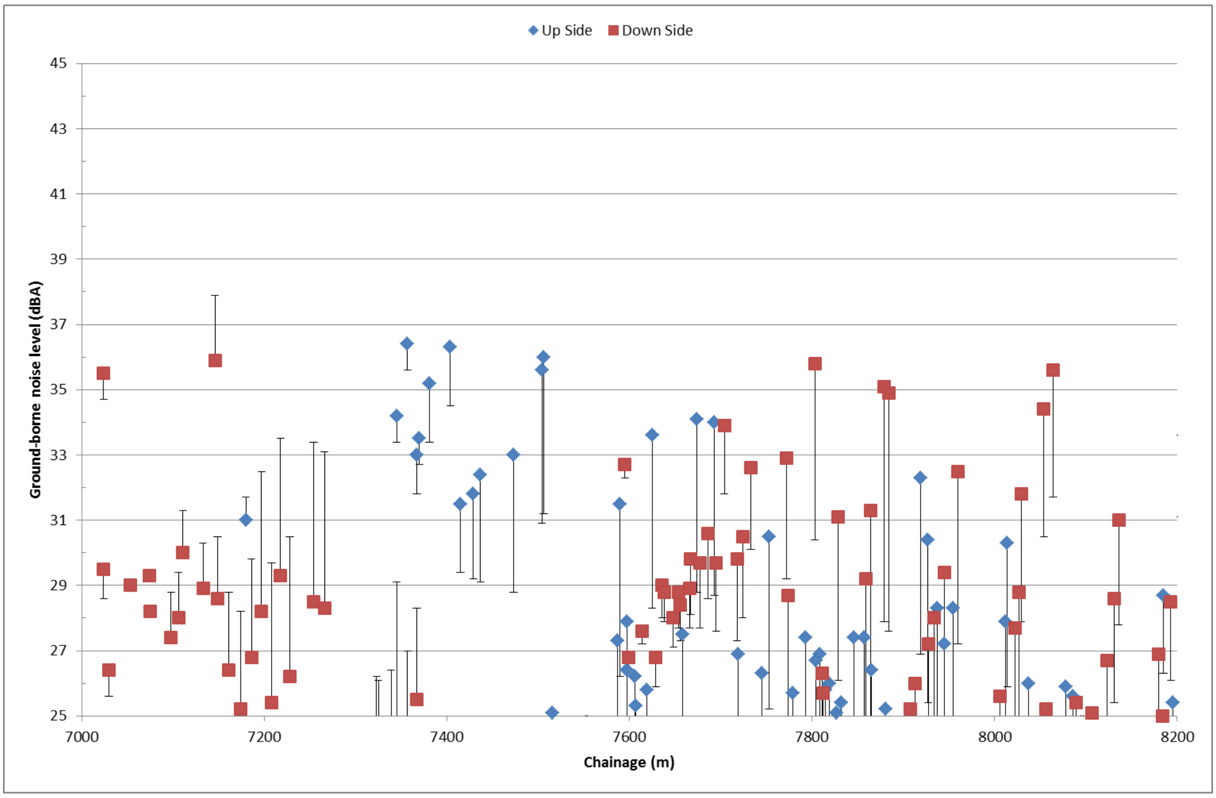
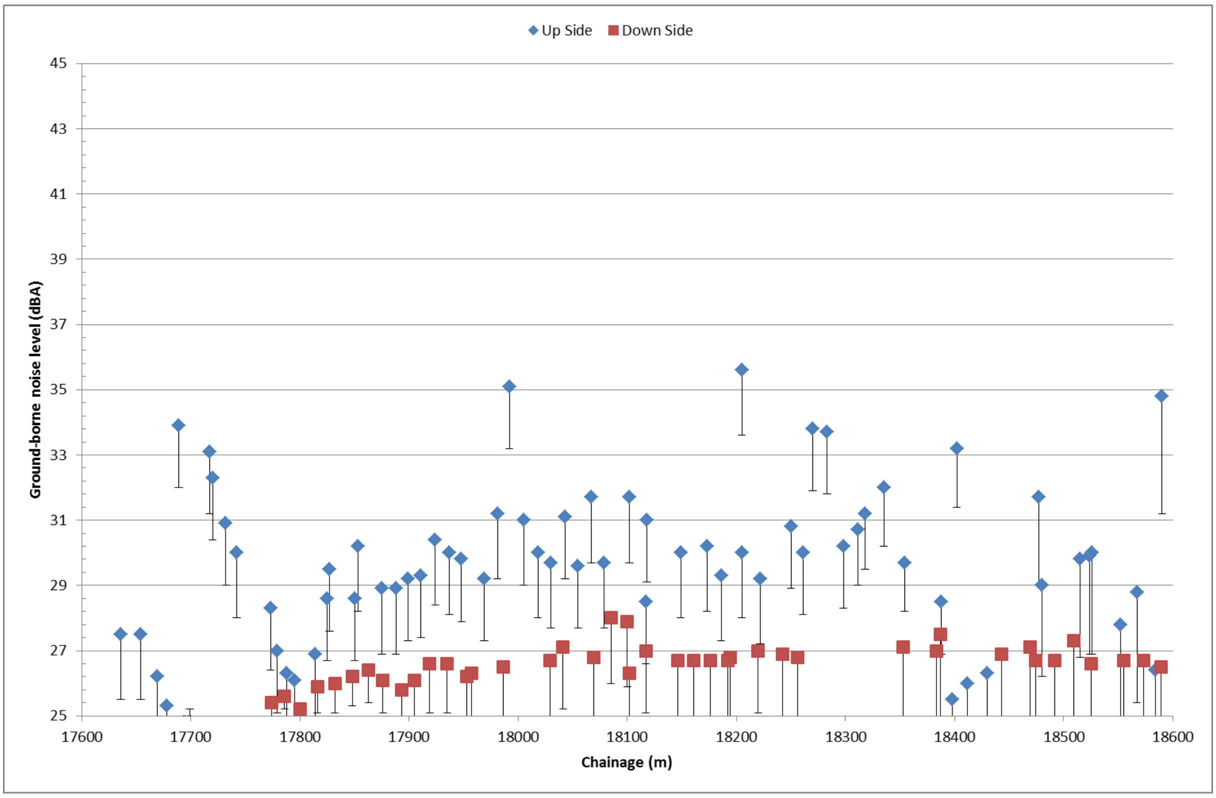


Figure 81 Ground-borne Noise Levels – Change in Noise from Passenger Rail - Chainage 17600 to 18600



To be eligible for consideration of noise mitigation the sensitive receivers must exceed the applicable noise criteria of 35 dBA (i.e. be 35.5 dBA or higher) and increase by more than 3 dBA. When considering the increase in ground-borne noise, freight has been excluded from this assessment. Freight movements are considered to be characteristically different. The exclusion of freight movements from the existing ground-borne noise has yielded a more conservative assessment.

A total of four sensitive receivers have been found to exceed the residential noise criteria and increase by more than 3 dBA. A summary of the results is provided below in **Table 113**.

Table 113 Receivers Exceeding Ground-borne Noise Criteria

ID	Chainage	Address	Ground-borne Noise Level, dBA			Predicted external noise level, dBA
			Existing Passenger	Future Metro	Increase	
02822	7506	30 Arthur Street, Marrickville	31	36	4.8	> 90
02698	7803	221 Livingstone Road Marrickville	30	36	5.4	> 90
02624	8064	29 Albermarle Street Marrickville	32	36	3.9	> 90
02827	7504	24 Arthur Street Marrickville	31	36	4.7	> 90

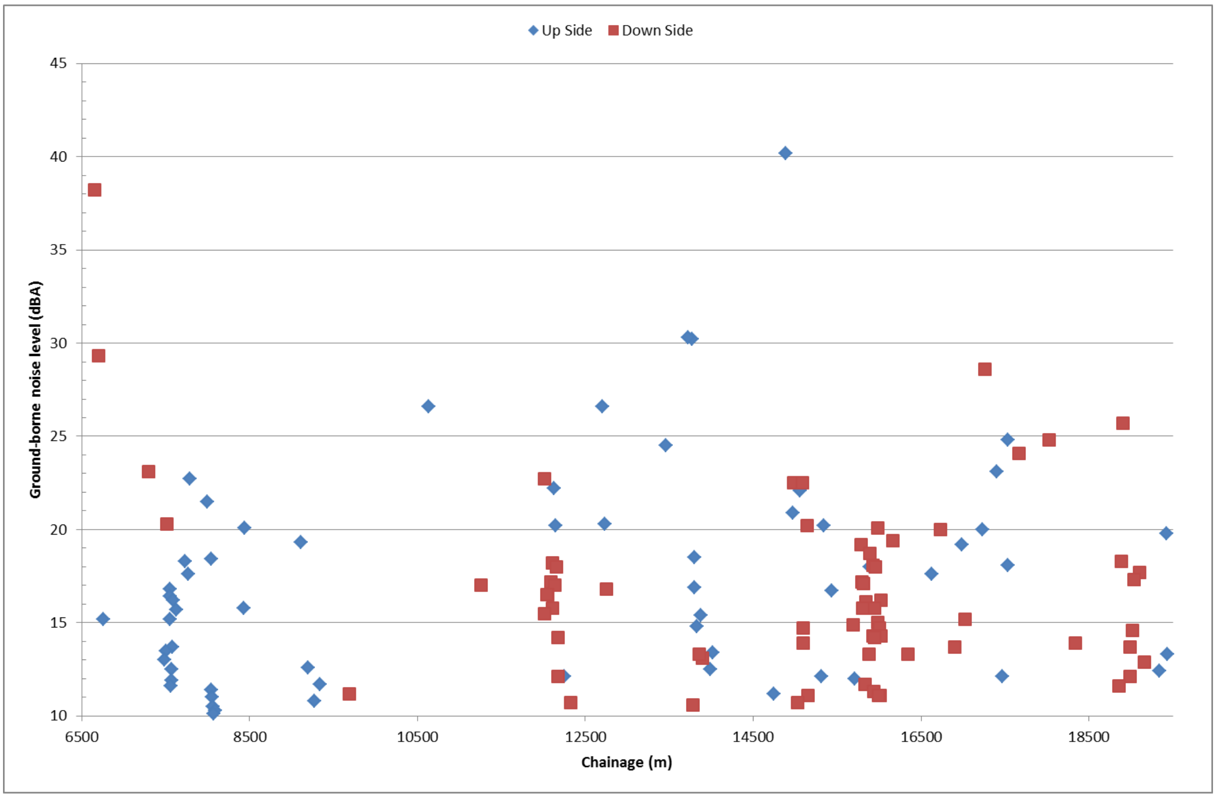
The results in **Table 113** show that a maximum exceedance of 1 dBA is predicted at four receivers. The predicted external noise levels show that the sensitive receivers would also be subject to appreciable external noise levels. With a moderate outdoor to indoor correction of 10 dBA the external noise levels would dominate noise within the affected buildings. The noise criteria only apply to sensitive receivers where ground-borne noise dominates the noise environment.

On this basis the four receivers identified here are deemed to comply with the applicable ground-borne noise criteria. Further consideration of reasonable and feasible mitigation is not required for ground-borne noise.

4.2.6 Other Sensitive Receivers

Provided below is a graphic summary of the predicted ground-borne noise levels for all other sensitive receivers within the project area.

Figure 82 Predicted Ground-borne Noise Levels – Other Sensitive Receivers

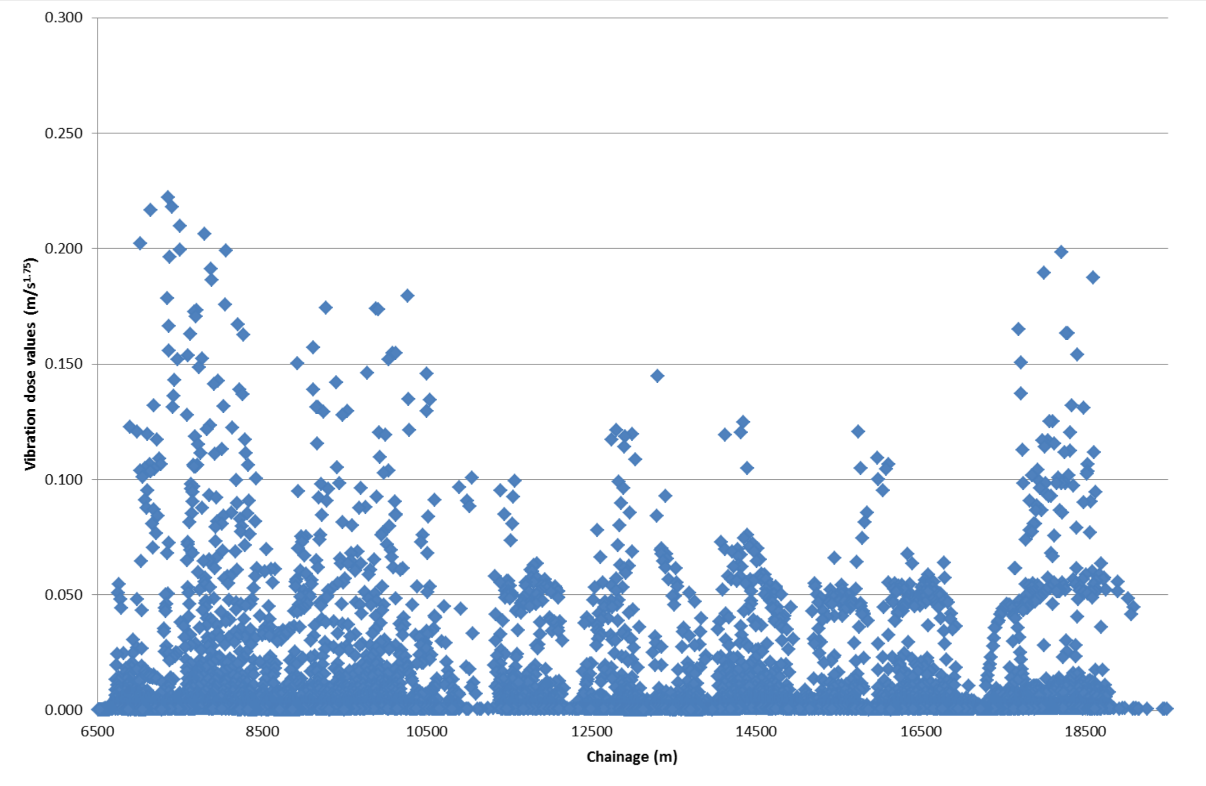


The results illustrated above in **Figure 82** show that there are no non-residential sensitive receivers that exceed the RING ground-borne noise criteria of L_{ASmax} 40 dBA to 45 dBA. Consideration of reasonable and feasible mitigation is not required for these receivers.

4.3 Vibration Impact Assessment

A summary of the predicted VDV levels is provided in **Figure 83** for residential receivers located closest to the rail corridor.

Figure 83 Predicted Vibration Dose Values – Residential Receivers



The results in **Figure 83** indicate that there are no locations which exceed the applicable VDV criteria for residential receivers of 0.26 ms$^{-1.75}$. As such the project is considered to comply with the transient vibration criteria. Consideration of vibration mitigation is not required.

4.4 Operational Noise from Traction Substations

A traction substation is an electrical substation which converts electricity from the main grid into appropriate voltage and current for use by the metro line. A traction substation powers the line based on demand, so as a train approaches, the load on the traction substation would increase, then decrease as the train passes. As such the noise generated by a traction substation increases and decreases based on the use of the line.

The actual noise experienced by nearby sensitive receivers is typically found to be mitigated by higher noise levels generated by the train itself. However when undertaking a noise assessment, noise generated by the substation and the operational line are considered separately so cannot be used to mask apparent impacts.

This assessment has assumed that the traction substation is operating at full load during the daytime, evening and night-time periods. This ensures a conservative assessment is undertaken.

Traction substations associated with the project are listed in **Table 114**.

Table 114 Traction Substations

Facility ID	Substation Name	Indicative Address
TS1	Dulwich traction substation	Randall Street, Marrickville
TS2	Canterbury traction substation	Hutton Street, Hurlstone Park
TS3	Campsie traction substation	Lilian Street, Campsie
TS4	Lakemba traction substation	The Boulevarde, Lakemba
TS5	Punchbowl traction substation	South Terrace, Bankstown

4.4.1 Noise Criteria

The Industrial Noise Policy (INP) sets two separate noise criteria to meet environmental noise objectives, one to account for intrusive noise and the other to protect the amenity of particular land uses. These criteria are to be met at the most-affected boundary of the receiver property. The more stringent of these two criteria usually defines the project specific noise levels. For both amenity and intrusiveness, night-time criteria are more stringent than daytime or evening criteria.

In addition to intrusiveness and amenity, the risk of sleep disturbance needs to be assessed. Sleep disturbance is assessed in accordance with the screening criterion described in the online Application Notes to the INP and the more detailed review of sleep disturbance contained in the Road Noise Policy (RNP).

4.4.1.1 Industrial Noise Policy Criteria for Intrusive Noise

To provide for protection against intrusive noise, the INP states that the L_{Aeq} noise level of the source, measured over a period of 15 minutes, should not be more than 5 dB above the background noise level (RBL), measured during the daytime, evening, and night-time periods. The intrusive criteria are determined from the measured RBLs in **Section 2.3** at sensitive receiver locations nearest to the facilities.

4.4.1.2 Industrial Noise Policy Criteria for Amenity

To provide protection against impacts on amenity, the INP specifies suitable maximum noise levels for particular land uses and activities during the daytime, evening and night-time periods. Due to the project's proximity to the exiting railway line, the existing residences in the vicinity of the stations and ancillary facilities are considered to be 'Urban'. According to the INP, an 'Urban' area is characterised by an acoustic environment dominated by 'urban hum' or industrial source noise, through traffic with characteristically heavy and continuous traffic flows during peak hours, located near commercial districts or industrial districts.

According to the INP, where existing transportation L_{Aeq} noise levels exceed the 'Acceptable' noise level by 10 dB or more, and the existing noise level is unlikely to decrease in future, the noise criteria should be taken to be the existing noise level minus 10 dB. This approach is also applicable to areas with high traffic noise.

The relevant INP external amenity noise criteria are presented in **Table 115**.

Table 115 Industrial Noise Policy Amenity Noise Levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50
Commercial	All	when in use	65	70
Active recreation area	All	when in use	55	60
Educational	All	when in use	45[1]	50[1]
Place of worship	All	when in use	50[1]	55[1]

Note 1: External levels, based on the internal levels specified in the INP plus 10 dB (assuming open windows).

Provided below is a summary of the noise criteria for each traction substation. The noise criteria have been based on background noise logger from a representative measurement location.

Table 116 Traction Substation Noise Criteria

Substation	Representative Noise Logger	Period	Measured Level, dBA		Noise Criteria, dBA		
			RBL	$L_{Aeq(period)}$	Intrusive	Amenity	Overall
TS1	B.03	Day	38	57	43	56	43
		Evening	39	57	43[1]	47	43
		Night	33	53	38	43	38
TS2	B.07	Day	40	53	45	60	45
		Evening	40	50	45	42	42
		Night	35	47	40	37	37
TS3	B.11	Day	44	59	49	54	49
		Evening	45	57	49	47	47
		Night	40	57	45	46	45
TS4	B.14	Day	47	65	52	55	52
		Evening	47	63	52	53	52
		Night	41	60	46	50	46
TS5	B.20	Day	47	65	52	55	52
		Evening	49	64	52	54	52
		Night	39	60	44	50	44

Note 1: For assessment purposes, the evening RBL is reduced to equal the lower daytime RBL in accordance with INP application notes.

4.4.2 Modifying Factor Adjustments

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other less-obtrusive noise sources at the same level. To account for this additional annoyance, the INP describes modifying factors to be applied when assessing amenity and intrusiveness. No modifying factors have been applied for the stations and ancillary facilities as it assumed that these noise sources would not exhibit these characteristics if designed and constructed in accordance with industry best practice procedures.

4.4.3 Tractions Substation Assessment

Provided below in **Table 117** is a summary of the nearest sensitive receiver, offset distance from the source to receiver, and the predicted noise level. Compliance at the closest sensitive receiver would ensure that all sensitive receivers comply with the applicable noise criteria.

Only the night-time criteria are provided below in **Table 117** for each location as the night-time is the most stringent period. For the purpose of this assessment, the noise generated by the substation is considered to be consistent across the entire period. Ensuring compliance with the night-time period would ensure compliance during all time periods.

Table 117 Traction Substation Most Affected Sensitive Receivers

Substation	Sensitive Receiver Address	Offset (m)	L_{Aeq} Noise Level, dBA	
			Night-time Criteria	Predicted
TS1	7 Randall Street, Marrickville	12	38	51
TS2	6 Hutton Street, Hurlstone Park	35	37	42
TS3	52 Lilian Street, Campsie	22	45	46
TS4	16 The Boulevarde, Lakemba	25	46	45
TS5	92 South Terrace, Bankstown	24	44	45

The predicted traction substation noise impacts identify that at four locations there is the potential to exceed the applicable noise criteria without mitigation.

4.4.4 Tractions Substation Mitigation

Noise levels from the Marrickville traction substation are predicted to exceed the night-time criteria by up to 13 dB. This exceedance of the night-time criteria is influenced by the location's proximity to the nearest sensitive receiver and the low night-time intrusive noise criteria. An exceedance of up to 5 dB is predicted from the Hurlstone Park substation. The remaining substations are either compliant with the criteria or have minor exceedances (up to 1 dB).

It is however considered that the substations at all locations can be readily designed to meet the noise goals by provision of shielding or an enclosure of the noise source, if necessary. Acoustic louvres should also be included in the design where ventilation is required and potentially affected receivers are nearby. With these noise mitigation measures included compliance with the applicable noise criteria can be achieved.

The highest exceedances are generated by TS1 due to the small offset distances. These noise levels can be reduced by locating noise emitting components further from sensitive receivers and erecting a noise barrier between the components and the affected sensitive receivers.

Specific noise mitigation measures would ultimately be confirmed during the detailed design of the project when more details about the equipment and layout are available. Cumulative noise impacts from fixed facilities are unlikely to be an issue due to the separation distances between the various fixed facilities. However, cumulative noise impacts should be assessed in the detailed design stage when selecting specific equipment locations and models for the facilities.

4.5 Operational Noise from Train Stations

The project would involve the upgrade of relevant train stations to accommodate the metro system. Stations emit noise from mechanical services and public address systems which need to comply with the applicable noise criteria. Operational noise from the metro system is assessed as part of the operational noise assessment in **Section 4.1**.

At this stage of the design mechanical plant and PA systems have not been selected, which means it is too early to prove compliance with the applicable noise criteria. However given the nature of the sources they can be easily mitigated during the detailed phase of the project through the selection of appropriate equipment. The applicable criteria for operational noise from train stations are shown in **Table 118**.

Given that the required information will not be available until the detailed design phase of the project, this assessment is limited to setting the applicable noise criteria. Compliance with the criteria would need to be proven at the detailed design phase of the project and form part of the detailed design documentation.

Cumulative noise impacts from fixed facilities are unlikely to be an issue due to the separation distances between the various fixed facilities. However, cumulative noise impacts should be assessed in the detailed design stage when selecting specific equipment locations and models for the facilities.

Table 118 Train Station Noise Criteria

Station	Representative Noise Logger	Period	Measured Level, dBA		Noise Criteria, dBA		
			RBL	$L_{Aeq,period}$	Intrusive	Amenity	Overall
Marrickville	B.02	Day	38	59	42	54	42
		Evening	38	58	42	48	42
		Night	33	51	38	41	38
Dulwich Hill	B.04	Day	41	54	46	58	46
		Evening	41	55	46	45	45
		Night	34	50	39	40	39
Hurlstone Park	B.06	Day	38	56	43	58	43
		Evening	39	53	43	43	43
		Night	34	49	39	39	39
Canterbury	B.08	Day	43	56	48	58	48
		Evening	43	53	48	43	43
		Night	36	49	41	39	39
Campsie	B.10	Day	45	55	50	58	50
		Evening	42	55	47	45	45
		Night	35	54	40	44	40
Belmore	B.13	Day	41	53	46	60	46
		Evening	41	49	46	44	44
		Night	36	46	41	37	37

Station	Representative Noise Logger	Period	Measured Level, dBA		Noise Criteria, dBA		
			RBL	$L_{Aeq,period}$	Intrusive	Amenity	Overall
Lakemba	B.15	Day	50	63	55	53	53
		Evening	50	64	55	53	53
		Night	43	63	48	53	48
Wiley Park	B.17	Day	44	52	49	60	49
		Evening	46	51	49	42	42
		Night	41	49	46	39	39
Punchbowl	B.19	Day	47	57	52	56	52
		Evening	47	54	52	44	44
		Night	41	53	46	43	43
Bankstown	B.22	Day	54	64	59	55	55
		Evening	51	63	56	53	53
		Night	42	60	47	50	47

5 SUMMARY OF IMPACTS AND RECOMMENDED MITIGATION

5.1 Construction Noise and Vibration

5.1.1 Construction Noise

Relatively high construction noise levels are predicted from the construction works in most catchments along the alignment. Noise levels are typically higher for front row receivers which have line of sight to the works, and where worksites are situated in close proximity to receivers. Where works are required in close vicinity of receivers, the assessment has identified the worst-case construction noise levels are likely to exceed 75 dBA during noise intensive activities.

During standard daytime construction hours, the highest impacts are generally predicted to be at receivers which are adjacent to worksites. Receivers which are further back from the works would have lower predicted noise levels and correspondingly lower Noise Management Level (NML) exceedances.

For out of hours works, the impacts are predicted to be more widely spread throughout the study area. This results from lower NMLs for residential receivers during these periods (especially the night-time period) compared to the daytime. Works activities that use noise intensive plant items (eg rockbreaker, diamond saw, and ballast tamper) during out of hours periods are predicted to result in construction noise levels being well above NMLs for many receivers surrounding the works.

In acknowledgement of the community's increased sensitivity to noise during the night-time period, the use of highly noise intensive rockbreaker plant would be restricted to standard daytime construction hours of 7 am to 6 pm (with occasional works being required in the evening between 6 pm to 10 pm). There may however be occasional circumstances where unforeseen site conditions are encountered which may require limited use of rockbreakers during night-time works. This would however be expected to happen infrequently. Additionally, at no location would rockbreakers be used for more than two weeks total duration in one area.

Works activities that use noise intensive ballast tamper plant during the night-time are predicted to result in construction noise levels above NML for many receivers surrounding the works. The assessment has shown that removing this noise intensive plant during the night-time provides a large benefit in reducing the predicted night-time noise levels and similarly reduces the extent and magnitude of the NML exceedances. Accordingly, it is recommended the use of noise intensive ballast tamper plant be restricted to daytime and evening periods (ie 7 am to 10 pm), except if unforeseen site conditions are encountered which require occasional night-time use of these plant items.

Additional noise mitigation measures to be explored in the CNVMPs have been recommended with reference to the TfNSW *Construction Noise Strategy* (CNS). Additional mitigation measures have been determined for works during standard daytime construction hours and for works at night-time during possessions/closedowns.

5.1.2 Construction Vibration

The separation distance(s) between the construction works and the nearest sensitive receivers would generally be sufficient so that nearby buildings are unlikely to suffer 'cosmetic damage' vibration impacts for most of the proposed construction equipment. However, based on the arrangement of the work zones, some items of construction equipment have the potential to be operated closer to sensitive receivers than the recommended minimum working distances.

During surface works, up to 360 buildings (including stations) in the vicinity of the works may be within the screening criteria should a large rockbreaker be used at the outer extents of each works area. In practice, it is unlikely that a rockbreaker would be required at all areas and therefore the vibration impacts presented in this assessment should be considered a worst-case.

5.1.3 Construction Road Traffic Noise

Temporary additional road traffic noise along the construction traffic routes and temporary transport vehicle routes has been assessed based on the construction vehicle and two Temporary Transport Management Plan (TTMP) scenario vehicle movements.

The assessment indicates that construction road traffic and TTMP scenario road traffic is predicted to result in an increase in road traffic noise levels of less than 2 dB on the majority of roads along the construction and TTMP routes.

Construction road traffic is however predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on eight roads. Similarly, TTMP scenario road traffic is predicted to increase existing traffic noise levels by greater than 2 dB and result in road traffic noise levels that exceed the base criteria on six and three roads for the Baseline TTMP and Refined Baseline TTMP scenarios, respectively.

Noticeable noise level increases from cumulative traffic impacts (from construction road traffic and Refined Baseline TTMP road traffic) are predicted on 10 road sections.

5.2 Operational Noise and Vibration

5.2.1 Operational Airborne Noise - Rail Operations

Airborne noise from operation of the project has been assessed at the project opening in 2024 and for future operations in 2034. The assessment has determined that noise levels at the majority of residential and other noise sensitive receptors would comply with the noise trigger levels from the RING.

The noise trigger levels are predicted to be exceeded at up to 99 and 121 sensitive receiver buildings for the 2024 or 2034 scenarios respectively.

Feasible and reasonable noise mitigation measures for the project have been investigated and the recommended mitigation strategy includes a combination of conventional noise barriers and at property treatments as summarised in **Table 119**.

Table 119 Recommended Potentially Reasonable and Feasible Noise Mitigation Options

NCA	Side	Mitigation	Description
NCA01	Down	At property treatments	One building
NCA04	Down	At property treatments	One building
NCA05 and NCA06	Down	2m high conventional noise barrier.	CNB-NCA07-01
	Up	2m high conventional noise barrier.	CNB-NCA07-02
NCA06	Down	At property treatments	Two buildings
	Up	At property treatments	One building
NCA07	Down	At property treatments	Two buildings
	Up	2m high conventional noise barrier.	CNB-NCA09-01
		At property treatments	One buildings
	Down	Residual impacts	Outdoor active recreation area
NCA008	Down	At property treatments	One building
	Up	At property treatments	One building
NCA09	Down	4m high conventional noise barrier.	CNB-NCA11-01
	Up	At property treatments	One building
NCA09 and	Down	3m high conventional noise barrier.	CNB-NCA11-01

NCA	Side	Mitigation	Description
NCA10	Up	2m high conventional noise barrier.	CNB-NCA11-02
NCA10	Up	2m - 4m high conventional noise barrier.	CNB-NCA11-01
	Down	At property treatments	Four buildings
	Down	At property treatments	One building
NCA11	Down	3m high conventional noise barrier.	CNB-NCA13-01
	Up	2m-4m high conventional noise barrier.	CNB-NCA13-02
	Up	Property Treatments	Residential building

The feasibility of these options requires further investigation of issues including detailed cost effectiveness assessment, constructability, visual impact, overshadowing, ecological impact, impact on maintenance and safety requirements, etc.

The final form of the proposed mitigation measures would however be determined during detailed design.

5.2.2 Operational Ground-borne Vibration - Rail Operations

Compliance with the ground-borne vibration objectives is predicted for all residential receivers and other sensitive receiver locations above or near to the proposed project alignment.

5.2.3 Operational Airborne Noise from Stations and Ancillary Facilities

A number of the traction substations have been found to result in exceedances at the nearest receivers. It is however considered that the substations at all locations can be readily designed to meet the noise goals by provision of shielding or an enclosure of the noise source, if necessary. Acoustic louvres should also be included in the design where ventilation is required and potentially affected receivers are nearby. With these noise mitigation measures included compliance with the applicable noise criteria can be achieved.

At this stage of the design, mechanical plant and PA systems for the train stations have not been selected, and as a consequence the assessment has been limited to determination of applicable noise criteria. Compliance with the criteria should be assessed at the detailed design phase of the project to confirm any mitigation requirements.

6 REFERENCES

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