NORTHWEST RAPID TRANSIT

PROJECT INTEGRATED MANAGEMENT SYSTEM

CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

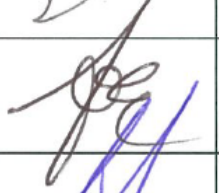
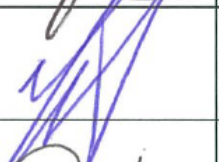
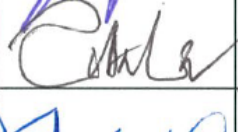
FOR

SYDNEY METRO NORTHWEST OPERATIONS, TRAINS and SYSTEMS PPP

DOCUMENT NUMBER:	NWRLOTS-NRT-PRD-PM-PLN-000858
NRT-PIMS NUMBER:	PIMS-SP-17/03
REVISION:	06
CONTROL STATUS:	Unmaintained unless stated otherwise

Construction Noise and Vibration Management Plan Approval Records

Approval Record

FUNCTION	POSITION	NAME	SIGNATURE	DATE
Reviewed by	Environment Manager	Peter Monsted		12.11.18
Reviewed by	Infrastructure Director	David Jackson		12/11/18
Reviewed by	Trains & Systems Director	Roger Ho PP		18/11/18
Reviewed by	D&D Director	Malachy Breslin		PP 16/11/18
Reviewed by	MTS CEO	Ivan Lai		16/11/18
Approved by	NRT CEO	Mark Elliott		29/11/18

Amendment Record

Changes made to this document since its last revision, which affect its scope or sense, are marked in the right margin by a vertical bar (|).

DATE	REV	AMENDMENT DESCRIPTION	BY	INITIALS
29/10/2015	03	Updated following TfNSW & IC informal comments	Cameron Newling	CN
08/03/2016	03.01	Updated to include Norwest Pedestrian Link works and 33kV Underground Feeder Powerline works	Alex Bamford Cameron Newling	AB CN
04/08/2016	03.02	Updated following TfNSW comments	Cameron Newling	CN
19/12/2016	04	Yearly update	Cameron Newling	CN
25/08/2017	05	Review and update as part of annual recertification	Cameron Newling	CN
06/11/2018	06	Yearly update and address MEO's	Peter Monsted	PM

Certification Record

DATE	REV	AMENDMENT DESCRIPTION	BY	INITIALS
10/07/2015	00	NWRLOTS-OIC-1NL-PM-CER-000024	OIC	OIC
07/10/2016	01	NWRLOTS-OIC-1NL-PM-CER-000039	OIC	OIC
02/03/2016	03	NWRLOTS-OIC-1NL-PM-CER-000065	OIC	OIC
13/02/2017	04	NWRLOTS-OIC-1NL-PM-CER-000122	OIC	OIC
15/11/2017	05	NWRLOTS-OIC-1NL-PM-CER-000151	OIC	OIC

Table of Contents

Table of Tables

Table of Figures

1 Introduction

This *Construction Noise and Vibration Management Plan* (*CNVMP*) outlines the construction environmental management arrangements by which Northwest Rapid Transit (NRT), in partnership with Transport for NSW (TfNSW), is delivering the Operations, Trains and Systems (OTS) Public Private Partnership (PPP) component of the Northwest Rail Link (NWRL) Project, now renamed as 'Sydney Metro Northwest'.

Note: In June 2015, TfNSW changed the project's name to Sydney Metro Northwest (from the North West Rail Link) to reflect its role in Sydney's new railway network. Any references to the North West Rail Link in this plan can be assumed to be referring to the Sydney Metro Northwest. Similarly, the Rapid Transit Rail Facility (RTRF) is now known as the Sydney Metro Trains Facility (SMTF).

1.1 OTS PPP

Sydney Metro is Australia's largest public transport project. Sydney Metro Northwest, formerly known as the North West Rail Link, is the first stage of Sydney's new fully-automated metro system and will open to customers in the first half of 2019.

Stage 2, Sydney Metro City & Southwest, will extend metro rail under Sydney Harbour, through the CBD and southwest to Bankstown.

The $8.3 billion Sydney Metro Northwest will deliver eight new railway stations and 4,000 commuter car parking spaces to Sydney's growing North West. Services will start with a train every four minutes in the peak. The project also includes the upgrade and conversion of five existing railway stations to metro standards.

The OTS contract is a 15-year PPP project – the largest in the history of New South Wales as well as the largest of the three delivery contracts for Sydney Metro Northwest.

Northwest Rapid Transit is delivering Sydney's new generation metro trains; building the new stations and car parks; installing tracks, signalling, mechanical and electrical systems; building and operating the RTRF at Tallawong Road; upgrading and converting the railway between Epping to Chatswood to rapid transit standards; and operating Sydney Metro Northwest – including all maintenance work.

1.2 Purpose and Application

This Construction Noise and Vibration Management Plan (CNVMP) describes how the NRT Consortium will manage obligations and performance with regard to the construction noise and vibration during the design and delivery of the Phase 1, ECRL Conversion, Phase 2, Norwest Pedestrian Link, 33kV Underground Feeder Powerline Works and Rouse Hill Temporary Bypass Powerline Works of the OTS Contract for the NWRL Project.

The OTS Phase 1 covers the works associated with the delivery of the RTRF and the Cudgegong Road Precinct Enabling Works, being the works west of Cudgegong Road and including the initial earth works in the vicinity of Cudgegong Road Station – see Figure 1 below.

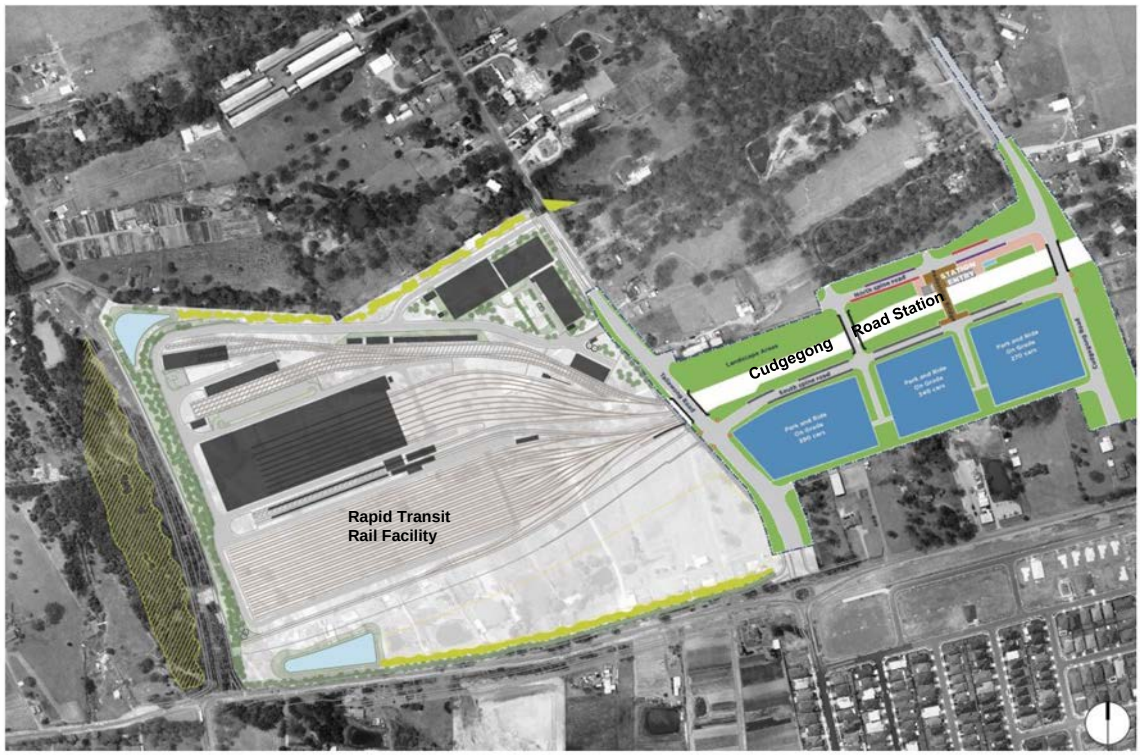


Figure 1 Indicative NWRL OTS Phase 1 Site: RTRF and Cudgegong Road Station

ECRL Conversion works refer to the conversion of the existing Epping to Chatswood Rail Line to rapid transit. See Figure 2 below.

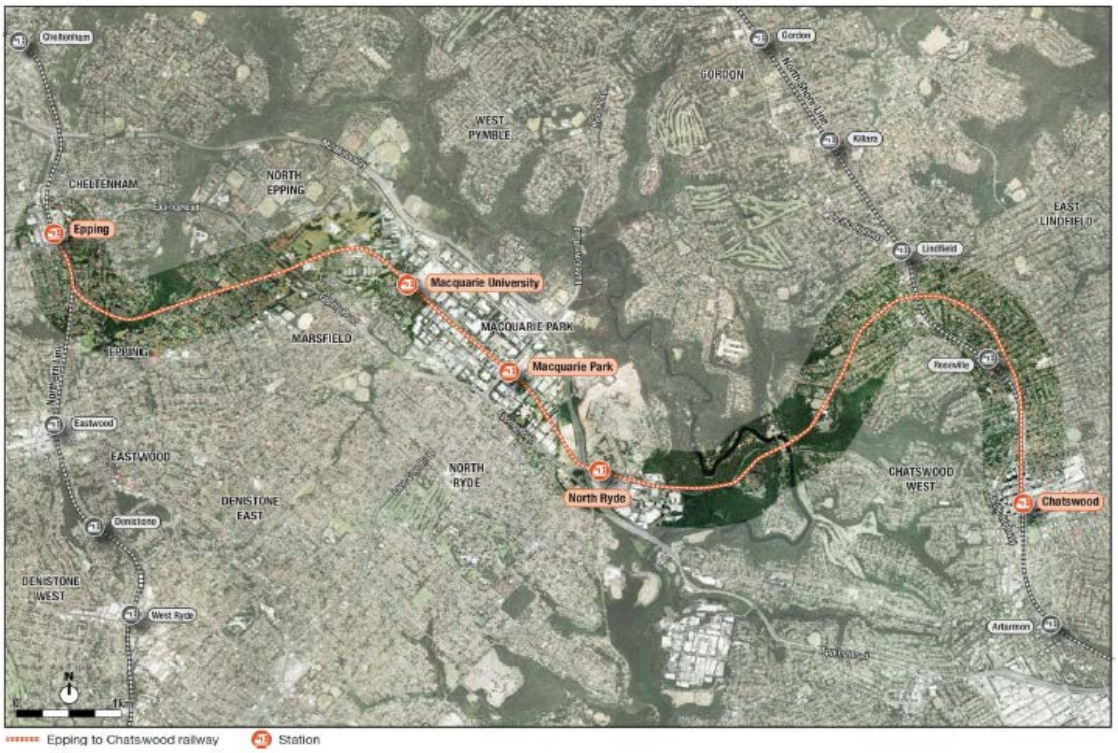


Figure 2 Indicative ERCL Conversion Work Areas

The OTS Phase 2 covers the works associated with the delivery of the Sydney Metro Northwest, following completion of the tunnelling works, between Epping and Cudgegong Road Station. The works include station and fixed facility construction, fit-out and precinct works; tunnel systems, at-grade and viaduct fitout; testing and commissioning – see Figure 1 below.

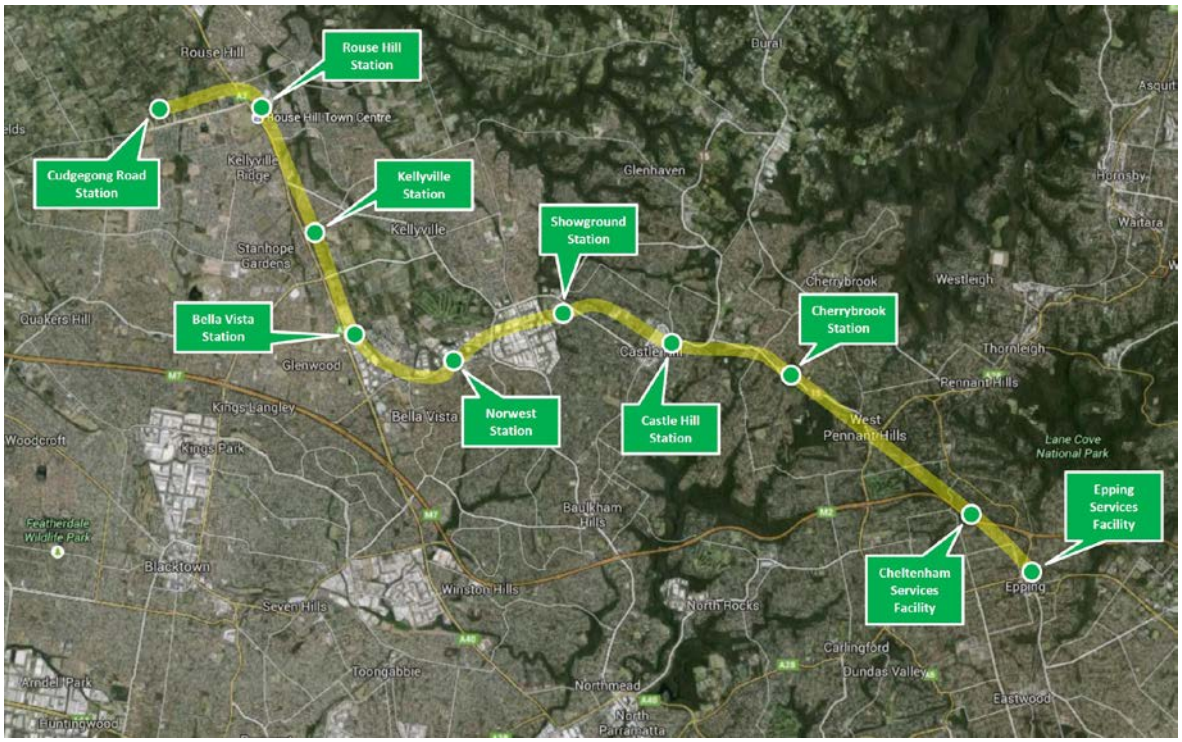


Figure 3 Indicative NWRL OTS Phase 2 Works Areas

Norwest Pedestrian Link works refer to the installation of an underground pedestrian link and second station entry on the northern side of Norwest Boulevard at Norwest Station. See Figure 4.

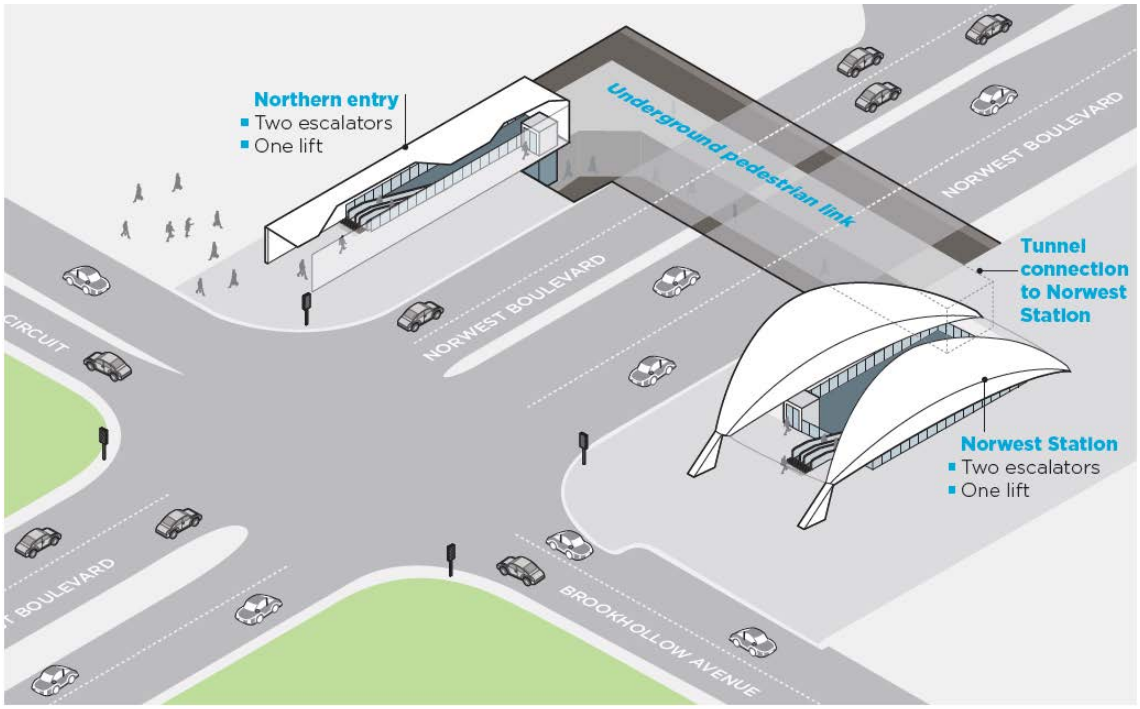


Figure 4 Artist Impression of the Norwest Pedestrian Link

The 33kV Underground Feeder Powerline works refer to the building and maintaining a new five kilometre 33kV feeder power line between Ausgrid's Willoughby Sub transmission Substation and the TfNSW Chatswood North Traction Substation. The proposal is required to provide dedicated, independent 33kV connection in order to meet the reliable supply of electricity requirements for this project. See Figure 5.

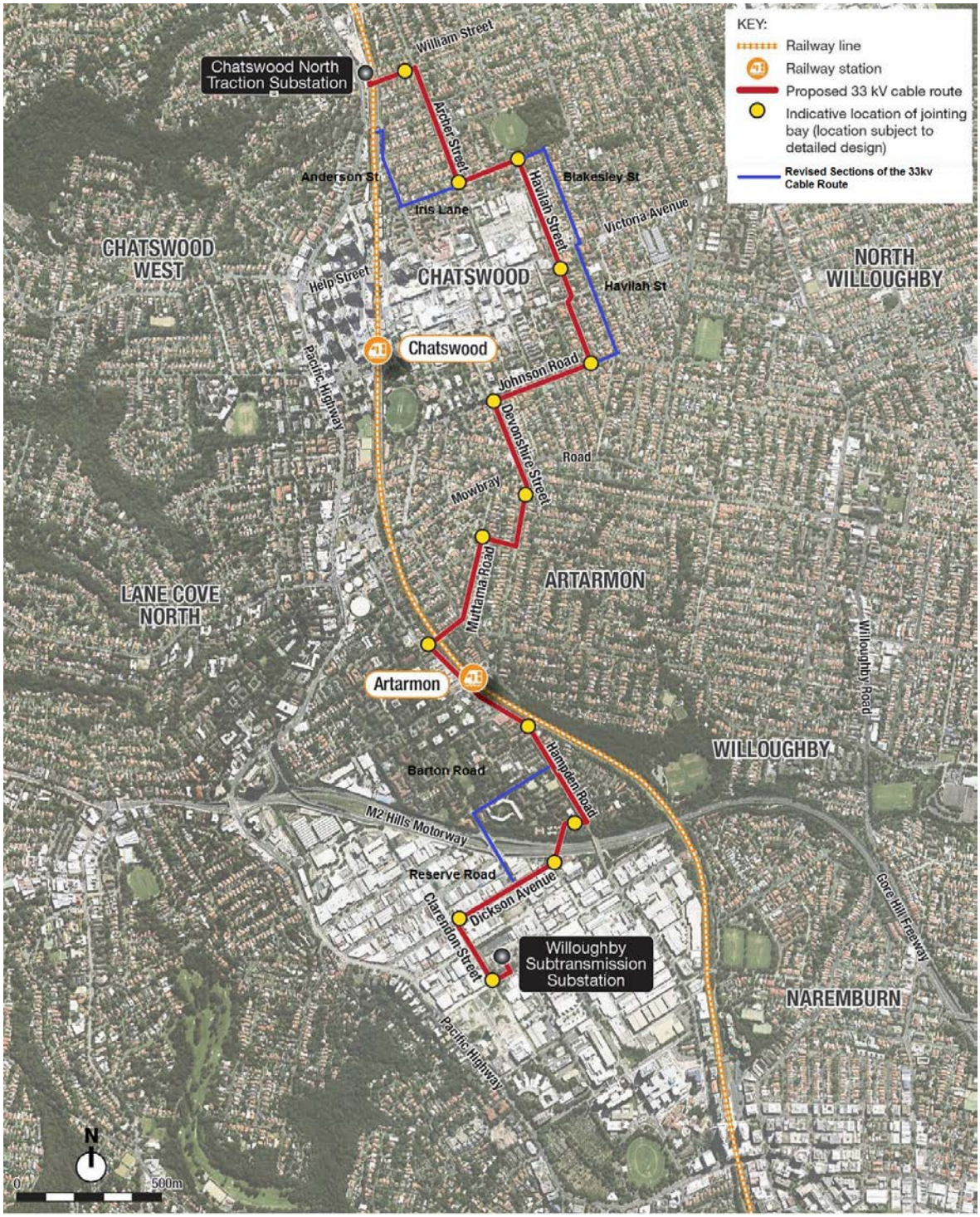


Figure 5 Overview of the 33kV Underground Feeder Powerline Route

The Rouse Temporary Bypass Powerline involves the construction of a temporary powerline from the southern side of the Sydney Metro Windsor Road Bridge crossing Schofields Road, running underground through Castlebrook Memorial Park transitioning back to overhead and crossing Windsor Road to the Rouse Hill traction substation located south of Sanctuary Drive. The purpose of the temporary powerline is to enable energisation and commissioning of the rail systems associated with the construction of Sydney Metro Northwest. See Figure 6 below.

Figure 6 Rouse Hill Temporary Bypass Power Work Area

The NVMP is a sub plan of the Phase 1, ECRL Conversion, Phase 2, Norwest Pedestrian Link and 33kV Underground Feeder Powerline CEMP and has a direct relationship with the Delivery Stage Sustainability Management Plan. The relationship of this plan to other NRT OTS Works Plans is described in detail in Section 1.4.

This Sub Plan:

- Describes the strategies that will:
  - Minimise construction noise and vibration
  - Manage works in line with achieving the construction noise management levels in the Interim Construction Noise Guideline (ICNG) and the North West Rail Link Construction Noise and Vibration Strategy (TfNSW 2012)
  - Set requirements for managing construction hours, high impact activities that generate impulsive or tonal noise and requirements for undertaking out of hours works
  - Outline the management of noise and vibration from works carried out outside of standard construction hours and the likely mitigation measures that will be required to reduce the potential impacts
  - Minimise noise generated and any potential adverse impacts as a result of construction activities
  - Minimise vibration loads and any potential adverse impacts as a result of construction activities
  - Implement proactive measures to mitigate impacts at the source, path and receptor to minimise complaints from sensitive receivers
  - Outline community consultation requirements regarding noise emissions.

- Manage potential noise and vibration issues so they are identified and controlled to meet legislative requirements.
- Provide processes for the implementation of strategies relating to noise and vibration mitigation and management at all levels.

1.3 Scope and Objectives

This *CNVMP* addresses the following requirements:

- OTS Project Deed, Operations, Trains and Systems, Exhibit 1, Scope and Performance Requirements, Appendix 54 – Project Plan Requirements, Section 3.17
- OTS Project Deed, Operations, Trains and Systems, Exhibit 1, Scope and Performance Requirements (SPR) App 50 Section 2.6
- Project Planning Approval – Rapid Transit Rail Facility (ref SSI-5931) – All Conditions applicable to Phase 1 NWRL OTS works.
- Project Planning Approval (and Modification 20 May 14) – NWRL Stage 2 – Stations, Rail Infrastructure & Systems (SSI-5414) – applicable to Phase 1 and Phase 2 NWRL OTS works, as defined in Staging Report
- ECRL Conversion Determination Report Conditions of Approval
- Applicable Revised Environmental Mitigation Measures from Project EISs:
    - Environmental Impact Statement 2 (EIS2) and Submissions Report (including – NWRL Stage 2 Stations, Rail Infrastructure and Systems (2012/3)
    - Environmental Impact Statement and Submissions Report – Tallawong Road, Rouse Hill Rapid Transit Rail Facility (JBA 2013)
- ECRL Conversion Review of Environmental Factors (Parsons Brinckerhoff, 10 October 2014) and Submissions Report (Parsons Brinckerhoff, 5 February 2015)
- Norwest Pedestrian Link Review of Environmental Factors (Parsons Brinkerhoff 4 June 2015) and Submissions Report (Parsons Brinkerhoff, 1 October 2015)
- Norwest Pedestrian Link Determination Report Conditions of Approval
- Willoughby to North Chatswood 33kV Underground Feeder Powerline Review of Environmental Factors (Parsons Brinkerhoff 20 October 2015) and Submissions Report (Parsons Brinkerhoff 9 March 2016)
- 33kV Underground Feeder Powerline Determination Report Conditions of Approval
- Rouse Hill Temporary Bypass Powerline Environmental Impact Assessment (EIA)
- NWRL Construction Environmental Management Framework (Rev 1.4)
- Applicable Legislative Obligations.

The Compliance Matrix in Annexure A details how the *CNVMP* complies with the requirements of the applicable CoAs requiring the Plan to be prepared, consulted and approved. Additional detail on compliance management is also contained in Section 2.2.

The noise and vibration objectives described in the NWRL Construction Environmental Management Framework apply to the design and delivery of OTS Works.

The following noise and vibration objectives will apply to the construction of the project:

- All works and activities would be undertaken in a manner that will minimise noise and vibration impacts on sensitive receivers
- Minimise unreasonable noise and vibration impacts on residents and businesses.
- Avoid structural damage to buildings or heritage items as a result of construction vibration.
- Undertake active community consultation.
- Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.
- Ensure compliance with relevant Conditions of Approval and the Environment Protection licence.

These objectives conform to TfNSW's objectives as described in the NWRL Construction Environmental Management Framework.

1.4 NRT Environmental Management System

In accordance with the OTS Project Deed, Exhibit 1, Scope and Performance Requirements, Section 5.2, NRT must implement and maintain an effective Management System, which addresses all its obligations under the Deed.

The Management Systems must seamlessly integrate all NRT's systems and processes, including those related to rail safety and rail accreditation quality, environmental, sustainability, health and safety and they must accommodate, coordinate and give effect to the Project Plans.

Details of NRT's Integrated Management System including the integrated relationship of the *CNVMP* with the other Project Plans and with the delivery Core Processes are contained in the Project Management Plan. As improvements are made to the processes and systems, these will be reflected in updates to the relevant Project Plans. All elements of the Integrated Management System will reside on Aconex as controlled copies. An intranet will contain a front page to the Integrated Management System with links between documents, processes and forms utilising the Aconex search engine.

1.5 Approval Before Submission

The *CNVMP* and future updates are to be approved by NRT's CEO before being submitted to TfNSW.

1.6 Certification by Independent Certifier

This updated *CNVMP* and any future update is to be submitted, in accordance with the provisions of clause 8 [LINK] of the Deed, to TfNSW for comment and to the OTS Independent Certifier for certification prior to its implementation by NRT.

1.7 Update and Ongoing Development

The *CNVMP* is incorporated as Appendix 76 of the Deed.

The *CNVMP* will be updated regularly in accordance with the requirements of the *Deed,* clause 8 and annually as required in *Exhibit 1, Scope and Performance Requirements, Appendix 54 – Project Plan Requirements, Table 1.*

NRT will undertake the ongoing development, amendment and updating of the *CNVMP* to ensure it remains consistent with Project priorities, risk management, client requirements and Project objectives, taking into account:

- The status and progress of NRT's activities
- Changes in the design, delivery and operations processes and conditions
- Lessons learnt during delivery and operations
- Changes in other related Project Plans
- Requirements and matters not covered by the existing Project Plans
- Changes to Plans resulting from any comments from the OTS Independent Certifier
- Changes to Project Plans as directed by TfNSW's Representative under the Deed
- Where construction noise is predicted to exceed NML and additional mitigation measures are required
- In response to noise and vibration impacts/complaints.

1.8 Agency and Stakeholder Consultation

The *CNVMP* requires statutory consultation with the EPA. See Annexure E.

Consultation would also be completed for the following:

- Potentially-affected community, religious and educational institutions;
- Proponents of other construction works in the vicinity of the SSI.

Updates to this plan for works approved under Part 5 of the EP&A does not require any further consultation.

2 Legal and Other Requirements

2.1 Relevant Legislation

The key legislation relevant to noise and vibration management includes:

- Environmental Planning and Assessment Act 1979
- *Protection of the Environment Operations Act 1997* (POEO Act)

Refer to the Construction Environmental Management Plan for further details.

The Environment Protection Licence (EPL) No. 20544 issued under the POEO Act for the OTS Works includes a number of conditions relevant to noise and vibration mitigation and management, which may be varied during construction. Under the POEO Act noise includes noise and vibration. Noise pollution means the emission of offensive noise. Offensive noise is defined as noise:

> (a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
>
> > (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
> >
> > (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or
>
> (b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

2.2 Compliance Requirements

Relevant planning requirements from the Conditions of Approval are summarised in the Compliance Matrix in Annexure A of this document.

Additional Noise and vibration management requirements from the Project Deed, Project Approval and Revised Environmental Mitigation Measures are included in Annexure A.

All compliance requirements associated with this Sub Plan including the Revised Environmental Management and Mitigation Measures from the NWRL Project Environmental Impact Assessments, ECRL Determination Report and Submissions Report, Norwest Pedestrian Link Review of Environmental Factors, Submissions and Determination Report and the Willoughby to North Chatswood 33kV Underground Feeder Powerline Review of Environmental Factors, Submissions and Determination Report that are pertinent to this sub plan are tracked and reported via the OTS compliance tracking program developed in accordance with CoA D5((a)-(h)).

In addition, the OTS PPP will comply with an Environment Protection Licence (EPL) for Rail Systems Activities as defined under Clause 33 of Schedule 1 of the *Protection of the Environment Operations Act 1997*.

2.3 Relevant Guidelines

Additional guidelines and standards relating to the management of noise and vibration include:

- NSW Assessing Vibration: a technical guideline (DECCW, 2006),
- NSW Interim Construction Noise Guideline (DECC, 2009),
- North West Rail Link Construction Noise and Vibration Strategy (TfNSW 2012);
- NSW Industrial Noise Policy (EPA, 2000),
- Interim Guideline for the Assessment of Noise from Rail Infrastructure, Projects (DECC, 2007),
- NSW Road Noise Policy (DECCW, 2011),
- AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites,
- AS 1055.1: 1997 Description and Measurement of Environmental Noise - General Procedures,
- German Standard DIN4150-1999 Structural vibration Part 3: Effects of vibration on Structures, and
- British Standard BS7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration.

2.3.1 Construction Noise and Vibration Strategy

A Construction Noise and Vibration Strategy (CNVS) has been developed as part of EIS 1, EIS 2 and the RTRF EIS. The CNVS documents the best-practice techniques specific to the NWRL Project for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures, including additional mitigation and management measures when construction noise is predicted to exceed the NMLs. Such measures include noise monitoring, individual briefings, respite offers and in some instances at night alternative accommodation.

The CNVS will be adopted by the OTS-PPP to manage construction noise and vibration across the Project.

2.4 Key NRT Personnel

The roles and responsibilities of key NRT Personnel with respect to noise and vibration are as follows:

Table 1 Roles and Responsibilities

Project Director	Managing the delivery of the NRT Works including overseeing implementation of noise and vibration management Act as Contractor's Representative
Environment Manager (EM)	Oversee the implementation of all noise and vibration management initiatives

	Responsible for managing ongoing compliance with the CoA and environmental document requirements. Additionally, coordination of noise and vibration requirements for EPL applications and management of Variations to EPL..
Commercial Manager	Ensure that relevant noise and vibration management obligations are addressed in procuring materials and services.
Construction Managers Site Superintendent	Manage the delivery of the construction process, in relation to noise and vibration management across all sites in conjunction with the Environment Manager
Sustainability Manager	Oversee tracking and reporting of noise and vibration against sustainability targets.
Environment Coordinator	Oversee implementation of noise and vibration management procedures on site Ongoing assessment of major site and works in CNVIS, to ensure the adequacy of the noise and vibration mitigation measures for the actual design and construction methods.
Project Engineer	Implement noise and vibration management activities during construction works
Specialist Noise and Vibration Consultant	Specialist consultants will be engaged to undertake investigations, modelling, and specialised monitoring.
Stakeholder & Community Relations Manager	Manage notification and consultation in relation to noise and vibration and liaise with the Environment and Sustainability Manager regarding the management of noise and vibration complaints. Undertaking activities required to consult, notify and deal with enquiries/complaints of Residential, Business and other Stakeholders

2.4.1 Noise and Vibration Specialists

A specialist noise and vibration consultant has been engaged to prepare this Plan. During delivery, a specialist noise and vibration consultant will continue to provide specialist advice and services in the development and implementation of this Plan to ensure that impacts can be avoided, minimised or appropriately mitigated including:

- Preparation of Construction Noise and Vibration Impact Statements
- Undertake some noise and vibration monitoring
- Assist with stakeholder meetings, where required
- Assist in community consultation, where required.

3 Aspects and Impacts

3.1 Indicative Construction Program and Activities

Section 2.2 of the CEMP provides an overview of construction activities and the indicative timing for each for Phase 1, ECRL Conversion Phase 2, Norwest Pedestrian Link and 33kV Underground Feeder Powerline works, and also displayed in Table 2.

For each worksite, a CNVIS will be prepared will detail the noise and vibration impacts associated with the construction activities, and the associated plant and equipment.

Table 2 Indicative Construction Program

Activity	Details	Timeframes (indicative)
Phase 1		
RTRF Construction	Site Establishment	January 2015 – February 2015
	Clear and grubbing Bulk Earthworks Demolition of existing buildings	February 2015 – August 2015
	Piling works and service installation Installation of pile caps and beams Construction of retaining walls Building construction – substructure, yard structural filling, in ground services, capping layers	August 2015 – March 2016
	Ballasted track install Tamping and track alignment OHW install	March 2016 – August 2016
	Internal road construction Landscaping Building Fit out and commissioning	August 2016 – December 2108
Cudgegong Road Enabling Works	Fill at site laydown area Set up Site Facilities Clear, grub and cut to fill from Cudgegong Road footprint Construct temporary retaining wall at Cudgegong Road to enable excavation of full extent of Cudgegong Road station platform Utilities work on both Cudgegong and Tallawong Roads Construct Precinct roads to base course layer for access	February 2015 – July 2015

Activity	Details	Timeframes (indicative)
	Close Tallawong Road and detour via Cudgegong Road	
	Commence piling of retaining walls on up & down sides of the formation Construction of drainage Construct track slab / formation and platform foundation through the station and platform precast units and platform slab Construct the overbridge and concourse abutments, including piling	July 2015 – November 2015
ECRL Conversion Works		
Site Inspections CSR Works Chiller Units Stub Tunnel Works	Install trays Construct ventilation building extensions Preparation of stub tunnel works, core holing, saw cutting	Possession 2 – November 2015
Site Inspections CSR Works Ventilation Works Stub Tunnel Works	Install Combined Services Route (CSR) trays/conduits HV cable haul Cable joining and local testing of HV cables Spot cooling and ventilation retrofitting works of Epping, Macquarie Uni, Macquarie Park and North Ryde Station Excavation of stub tunnel slab	Possession 3 – April 2016
CSR Works Ventilation Works Platform Works Stub Tunnel Works	Spot cooling and ventilation retrofitting works of Epping, Macquarie Uni, Macquarie Park and North Ryde Station. Install Combined Services Route (CSR) trays/conduits HV cable haul Cable joining and local testing of HV cable Continue excavation of Epping existing stub tunnel slab Remove pavers, saw cut rebate and install temporary threshold for PSDs at Macquarie Park Station Install GST route at Chatswood Continue excavation of Epping existing stub tunnel slab	Possession 4 – July 2016
Stub Tunnel Works	TSC works complete. Continued excavation of Epping existing stub tunnel slab	August to December 2016
CSR Works Ventilation Works Platform Works Stub Tunnel Works	Spot cooling and ventilation retrofitting works of Epping Station, Macquarie Uni, Macquarie Park and North Ryde Station. Install Combined Services Route (CSR) trays/conduits HV cable haul Cable joining and local testing of HV cable	Possession 5 – August 2016 Possession 6 – December 2016

Activity	Details	Timeframes (indicative)
	Excavation of Epping existing stub tunnel slab Remove stub tunnel bulkhead on Up Shore and excavate ground (TSC handover of tunnels 13.08.16) Remove pavers, saw cut rebate and install temporary threshold for PSDs at Epping Station and Macquarie Station	
CSR Works Platform works	Install Combined Services Route (CSR) trays/conduits HV cable haul Cable joining and local testing of HV cable Remove pavers, saw cut rebate and install temporary threshold for PSDs at Chatswood Station	Possession 7 – April 2017
CSR Works Stub Tunnel Works	Install Combined Services Route (CSR) trays/conduits HV cable haul Cable joining and local testing of HV cable Form, reo and pour new concrete slab and retaining wall	Possession 8 – July 2017
CSR Works	HV cable haul Cable joining and local testing of HV cable	Possession 9 – November 2017
CSR Works Track Works	Saw cutting of existing Epping Up track slab in preparation for new turnout. Reinstate track upon completion. Cable joining and local testing of HV cable Fencing Works	Possession 10 – February 2018 Possession 11 – March 2018 Possession 12 – June 2018 Possession 13 – August 2018
Track works OHW Works Electrical Works Platform works	ECRL Shutdown Remove turnouts Track reconditioning works Substation modifications Install new fire protection system Install PSDs Install new OHW	October 2018 – March 2019
Phase 2		
Construction of Stations and Precincts	Rouse Hill and Kellyville: • Station construction • Viaduct launch/support • Station construction and fit-out • Station precinct works	October 2016 – December 2017
	Bella Vista:	January 2016 – May 2018

Activity	Details	Timeframes (indicative)
	• Station construction • General civil works • Station construction and fit-out • Station precinct works	
	Norwest: • Station construction • Station construction and fit-out • Station precinct works	January 2016 – October 2017
	Showground and Castle Hill: • Station construction • Station construction and fit-out • Station precinct works	January 2016 – September 2018
	Cherrybrook: • Station construction • Station construction and fit-out • Station precinct works	August 2016 – April 2018
	Cheltenham Service Facility and Epping Service Facility: • Services facility construction	August 2016 – July 2017
Rail Systems	At Grade and Viaduct: • General civil works • At-grade surface and viaduct systems fit-out	December 2015 – December 2017
	Tunnel: • Tunnel systems fit-out	July 2016 – August 2018
Testing and Commissioning	All areas	October 2017 – March 2019
Norwest Pedestrian Link Works		
Norwest Pedestrian Link Works	Site establishment Earthwork and excavation Civil and building work Fit out and furnishing Pre-commissioning and commissioning Post work tie-ins, treatments and vegetation planting Demobilisation	June 2016 – October 2018
33kV Underground Feeder Powerline Installation		

Activity	Details	Timeframes (indicative)
Route Construction	• Survey and service search • Excavation of trench • Removal of spoil • Installation of conduit / pit • Trench fill and reinstatement of road, place lids on pits • Cable bridge construction	April 2016 – February 2017
Cable Installation	• Delivery and set up of cable • Removal of pit lids • Haul cable between pits • Cable cut to length and sealed • Reinstatement of pit lids and site cleared	February – June 2017
Jointing and testing	• Removal of sealing ends • Testing of cable lengths • Joint cable	July – November 2017
Commissioning	• Commissioning of project	July – November 2017
Rouse Hill Temporary Bypass Powerline		
Route Construction	• Survey and service search • Excavation of trench • Removal of spoil • Vegetation Removal	July 2017 – December 2017
Powerline Construction	• Installation of poles and wires • Installation of cables and conduits	July 2017 – December 2017
Commissioning	• Commissioning and testing of power	October 2017 – March 2018

3.2 Construction Hours of Work

3.2.1 Standard Construction Hours

The standard construction hours for the Project are defined by

- SSI-5414 CoA E12, E13 and E14
- SSI-5931 E5, E6 and E7

- ECRL Determination Report CoA 8
- EPL 20544 Condition L4
- Norwest Pedestrian Link Determination Report CoA 26

All construction works will be carried out within the approved hours or as otherwise approved as part of the EPL.

The standard construction hours of work are detailed in the table below, including the standard hours for work carried out below ground in the tunnel and for impulsive or tonal noise missions. Recommended standard hours for blasting are also included below.

Table 3 Construction Hours

Construction Activity	Monday to Friday	Saturday	Sunday/ Public holiday
Below ground activities: Track work, tunnel systems and tunnel rail systems and fit out works	24 hours	24 hours	24 hours
Above ground activities: Construction Sites and Construction Traffic	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Impulsive or tonal noise emissions	8:00 am to 5:00 pm[1]	9:00 am to 1:00 pm[1]	No work

Notes: 1. In continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block (see Section 3.2.3 below)

3.2.2 Works Outside of the Standard Construction Hours

In accordance with SSI-5414; CoA E16 SSI-5931 E6; Condition L4.2 of the EPL, Condition 8 of the ERCL Determination Report and Condition 26 of the Norwest Pedestrian Link Determination Report, all construction works are to be carried out within the above hours, except under the following circumstances:

- construction works that generate air-borne noise that is:
  - no more than 5 dB(A) above rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009);
  - no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers;
- construction works that generate continuous or impulsive vibration values, measured at the most affected residence, that are no more than those for human exposure to vibration, specified for residences in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006);
- works that generate intermittent vibration values, measured at the most affected residence, that are no more than those for human exposure to vibration, specified for residences in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006);
- where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved;

- for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons;
- where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; (in this case the EPA must be notified in accordance with the EPL) and
- rail maintenance works including tamping and regulating to remediate vertical or horizontal movement >4 mm in track geometry that has occurred as a direct result of works being undertaken for the project
- works approved through an EPL, including for works identified in an out of hours procedure

Annexure C of this report sets out the Out of Hours Works (OOHW) Procedure for the works.

All out of hours works (except in emergency situations as managed under the EPL) will be assessed and managed via the Out of Hours Procedure (Annexure C). The OOHW assessment will contain the following information:

- A description of the proposed activities
- The duration of the works
- How often out of hours works are required
- The potential noise and vibration impacts in relation to the management levels
- The likely mitigation measures that will be required to reduce the potential impacts

3.2.3 Noise Intensive Activities

Construction activities resulting in noise with impulsive or tonal characteristics, such as jackhammering, rock breaking, rock hammering, sheet piling and pile driving, shall, in accordance with SSI-5414 CoA E14 and SSI-5931 CoA E7, only be undertaken:

- Between the hours of 8:00am to 5:00pm Monday to Friday;
- Between the hours of 8:00am to 1:00pm Saturday; and
- In continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block, except as expressly permitted by the EPL.

For the purposes of this requirement ‘continuous’ includes any period during which there is less than 1 (one) hour respite between ceasing and recommencing any of the work that is subject to this requirement.

3.2.4 Out of Hours Deliveries

Delivery of most plant and equipment to the project will be undertaken during standard construction hours. However, during the various stages of construction works, there will be instances where oversized deliveries are necessary. Oversized movements can cause

disruptions to the existing traffic, and can be a potential hazard for road users. Therefore there is a requirement for these vehicles to move during off-peak hours when traffic volumes are typically at a minimum, thereby ensuring road user and public safety and minimising disruption to the road network.

The transportation of oversized equipment and machinery may require the occupation of more than one traffic lane. Where this occurs, all movements are to be strictly in accordance with RTA guidelines for oversized movements and where required the issuing of a Road Occupancy Licence (ROL).

All out of hours works (except in emergency situations as managed under the EPL) will be assessed and managed via the Out of Hours Procedure (Annexure C). The OOHW assessment will contain the following information:

- A description of the proposed activities
- The duration of the works
- How often out of hours works are required
- The potential noise and vibration impacts in relation to the management levels
- The likely mitigation measures that will be required to reduce the potential impacts

3.3 Construction Noise and Vibration Objectives

3.3.1 Airborne Construction Noise Objectives

3.3.1.1 Construction Noise Management Levels

Construction noise management levels have been determined using the NSW Interim Construction Noise Guideline (ICNG), in accordance with Project Planning Approval Condition E18. Table 4 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied.

Table 4 Noise Management Levels at Residential Receivers

Time of Day	Noise Management Level $L_{Aeq(15min)}$	How to Apply
Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public	RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices 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.

Time of Day	Noise Management Level $L_{Aeq(15min)}$	How to Apply
holidays	Highly noise affected 75dB(A)	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 restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times
Outside recommended standard hours	Noise affected RBL + 5dB(A)	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 practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 5 sets out the noise management levels for various noise-sensitive land use developments, including commercial premises adopted from the ICNG. The noise management levels are applicable where the premises are in use.

Table 5 Noise Management Levels at Other Noise Sensitive Land Uses

Land Use	Noise Management Level $L_{Aeq(15min)}$	Where NML Applies
Cinema Space	35 dB(A)	Internal noise level based on ‘maximum’ internal levels in AS2107
Classrooms at schools and other educational institutions	45 dB(A)	Internal noise level
Hospital wards and operating theatres	45 dB(A)	Internal noise level
Places of worship	45 dB(A)	Internal noise level
Community centres – Municipal Buildings	50 dB(A)	Internal noise level based on ‘maximum’ internal levels in AS2107
Active recreation areas	65 dB(A)	External noise level
Passive recreation areas	60 dB(A)	External noise level

Land Use	Noise Management Level $L_{Aeq(15min)}$	Where NML Applies
Commercial premises (including offices and retail outlets)	70 dB(A)	External noise level
Industrial premises	75 dB(A)	External noise level

As identified for residential receivers, at all 'other noise sensitive receivers' a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) shall apply. Construction activity noise above this level should be handled as described in Table 4 above.

3.3.1.2 Sleep Disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the assessment should consider maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL. The ICNG takes guidance from the NSW Environmental Criteria for Road Traffic Noise (ECRTN, Environment Protection Authority 1999) for recommended night time noise goals to minimise potential impacts and preserve acoustic amenity within receivers:

Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.

One or two events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing.

Taking guidance from the ECRTN, the NML for sleep disturbance adopted in this *CNVMP* is $L_{A1(1min)}$ 65 dB(A), applied at the façade (i.e. external).

3.3.1.3 Maximum Noise Levels for Plant and Equipment

All plant and equipment used for the OTS-PPP Works should have operating Sound Power or Sound Pressure Levels less than or equal to those in Table 6. The L_{Amax} noise levels in Table 6 can also be used as a guide in the prediction of $L_{Aeq(15\ min)}$ construction noise. In doing so, it is recognised that $L_{Aeq(15\ min)}$ noise levels are typically 5dB(A) to 10dB(A) lower than the L_{Amax} noise levels (depending on the duration of the construction activities, the number of plant items and their location on site in relation to the nearest receivers). Noise audit measurements of plant and equipment to be used on site are addressed in Section 4.3.1.1.

Table 6 Maximum Allowable Noise Levels for Plant and Equipment

	Maximum Allowable Noise Level, dB(A) - LAmax	
Land Use	Sound Power Level (SWL) re: 1pW	Sound Pressure Level (SPL) at 7m
Cherry Picker	102	77
Compactor	105	80
Compressor (approx. 600 CFM)	100	75

Land Use	Maximum Allowable Noise Level, dB(A) - LAmax	
Compressor (approx. 1500 CFM)	105	80
Concrete Pump	109	84
Concrete Saw	118	93
Concrete Truck	112	87
Concrete Vibrator	105	80
Dump Truck (approx. 15 tonne)	108	83
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Flood Lights	90	65
Jackhammer	113	88
Generator	104	79
Grader	110	85
Hi-Rail Boom Lift	108	76
Lighting Tower	80	55
Mobile Crane	110	85
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Backhoe/FE Loader	111	86
Scraper	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Water Cart	108	83
Water Pump	108	83

Notes:

Source – North West Rail Link Construction Noise and Vibration Strategy (ref: NWRL-10046-R-NO-00004-v1.0 and NWRL-10046-R-NO-00012-v1.0-, February 2012

The Sound Power Level (SWL) represents the total noise output of the plant of equipment. The SWL is normally used in computer noise models to predict the Sound Pressure Levels (SPLs) at nearby receivers. When undertaking site compliance measurements, it is normally the SPL that is measured at a specified distance (typically 7m) from the plant or equipment.

Plant and equipment with SWLs higher than those presented in the table would be deemed to be emitting an excessive level of noise and should not be permitted to operate on construction sites.

3.3.1.4 Piling Activity

It is unlikely that piling activity will be required as part of the OTS-PPP works. Should piling be necessary, SSI-5414 CoA E22 and SSI-5931 CoA E15 requires that, wherever reasonable and feasible, piling activities shall be undertaken using quieter, alternative methods such as bored piles in preference to impact or percussion piling.

3.3.2 Ground-borne/Regenerated Construction Noise Objectives

Ground-borne noise management levels (GBNMLs) are based on the ICNG, in accordance with SSI-5414 CoA E19and SSI-5931 CoA E8. Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher ambient levels which mask the audibility of ground-borne noise emissions. During evening and night periods however, when ambient noise levels are often much lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

Table 7 below provides a summary of GBNMLs, taken from the ICNG. These GBNMLs apply where noise sensitive receivers are located above underground construction activities (e.g. rock breaking) where ground-borne noise levels are higher than airborne noise levels. This situation may occur at construction sites where airborne noise levels are shielded by noise barriers or other structures, or sensitive areas within residential or commercial buildings which are removed from the airborne noise source.

Table 7 Ground-borne Noise Objectives at Residences

Time of Day	Time Periods	Ground-borne Noise Management Level $L_{Aeq(15min)}$
Daytime	7:00am to 6:00pm	N/A - Human comfort vibration objectives only
Evening	6:00pm to 10:00pm	40 dB(A) internal
Night	10:00pm to 6:00am	35 dB(A) internal

For commercial receivers such as offices and retail areas, the ICNG does not provide guidance in relation to acceptable ground-borne noise levels. This *CNVMP* however has adopted an internal GBNML of $L_{Aeq(15minute)}$ 60 dB(A) for commercial receivers, which has been derived from the airborne NML presented in the ICNG for commercial premises, being 70dB(A) externally, and assuming a 10dB(A) noise reduction from outside to inside with windows open for ventilation.

3.3.3 Construction Vibration Objectives

3.3.3.1 Disturbance to Building Occupants

Vibration potentially disturbing human occupants of buildings is managed by reference to DECC's 'Assessing Vibration; a technical guideline', published in February 2006, in accordance with Project Planning Approval Condition E19 b). This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 8 provides a definition and examples of each type of vibration.

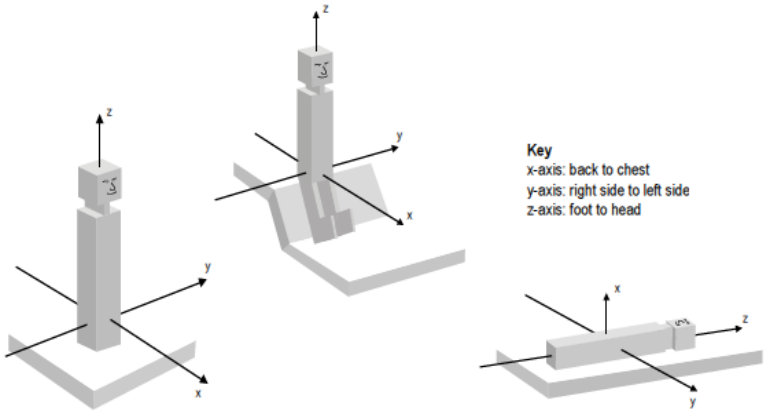
Table 8 Types of Vibration

Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Dept. Environment & Climate Change 2006

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states: 'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.



Source: Assessing Vibration; a technical guideline, Dept. Environment & Climate Change 2006 p4

Figure 7 Orthogonal Axes for Human Exposure to Vibration

Preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below.

Table 9 Preferred and Maximum Levels for Human Comfort

Location	Assessment period1	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration3 (Weighted RMS Acceleration, m/s^2, 1-80Hz)					
Critical areas2	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration3 (Weighted RMS Acceleration, m/s^2, 1-80Hz)					
Critical areas2	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92

Location	Assessment period1	Preferred values		Maximum values	
Workshops	Day- or night-time	0.64	0.46	1.28	0.92
Intermittent vibration4 (Vibration Dose Values, VDV, m/s1.75, 1-80Hz)					
Critical areas2	Day- or night-time	0.10	0.20	-	-
Residences	Daytime	0.20	0.40	-	-
	Night-time	0.13	0.26	-	-
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40	0.80	-	-
Workshops	Day- or night-time	0.80	1.60	-	-

Notes:

1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above.
3. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992
4. For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s2)
5. For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values (m/s1.75)

3.3.3.2 Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, with regard to the assessing structural damage reference is made to:

British Standard BS 7385: Part 2), which is referenced in the NWRL CNVS; and

German Standard DIN 4150: Part 3, which is referenced in the Project Planning Approval Conditions.

BRITISH STANDARD BS7385

The British Standard 7385: Part 2 “Evaluation and measurement of vibration in buildings”, can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which ‘cosmetic’, ‘minor’ and ‘major’ categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage objectives for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The objectives from the standard are given below in Table 9.

Table 9 BS 7385 Structural Damage Objectives

Group	Type of Structure	Peak component particle velocity, mm/s [1]		
		4Hz to 15Hz	15Hz to 40Hz	40Hz & above

Group	Type of Structure	Peak component particle velocity, mm/s [1]		
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20 [2]	20 to 50	50
Note:	1. Values referred to are at the base of the building, on the side of the building facing the source of vibration (where feasible) 2. At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded			

The peak vibration objectives set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Line 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Line 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery. As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

Notwithstanding the above, limits for construction generated vibration have been determined using the vibration limits set out in the German Standard DIN 4150 Part 3-1999 Structural Vibration in Buildings – Effects on Structures, in accordance with Project Planning Approval Condition E19 a).

GERMAN STANDARD DIN4150

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (e.g. historical with preservation orders), it is 3mm/s. These limits increase as the frequency

content of the vibration increases. These values are presented in Table 10 are generally recognised to be conservative.

Table 10 DIN 4150-3 Structural Damage Criteria

		Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor
Group	Type of Structure	1 to 10 Hz	10 to 50Hz	50 to	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8
Note:	At frequencies above 100 Hz, the values given in this column may be used as minimum values				

3.3.3.3 Indicative Minimum Working Distances for Vibration Intensive Equipment

As a guide, indicative minimum working distances for typical items of vibration intensive plant and equipment are provided in Table 11 below. The minimum working distances are quoted for the purpose of minimising:

‘Cosmetic’ damage, (refer BS 7385), and

Human discomfort (refer DEC’s Assessing Vibration – A Technical Guideline).

The minimum working distances for ‘cosmetic’ damage nominated in Table 11 above must be complied with at all times, unless otherwise approved by the relevant authority.

Table 11 Recommended Minimum Working Distances for Vibration Intensive Equipment

Plant Item	Rating/ Description	Minimum Working Distance	
		Cosmetic Damage	Human Response
Vibratory Roller	<50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	<100 kN (Typically 2-4 tonnes)	6 m	20 m
	<200 kN (Typically 4-6 tonnes)	12 m	40 m
	<300 kN (Typically 7-13 tonnes)	15 m	100 m
	<300 kN (Typically 13-18 tonnes)	20 m	100 m
	>300 kN (Typically >18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300kg (5-12 tonne excavator)	2 m	7 m
Medium Hydraulic Hammer	900kg (12-18 tonne excavator)	7 m	23 m
Large Hydraulic Hammer	1600kg (18-34 tonne excavator)	22 m	73 m
Vibratory Pile Driver	Sheet Piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure
Notes:	More stringent conditions may apply to heritage or other sensitive structures		

Note that the minimum working distances presented in Table 11 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

For highly sensitive receivers (e.g., high technology facilities, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.

In relation to human comfort (response), the minimum working distances in Table 11 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. Where the predicted vibration levels exceed the human comfort objectives, the procedures in Section 4.2.3 are to be followed in order to mitigate the potential impacts at sensitive receivers.

3.3.4 Construction Related Road Traffic Noise Objectives

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the project. Once the heavy vehicles move further from construction sites onto major sub-arterial or arterial roads, the noise may be perceived as part of the general road traffic.

In most situations, it will be sufficient to undertake a qualitative assessment of the potential noise impacts associated with heavy vehicle movements. This assessment should take into consideration the number of heavy vehicle movements per hour or shift, the proximity of sensitive receivers, the duration of the construction works and the time of day. This assessment would be included in the preparation of each CNVIS.

Where traffic from the project is anticipated to increase traffic noise significantly [by more than 2 dB(A)] for OOHW, which equates to project traffic being more than approx. 1.6 times existing traffic volumes, a quantitative assessment will be prepared. Construction-related traffic noise goals can be based on the guidance contained in the NSW Road Noise Policy (RNP). If heavy vehicle movements occur during the 10pm to 7am night-time period, guidance on the potential for sleep disturbance is contained in the NSW Environmental Criteria for Road Traffic Noise (ECRTN), as discussed in Section 3.3.1.

3.4 Noise and Vibration Sensitive Receivers

3.4.1 Land Use Survey

In accordance with SSI-5414 E23 and SSI-5931 E4, a Land Use Survey has been undertaken prior to construction commencement. Noise and vibration sensitive residential receivers have been identified surrounding the Sydney Metro Northwest Project area. To assist in the assessment and management of construction noise and vibration, Noise Catchment Areas (NCAs) have been nominated adjacent to the OTS-PPP work area based on their assumed similar acoustic environment prior to the commencement of construction works.

The land use survey is presented in Section 3.3.2, Section 3.3.3 and Annexure B.

3.4.2 Phase 1 and 2 Works

3.4.2.1 Residential and Vibration Sensitive Residential Receivers

An indicative list of the nearest sensitive residential receivers in each NCA is summarised in Table 12. Further to this, Appendix B contains figures showing the location of each NCA and the identified representative noise sensitive receivers. Note that the list of receivers presented below is for report presentation only. Noise levels will be predicted to all noise sensitive receivers surrounding the Worksites as part of the noise assessment process.

The NCA locations are marked on the figure provided in Appendix B.

Table 12 Nearest Residential Noise and Vibration Sensitive Receivers

NCA	Approx. Number of Receivers in NCA	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
RTF-01	55	RTF-01_06 RTF-01_07 RTF-01_12	84 Schofield Rd, Rouse Hill 88 Schofield Rd, The Ponds 88 Amarco Cct, The Ponds	RTRF RTRF RTRF	55 m 50 m 50 m
RTF-02	5	RTF-02_03 RTF-02_02 RTF-02_04	43 Schofields Rd, Rouse Hill 41 Schofields Rd, Rouse Hill 62 Gordon Rd, Schofields	RTRF RTRF RTRF	265 m 315 m 110 m
RTF-03	15	RTF-03_01 RTF-03_04	67 Tallawong Rd, Rouse Hill 6 Oak St, Schofields	RTRF RTRF	35 m 5 m

NCA	Approx. Number of Receivers in NCA	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
		RTF-03_05	14 Oak St, Schofields	RTRF	80 m
RTF-04	20	RTF-04_01 RTF-04_02 RTF-04_07	34 Tallawong Rd, Rouse Hill 42 Tallawong Rd, Rouse Hill 43 Cudgegong Rd, Rouse Hill	RTRF RTRF Cudgegong Rd Stn	10 m 10 m 60 m
RTF-05	210	RTF-05_02 RTF-05_03 RTF-05_04	5 Ridge Dr, The Ponds 1 Adelong Pd, The Ponds 1 Paringa Dr, The Ponds	RTRF RTRF Cudgegong Rd	170 m 240 m 240 m
CUD-01	115	CUD-01_01 CUD-01_02	2 McCombe Ave, Rouse Hill 24 Carnoustie St, Rouse Hill	Viaduct Viaduct	450 m 350 m
CUD-02	126	CUD-02_01 CUD-02_02	798 Windsor Rd, Rouse Hill OK Caravan Park, 51 Terry Rd, Rouse Hill	Rail corridor Rail corridor	Adjacent Adjacent
CUD-03	25	CR-03_01 CR-03_02 CR-03_03	38 Cudgegong Rd, Rouse Hill 44 Cudgegong Rd, Rouse Hill 56 Cudgegong Rd, Rouse Hill	Cudgegong Rd Cudgegong Rd Stn Cudgegong Rd Stn	45 m 15 m 50 m
CUD-04	10	CR-04_01 CR-04_02 CR-04_03	85 Schofields Rd, Rouse Hill 87 Schofields Rd, Rouse Hill 89 Schofields Rd, Rouse Hill	Cudgegong Rd Cudgegong Rd Stn Cudgegong Rd Stn	110 m 205 m 305 m
CUD-05	50	CR-05_01 CR-05_02 CR-05_03	59 Lomandra Cr, The Ponds 40 Lomandra Cr, The Ponds 74 Petal Pkw, The Ponds	Cudgegong Rd Cudgegong Rd Stn Cudgegong Rd Stn	650 m 690 m 850 m
CUD-06	320	CR-05_01 CR-05_02 CR-05_03	25 Arrowroot St, The Ponds 19 Arrowroot St, The Ponds 11 Arrowroot St, The Ponds	Cudgegong Rd Cudgegong Rd Stn Cudgegong Rd Stn	230 m 305 m 360 m
RSH-01	129	RSH-01_01 RSH-01_02	1 Beck Place, Kellyville Ridge 36 Stave Place, Kellyville Ridge	Viaduct Viaduct	65 m 65 m
RSH-02	238	RSH-02_01 RSH-02_02 RSH-02_03	35 Waterford St, Kellyville Ridge 49 Waterford St, Kellyville Ridge 3 Kilbenny St, Kellyville Ridge	Viaduct Viaduct Viaduct	55 m 60 m 70 m

NCA	Approx. Number of Receivers in NCA	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
		RSH-02_04	15 Kilbenny St Kellyville Ridge	Viaduct	70 m
RSH-03	287	RSH-03_01	61 Caddies Bld, Rouse Hill	Rouse Hill Stn	400 m
		RSH-03_02	45 Caddies Bld, Rouse Hill	Rouse Hill Stn	400 m
		RSH-03_03	27 Bellcast Rd Rouse Hill	Viaduct	190 m
		RSH-03_04	1 Bellcast Rd Rouse Hill	Viaduct	40 m
RSH-04	87	RSH-04_01	41 Kirkton Pl, Beaumont Hills	Viaduct	350 m
		RSH-04_02	21 Dunross Pl, Beaumont Hills	Viaduct	220 m
KVE-01	86	KVE-01_01	15 Carolyn Crt, Glenwood	Viaduct	80 m
		KVE-01_02	10A Rothwell Cct, Glenwood	Viaduct	80 m
KVE-02	60	KVE-02_01	27 Meldon Pl, Stanhope Gardens	Viaduct	90 m
		KVE-02_02	14 Kentwell Cres, Stanhope Gardens	Viaduct	80 m
		KVE-02_03	1 Newbury Ave, Stanhope Gardens	Kellyville Station	80 m
		KVE-02_04	37 Bentwood Tce, Stanhope Gardens	Viaduct	75 m
KVE-03	246	KVE-03_01	16 Meldon Pl, Stanhope Gardens	Viaduct	130 m
		KVE-03_02	27 Roxburgh Cres, Stanhope Gardens	Kellyville Station	120 m
KVE-04	237	KVE-04_01	41 Memorial Ave, Kellyville	Viaduct	160 m
		KVE-04_02	10 Colonial St, Kellyville	Viaduct	220 m
		KVE-04_03	16 Wenden Ave, Kellyville	Kellyville Station	180 m
		KVE-04_04	23 Landy Pl, Kellyville	Kellyville Station	250 m
KVE-05	288	KVE-05_01	26 Bridget Pl, Kellyville	Kellyville Station	250 m
		KVE-05_02	9 Clovelly Cct, Kellyville	Viaduct	80 m
		KVE-05_03	36 Lycett Ave, Kellyville	Viaduct	60 m
KVE-06	353	KVE-06_01	32 Brentwood Tce, Stanhope Gardens	Viaduct	120 m
		KVE-06_02	24 Brentwood Tce, Stanhope Gardens	Viaduct	120 m
KVE-07	53	KVE-07_01	30 Martens Cct, Kellyville	Viaduct	440 m
		KVE-07_02	55 Lycett Ave, Kellyville	Viaduct	90 m
BLV-01	45	BLV-01_01	19 Vanessa Ct, Glenwood	Bella Vista Stn	180 m
		BLV-01_02	5 Maley Gr, Glenwood	Bella Vista Stn	200 m
		BLV-01_03	2 Maley Gr, Glenwood	Bella Vista Stn	220 m
BLV-02	55	BLV-02_01	30 Emmanuel Tce, Glenwood	Viaduct	80 m
		BLV-02_02	2 Emmanuel Tce, Glenwood	Viaduct	70 m
		BLV-02_03	43 Sharrock Ave, Glenwood	Bella Vista Stn	80 m
		BLV-02_04	10 Swansea Ct, Glenwood	Bella Vista Stn	80 m
BLV-03	135	BLV-03_01	19 Emmanuel Tce, Glenwood	Viaduct	120 m
		BLV-03_02	16 Whibley Ave, Glenwood	Viaduct	120 m
		BLV-03_03	34 Sharrock Ave, Glenwood	Bella Vista Stn	120 m
BLV-04	15	BLV-04_01	21 Balmoral Rd, Kellyville	Viaduct	Adjacent
		BLV-04_02	19 Balmoral Rd, Kellyville	Viaduct	170 m
		BLV-04_03	40 Memorial Rd, Kellyville	Viaduct	Adjacent
		BLV-04_04	16 Craigend Pl, Kellyville	Bella Vista Stn	280 m
		BLV-04_05	40 Balmoral Rd, Kellyville	Bella Vista Stn	130 m
BLV-05	100	BLV-05_01	20 Waterside Cres, Bella Vista	Bella Vista Stn	80 m
		BLV-05_02	97 Brighton Dr, Bella Vista	Bella Vista Stn	80 m
		BLV-05_03	20 Bridgeview Cct, Bella Vista	Bella Vista Stn	185 m
NRW-01	35	NW-01_01	4 Peninsula Way, Baulkham Hills	Norwest Station	490 m
		NW-01_02	92 Central Park Ave, Baulkham Hills	Norwest Station	360 m

NCA	Approx. Number of Receivers in NCA	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
		NW-01_03	29 Central Park Ave, Baulkham Hills	Norwest Station	490 m
NRW-02	105	NW-02_01 NW-02_02 NW-02_03 NW-02_04 NW-02_05	38A Ridgehaven Pl, Bella Vista 54 Ridgehaven Pl, Baulkham Hills 19-21 Jacqui Cct, Baulkham Hills 16 Evesham Ct, Baulkham Hills 32 Fairmont Ave, Baulkham Hills	Norwest Station Norwest Station Norwest Station Norwest Station Norwest Station	200 m 110 m 100 m 160 m 270 m
NRW-03	85	NW-03_01	7-9 Plover Glen, Baulkham Hills	Norwest Station	310 m
SHW-01	15	SG-01_01	14 Cedar Gr, Castle Hill	Showground Stn	500 m
SHW-02	40	SG-02_01 SG-02_02 SG-02_03	150 Showground Rd, Castle Hill 136A Showground Rd, Castle Hill 122 Showground Rd, Castle Hill	Showground Stn Showground Stn Showground Stn	200 m 150 m 200 m
SHW-03	65	SG-03_01 SG-03_02 SG-03_03 SG-03_04	38 Carrington Road, Castle Hill 34 Carrington Road, Castle Hill 1 Middleton Ave, Castle Hill 10 Carrington Road, Castle Hill	Showground Stn Showground Stn Showground Stn Showground Stn	22 m 22 m 65 m 170 m
CSH-01	250 (mostly	CSH-01_01 CSH-01_02 CSH-01_03	4-6 Mercer St, Castle Hill (Apartments) 325 Old Northern Rd, Castle Hill 335 Old Northern Rd, Castle Hill	Castle Hill Stn Castle Hill Stn Castle Hill Stn	50 m 50 m 150 m
CSH-02	55	CSH-02_01 CSH-02_02	9 Garthowen Cres, Castle Hill (Townhouses) 20-22 Old Castle Hill Rd, Castle HilL	Castle Hill Stn Castle Hill Stn	150 m 100 m
CHE-01	30	CHE-01_01 CHE-01_02	210 Castle Hill Rd, Cherrybrook 3 Robert Rd, Cherrybrook	Castle Hill Stn Castle Hill Stn	15 m 25 m
CHE-02	80	CHE-02_01 CHE-02_02 CHE-02_03 CHE-02_04	7 Robert Rd, Cherrybrook 13 Oliver Way, Cherrybrook 12 Kayla Way, Cherrybrook 2 Kayla Way, Cherrybrook	Castle Hill Stn Castle Hill Stn Castle Hill Stn Castle Hill Stn	60 m 25 m 50 m 50 m
CHE-03	10	CHE-03_01 CHE-03_02	158 Castle Hill Rd, Cherrybrook Inala School Residential	Cherrybrook Stn Cherrybrook Stn	160 m 110 m
CHE-04	35	CHE-04_01 CHE-04_02 CHE-04_03	Glenhope, 113 Castle Hill Road, West Pennant Hills 2 Glenhope Rd, West Pennant Hills 125 Castle Hill Rd, West Pennant Hills	Cherrybrook Stn Cherrybrook Stn Cherrybrook Stn	35 m 25 m 35 m
CSF-01	40	CN-01_01 CN-01_02	226 Midson Rd, Beecroft 9 Kerry Ave, Beecroft	Cheltenham	130 m 170 m
CSF-02	4	CN-02_01 CN-02_02	1 Castle Howard Rd, Cheltenham 5 Castle Howard Rd, Cheltenham	Cheltenham	25 m 35 m
CSF-03	50	CN-03_01 CN-03_02 CN-03_03	34 Castle Howard Rd, Cheltenham 50 Castle Howard Rd, Cheltenham 66 Castle Howard Rd, Cheltenham	Cheltenham	200 m 85 m 115 m

NCA	Approx. Number of Receivers in NCA	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
EP-01	65	EP-01_01 EP-01_02	3-5 Kandy Ave, Epping 9 Edensor St, Epping	Epping Services	285 m 320 m
EP-02	230	EP-02_01 EP-02_02	1 Surrey St, Epping 30-34 Cambridge St, Epping	Epping Services	240 m 105 m
EP-03	125	EP-03_01 EP-03_02 EP-03_03	29 Ray Rd, Epping 23-27 Ray Rd, Epping 13-15 Ray Rd, Epping	Epping Services	140 m 90 m 30 m
EP-04	170 (all apartments)	EP-04_01 EP-04_02 EP-04_03 EP-04_04 EP-04_05	24-32 Edensor Rd, Epping 10-12 Edensor Rd, Epping 6-8 Edensor Rd, Epping 2-4 Edensor Rd, Epping 6 Ray Rd, Epping	Epping Services	120 m 15 m 20 m 20 m Adjacent
EP-05	60 (all apartments)	EP-05_01	74 Rawson St, Epping	Epping Services	90 m

3.4.2.2 Other Land Uses

An indicative list of the nearest 'other' sensitive receivers in each NCA is summarised in . The location of 'other' noise sensitive receivers near the Project works is identified on the figure in Annexure B.

Table 13 Nearest 'Other' Noise Sensitive Receivers

Land Use	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
Place of Worship	RTO_01	Lankarama Buddhist Temple	RTRF	155 m
Educational Facility	CUD_O_01 CUD_O_02	Rouse Hill Anglican College, Worcester Rd, Rouse Hill The Ponds Primary School, The Ponds	Cudgegong Rd Stn Cudgegong Rd Stn	530 m 600 m
Commercial Area	CUD_O-03	The Mean Fiddler Hotel, Commercial Rd & Windsor Rd, Rouse Hill	Viaduct	140 m
Commercial Area	RSH_O-01	Rouse Hill Town Centre/ Shopping Centre	Rouse Hill Station	30 m
Recreation	RSH_O-02	Castlebrook Memorial Park, Windsor Road, Rouse Hill	Rouse Hill Station	50 m
Recreation	RSH_O-03	Rouse Hill Community Area	Viaduct	Adjacent

Land Use	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
Recreation	RSH_O-04	Vinegar Hill Reserve, Waterford St, Kellyville Ridge	Viaduct	175 m
Recreation	RSH_O-05	Caddies Creek Reserve	Viaduct	Adjacent
Industrial	RSH_O-06	Caltex Service Station, 662 Windsor Rd, Kellyville Ridge	Viaduct	70 m
Commercial	RSH_O-07	McDonalds Restaurant, 558 Windsor Rd, Kellyville Ridge	Viaduct	70 m
Commercial	RSH_O-08	Ettamogah Hotel, 15 Merrivale Rd, Kellyville Ridge	Viaduct	70 m
Commercial	RSH_O-09	Kellyville Pets, 106 Windsor Rd, Beaumont Hills	Viaduct	300 m
Industrial	RSH_O-10	Baulkham Hills Landscape Supplies, 113 Windsor Rd, Beaumont Hills	Viaduct	Adjacent
Recreation	KVE_O-01	Longshot Driving Range, 1324 Old Windsor Rd, Stanhope Gardens	Viaduct	80 m
Recreation	KVE_O-02	Caddies Creek Reserve	Viaduct	Adjacent
Educational Facility	KVE_O-03	John XXIII Catholic Primary School, 160 Perfection Ave, Stanhope Gardens	Viaduct	160 m
Recreation	KVE_O-04	Elizabeth MacArthur Park, 20 Macquarie Ave, Kellyville	Viaduct	180 m
Educational Facility	KVE_O-05	Graceland Early Education Centre, 7 Arnold Ave, Kellyville	Kellyville Station	380 m
Industrial	KVE_O-06	Integral Energy Substation, Stanhope Gardens	Kellyville Station	120 m
Commercial	KVE_O-07	Hungry Jacks Restaurant, 1190 Old Windsor Rd, Parklea	Viaduct	80 m
Industrial	KVE_O-08	Caltex Service Station, 3/1190 Old Windsor Rd, Parklea	Viaduct	80 m
Educational Facility	KVE_O-09	Childcare Centre, 15 Carolyn Crt, Glenwood	Viaduct	75 m
Recreation	KVE_O-10	Newbury Park	Kellyville Station	100 m
Educational Facility	BLV_O-01	Anglican Technical College Western Sydney, 1000 Old Windsor Rd, Glenwood	Bella Vista Station	180 m
Educational Facility	BLV_O-02	Glenwood High School, 85 Foreman Ave, Glenwood	Bella Vista Station	590 m
Educational Facility	BLV_O-03	Headstart Early Learning Centre, 2/4A Meridian Ave, Bella Vista	Bella Vista Station	150 m
Place of Worship	BVO_04	Emmanuel Baptist Church, 992 Old Windsor Rd, Glenwood	Bella Vista Station	175 m
Medical (sensitive equipment)	BVO_05	Norwest General Practice, 32 Lexington Dr, Bella Vista	Bella Vista Station	175 m

Land Use	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
Medical (sensitive equipment)	BVO_06	Sydney Animal Hospital, 1-3 Celebration Dr, Bella Vista	Bella Vista Station	175 m
Commercial	BLV_O-07	Alpha - 5 Celebration Dr, Bella Vista	Bella Vista Station	50 m
	BLV_O-08	Zhen - 33 Lexington Dr, Bella Vista	Bella Vista Station	55 m
	BLV_O-09	1 Celebration Drive, Bella Vista	Bella Vista Station	100 m
	BLV_O-10	McDonalds Restaurant, 6 Celebration Dr Bella Vista	Bella Vista Station	Adjacent
Industrial	BLV_O-11	BP Service Station, 2 Celebration Dr, Bella Vista	Bella Vista Station	Adjacent
Place of Worship	NRW_O-01	Hillsong Convention Centre	Norwest Station	140 m
	NRW_O-02	Hillsong Chapel 1-9 Solent Cct, Baulkham Hills	Norwest Station	230 m
Educational Facility	NRW_O-03	Parkview Childcare Centre, Norwest Marketown, 4 Century Cct, Baulkham Hills	Norwest Station	185 m
Medical (sensitive equipment)	NRW_O-04	Bella Vista Medical Centre, 10 Century Circuit, Baulkham Hills	Norwest Station	45 m
Commercial	NRW_O-05	Norwest Business Park, 19 Brookhollow Ave, Baulkham Hills	Norwest Station .	Adjacent
	NRW_O-06	Norwest Market Town Shopping Centre	Norwest Station	80 m
	NRW_O-07	2 Century Cct, Baulkham Hills	Norwest Station	30 m
	NRW_O-08	Block A, Capital Business Centre, 38 Norwest Bld, Baulkham Hills	Norwest Station	40 m
Industrial	NRW_O-09	Shell Service Station, 4 Century Cct, Baulkham Hills	Norwest Station	20 m
Educational Facility	SG-OSR_01	Carrington Pre-School, 36 Carrington Road, Castle Hill	Showground Station .	22m
	SG-OSR_02 .	Kings Rd Long Day Care, 5 Kings Road, Castle Hill	Showground Station .	570m .
	SG-OSR_03	Gemhill Cottage, North West Disability Services respite care, 28 Carrington Rd	Showground Station	30 m
Place of Worship	SG-OSR_03	Life Church, 1-3 Kings Road, Castle Hill	Showground Station	550m
	SG-OSR_04	Day Spring Church, 15 Salisbury Road, Castle Hill	Showground Station	360m
Active Recreation	SG-OSR_05	Fred Caterson Reserve, Gilbert Rd, Castle Hill	Showground Station .	420m
	SHW_O_06	Castle Hill Showground	Showground Station	Adjacent
Medical (sensitive equipment)	SG-OSR_07	Carrington Dental, 4 Carrington Road, Castle Hill	Showground Station .	135m
	SG-OSR_08	Castle Hill Dental Care, 26 Carrington Road, Castle Hill	Showground Station	22m
Community Centre	CSH_O-01	Castle Hill Senior Citizens Centre, 2-6 McMullen Ave, Castle Hill	Castle Hill Stn .	110 m
	CSH_O-02	CWA Office, 329 Old Northern Rd, Castle Hill	Castle Hill Stn	45 m
Educational Facility	CSH_O-03	Bernadette's Primary School, 15 Brisbane Rd, Castle Hill	Castle Hill Stn	170 m
Place of Worship	CSH_O-04	St Bernadette's Catholic Church, 15 Brisbane Rd, Castle Hill	Castle Hill Stn	340 m
Cinema Space	CSH_O-05	Castle Hill Cinema Complex (Gold Class),	Castle Hill Stn	40 m

Land Use	Receiver ID	Representative Receiver Address	Nearest Project Construction Area	Approx. Distance to NCA
		Castle Hill Towers, Old Castle Hill Rd		
Commercial	CSH_O-06	Old Northern Rd/ McMullen St/ Old Castle Hill Rd - Retail and commercial buildings	Castle Hill Stn	Adjacent
Commercial	CSH_O-07	Castle Hill Towers Shopping Centre	Castle Hill Stn	30 m
Medical (sensitive equipment)	CSH_O-08 CSH_O-09 CSH_O-10 . CSH_O-11 CSH_O-12 CSH_O-13 CSH_O-14	Children's Dentistry, 329 Old Northern Rd Hills Dentistry, 6-8 Old Castle Hill Rd Castle Hill Orthodontics, 25/6-8 Old Castle Hill Rd Hills Smile Care, 2/6-8 Old Castle Hill Rd Sydney Cardiology, 8/2-4 Old Castle Hill Rd Medical Centre, 5 Crane Rd, Castle Hill Castle Hill Towers Medical & Dental, Piazza Court, Old Northern Rd, Castle Hill	Castle Hill Stn Castle Hill Stn Castle Hill Stn . Castle Hill Stn Castle Hill Stn Castle Hill Stn Castle Hill Stn	45 m Adjacent 50 m . 100 m 50 m 100 m 144 m
Industry (sensitive equipment)	CSH_O-15	Castle Hill Telstra Exchange	Castle Hill Station	
Educational Facility	CHE_O-01 CHE_O-02 CHE_O-03	Kindalin Early Learning Centre, 1 Glenhope Rd, West Pennant Hills Playdays Pre-School, 15 Glenhope Rd, West Pennant Hills Tangara School for Girls, 77-97 Franklin Rd, Cherrybrook	Cherrybrook Station . Cherrybrook Stn . Cherrybrook Stn	25 m 185 m 80 m
Community Facility	CHE_O-04	Inala Disability Services, 160-168 Castle Hill Rd, Cherrybrook	Cherrybrook Stn	80 m
Educational Facility	CFS_O-01	Epping Heights Public School	Cheltenham	400 m
Active Recreation	CFS_O-02	Cheltenham Oval	Cheltenham	Adjacent
Educational Facility	ESF_O-01	Our Lady Help of Christians Primary School, 31 Oxford St, Epping	Epping Services	100 m
Place of Worship	ESF_O-02 ESF_O-03	Epping Catholic Church, 31 Oxford St, Epping Epping Baptist Church, 1-5 Ray Rd, Epping	Epping Services	160 m 30 m
Medical (sensitive equipment)	ESF_O-04 ESF_O-05	Medical Centre/ Dental, 74 Rawson Street, Epping Rawson Dental, 1/ 56C Rawson Street, Epping	Epping Services	90 m 240 m
Industrial	ESF_O-06	Seven-11 Service Station	Epping Services	Adjacent

3.4.2.3 Noise Management Levels

Table 17 following identifies the adopted construction noise management levels for each NCA for the day, evening and night period as defined by the ICNG. The construction noise management levels are conservative, derived from the lowest measured Rating Background Level (RBL) within the local noise environment.

The location of the NCAs and the relevant background noise monitoring locations are marked on the figures provided in Annexure B.

Table 14 Rating Background Levels and Noise Management Levels at Residential Receivers

NCA	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$[1]				Sleep NML
					Standard Hours	Outside Standard Hours			
		Day	Eve	Night	Day	Day	Eve	Night	$L_{A1(1min)}$[2]
RTF-01	88 Amarco Cct, The Ponds	43	44	32	53	48	48	37	65
RTF-02	BG25 43 Schofields Rd, Rouse Hill	43	44	30	53	48	48	35	65
RTF-03	67 Tallawong Rd, Rouse Hill	33	34	33	43	38	38	38	65
RTF-04	67 Tallawong Rd, Rouse Hill	33	34	33	43	38	38	38	65
RTF-05	116 Hambledon Rd, The Ponds	43	40	30	53	38	45	35	65
CUD-01	BG022 830 Windsor Rd, Rouse Hill	52	51	39	62	57	56	44	65
CUD-02	BG022 830 Windsor Rd, Rouse Hill	52	51	39	62	57	56	44	65
CUD-03	56 Cudgegong Rd, Rouse Hill	40	39	38	50	45	44	43	65
CUD-04	91 Schofields Rd, Rouse Hill	43	43	33	53	48	48	38	65
CUD-05	88 Amarco Cct, The Ponds	43	44	32	53	48	48	37	65
CUD-06	116 Hambledon Rd, The Ponds	43	40	30	53	48	45	35	65
RSH-01	BG18 1 Beck Pl, Kellyville	54	52	47	64	59	57	52	65
RSH-02	BG19 9-19 Kilbenny St, Kellyville	52	49	32	62	57	54	37	65
RSH-03	BG20 19 Bellcast Rd, Rouse Hill	41	41	33	51	46	46	38	65
RSH-04	BG17 45 Lycett Ave, Kellyville	48	44	32	58	53	49	37	65
KVE-01	BG13 36 Rothwell Cct, Glenwood	51	50	34	61	56	55	39	65
KVE-02	BG14 15 Kentwell St, Stanhope Gardens	47	48	38	57	52	52	43	65
KVE-03	BG14 15 Kentwell St, Stanhope Gardens	47	48	38	57	52	52	43	65
KVE-04	BG15 16 Wenden Ave, Kellyville	39	41	39	49	44	44	44	65
KVE-05	BG16 9 Clovelly Cct, Kellyville	45	46	37	55	50	50	42	65
KVE-06	BG16 9 Clovelly Cct, Kellyville	45	46	37	55	50	50	42	65
KVE-07	BG17 45 Lycett Ave, Kellyville	48	44	32	58	53	49	37	65
BLV-01	BG10 8 Maley Gr, Glenwood	46	45	36	56	51	50	41	65
BLV-02	BG12 24 Emmanuel Tce, Glenwood	51	48	33	61	56	53	38	65
BLV-03	ABG09 11 Emmanuel Tce, Glenwood	47	47	33	57	52	52	38	65
BLV-04	ABG10 32 Balmoral Rd, Kellyville	40	39	34	50	55	44	39	65
BLV-05	BG11 12 Craigend Pl, Bella Vista	36	35	31	46	51	40	36	65
NRW-01	BG09 33 Jacqui Cct, Baulkham Hills	47	45	38	57	52	50	43	65
NRW-02	BG09 33 Jacqui Cct, Baulkham Hills	47	45	38	57	52	50	43	65
NRW-03	BG09 33 Jacqui Cct, Baulkham Hills	47	45	38	57	52	50	43	65
SHW-01	BG07 142 Showground Rd, Castle Hill	54	48	30	64	59	53	35	65
SHW-02	BG07 142 Showground Rd, Castle Hill	54	48	30	64	59	53	35	65
SHW-03	ABG07 32 Carrington St, Castle Hill	54	44	32	64	59	49	37	65

NCA	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$[1]				Sleep NML
CSH-01	BG06 329 Old Northern Rd, Castle Hill	50	47	31	60	55	52	36	65
CSH-02	ABG06 4 McMullen Ave, Castle Hill	49	46	31	59	54	51	36	65
CHE-01	BG04 130 Franklin Rd, Cherrybrook	45	41	34	55	50	46	39	65
CHE-02	BG05 11 Kayla Way, Cherrybrook	37	38	30	47	42	42	35	65
CHE-03	BG04 130 Franklin Rd, Cherrybrook	45	41	34	55	50	46	39	65
CHE-04	ABG05 113 Castle Hill Rd, West Pennant Hills	50	47	32	60	55	52	37	65
CSF-01	BG03 2 Ferndale Rd, Beecroft	55	52	35	65	60	57	40	65
CSF-02	BG02 32A Castle Howard Rd, Cheltenham	49	41	31	59	54	46	36	65
CSF-03	BG02 32A Castle Howard Rd, Cheltenham	49	41	31	59	54	46	36	65
EP-01	ABG04 7 Kandy Ave, Epping	49	46	37	59	54	51	42	65
EP-02	ABG03 1/40 Cambridge St, Epping	44	43	35	54	49	48	40	65
EP-03	ABG02 6 Ray Rd, Epping	45	45	38	55	50	50	43	65
EP-04	BG01 12/10 Edensor St, Epping	45	41	32	55	50	46	37	65
EP-05	ABG01 3 Carlingford Rd, Epping	60	58	44	70	65	63	49	65

Table 15 following identifies the adopted construction noise management levels for each ‘other’ sensitive receiver for the day, evening and night period as defined by the ICNG.

The locations of the other sensitive receivers are shown on the figures in Annexure B.

Table 15 Noise Management Levels at Other Sensitive Receivers

Receiver Type	ID	Receiver Address	Noise Management Level, $L_{Aeq(15min)}$ when in use
Educational Facility	CUD_O_01 CUD_O_02	Rouse Hill Anglican College The Ponds Primary School	55[1]
	KVE_O-03	John XXIII Catholic Primary School	
	KVE_O-05	Graceland Early Education Centre	
	KVE_O-09	Childcare Centre, Glenwood	
	BLV_O-01	Anglican Technical College	
	BLV_O-02	Glenwood High School	
	BLV_O-03	Headstart Early Learning Centre, Bella Vista	
	NRW_O-03	Parkview Childcare Centre	
	SHW_O-01 SHW_O-02 SHW_O-03	Carrington Pre-School, Kings Rd Long Day Care Gemhill Cottage	
	CSH_O-03	Bernadette’s Primary School	
	CHE_O-01 CHE_O-02	Kindalin Early Learning Centre Playdays Pre-School	

Receiver Type	ID	Receiver Address	Noise Management Level, $L_{Aeq(15min)}$ when in use
	CHE_O-03	Tangara School for Girls	
	CFS_O-01	Epping Heights Public School	
	ESF_O-01	Our Lady Help of Christians Primary School	
Place of Worship	RTO_01	Lankarama Buddhist Temple	55[1]
	BVO_04	Emmanuel Baptist Church	
	NRW_O-01 NRW_O-02	Hillsong Convention Centre Hillsong Chapel	
	SHW_O-03 SHW_O-04	Life Church, Castle Hill Day Spring Church, Castle Hill	
	CSH_O-04	St Bernadette's Catholic Church	
	ESF_O-02 ESF_O-03	Epping Catholic Church Epping Baptist Church	
Community Centre	CSH_O-01 CSH_O-02	Castle Hill Senior Citizens Centre CWA Office, Castle Hill	60[1, 2]
Community Facility	CHE_O-04	Inala Disability Services, Cherrybrook	
Passive Recreation	RSH_O-02	Castlebrook Memorial Park	60
	RSH_O-03	Rouse Hill Community Area	
	RSH_O-04	Vinegar Hill Reserve, Kellyville Ridge	
	RSH_O-05	Caddies Creek Reserve	
	KVE_O-02	Caddies Creek Reserve	
	KVE_O-04	Elizabeth MacArthur Park	
	KVE_O-10	Newbury Park	
Active Recreation	KVE_O-01	Longshot Driving Range	65
	SHW_O-05 SHW_O-06	Fred Caterson Reserve, Gilbert Rd Castle Hill Showground	
	CFS_O-02	Cheltenham Oval	
Medical/ Sensitive Commercial	BVO_05	Norwest General Practice	55[1]
	BVO_06	Sydney Animal Hospital	
	NRW_O-04	Bella Vista Medical Centre	
	SHW_O-07 SHW_O-08	Carrington Dental Castle Hill Dental Care	
	CSH_O-08 CSH_O-09 CSH_O-10 CSH_O-11 CSH_O-12 CSH_O-13 CSH_O-14	Children's Dentistry Hills Dentistry Castle Hill Orthodontics Hills Smile Care Sydney Cardiology Medical Centre Castle Hill Towers Medical & Dental	
	ESF_O-04 ESF_O-05	Medical Centre/ Dental, Epping Rawson Dental, Epping	
Cinema Space	CSH_O-05	Castle Hill Cinema Complex (Gold Class)	35[2]
Commercial Area	CUD_O-03	The Mean Fiddler Hotel	70
	RSH_O-01	Rouse Hill Town Centre/ Shopping Centre	
	RSH_O-07	McDonalds Restaurant	

Receiver Type	ID	Receiver Address	Noise Management Level, $L_{Aeq(15min)}$ when in use
	RSH_O-08	Ettamogah Hotel	
	RSH_O-09	Kellyville Pets	
	KVE_O-07	Hungry Jacks Restaurant, Kellyville	
	BLV_O-07 BLV_O-08 BLV_O-09 BLV_O-10	Alpha - 5 Celebration Dr, Bella Vista Zhen - 33 Lexington Dr, Bella Vista 1 Celebration Drive, Bella Vista McDonalds Restaurant, Bella Vista	
	NRW_O-05 NRW_O-06 NRW_O-07 NRW_O-08	Norwest Business Park Norwest Market Town Shopping Centre 2 Century Cct, Baulkham Hills Block A, Capital Business Centre	
	CSH_O-06	Retail and commercial buildings	
	CSH_O-07	Castle Hill Towers Shopping Centre	
Industrial	RSH_O-06	Caltex Service Station, Kellyville Ridge	75
	RSH_O-10	Baulkham Hills Landscape Supplies	
	KVE_O-06	Integral Energy Substation	
	KVE_O-08	Caltex Service Station, Parklea	
	BLV_O-11	BP Service Station, Bella Vista	
	NRW_O-09	Shell Service Station, Baulkham Hills	
	CSH_O-15	Castle Hill Telstra Exchange	
	ESF_O-06	Seven-11 Service Station, Epping	

Notes:
1. Outside noise level approximated based on 10dB(A) insertion loss through an open window [NSW Environmental Criteria for Rd Traffic Noise, Environment Protection Authority 1999 p14].
2. Indoor noise level based on 'maximum' internal levels in AS2107.

3.4.3 ECRL Conversion Works

3.4.3.1 Noise and Vibration Sensitive Residential Receivers

The ECRL Conversion Determination Report did not specify the requirement to produce a Land Use Survey. An indicative list of the nearest sensitive residential receivers in each NCA is summarised below based on the information produced in the ECRL REF.

Further to this, Appendix B contains figures showing the location of the station sites and the identified representative noise sensitive receivers drawn from the REF. Note that the list of receivers presented below is for report presentation only. Noise levels will be predicted to all noise sensitive receivers surrounding the worksites as part of the preparation of CNVISs. Due to the fact noise intensive works are not predicted to occur until the full shutdown of the ECRL in 2018, the list of sensitive receivers and a detailed CNVIS would not be prepared until at least 3 months prior to these works occurring.

Table 16 Residential Receivers

Representative Residential Address	Approximate Distance to Site (m)

Representative Residential Address	Approximate Distance to Site (m)
78-80 Rawson St, Epping	90
176 Herring Road, Macquarie Park	35
21 Waterloo Road, Macquarie Park	115
436 Victoria Avenue	Above Chatswood Station
1 Katherine Street, Chatswood	85
37 Victor Street, Chatswood	80
77 Albert Avenue, Chatswood	50

3.4.3.2 Other Land Uses

An indicative list of the nearest 'other' sensitive receivers along the ECRL conversion works is summarised in Table 16. The location of 'other' noise sensitive receivers near the Project works is identified on the figure in Annexure B.

Table 17 Other Sensitive Receivers

Land Use	Receiver Address	Approximate Distance to Site (m)
Place of Worship	3 Pembroke St Epping	165
Place of Worship	29 Oxford St Epping	180
Place of Worship	4 Cambridge St Epping	200
Library	Chambers Ct Epping	190
Educational Facility	University Avenue, Macquarie Park	200
Place of Worship	78 Albert Avenue, Chatswood	150
Educational Facility	19 Orchard Road, Chatswood	250
Educational Facility	5 Centennial Ave Chatswood	250
Hotel	10 Brown St Chatswood	40

3.4.3.3 Noise Management Levels

A total of 4 locations were identified surrounding the ECRL work areas as representative locations for background noise monitoring as part of the ECRL Conversion REF.

Table 18 following identifies the adopted construction noise management levels for each NCA for the day, evening and night period as defined by the ICNG. The construction noise

management levels are conservative, derived from the lowest measured Rating Background Level (RBL) within the local noise environment.

The location of the NCAs and the relevant background noise monitoring locations are marked on the figures provided in Annexure B.

Table 18 Noise Management Levels

Location	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$			Sleep NML[2]
		Day	Eve	Night	Day	Eve	Night	$L_{A1(1min)}$
BG1	73 Albert Ave, Chatswood[1]	53	48	43	63	53	48	65
BG2	Our Lady Help of Christians, Epping[1]	54	53	43	64	58	48	65
BG3	4/175 Herring Road, Macquarie Park[1]	60	53	43	70	58	48	65
BG4	56 Delhi Road, North Ryde[1]	60	53	48	70	58	53	65
-	Place of Worship	-	-	-	55[3, 4]			-
-	Library	-	-	-	55[3, 4]			-
-	Educational Facility	-	-	-	55[3, 4]			-
-	Hotel	-	-	-	70			-

Notes:
1. For residential receivers noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.
2. Applies during the Night period
3. Noise management level applies when facility in use.
4. Outside noise level approximated based on 10dB(A) insertion loss through an open window

3.4.4 Norwest Pedestrian Link Works

3.4.4.1 Noise and Vibration Sensitive Residential Receivers

The Norwest Pedestrian Link Determination Report did not specify the requirement to produce a Land Use Survey. An indicative list of the nearest sensitive residential receivers in each NCA is summarised below based on the information produced in the Norwest Pedestrian Link REF.

Further to this, Appendix B contains a figure showing the location of the monitoring sites and the identified representative noise sensitive receivers drawn from the REF. Note that the list of receivers presented below is for report presentation only. Noise levels will be predicted to all noise sensitive receivers surrounding the worksites as part of the preparation of CNVISs.

Table 19 Residential Receivers

NCA	Total Number of Residential Receivers	Property ID	Representative Residential Address	Approximate Distance to Site (m)
NCA	90	01	4 Peninsula Way, Baulkham Hills	490

NCA	Total Number of Residential Receivers	Property ID	Representative Residential Address	Approximate Distance to Site (m)
01		02	92 Central Park Ave, Baulkham Hills	360
		03	29 Central Park Ave, Baulkham Hills	490
NCA 02	170	01	2 Ashburn Close, Bella Vista	635
		02	1 Glenview Close, Bella Vista	625
		03	2 Middlebrook Road, Bella Vista	650
NCA 03	170	01	38A Ridgehaven Place, Bella Vista	235
		02	54 Ridgehaven Place, Baulkham Hills	160
		03	19-21 Jacqui Cct, Baulkham Hills	140
		04	16 Evesham Ct, Baulkham Hills	190
		05	32 Fairmont Avenue, Baulkham Hills	330
NCA 04	100	01	7-9 Plover Glen, Baulkham Hills	360

3.4.4.2 Other Land Uses

An indicative list of the nearest 'other' sensitive receivers to the Norwest Pedestrian Link works is summarised in Table 20 The location of 'other' noise sensitive receivers near the Project works is identified on the figure in Annexure B.

Table 20 Other Sensitive Receivers

Land Use	Property ID	Receiver Address	Approximate Distance to Site (m)
Place of worship	NWO 01	Hillsong Convention Centre, 1-9 Solent Circuit Baulkham Hills	140
	NWO 02	Hillsong Chapel, 1-9 Solent Circuit, Baulkham Hills	205
Education	NWO03	Hillsong International Leadership College	150
	NWO 04	Parkview Childcare Centre, 4 Century Circuit, Baulkham Hills	140
	NWO 05	Norwest Childcare Centre, 2 Maitland Place, Baulkham Hills	525
Commercial	NWO 06	Shell Service Station, 4 Century Circuit, Baulkham Hills	70

Land Use	Property ID	Receiver Address	Approximate Distance to Site (m)
(office and retail)	NWO 07	Norwest Market Town shopping centre	95
	NWO 08	2 Century Circuit, Baulkham Hills	140
	NWO 09	Block A, Capital Business Centre, 38 Norwest Boulevard, Baulkham Hills	60
	NWO 10	19 Brookhollow Avenue, Baulkham Hills	150
	NWO 11	21 Brookhollow Avenue, Baulkham Hills	165
	NWO 12	Adina Apartments Hotel, 22 Brookhollow Avenue, Baulkham Hills	350

3.4.4.3 Noise Management Levels

Table 21 following identifies the adopted construction noise management levels for each NCA for the day, evening and night period as defined by the ICNG. The construction noise management levels are conservative, derived from the lowest measured Rating Background Level (RBL) within the local noise environment.

The location of the NCAs and the relevant background noise monitoring locations are marked on the figures provided in Annexure B.

Table 21 Noise Management Levels

NCA	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$			Sleep NML
		Day	Eve	Night	Day	Eve	Night	$L_{A1(1min)}$
NW 01	4 Peninsula Way, Baulkham Hills	47	45	38	57	50	43	65
	92 Central Park Ave, Baulkham Hills							
	29 Central Park Ave, Baulkham Hills							
NW 02	2 Ashburn Close, Bella Vista	47	45	38	57	50	43	65
	1 Glenview Close, Bella Vista							
	2 Middlebrook Road, Bella Vista							
NW 03	38A Ridgehaven Place, Bella Vista	47	45	38	57	50	43	65
	54 Ridgehaven Place, Baulkham Hills							
	19-21 Jacqui Cct, Baulkham Hills							
	16 Evesham Ct, Baulkham Hills							
	32 Fairmont Avenue, Baulkham Hills							
NW 04	7-9 Plover Glen, Baulkham Hills	47	45	38	57	50	43	65
NWO 01	Hillsong Convention Centre, 1-9 Solent Circuit Baulkham	47	-	-	55	-	-	-

NCA	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$			Sleep NML
	Hills							
NWO 02	Hillsong Chapel, 1-9 Solent Circuit, Baulkham Hills	47	-	-	55	-	-	-
NWO 03	Hillsong Internation Leadership College	47	-	-	55	-	-	-
NWO 04	Parkview Childcare Centre, 4 Century Circuit, Baulkham Hills	47	-	-	55	-	-	-
NWO 05	Norwest Childcare Centre, 2 Maitland Place, Baulkham Hills	47	-	-	55	-	-	-
NWO 06	Shell Service Station, 4 Century Circuit, Baulkham Hills	47	-	-	75	-	-	-
NWO 07	Norwest Market Town shopping centre	47	-	-	70	-	-	-
NWO 08	2 Century Circuit, Baulkham Hills	47	-	-	70	-	-	-
NWO 09	Block A, Capital Business Centre, 38 Norwest Boulevard, Baulkham Hills	47	-	-	70	-	-	-
NWO 10	19 Brookhollow Avenue, Baulkham Hills	47	-	-	70	-	-	-
NWO 11	21 Brookhollow Avenue, Baulkham Hills	47	-	-	70	-	-	-
NWO 12	Adina Apartments Hotel, 22 Brookhollow Avenue, Baulkham Hills	47	45	38-	57	50	43	65

3.4.5 33kV Underground Feeder Powerline Works

3.4.5.1 Noise and Vibration Sensitive Residential Receivers

The noise assessment methodology for the works included a qualitative assessment along the majority of the route where short-term works will occur, with three areas identified for quantitative assessment where noise intensive activities occur for longer than three weeks or over consecutive nights.

An indicative list of the nearest sensitive residential receivers in each of the three quantitative assessment areas is summarised below based on the information produced in the 33kV Underground Feeder Powerline REF.

Further to this, Appendix B contains a figure showing the location of the monitoring sites and the identified representative noise sensitive receivers drawn from the REF. Note that the list of receivers presented below is for report presentation only. Noise levels will be predicted to all noise sensitive receivers surrounding the worksites as part of the preparation of CNVISs.

Table 22 Residential Receivers

Area	Property ID	Representative Residential Address	Approximate Distance to Site (m)
Gore Hill Freeway	R1	18-22 Parkes Road Artarmon	60
	R2	10-16 Parkes Road Artarmon	15
	R3	2 Parkes Road Artarmon	15
	R4	23-27 Parkes Road Artarmon	50
	R5	6-10 Parkes Road Artarmon	55
	R6	6-10 Hampden Road Artarmon	15
Hampden Road	R7	36 Hampden Road Artarmon	15
	R8	38 Hampden Road Artarmon	15
	R9	33 Hampden Road Artarmon	10
	R10	35 Hampden Road Artarmon	10
	R11	52 Burra Road	100
	R12	3 Elizabeth Street	85
	R13	2 Broughton Road	75
	R14	1-3 Broughton Road	75
	R15	7-9 Valetta Lane	62
	R16	2 Francis Road	80
	R17	1 Francis Road	75
	R18	67 Hampden Road	60
	R19	8-10 Brand Street	20
	R20	4 Brand Street	20
	R21	2 Brand Street	20
	R22	5 Brand Street	10
	R23	9 Brand Street	10
	R24	3 Brand Street	10
	R25	31 Elizabeth Street	20
Mowbray Road	R27	1A Devonshire Street	10

Area	Property ID	Representative Residential Address	Approximate Distance to Site (m)
	R28	77 Devonshire Street	10
	R29	68 Stafford Road	10
	R30	297 Mowbray Road	95

3.4.5.2 Other Land Uses

An indicative list of the nearest 'other' sensitive receivers where a quantitative assessment has been performed is summarised in Table 23 The location of 'other' noise sensitive receivers near the Project works is identified on the figure in Annexure B.

Table 23 Other Sensitive Receivers

Land Use	Property ID	Receiver Address	Approximate Distance to Site (m)
Hotel	C1	Freeway Hotel, 115 Reserve Road, Artarmon	55
Commercial	C2	1-5 Dickson Avenue	25
Commercial	C3	2 Waltham Street	10
Commercial	C4	1-3 Waltham Street	15
Child Care Centre	C5	9 Waltham Street, Artarmon	70
Educational Facility	C6	Artarmon Primary School, McMillan Road, Artarmon	85
Commercial	C7	44 Hampden Road, Artarmon	5-10
Commercial	C8	64-94 Hampden Road, Artarmon	10
Commercial	C9	96-106 Hampden Road, Artarmon	5
Commercial	C10	110-128 Hampden Road, Artarmon	5
Commercial	C11	22 Wilkes Avenue	60
Commercial	C12	130-136 Hampden Road, Artarmon	5
Commercial	C13	142 Hampden Road, Artarmon	5
Aged Care Facility	R26	Willowood Centre, 297 Mowbray Road, Chatswood	95
Commercial		Chatswood Auto Repairs, 2 Devonshire Street, Chatswood	5

Land Use	Property ID	Receiver Address	Approximate Distance to Site (m)
Place of Worship		Seventh Day Adventist Church, 50 Johnson Street, Chatswood	5
Place of Worship		Salvation Army Church, 23 Archer Street, Chatswood	10
Commercial		29 Bertram Street, Chatswood	8
Child Care Facility		Chatswood International Kindergarten, 30/32 Albert Avenue, Chatswood	90
Place of Worship		Second Church of Christ, Scientist, Sydney, 26 Anthony Street, Chatswood	10
Hopsital ward and operating theatres		Ophthalmic Surgery Centre / Chatswood Eye Centre 6/12-14 Malvern Avenue, Chatswood	90
Commercial		Chatswood Village, 47 Oscar Street, Chatswood	5
Commercial		Chatswood Chase, 345 Victoria Avenue, Chatswood	15
Educational Facility		Mercy Catholic College, 101 Archer Street, Chatswood	95
Active Recreation Area		Beauchamp Park	10

3.4.5.3 Noise Management Levels

Background noise levels were measured at three locations representative of the nearest sensitive receivers identified for quantitative assessment. Table 24 following identifies the adopted construction noise management levels for the day, evening and night period as defined by the ICNG.

Table 24 Noise Management Levels

Noise Monitoring Location	Rating Background Level (RBL) LA90			Noise Management Level LAeq(15min)		
	Day	Eve	Night	Day	Eve	Night
Gore Hill / Simpson Street	51	48	39	61	53	44
Hampden Road	52	47	41	62	52	46
Mowbray Road	56	51	45	66	56	50

3.4.6 Rouse Hill Temporary Bypass Powerline Works

Works would be localised and of a short duration at each site. Additionally, apart from the Castlebrook Memorial Park there are no adjacent sensitive receivers. At times works may be required out of standard working hours, particularly where road opening permits stipulate.

Castlebrook Memorial Park is an active Cemetery with many funerals carried out daily, plus many visitors at all times of the day. Castlebrook carries out burial lawn ceremonies which have the potential to be in close proximity to the works.

3.5 Evaluation and Assessment of Construction Noise and Vibration Impacts

3.5.1 Site and Activity Construction Noise Impact Statements

Construction Noise Impact Statements (CNIS) will be prepared during project delivery to address the different phases of construction and for EPL variations and working outside of approved hours. Site- and activity-specific Construction Noise Impact Statements (CNIS) will be prepared to address:

- RTRF and Cudgegong Road site establishment and enabling works
- RTRF and Cudgegong Road civil works
- Out of hours local area (road) Works and utility relocation, protection and connection works surrounding RTRF and Cudgegong Road CNIS
- RTRF to Epping – station and fixed facility construction, fit-out and precinct works
- RTRF to Epping rail systems – tunnel systems, at-grade and viaduct fitout
- ECRL possession works
- ECRL above ground platform works
- ECRL civil works
- Station Construction Works
- Corridor Construction Works
- Out of hours work for specific activities as required
- RTRF to Chatswood – testing and commissioning.

Site specific management measures identified in the CNIS will be incorporated into the Site Environment Plans.

3.5.2 Process for Assessing Construction Noise and Vibration

The format of the CNISs and process of assessment of impacts are detailed in the Figure 4 below.

Figure 8 Process for Assessing Construction Noise and Vibration

1. Determine noise and vibration objectives

For each key construction area:

- Describe of the proposed activities including duration of the proposed out of hours works and how often the works are required.
- Identify noise sensitive receivers
- Determine relevant noise and vibration objectives, with reference to Section 3.

Note: Assessment usually undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to construction works.

2. Identify Construction Stages

For each key construction area:

- Identify construction aspects or stages and key activities for each stage
- Include:
  - the site location;
  - times of operation;
  - processes involved;
  - plant & equipment (inc. size / type).
- Identify construction works in the vicinity of the project. Liaise with Proponent to ensure cumulative noise & vibration impacts are managed, in particular in relation to OOHW.

3. Predict Noise and Vibration Impacts

Airborne Construction Noise

- Determine $L_{Aeq(15\ minute)}$ sound power levels (potential noise and vibration impacts) based on operating scenarios for input to noise model (see below).
- Establish noise model for construction activity/ component.
- The noise model should include:
  - Height and location of sources and receivers;
  - Distance attenuation (incorporating noise reflections and ground absorption);
  - Effects of noise shielding (topography, buildings, boundary fences, noise barriers etc); and
  - Effects of *standard* noise mitigation measures.
  - Calculate the $L_{Aeq(15minute)}$ noise levels from the proposed construction activities at each receiver and compare these with the construction noise objectives.
  - For night-time activities, calculate the maximum (L_{Amax}) noise levels and compare with $L_{A1(1min)}$ 65 dB(A) sleep disturbance criterion, applied at the external facade.

Ground-borne Construction Noise

- Determine the location of each plant or equipment item in relation to each receiver.
- On the basis of ground-borne noise levels versus distance prediction curves for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building.

Construction Vibration

- Determine the location of each plant or equipment item in relation to each receiver.
- Where vibration intensive equipment could potentially be operating in close proximity to receivers, determine whether this is within the minimum working distances identified in Table 13. Note that minimum working distances may differ for heritage items;
- Where plant & equipment may operate within minimum working distances, or for heritage items:
- Use vibration levels vs distance prediction curves for each plant item
- Determine the vibration likely to occur at each building location

	• For highly sensitive equipment, assessment may need to incorporate structural response of building & particular sensitivities of equipment.
Construction Related Road Traffic Noise	• Identify truck haulage routes to be used to access site and confirm hourly construction traffic volumes (light and heavy vehicles) for day (7am to 10pm) and night (10pm to 7am). • Confirm existing traffic volumes on public roads accessed for truck haulage. • Predict traffic noise levels on public roads used by construction vehicles, both with and without construction traffic, for comparison against road traffic noise management levels. • Review and confirm sleep disturbance impacts from truck entry/ egress points and on public roads.

4. Assess Noise and Vibration Impacts

Where predicted noise and vibration exceeds the objectives identified in Step 1:	• Implement appropriate reasonable/ feasible standard mitigation measures (see Section 4.1 • Predicted noise / vibration at receivers, incorporating nominated mitigation measures, based on the expected noise reduction from mitigation measures. • Additional mitigation measures may need to be considered. Note: Assessment usually undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to construction works.

3.5.3 Approach to 24 Hour Tunnel Works

SSI-5414 and the ECRL Determination Report allows for works in tunnels and underground activities to be undertaken 24 hours per day, seven days per week.

This does not apply to above ground works. Above ground works are subject to construction hours as outlined in Section 3.2.

3.5.4 Approach to Blasting

There is no blasting anticipated on the OTS contract.

4 Noise and Vibration Management

4.1 Standard Noise and Vibration Mitigation Measures

Table 25 sets out standard noise and vibration mitigation measures to be implemented during the OTS construction works as required to reduce construction noise and vibration.

Table 25 Standard noise and vibration mitigation measures

	Action Required	Applies to	Details	Responsibility
Construction Planning	Building condition surveys	Vibration	Offer building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage. Where accepted, a comprehensive written and photographic condition report will be produced prior to relevant works commencing.	Construction Manager Environment Coordinator
	Implement community consultation measures – inform community of construction activity & potential impacts	Airborne noise Ground-borne noise Vibration	See Community Liaison Implementation Plan	Stakeholder & Community Relations Manager Environment Manager Environment Coordinator
	Work scheduling around sensitive areas	Airborne noise Ground-borne noise Vibration	Prior to the commencement of construction works, consultation would be conducted with sensitive receivers (such as places of worship) to determine times of the day when there would be the potential for greater impacts (i.e. quiet times). Where practical, high impact works would be scheduled around these times. Potentially affected pre-schools, schools, universities and any other affected permanent educational institutions shall be consulted in relation to noise mitigation measures to identify any noise sensitive periods, e.g. exam periods. As much as reasonably possible noise intensive construction works in the vicinity of affected educational buildings are to be minimised. During detailed design, consideration would be given to breaking up the construction program between Hampden Road/Brand Street and other locations where proposed night works are to be undertaken. The intention of this would be to assist in providing respite periods to any potentially impacted sensitive receivers/residents along Hampden Road and Brand Street throughout the construction works. Schedule works around lawn ceremonies when required and in conjunction with Castlebrook Memorial Park.	Stakeholder & Community Relations Manager Environment Manager
	Cumulative construction noise and vibration impacts	Airborne noise Ground-borne noise Vibration	Consult proponents of other construction works in the vicinity of the Project area, in accordance with SSI-5414 CoA E23, including the NWRL Surface and Viaducts Civil (SVC) works. Undertake reasonable steps to coordinate works to minimise impacts on, and maximise respite for, affected sensitive	Stakeholder & Community Relations Manager Environment Manager Environment Coordinator

	Action Required	Applies to	Details	Responsibility
			receivers.	
	Site inductions	Airborne noise Ground-borne noise Vibration	All employees, contractors & subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes & must include: • relevant licence & approval conditions; • permissible hours of work; • any limitations on high noise generating activities; • location of nearest sensitive receivers; • construction employee parking areas; • relevant site-specific mitigation measures • appropriate behavioural practises	Environment Coordinator
	Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of items & slamming of doors.	Environment Coordinator Site Supervisor
	Equipment selection	Airborne noise Vibration	Use quieter & less noise/ vibration emitting construction methods where feasible & reasonable. Where vibration intensive equipment is used within the minimum working distances identified in Table 11, determine whether alternative construction methodology or less vibration intensive equipment can be used, e.g. use bored piles rather than impact or percussion piling.	Area Project Managers Project Engineers Site Supervisors Environment Coordinators
	Rental plant and equipment	Airborne noise	The noise levels of plant & equipment items are to be considered in rental decisions.	Area Project Managers Project Engineers Site Supervisors
	Plan worksite and activities to minimise noise and vibration.	Airborne noise Vibration	Plan traffic flow, parking & loading/unloading areas to minimise reversing movements within the site. NB. Night-time truck access at Bella Vista Station site would be via the Celebration Dr roundabout to the south of the site	Construction Manager Area Project Managers Project Engineers Site Supervisors Environment Coordinator
Hours of Work	Construction hours and scheduling	Airborne noise Ground-borne noise Vibration	Where feasible & reasonable, construction should be carried out during the standard construction hours identified in Section 3.2 of this Plan. Identify sensitive land uses and implement mitigations including altering hours of impact outside of sensitive periods Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods if practicable as required by the EPL. Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receptors would result in reduced noise emissions	Construction Director Construction Manager Site Supervisor Environment Coordinator
	Construction respite period	Airborne noise Ground-borne noise	Activities with impulsive or tonal noise emissions (such as jack hammering, rock breaking, rock hammering) may only be undertaken as detailed in Section 3.2.3 of this Plan unless otherwise specified in the EPL.	Construction Director Construction Manager Site Supervisor Environment Coordinator Stakeholder and

Action Required		Applies to	Details	Responsibility
				Community Relations Manager
	Out of Hours Works	Airborne noise Ground-borne noise Vibration	Out of Hours Works to be undertaken in accordance with the Project Approval Conditions, EPL conditions and this Plan. Test would be programmed to minimise the number of consecutive nights impacting the same receptors, where possible	Construction Director Construction Manager Site Supervisor Environment Coordinator
	Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Ensure all deliveries occur during standard construction hours, except where detailed in 3.2.4.	Construction Manager Project Engineer Site Supervisor Environment Coordinator
Source Controls.	Maximum noise levels	Airborne noise	All plant & equipment to be appropriately maintained to ensure optimum running conditions, with periodic monitoring as per Section 4.3.1.1.	Area Project Managers Project Engineers Site Supervisors Environment Coordinator
	Use and siting of plant	Airborne noise Vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/ avoided where possible. The offset distance between noisy plant & adjacent sensitive receivers is to be maximised where practicable. Plant used intermittently to be throttled down or shut down when not in use where practicable. Regular compliance checks on the noise emissions of all plant and machinery used for the proposal Noise-emitting plant to be directed away from sensitive receivers where possible, particularly during OOHW. NOTE: Due to limited land available for construction this may not at times be practical.	Area Project Managers Project Engineers Site Supervisors
	Non-tonal reversing alarms.	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted & used on all construction vehicles & mobile plant regularly used on site for periods of over two months, where practicable, and on all equipment required for OOHW.	Construction Manager Area Project Managers Project Engineers Site Supervisors Environment Coordinator Environment Coordinator
Path Controls	Shield sensitive receivers from noisy activities.	Airborne noise	Where reasonable & feasible, use structures to shield residential receivers from noise such as: • site shed placement; • earth bunds; • hoarding • enclosures to shield fixed noise sources such as pumps, compressors, fans etc. (where practicable); • Where feasible and reasonable, operation noise barriers shall be implemented at the start of construction (or at other times during construction) to minimise construction noise impacts For construction concentrated in a single area, temporary acoustic fencing/barriers around the site perimeter would be considered where feasible and reasonable to mitigate off-site noise levels During underbore works utilise the	Area Project Managers Project Engineers Site Supervisors

Action Required		Applies to	Details	Responsibility
			following controls: • Use a portable barrier (or similar protection) to shield the underbore equipment where works occur in proximity to residential receivers where reasonable and feasible. The height and nature of the barrier would be determined when the equipment selection is finalised. The barrier would be construction of a material of minimum mass 12 kilograms per metre squared such as 20 millimetre plywood or a proprietary barrier such as Echobarrier. • Carry out underbore works within standard construction hours, where this is considered to be feasible. • Orientate and locate underbore equipment to minimise noise impact to residential receivers, where this is considered to be feasible Notification to surrounding residents of planned works prior to the works commencing	
Monitoring	Monitoring	Airborne noise Ground-borne noise Vibration	Air blast overpressure, noise & vibration monitoring will be monitored during construction: • as required by the EPL; • As detailed in Section 4.3. • Any necessary adaptive management requirements will be identified and implemented where reasonable and feasible.	Environment Coordinator Environment Coordinator
	Site specific attended vibration measurements	Vibration	Representative attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration is within the acceptable range to prevent cosmetic building damage.	Environment Coordinator
EPL	Implementation of any additional measures required by the EPL conditions	Airborne noise Vibration	Any additional measures required by the OTS-PPP construction EPL are to be implemented as required and detailed in Annexure A	Construction Manager Area Project Managers Project Engineers Site Supervisors Environment Coordinator Environment Coordinator

4.2 Additional Noise and Vibration Mitigation Measures

During the OTS PPP construction works there will be a number of circumstances where after application of the standard mitigation measures identified Table 25, the construction noise and vibration objectives (refer Section 3.3) will be exceeded. In these instances, additional noise and vibration mitigation may be applicable, taking into consideration the time period works are being undertaken and the level of exceedance.

Additional mitigation measures to be considered in preparing CNISs include:

- Phone calls: phone calls detailing relevant information would be made to identified/ affected stakeholders;

- Letter box drops: used to disseminate information to interested stakeholders and/or to provide advanced warning of high noise impact activities during the day or potentially audible OOHW activities (can also be emailed);
- Individual briefings: used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented;
- Respite offer (OTS PPP works specific): residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer (e.g. pre-purchased movie tickets);
- Specific notifications: letterbox dropped, emailed or hand delivered to advise stakeholders that construction activities are likely to exceed the noise objectives;
- Monitoring: noise or vibration monitoring offered to stakeholders in the event of complaints relating to noise or vibration emanating from the construction works
- Alternative accommodation: offered to residents living in close proximity to construction works that are likely to incur noise and/ or vibration significantly above the applicable levels in Section 3.3.

The following sections outline the approach to be taken in the adoption of additional mitigation measures during construction.

4.2.1 Additional Airborne Noise Mitigation Measures

Table 26 below should be used to advise the appropriate additional noise mitigation.

Table 26 Additional Airborne Noise Mitigation Measures

Time Period		Mitigation Measures/Predicted $L_{Aeq(15min)}$ Noise Level above RBL			
		0 to 10 dB(A) Noticeable	10 to 20 dB(A) Clearly audible	20 to 30 dB(A) Moderately intrusive	>30 dB(A) Highly intrusive
Standard	Mon-Fri (7:00 am - 6:00 pm) Sat (8:00 am – 1:00 pm) Sun/ Public Hol. (Nil)	-	-	Letterbox drop Monitoring	Letterbox drop Monitoring
OOHW Period 1	Mon-Fri (6:00 pm - 10:00 pm) Sat (7:00 am - 8:00 am & 1:00 pm - 10:00 pm) Sun/ Public Hol (8:00 am -6:00 pm)	-	Letterbox Drop	Letterbox drop Monitoring	Letterbox drop Monitoring Individual Briefing Respite Offer Phone Calls Specific Notification
OOHW Period 2	Mon-Fri (10:00 pm - 7:00 pm) Sat (10:00 pm - 7:00 am) Sun/ Public Hol (6:00 pm - 8:00 am)	Letterbox Drop	Letterbox drop Monitoring	Letterbox drop Monitoring Individual Briefing Phone Calls Specific Notification	Letterbox drop Monitoring Individual Briefing Phone Calls Specific Notification Alternate Accommodation

4.2.2 Additional Ground-borne Noise Mitigation Measures

Table 27 below should be used to advise the appropriate additional ground-borne noise mitigation.

Table 27 Additional Ground-borne Noise Mitigation Measures

Time Period		Mitigation Measures/Predicted $L_{Aeq(15min)}$ Noise Level Exceedance		
		0 to 10 dB(A) Clearly audible	10 to 20 dB(A) Moderately intrusive	>20 dB(A) Highly intrusive
Standard	Mon-Fri (7:00 am - 6:00 pm) Sat (8:00 am – 1:00 pm) Sun/ Public Hol (Nil)	Letterbox drop	Letterbox drop	Letterbox drop Monitoring Specific Notification
OOHW Period 1	Mon-Fri (6:00 pm - 10:00 pm) Sat (7:00 am - 8:00 am & 1:00 pm - 10:00 pm) Sun/ Public Hol (8:00 am -6:00 pm)	Letterbox drop	Letterbox drop Monitoring Respite Offer Specific Notification	Letterbox drop Monitoring Individual Briefing Respite Offer Phone Calls Specific Notification
OOHW Period 2	Mon-Fri (10:00 pm - 7:00 pm) Sat (10:00 pm - 7:00 am) Sun/ Public Hol (6:00 pm - 8:00 am)	Letterbox drop Monitoring Specific Notification	Letterbox drop Monitoring Individual Briefing Respite Offer Phone Calls Specific Notification Alternate Accommodation	Letterbox drop Monitoring Individual Briefing Respite Offer Phone Calls Specific Notification Alternate Accommodation

4.2.3 Additional Vibration Mitigation Measures

Table 28 below should be used to advise the appropriate additional ground-borne vibration mitigation.

Table 28 Additional Ground-borne Vibration Mitigation Measures

Time Period		Mitigation Measures/Predicted Vibration Exceeds Maximum Levels	
Standard	Mon-Fri (7:00 am - 6:00 pm) Sat (8:00 am – 1:00 pm) Sun/ Public Hol (Nil)	Letterbox drop Monitoring Respite Offer	
OOHW Period 1	Mon-Fri (6:00 pm - 10:00 pm) Sat (7:00 am - 8:00 am & 1:00 pm - 10:00 pm) Sun/ Public Hol (8:00 am -6:00 pm)	Letterbox drop Monitoring Individual Briefing	Respite Offer Phone Calls Specific Notification
OOHW Period 2	Mon-Fri (10:00 pm - 7:00 pm) Sat (10:00 pm - 7:00 am) Sun/ Public Hol (6:00 pm - 8:00 am)	Letterbox drop Monitoring Individual Briefing Respite Offer	Phone Calls Specific Notification Alternate Accommodation

If the predicted ground-borne vibration levels exceed the structural damage objectives in Section 3.3.3, a different construction method with lower source vibration levels should be considered. Attended measurements should be undertaken at the commencement of all high vibration generating activities. If there is any risk of exceedance of the structural damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc.) when vibration levels are approaching the structural damage objective.

4.3 Monitoring, Auditing and Reporting

4.3.1 Noise Monitoring

4.3.1.1 Plant and Equipment Noise Audits

A Plant Induction Process will be put in place for the OTS PPP construction stage. Part of the Plant Induction Process will be to complete periodic noise audits of plant and equipment in use to confirm actual plant noise levels are within the Table 6 maximum noise levels.

Plant and equipment noise monitoring procedure is further detailed in Appendix D.

4.3.1.2 Airborne Noise Monitoring in the Community

Attended monitoring of construction noise levels will be undertaken as follows:

- within a period of 14 days from the commencement of construction activity to confirm the effectiveness of actions and measures determined in CNIS process;
- repeated on a three-monthly basis or as described in the CNIS, as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNIS;
- where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis);
- During sensitive periods (i.e. night works)
- As otherwise required by the EPL.
- A directed by an authorised officer of the EPA.

Monitoring would be undertaken at the potentially most exposed receivers in proximity to construction activities. Noise monitoring locations should be consistent with the distances/ locations identified in the CNISs and will consider factors including:

- the location of previous monitoring sites;
- the proximity of the receiver to a worksite;
- the sensitivity of the receiver to noise;
- background noise levels; and
- the expected duration of the impact.

In addition to the above, noise measurements will be conducted in the Gold Class cinema complex at Castle Hill during high vibration activities (as identified in the CNVIS) to determine ground-borne noise levels inside the cinemas.

Where monitoring indicates that the NML's are not being complied, work practices would be reviewed and further mitigation measures applied where reasonable and feasible.

Monitoring may also be undertaken in response to a complaint where this is considered an appropriate response in accordance with the EPL. The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise, who is familiar with the requirements of the relevant standards and procedures.

4.3.1.3 Ground-borne Noise Monitoring in the Community

Attended monitoring of ground-borne construction noise levels will be undertaken as follows:

- where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis);
- as otherwise required by the EPL.

Monitoring would be undertaken in the most affected room of the residence or other sensitive building. Note that the room selected for noise monitoring should be well shielded from airborne noise intrusions, such as road traffic noise; to allow the ground-borne noise to dominate over non-construction generated airborne noise.

The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise, who is familiar with the requirements of the relevant standards and procedures (refer Appendix D).

4.3.2 Vibration Monitoring

Attended vibration monitoring is to be undertaken as follows:

- At the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so to refine the indicative minimum working distances set out in Table 11 and provide a site-specific table of minimum working distances
- Where it is not feasible to modify construction methodology to reduce vibration intensive construction activities within the minimum working distances for cosmetic damage;
- For short periods of potential risk for cosmetic damage to buildings and structures; and
- Where deemed to be relevant to construction works in response to a vibration related complaint.
- As directed by an authorised officer of the EPA.

Where attended vibration monitoring is not feasible, due to extended periods of vibration intensive works, a permanent vibration monitoring system is to be installed to warn plant operators (via flashing light, audible alarm, etc.) that there is potential cosmetic damage to buildings and structures.

Plant and equipment vibration measurement procedures are further detailed in (refer: Appendix D).

5 Complaints Handling and Incident Response

NRT will handle enquiries/ complaints in a responsive manner. Throughout the works, the team will be making contact with multiple and varied internal and external stakeholders. The Community Liaison Implementation Plan details procedures to ensure that the process of dealing with RTRF Works enquires and complaints by the NRT Works team is consistent and in line with the Project's enquiry and complaints handling management policies.

The Environment Manager and Environment Coordinator will assist the Stakeholder and Community Relations Manager in responding to environmental complaints and maintain a register of Environmental Complaints for reporting to the EPA and other relevant agencies.

Transport for NSW operate a 24 hour construction complaints line (1800 019 989). Enquiries/ complaints may also be received through the Project email (info@northwestrail.com.au).

Complaints will be responded to within two hours, unless otherwise requested by the complainant. The response will confirm the action to be undertaken.

Where noise or vibration monitoring/ investigation is required, a Preliminary Investigation Report will be provided to the EPA in accordance with the timeframe specified in the EPL (See Annexure A – Condition M6.5 and M6.6) following any noise or vibration monitoring. A Follow-up Investigation Report will be provided if required to satisfy the EPL.

In relation to construction hours, including for standard and out of hours activities, the SSI shall be constructed to comply with an EPL applying to the SSI, including all relevant noise mitigation and management measures. In the event of a dispute between the Proponent (including its contractors) and the EPA, in relation to construction hours, either party may refer the matter to the Director General for resolution.

6 Training, Reporting and Review

6.1 Training

All personnel working on the site will undertake a site induction, which will provide initial training on various environmental aspects including Noise and vibration.

Additional training will be provided to the workforce during toolbox talk which will explain the aspects of noise monitoring in further detail. The tool box will be presented when seasonal weather or changes in work practices (e.g. OOHW) increases the risk of adverse impact from noise and/ or vibration.

6.2 Compliance and Reporting

Monitoring and inspection will be recorded on the Weekly Environmental Inspection Forms. The results of noise and vibration monitoring will be documented and provided to the EPA in accordance with the EPL.

The Environmental Representative will inspect the site regularly and will inspect any noise and vibration control measures.

Typical Compliance records would consist of:

- Inspections undertaken in relation to noise and vibration management measures
- Weekly Environmental Inspection forms
- Toolbox training records
- Noise record sheets from plant and environmental noise monitoring
- Noise monitoring records by specialist consultants
- Vibration monitoring records, records of enquiries and complaints
- Records of noise and vibration monitoring results against appropriate NML's and vibration criteria
- Records of community enquiries and complaints and NRT's response.

Results and outcomes of inspections, monitoring and auditing will be reported internally on a monthly basis. Records are to include a comparison of measured noise and vibration monitoring results against the noise and vibration management levels. Six-monthly construction compliance reports will be prepared to report on compliance with the Project Approval.

6.2.1 Noise and Vibration Reports

Upon request of an authorised officer of the EPA, the licensee must submit a Preliminary Investigation Report to the EPA in respect of any noise or vibration monitoring undertaken in

accordance with the requirements of Condition M6.5 or a direction made pursuant to Condition M7.4.

6.3 Review and Improvement

A non-conformance is an action or omission that does not conform to the requirements of this Plan or any legal and other requirements. Any member of the project team or the Environmental Representative can identify a non-conformance or opportunity for improvement. The CEMP identifies the process for identifying, reporting, recoding and reviewing non-conformances. This will ensure continual improvement.

The processes described in the CEMP may result in the need to update or revise this Plan. This will occur as needed. This Plan will be audited within six months of the commencement of construction and thereafter as per the CEMP. The Plan shall be reviewed and updated based on the findings of the audit.

Annexure A. Noise and Vibration Management Measures and Compliance Matrix

No,	Condition	Timing	Requirement	Responsibility	Reference
Project Approval – Specific Management Plan Requirements					
1)	Construction Noise and Vibration Management Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECC, 2009) and Assessing Vibration: a technical guide (DEC,2006) The plan shall be developed in consultation with the EPA and shall include, but not be limited to:	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	This Plan
2)	(i) identification of work areas, site compounds and access points;	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 3.3 Annexure B
3)	(ii) identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval;	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 3.2 and 3.3

No,	Condition	Timing	Requirement	Responsibility	Reference
4)	(iii) details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 3.4
5)	(iv) identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise impacts (including construction traffic noise impacts), including, but not limited to, acoustic enclosures ,erection of noise walls (hoardings), respite periods and the limiting of truck movements during night periods	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 4
6)	(v) identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program applicable buffer distances for vibration intensive works, use of low-vibration generating equipment/ vibration dampeners or alternative construction methodology and pre-and post-construction dilapidation survey of sensitive structures where blasting and/or vibration is likely to result in damage to buildings and structures(including surveys being undertaken immediately following a monitored exceedance of the criteria);	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 3.4.4
7)	(vi) if blasting is required, an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program;)	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 3.4.4

No,	Condition	Timing	Requirement	Responsibility	Reference
8)	(vii) a description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any non- compliance would be rectified; and	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 4.3
9)	(viii) mechanisms for the monitoring, review and amendment of this plan.	Before Construction	RTRF Approval SSI-5931 CoA E29(b) OTS Approval SSI-5414 CoA E35(b)	Environment Manager	Section 1.7 Section 6.3
10)	Prior to construction, a detailed land use survey to identify potentially critical areas that are sensitive to construction noise (airborne and ground-borne) and vibration impacts shall be undertaken. The results of the survey shall be incorporated into the Construction Noise and Vibration Management Plan (condition E29(b)).	Before Construction	RTRF Approval SSI-5931 CoA E4	Environment Manager	Section 3.3 Annexure B
11)	Construction activities associated with the SSI shall be undertaken during the following standard construction hours: (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; and (b) 8:00am to 1:00pm Saturdays; (c) at no time on Sundays or public holidays.	During Construction	RTRF Approval SSI-5931 CoA E5	Environment Manager Site Supervisor	Section 3.1

No,	Condition	Timing	Requirement	Responsibility	Reference
12)	Construction works outside of the standard construction hours identified in condition E5 may be undertaken in the following circumstances: (a) construction works that generate air-borne noise that is: (i) no more than 5 dB(A) above rating background level at any residence in accordance with the Interim Construction Norse Guideline (DECC, 2009); (ii) no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers; (b) where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved; (c) for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; (d) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; and (e) works approved through an EPL	During Construction	RTRF Approval SSI-5931 CoA E6	Environment Manager Planning and Approvals Manager	Section 3.1.2 and 3.4.2
13)	Except as expressly permitted by an EPL, activities resulting in impulsive or tonal noise emission (such as rock breaking, rock hammering, pile driving) shall only be undertaken: (a) between the hours of 8:00 am to 5:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. For the purposes of this condition 'continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.	During Construction	RTRF Approval SSI-5931 CoA E7	Environment Coordinator Site Supervisor	Section 3.1.3
14)	The SSI shall be constructed with the aim of achieving the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the Construction Noise and Vibration Management Plan (condition E29(b)). Note: The Interim Construction Noise Guideline identifies 'particularly annoying' activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML.	During Construction	RTRF Approval SSI-5931 CoA E8	Environment Coordinator Site Supervisor	Section 3.2.1.1

No,	Condition	Timing	Requirement	Responsibility	Reference
15)	The SSI shall be constructed with the aim of achieving the following construction vibration goals: (a) for structural damage, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures; and (b) for human exposure, the acceptable vibration values set out in the Environmental Norse Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).	During Construction	RTRF Approval SSI-5931 CoA E9	Environment Coordinator Site Supervisor	Section 3.2.3
16)	Where feasible and reasonable, operation noise mitigation measures, such as noise barriers shall be implemented at the start of construction (or at other times during construction) to minimise construction noise impacts.	During Construction	RTRF Approval SSI-5931 CoA E10	Environment Coordinator Site Supervisor	Section 3.4.2 and Section 4.1
17)	The Proponent shall consult with potentially-affected community, religious and educational institutions to ensure, where feasible and reasonable, that noise generating construction works in the vicinity of the institutions are not timetabled during sensitive periods, unless appropriate other arrangements are made	During Construction	RTRF Approval SSI-5931 CoA E11	Communications and Stakeholder Manager	Section 4.1 Section 5
18)	During construction, Proponents of other construction works in the vicinity of the SSI shall be consulted, and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	During Construction	RTRF Approval SSI-5931 CoA E12	Communications and Stakeholder Manager	Section 4.1
19)	Air-blast overpressure generated by blasting associated with the SSI shall not exceed the criteria specified in Table 1 when measured at the most affected residence or other sensitive receiver. **Table 1 Airblast overpressure criteria** **Airblast overpressure (dB(Lin Peak))** | **Allowable exceedance** 115 | 5% of total number of blasts over a 12 month period 120 | 0%	During Construction	RTRF Approval SSI-5931 CoA E13	Environment Coordinator Site Supervisor	Section 3.4.4

<table>
<tr><th>No,</th><th>Condition</th><th>Timing</th><th>Requirement</th><th>Responsibility</th><th>Reference</th></tr>
<tr><td>20)</td><td>Ground vibration generated by blasting associated with the SSI shall not exceed the criteria specified in Table 2 when measured at the most affected residence or other sensitive receiver.
Table 2 Peak particle velocity criteria<table><tr><th>Receiver</th><th>Peak particle velocity (mm/s)</th><th>Allowable exceedance</th></tr><tr><td rowspan="2">Residence on privately owned land</td><td>5</td><td>5% of total number of blasts over a 12 month period</td></tr><tr><td>10</td><td>0%</td></tr><tr><td>Historic heritage structures</td><td>3</td><td>0%</td></tr></table>These criteria do not apply if the Proponent has a written agreement with the relevant owner, and has advised the Department in writing of the terms of this agreement.</td><td>During Construction</td><td>RTRF Approval SSI-5931 CoA E14</td><td>Environment Coordinator
Site Supervisor</td><td>Section 3.4.4</td></tr>
<tr><td>21)</td><td>Wherever feasible and reasonable, piling activities shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.</td><td>During Construction</td><td>RTRF Approval SSI-5931 CoA E15</td><td>Environment Coordinator
Site Supervisor</td><td>Section 3.2.1.4
Section 4.1</td></tr>
<tr><td>22)</td><td>Construction activities associated with the SSI shall be undertaken during the following standard construction hours:
(a) 7:00am to 6:00pm Mondays to Fridays, inclusive; and
(b) 8:00am to 1:00pm Saturdays;
(c) at no time on Sundays or public holidays.</td><td>During Construction</td><td>OTS Approval SSI-5414 CoA E13</td><td>Environment Coordinator
Site Supervisor</td><td>Section 3.2</td></tr>
<tr><td>23)</td><td>Notwithstanding condition E12, track work, tunnel systems works and fit out works within the tunnel may be undertaken 24 hours, seven days a week.</td><td>During Construction</td><td>OTS Approval SSI-5414 CoA E14</td><td>Environment Coordinator
Site Supervisor</td><td>Section 3.2</td></tr>
</table>

No,	Condition	Timing	Requirement	Responsibility	Reference
24)	"Except as permitted by an EPL, activities resulting in impulsive or tonal noise emissions shall only be undertaken: (a) between the hours of 8:00 am to 5:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. For the purposes of this condition 'continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition."	During Construction	OTS Approval SSI-5414 CoA E15	Environment Coordinator Site Supervisor	Section 3.2
25)	"Notwithstanding conditions E12 to E14, construction activities outside of the prescribed construction hours may be undertaken in any of the following circumstances: (a) construction works that generate air-borne noise that is: (i) no more than 5 dB(A) above rating background level at any residence in accordance with the ICNG; (ii) no more than the noise management levels specified in Table 3 of the ICNG at other sensitive receivers; (b) construction works that generate continuous or impulsive vibration values, measured at the most affected residence, that are no more than those for human exposure to vibration, specified for residences in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006); (c) works that generate intermittent vibration values, measured at the most affected residence, that are no more than those for human exposure to vibration, specified for residences in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006); (d) where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved; (e) for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; (f) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; and	During Construction	OTS Approval SSI-5414 CoA E16	Environment Manager Planning and Approvals Manager	Section 3.2

No,	Condition	Timing	Requirement	Responsibility	Reference
	(g) works approved through an EPL, including for works identified in an out of hours During Construction procedure."				
26)	In relation to construction hours, including for standard and out of hours activities, the SSI shall be constructed to comply with an EPL applying to the SSI, including all relevant noise mitigation and management measures. In the event of a dispute between the Proponent (including its contractors) and the EPA, in relation to construction hours, either party may refer the matter to the Director-General for resolution.	During Construction	OTS Approval SSI-5414 CoA E17	Environment Manager Planning and Approvals Manager	Section 3.1.2
27)	For any section of construction where blasting is proposed, a series of initial trials at reduced scale shall be conducted prior to production blasting to determine site-specific blast response characteristics and to define allowable blast sizes to meet the air blast overpressure and ground vibration limits in this approval.	During Construction	OTS Approval SSI-5414 CoA E18	Environment Manager Planning and Approvals Manager	Section 3.4.4
28)	The SSI shall be constructed with the aim of achieving the construction noise management levels detailed in the ICNG. All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the Construction Noise and Vibration Management Plan (E34(b)). Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5dB(A) to the predicted level before comparing to the construction Noise Management Levels.	During Construction	OTS Approval SSI-5414 CoA E19	Environment Manager Planning and Approvals Manager	Section 3.2, 4.1 and 4.2
29)	The SSI shall be constructed with the aim of achieving the following construction vibration goals: (a) for structural damage, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures; and (b) for human exposure, the acceptable vibration values set out in the Assessing Vibration: a Technical Guideline (DEC, 2006). Where vibration levels exceed the acceptable vibration dose values, feasible and reasonable mitigation measures shall be considered.	During Construction	OTS Approval SSI-5414 CoA E20	Environment Manager Planning and Approvals Manager	Section 3.2 and 4.2.3

No,	Condition	Timing	Requirement	Responsibility	Reference
30)	Ground vibration generated by blasting associated with the SSI shall not exceed the criteria specified in Table 3 when measured at the most affected receiver. Table 3 - Ground Vibration criteria (Table not included) These criteria do not apply if the Proponent has a written agreement with the relevant owner, and has advised the Department in writing of the terms of this agreement.	During Construction	OTS Approval SSI-5414 CoA E21	Environment Coordinator Site Supervisor	Section 3.2 and 4.4.4
31)	Wherever feasible and reasonable, piling activities shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.	During Construction	OTS Approval SSI-5414 CoA E22	Environment Coordinator Site Supervisor	Section 3.3.1.4
32)	The Proponent shall identify and consult with potentially-affected community, religious, educational institutions and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) and where feasible and reasonable ensure that noise generating construction works in the vicinity of the receivers are not timetabled during sensitive periods, unless appropriate other arrangements are made.	During Construction	OTS Approval SSI-5414 CoA E23	Communications and Stakeholder Manager	Section 3.3 Annexure B
33)	During construction, Proponents of other construction works in the vicinity of the SSI shall be consulted, and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	During Construction	OTS Approval SSI-5414 CoA E24	Communications and Stakeholder Manager	Section 1.8 and Section 5
EIS Revised Environmental Mitigation Measures					
34)	Noise and vibration mitigation measures described in the Construction Noise and Vibration Strategy would be implemented (refer Appendix J of Technical Paper 2).	During Construction	EIS 2 REMM SSI-5414 NV1 RTRF EMM SSI-5931 NV1	Environment Manager	Section 4

No,	Condition	Timing	Requirement	Responsibility	Reference
35)	Three metre high noise barriers (site hoardings) would be constructed around the perimeter of construction sites.	During Construction	EIS 2 REMM SSI-5414 NV5	Environment Manager	N/A to this phase of works
36)	Six metre high barriers would be constructed at Cherrybrook to manage night-time spoil truck movements.	During Construction	EIS 2 REMM SSI-5414 NV6	Environment Manager	N/A to this phase of works
37)	Three metre high noise barriers (site hoardings) would be constructed at Bella Vista Station site on the north and eastern side of the main construction site and to the west of the station box.	During Construction	EIS 2 REMM SSI-5414 NV7	Environment Manager	N/A to this phase of works
38)	Attended vibration monitoring would be undertaken at the nearest commercial building during high vibration activities to ensure vibration levels remain below safe limits.	During Construction	EIS 2 REMM SSI-5414 NV8	Environment Coordinator	Section 4.3
39)	Attended vibration monitoring would be undertaken at the nearest residential buildings during high vibration activities to ensure vibration levels remain below safe limits.	During Construction	EIS 2 REMM SSI-5414 NV9	Environment Coordinator	Section 4.3
40)	Noise measurements in the Gold Class cinema complex at Castle Hill during high vibration activities would be undertaken to determine ground-borne noise levels. Depending on the results of this monitoring, discussions would be held with the cinema managers to identify additional feasible and reasonable mitigation measures such as respite period and use of alternative equipment.	During Construction	EIS 2 REMM SSI-5414 NV10	Environment Coordinator	Section 4.3.1
41)	Night-time truck access at Bella Vista Station site would be via the Celebration Drive roundabout to the south of the site.	During Construction	EIS 2 REMM SSI-5414 NV13	Environment Manager	Section 4.1

No,	Condition	Timing	Requirement	Responsibility	Reference
42)	Noise attenuation measures would be implemented where reasonable and feasible on tunnel ventilation equipment and other items of fixed plant (e.g. pumps, water treatment plant, diesel generators) that would be required to operate on a 24 hour per day, seven day per week basis in support of the underground works (e.g. ventilation fan enclosures and silencers, and additional enclosures and silencers for diesel generating equipment). At each site, the combined LAeq noise from the operation of this equipment would aim to not exceed the rating background level at nearest residential receivers.	During Construction	EIS 2 REMM SSI-5414 NV16	Environment Manager	Section 4.1 (site specific details to be provided in CNVISs)
43)	A site management and / or physical mitigation solution would be implemented at the Epping Services Facility to ensure noise levels from onsite heavy vehicle movements during the night-time period comply with the sleep disturbance NML. This may include restricting night-time heavy vehicle access from Beecroft Road directly into the acoustic sheds and the establishment of a dedicated unloading bay directly adjacent to Beecroft Road for night-time deliveries.	During Construction	EIS 2 REMM SSI-5414 NV18	Environment Manager	Section 4.1 (site specific details to be provided in CNVISs)
North West Rail Link Construction Environmental Management Framework					
44	The following noise and vibration management objectives will apply to the construction of the project: i. Minimise unreasonable noise and vibration impacts on residents and businesses. ii. Avoid structural damage to buildings or heritage items as a result of construction vibration. iii. Undertake active community consultation. iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.	During Construction	NWRL CEMP Framework Section 9.1	Environment Manager	Section 1.3

No,	Condition	Timing	Requirement	Responsibility	Reference
45	NWRL Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for their scope of works. The Construction Noise and Vibration Management Plan will include as a minimum: i. Noise and vibration mitigation measures in the environmental approval documentation and NWRL Construction Noise and Vibration Strategy. ii. The requirements of any applicable EPL conditions. iii. Site plans or maps indicating locations of sensitive receivers, and key noise and vibration controls. iv. Pre-construction compliance requirements and hold points. v. The responsibilities of key project personnel with respect to the implementation of the plan. vi. Noise monitoring requirements. vii. Compliance record generation and management. viii. Community consultation requirements. ix. An Out of Hours Works Procedure applicable to all construction methods and sites (refer to the CNVS).	Before Construction	NWRL CEMP Framework Section 9.2 a	Environment Manager	This document Hold Points are detailed in the CEMP and OOHW Procedure
46	Detailed Construction Noise and Vibration Impact Statements will be prepared for major noise-intensive construction sites and or activities, to ensure the adequacy of the noise and vibration mitigation measures for the actual design and construction methods. Specifically Construction Noise and Vibration Impact Statements will be prepared for EPL variation applications and works proposed to be undertaken outside of standard construction hours.	Before Construction	NWRL CEMP Framework Section 9.2 b	Environment Manager	Section 3.4
47	Noise and vibration monitoring would be undertaken for construction as specified in the CNVS and the EPL.	During Construction	NWRL CEMP Framework Section 9.2 c	Environment Manager	Section 4.3
48	The following compliance records would be kept by the NWRL Contractor: i. Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria. ii. Records of community enquiries and complaints, and the Contractor's response.	During Construction	NWRL CEMP Framework Section 9.2 d	Environment Manager	Section 6.2

No,	Condition	Timing	Requirement	Responsibility	Reference
49	"All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. Examples of noise and vibration mitigation measures include: - Construction hours will be in accordance with the working hours specified in section 5.1. - Hoarding and enclosures will be implemented where required to minimise airborne noise impacts. - The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers."	During Construction	NWRL CEMP Framework Section 9.3	Environment Manager	Section 4
EPL Conditions					
50	All works and activities must be undertaken in a manner that will minimise noise and vibration impacts on sensitive receivers	During Construction	L3.1	Environment Coordinator Project Engineer	Section 1.3
51	The licensee must ensure that all feasible and reasonable noise and vibration mitigation and management measures are implemented during construction work authorised by this licence in accordance with the Interim Construction Noise Guideline (DECC, 2009).	During Construction	L3.2	Environment Manager	Section 4.1
52	Standard construction hours Unless permitted by another condition of this licence, construction works and activities must: a) only be undertaken between the hours of 7:00 am and 6:00 pm Monday to Friday; b) only be undertaken between the hours of 8:00 am and 1:00 pm Saturday; and c) not be undertaken on Sundays or Public Holidays.	During Construction	L4.1	Environment Coordinator Project Engineer	Section 3.2

No,	Condition	Timing	Requirement	Responsibility	Reference
53	Exemptions to standard construction hours The following construction work may be undertaken outside of the hours specified by Condition L4.1: a) Construction work that causes LAeq(15minute) noise levels that are: (i) no more than 5 dB above rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and (ii) no more than the noise management levels specified Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses; b) Delivery of plant, equipment and materials required to be delivered out of hours for safety reasons; c) Rail maintenance works including tamping and regulating to remediate vertical or horizontal movement >4 mm in track geometry that has occurred as a direct result of works being undertaken for the project; and d) Emergency construction works or activities to ensure the safe operation of rail or avoid loss of life, damage to property, or environmental harm. The licensee must: (i) on becoming aware of the need to undertake emergency construction work, notify the Environment Protection Authority's Environment Line on 131 555 of the need for those activities or work; and: (ii) the next working day following the emergency works, submit a report to the EPA's Manager Metropolitan Infrastructure detailing: 1. the cause, time and duration of the emergency; 2. action taken by the licensee in relation to the emergency; and 3. details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of the emergency.	During Construction	L4.2	Environment Manager	Section 3.2

No,	Condition	Timing	Requirement	Responsibility	Reference
54	High Noise Impact Works High noise impact works and activities must only be undertaken: a) between the hours of 8:00am to 5:00pm Monday to Friday; b) between the hours of 8:00am to 1:00pm Saturday; and c) in continuous blocks not exceeding 3 hours each with a minimum respite from those activities and works of not less than 1 hour between each block. For the purposes of this condition 'continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work that is the subject of this condition	During Construction	L4.3	Environment Coordinator Site Supervisor	Section 3.2.3
55	Noise and Vibration Complaints a) The licensee must investigate noise and vibration complaints from the occupants of dwellings or the management of noise sensitive receivers other than dwellings: (i) within two hours of the complaint being made; or (ii) in accordance with any prior complaint management agreement the licensee may have made with the complainant, b) The licensee must ensure that any investigation referred to in this condition that identifies works or activities being undertaken on the licensed premises as the likely source of the complaint, includes an offer to the complainant to undertake attended noise or vibration monitoring at their premises, and c) If the occupant of the dwelling or the management of a noise sensitive receiver other than a dwelling accepts the offer of attended noise or vibration monitoring the licensee must undertake that attended monitoring: (i) as soon as practicable; or (ii) at a time agreed with the complainant.	During Construction	M6.5	Environment Manager Communications and Stakeholder Relations Manager	Section 5

No,	Condition	Timing	Requirement	Responsibility	Reference
56	The licensee must, in respect of each complaint made to the telephone complaints line required by condition M6.1, advise each complainant of the results of its investigation of their complaint and any proposed remedial action.	During Construction	M6.6	Environment Manager Communications and Stakeholder Relations Manager	Section 5
57	The licensee must monitor noise and vibration from construction work, including during work undertaken out of hours.	During Construction	M7.1	Environment Coordinator	Section 4.3
58	All noise monitoring must be undertaken in accordance with Australian Standard AS 2659.1 – 1998:Guide to the use of sound measuring equipment – Portable sound level meters, or any revisions of that standard which may be made by Standards Australia, and the compliance monitoring guidance provided in the NSW Industrial Noise Policy.	During Construction	M7.2	Environment Coordinator	Annexure D
59	All vibration monitoring must be undertaken in accordance with the guidance provided in the Environmental Noise Management Assessing Vibration: A Technical Guideline published by the Department of Environment and Conservation, February 2006. All vibration monitoring results must be assessed and reported against the acceptable values of human exposure to vibration set out in Tables 2.2 and 2.4 in this guideline	During Construction	M7.3	Environment Coordinator	Annexure D
60	The licensee must undertake noise and vibration monitoring as directed by an authorised officer of the EPA.	During Construction	M7.4		Section 4.3.1.2, 4.3.2
61	Noise and Vibration Reports Upon request of an authorised officer of the EPA, the licensee must submit a Preliminary Investigation Report to the EPA in respect of any noise or vibration monitoring undertaken in accordance with the requirements of Condition M6.5 or a direction made pursuant to Condition M7.4. b) The Preliminary Investigation Report must be submitted to the EPA by 4.30 pm of the afternoon of the next working day following any noise or vibration monitoring. c) The Preliminary Investigation Report must: (i) include numerical and/or graphical representation of the noise and vibration monitoring results;	During Construction	R4.2		Section 6.2.1

No,	Condition	Timing	Requirement	Responsibility	Reference
	and (ii) highlight any detected exceedance of noise goals or limits specified in: (1) this licence; (2) relevant noise guidelines; and (3) relevant noise modelling. d) In the event of any exceedance of the noise goals or limits referred to in Condition R4.2 c)(ii), the licensee must: (i) modify work practices and methods and implement all practicable and reasonable measures to prevent a recurrence of the exceedance; and (ii) submit a Follow-up Investigation Report to the EPA within 5 working days of any noise or vibration monitoring having been undertaken (unless otherwise approved by the EPA). e) the Follow-up Investigation Report must include: (i) confirmation of whether noise monitoring has been undertaken in accordance with AS2659 and the compliance monitoring guidance provided in the INP; (ii) confirmation of whether vibration monitoring has been undertaken in accordance with the guidance provided in the Assessing vibration: a technical guideline (DEC, 2006); (iii) details of the prevailing meteorological conditions during the period when the noise or vibration monitoring was undertaken; (iv) a map of each noise and vibration monitoring location in relation to the noise source, including relevant distances; (v) numerical and graphical representation of the noise and vibration monitoring results; (vi) an analysis of the noise and vibration monitoring results; (vii) details of any remedial action taken in relation to the matter; and (viii) in cases not the subject of remedial action, detailed justification of the decision not to undertake remedial action.				
Project Deed Requirements					
62	In addition to the requirements identified in the Environmental Documents, the Construction Noise	Before Construction	3.17(f)i	Environment	Section 2.3

No,	Condition	Timing	Requirement	Responsibility	Reference
	and Vibration Management Plan must include: (i) a general description detailing how construction noise and vibration is proposed to be managed in accordance with the Interim Construction Noise Guideline (DECC 1999), North West Rail Link Construction Noise and Vibration Strategy (TfNSW 2012);			Manager	
63	for construction sites which require activities to be undertaken outside of the standard daytime construction periods, a description of the proposed activities, the duration of the works, how often out of hours works are required, the potential noise and vibration impacts in relation to the management levels and the likely mitigation measures that will be required to reduce the potential impacts; and	Before Construction	3.17(f)ii	Environment Manager	As per CNVIS Annexure C Section 3.2.1
64	for construction sites where heavy vehicle movements will be undertaken outside of the standard daytime construction periods, a description of the proposed activities, the duration of the works, how often out of hours works are required, the potential noise and vibration impacts in relation to the management levels and the likely mitigation measures that will be required to reduce the potential impacts.	During Construction	3.17(f)iii	Environment Manager	As per CNVIS Annexure C Section 3.2.4
ECRL Conversion Determination Report Conditions of Approval					
65	Construction Hours a) Construction and demolition activities shall be restricted to the hours of 7:00 am to 6:00 pm (Monday to Friday); 8:00 am to 1:00 pm (Saturday) and at no time on Sundays and public holidays except for the following works which are permitted outside these standard hours: i. any works which do not cause noise emissions to be more than 5dBA higher than Rating Background Level (RBL) (background) noise levels at any nearby residential property and/or other noise sensitive receivers; ii. the delivery of plant, equipment and materials which is required outside these hours as requested by police or other authorities for safety reasons and with suitable notification to the community as agreed by the Principal Manager Environment; iii. emergency work to avoid the loss of lives, property and/or to prevent environmental harm; and iv. any other work in accordance with an Out of Hours Work Procedure and considered	During Construction	CoA 8	Environment Manager	Section 3.2

No,	Condition	Timing	Requirement	Responsibility	Reference
	essential to the Project. b) Alternative hours of construction may be approved through an EPL. c) Works associated with in tunnel and underground activities may be undertaken 24-hours, seven days per week				
66	A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared that outlines the required management practises and procedures to reduce and control potential noise, ground vibration and ground-borne noise impacts during construction	Before Construction	CoA 23(a)	Environment Manager	This Plan
67	Construction noise and vibration mitigation measures implemented shall be in accordance with DECCW's Interim Construction Noise Guideline July 2009.	During Construction	CoA 23(b)	Environment Manager	Section 2.3
68	All construction works would be managed in accordance with the Construction Noise and Vibration Strategy.	During Construction	CoA 23(c)	Environment Manager	Section 2.3
69	The CNVMP shall include, but not necessarily be limited to: identification of construction activities that have the potential to generate noise and/or vibration impacts on surrounding land uses, particularly sensitive noise receivers	During Construction	CoA 23(d)i	Environment Manager	Section 3.1
70	details of what reasonable and feasible actions and measures shall be implemented to minimise noise impacts (including those identified in the Environmental Impact Assessment);	During Construction	CoA 23(d)ii	Environment Manager	Section 4 Annexure A
71	procedures for notifying sensitive receivers of construction activities that are likely to affect their noise and vibration amenity, as well as procedures for dealing with and responding to noise complaints;	During Construction	CoA 23(d)iii	Communications and Stakeholder relations Manager	Section 5
72	where not otherwise subject to an EPL, an out of hours work protocol (OOHWP) for the assessment, management and approval of works outside the standard construction hours Identified in this approval, including a risk assessment process under which the ER may approve out of hours activities deemed to be of low or to medium environmental risk	During Construction	CoA 23(d)iv	Environment Manager	N/A as construction works will be regulated by the EPL

No,	Condition	Timing	Requirement	Responsibility	Reference
73	A description of how the effectiveness of actions and measures shall be monitored during the proposed works, clearly indicating the frequency of monitoring, the locations at which monitoring shall take place, recording and reporting of monitoring results and if any exceedance is detected, the manner in which any non-compliance shall be rectified.	During Construction	CoA 23(d)v	Environment Manager	Section 4.3
74	The Proponent shall undertake all relevant construction activities with the objective of not exceeding the following ground-borne noise criteria at residential receivers: a) an internal LAeq(15min) of 40 dB(A) between 6:00 pm and 10:00 pm; and b) an internal LAeq(15min) of 35 dB(A) between 10:00 pm and 7:00 am. Where these objectives may be exceeded, the Proponent shall develop and implement all reasonable and feasible noise mitigation measures with the aim of minimising ground-borne noise impacts.	During Construction	CoA 24	Environment Manager	Section 3.3.2 Section 4.2.2
75	Vibration Criteria Vibration {other than from blasting) resulting from construction and received at any structure outside of the Project shall be limited to: For structural damage vibration -the acceptable vibration values set out in the German Standard DIN 4150: Part 3-1999 "Structural Vibration in Buildings: Effects on Structures"; and For human exposure to vibration -the acceptable vibration values set out in the Assessing Vibration: A Technical Guideline (DEC 2006). These limits apply unless otherwise approved by the EPA (where relevant to the issuing of an EPL).	During Construction	CoA 25	Environment Manager	Section 3.3.3 Section 4.2.3
76	Non-tonal Reversing Beepers Non-tonal reversing beepers {or an equivalent mechanism) shall be fitted and used on all construction vehicles and mobile plant regularly used on-site and for any out of hours work.	During Construction	CoA 26	Site Supervisor	Section 4.1
77	Noise Impact on Educational Facilities Potentially affected pre-schools, schools, universities and any other affected permanent educational institutions shall be consulted in relation to noise mitigation measures to identify any noise sensitive periods, e.g. exam periods. As much as reasonably possible noise intensive construction works in the vicinity of affected educational buildings are to be minimised	During Construction	CoA 27	Communications and Stakeholder Relations Manager	Section 4.1

No,	Condition	Timing	Requirement	Responsibility	Reference
ECRL Conversion Submissions Report Environmental Management Measures					
78	All construction works associated with the proposal would be managed in accordance with the Construction Noise and Vibration Strategy (CNVS). which was previously developed for the NWRL. The CNVS would document the best-practice techniques specific to the proposal for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.	During Construction	REMM B1	Communications and Stakeholder Relations Manager	Section 2.3
79	Example mitigation measures which are considered appropriate for these works which could be implemented during construction include: • implementation of proactive community consultation measures • site inductions for all contractors • shielding of works using site hoardings • for construction concentrated in a single area, temporary acoustic fencing/barriers around the site perimeter would be considered where feasible and reasonable to mitigate off-site noise levels • restriction of noise intensive works to daytime and evening periods, where possible • where night works are required, these would be programmed to minimise the number of consecutive nights impacting the same receptors, where possible • avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receptors would result in reduced noise emissions • equipment which is used intermittently is to be shutdown when not in use • where possible, the offset distance between noisy plant items and nearby noise sensitive receptors should be as great as possible • where possible, equipment with directional noise emissions should be oriented away from sensitive receptors • use of less noisy equipment • regular compliance checks on the noise emissions of all plant and machinery used for the proposal would indicate whether noise emissions from plant items were higher than predicted • reversing of equipment should be minimised so as to prevent nuisance caused by reversing	During Construction	REMM B2	Environment Manager Environment Coordinator Site Supervisor Project Engineer	Section 4

No,	Condition	Timing	Requirement	Responsibility	Reference
	alarms • respite periods				
Norwest Pedestrian Link Determination Report					
80	The project shall be constructed with the aim of achieving the construction noise management levels detailed in the *Interim Construction Noise Guidelines* (ICNG) (DECC, 2009)	During Construction	CoA 25	Environment Manager	Section 2.3
81	a) Construction activities associated with the Project shall be undertaken during the following standard construction hours i. 7:00 am to 6:00 pm (Monday to Friday, inclusive); ii. 8:00 am to 1:00 pm (Saturday; and, iii. At no time on Sundays and public holidays b) Notwithstanding the conditions 26.a) i – iii construction activities outside of the prescribed construction hours may be undertaken in any of the following circumstances: i. Any works which do not cause noise emissions to be more than 5 dBA higher than Rating Background Level (RBL) (background) noise levels at any nearby residential property and/or other noise sensitive receivers; ii. The delivery of plant, equipment and materials which is required outside these hours as requested by police or other authorities for safety reasons and with suitable notification to the community as agreed by the Principal Manager Environment; iii. Emergency work to avoid the loss of lives, property and/or to prevent environmental harm; and, iv. Any other work in accordance with an Out of Hours Work Procedure and considered essential to the Project c) Alternative hours of construction may be approved through and EPL. d) Works must be in accordance with the existing Construction Noise and Vibration Management Plan	During Construction	CoA 26	Environment Manager	Section 3.3
Norwest Station Subsurface Pedestrian Link and Northern Entry REF					

No,	Condition	Timing	Requirement	Responsibility	Reference
82	Wherever feasible and reasonable vibration-generating activities shall be undertaken using quieter alternative methods	During Construction	Norwest Pedestrian Link REF EMM 30	Environment Coordinator Project Engineer	Section 4
83	Three metre high noise barriers (site hoardings) would be constructed around the perimeter of construction sites	Before Construction	Norwest Pedestrian Link REF EMM 31	Project Engineer	Barriers already installed by TSC contractor
84	Undertake noise monitoring at representative noise-affected receivers and representative locations in each noise catchment area while work is taking place to validate the modelling predictions Implement additional feasible and reasonable safeguards if the observed monitoring results are higher than predicted noise levels	During Construction	Norwest Pedestrian Link REF EMM 32	Environment Coordinator	Section 4.3.1 Annexure D
85	Prepare a Construction Noise and Vibration Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECC, 2009) and Assessing Vibration: a technical guide (DEC. 2006). The plan shall include, but not be limited to: • Identification of work areas, site compounds and access points • Identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval • Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas • Identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise impacts (including construction traffic noise impacts), including, but not limited to, acoustic enclosures, erection of noise walls (hoardings), respite periods and the limiting of truck movements during night periods. • Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program,	Before Construction	Norwest Pedestrian Link REF EMM 33	Environment Manager	This Plan

No,	Condition	Timing	Requirement	Responsibility	Reference
	applicable buffer distances for vibration intensive works, use of low-vibration generating equipment / vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and/or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria). • Where the use of vibration-intensive activities take place an assessment of the potential nose and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program. • A description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and if any exceedance is detected, how any noncompliance would be rectified • Mechanisms for the monitoring, review and amendment of this plan				
Willoughby to North Chatswood 33kV Underground Feeder Powerline Determination Report Conditions of Approval					
86	During excavation the following work practices would be implemented: a) Notify surrounding residents of planned works prior to the works commencing b) Use equipment that has noise levels equal to or less than the sound power levels in Table 4.2 of the *Noise and Vibration Assessment* (WSP Parsons Brinckerhoff, 2015).	During Construction	CoA 8	Project Engineer	Section 4
87	During underbore utilise the following controls: a) Use a portable barrier (or similar protection) to shield the underbore equipment where works occur in proximity to residential receivers where reasonable and feasible. The height and nature of the barrier would be determined when the equipment selection is finalised. The barrier would be construction of a material of minimum mass 12 kilograms per metre squared such as as 20 millimetre plywood or a proprietary barrier such as Echobarrier. b) Carry out underbore works within standard construction hours, where this is considered to be feasible. c) Orientate and locate underbore equipment to minimise noise impact to residential receivers, where this is considered to be feasible d) Notification to surrounding residents of planned works prior to the works commencing	During Construction	CoA 9	Project Engineer	Section 4.1

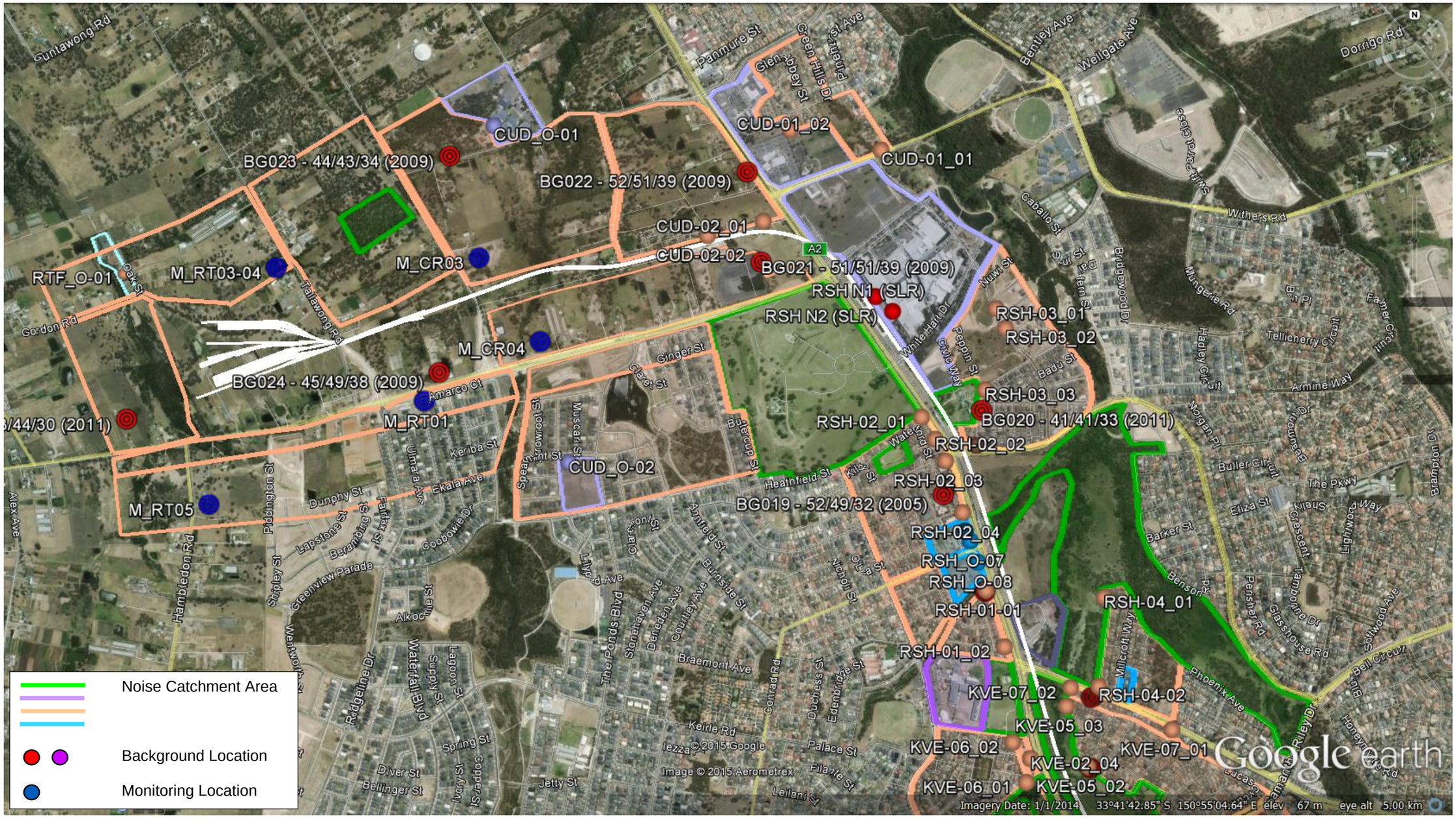
No,	Condition	Timing	Requirement	Responsibility	Reference
88	During road reinstatement utilise the following controls: a) Notify surrounding residents of planned works prior to the works commencing	During Construction	CoA 10	Project Engineer Community and Stakeholder Manager	Section 4.2
89	To minimise the potential for sleep disturbance, where night works are proposed to be undertaken, the following controls would be implemented: a) Notify surrounding residents of planned works prior to the works commencing b) Any night works undertaken would be subject to the preparation of a Construction Noise Impact Assessment and be consistent with the Northwest Rail Link Construction and Noise Vibration Strategy c) During detailed design, consideration would be given to breaking up the construction program between Hampden Road / Brand Street and other locations where proposed night works are to be undertaken. The intention of this would be to assist in providing respite periods to any potentially impacted sensitive receivers / residents along Hampden Road and Brand Street throughout the construction works.	Prior to Construction	CoA11	Project Engineer Community and Stakeholder Manager	Section 4
Willoughby to North Chatswood 33kV Underground Feeder Powerline Submissions Report Revised Environmental Management Measures					
90	During excavation the following work practices would be implemented: ▪ Carry out work mainly during standard construction hours when in the vicinity of residential receivers. ▪ Use a portable barrier (or similar protection) to shield the equipment where works occur in proximity to residential receivers where reasonable and feasible. The height and nature of the barrier would be determined when the equipment selection is finalised. The barrier would be constructed of a material of minimum mass 12 kilograms per metre squared such as 20 millimetre plywood or a proprietary barrier such as Echobarrier. ▪ Provide periods of respite from use of the road saw. ▪ Schedule the use of the road saw to times when the community are less sensitive by avoiding early morning and late evening/night periods, where feasible with respect to the proposed construction methodology. ▪ Inform Notify surrounding residents of planned works prior to the works commencing. ▪ Organise the site to avoid unnecessary use of reversing alarms on vehicles. ▪ Truck drivers to use approved access routes to the site. ▪ Orientate and place water pumps and vacuum trucks away from receivers.	Construction	REMM 1	Project Engineer Environment Coordinator	Section 4.1

No,	Condition	Timing	Requirement	Responsibility	Reference
	■ Turn equipment off when not in use and avoid idling machinery or trucks near sensitive receivers. ■ Utilise vehicles, obstacles and stockpiles on site to provide shielding to receivers, where possible. ■ Use equipment that has noise levels equal to or less than the sound power levels in Table 4.2 of the *Noise and Vibration Assessment* (WSP| Parsons Brinckerhoff, 2015).				
91	During underbore utilise the following controls: ■ Use a portable barrier (or similar protection) to shield the underbore equipment where works occur in proximity to residential receivers where reasonable and feasible. The height and nature of the barrier would be determined when the equipment selection is finalised. The barrier would be constructed of a material of minimum mass 12 kilograms per metre squared such as 20 millimetre plywood or a proprietary barrier such as Echobarrier. ■ Carry out underbore works within standard construction hours, where this is considered to be feasible. ■ Orientate and locate underbore equipment to minimise noise impacts to residential receivers, where this is considered to be feasible. ■ Notification to surrounding residents of planned works prior to the works commencing.	Construction	REMM2	Project Engineer Environment Coordinator	Section 4.1
92	During road reinstatement utilise the following controls: ■ Schedule deliveries to be carried out to avoid sensitive periods in the early morning and late evening/night. ■ Turn equipment off when not in use and avoid idling machinery or trucks near sensitive receivers. ■ Provide respite periods from tipper and compactor usage. ■ Select compactor and tipper trucks based on lower noise emissions and use equipment that has noise levels equal to or less than the sound power levels in Table 4.2 of the *Noise and Vibration Impact Assessmen*t (WSP| Parsons Brinckerhoff, 2015). ■ Notify surrounding residents of planned works prior to the works commencing.	Construction	REMM3	Project Engineer Environment Coordinator	Section 4.1
93	To minimise the potential for sleep disturbance, where night works are proposed to be undertaken, the following controls would be implemented: ■ Schedule noise intensive activities such as road sawing to before 10 pm. ■ Schedule activities which are likely to cause maximum noise events to before 10 pm. ■ Avoid dropping tools or materials from height, striking materials or making metal-metal contact. ■ Operate the excavator in a manner that avoids maximum noise levels associated with striking or shaking the bucket. ■ Educate workers on the importance of minimising noise and avoid creating short duration high noise level events. ■ Carry out a survey of sensitive receivers to ensure adequate acoustic performance of façade. ■ Notify surrounding residents of planned works prior to the works commencing. ■ Where works outside of normal construction hours are required, early advanced communication with affected stakeholders would be undertaken to identify alternative arrangements e.g. relocation, where applicable. ■ Any night works undertaken would be subject to the preparation of a Construction Noise Impact Assessment and be consistent with the *Northwest Rail Link Construction Noise and Vibration*	Construction	REMM4	Project Engineer Environment Coordinator	Section 4.1

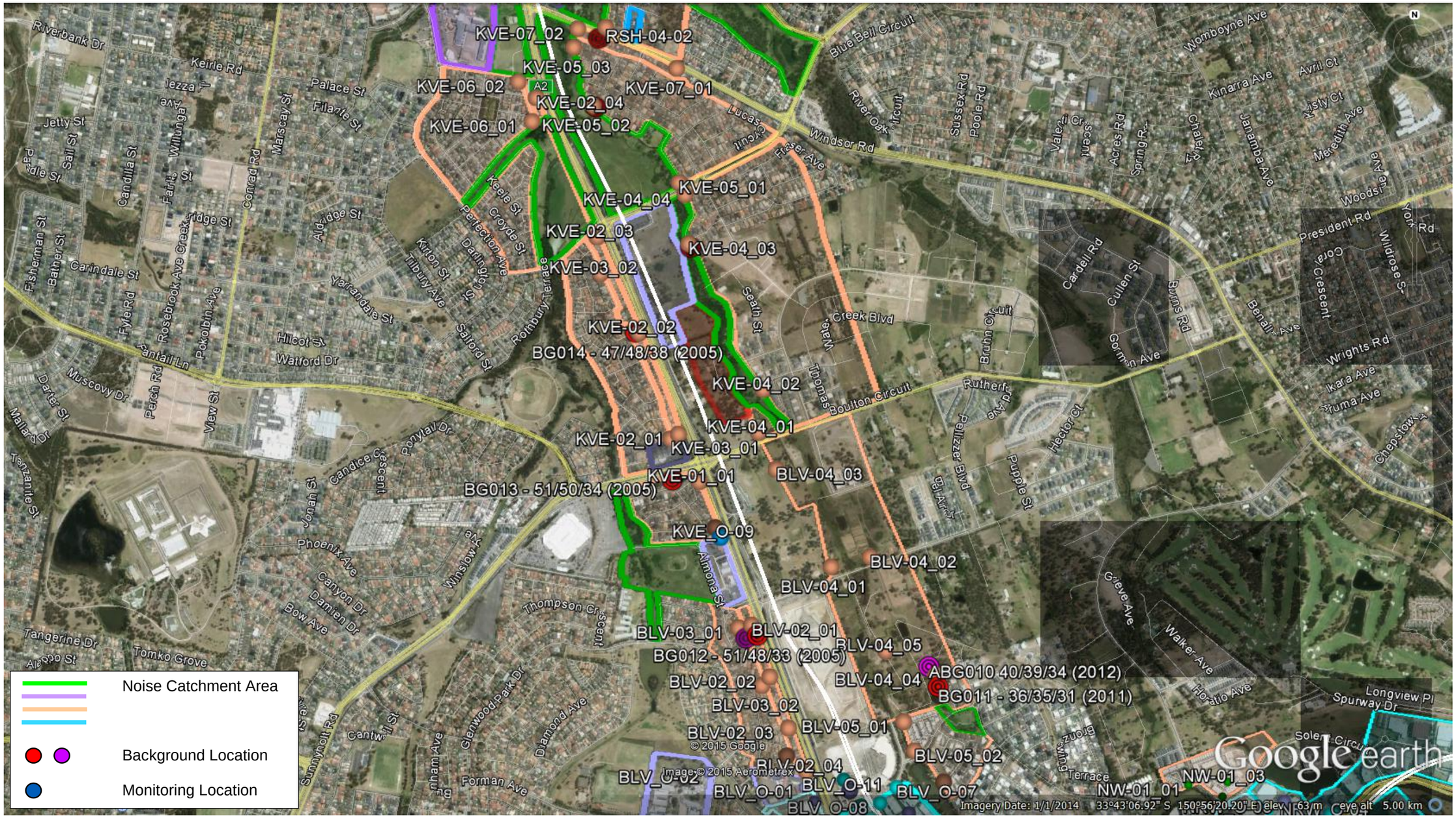
No,	Condition	Timing	Requirement	Responsibility	Reference
	Strategy (SLR, December 2015). ■ During detailed design, consideration would be given to breaking up the construction program between Hampden Road/Brand Street and other locations where proposed night works are to be undertaken. The intention of this would be to assist in providing respite periods to any potentially impacted sensitive receivers/residents along Hampden Road and Brand Street throughout the construction works.				
Rouse Hill Temporary Bypass Powerline EIA					
94	1) Out of Hours Works would be managed as per the contractor's procedure. 2) Work is not a "scheduled activity" therefore an EPL is not required. 3) The contractor is to schedule works around lawn ceremonies when required and in conjunction with Castlebrook Memorial Park.	Construction	EIA Control Measure	Project Engineer	Annexure C Section 4.1

Annexure B. Figures

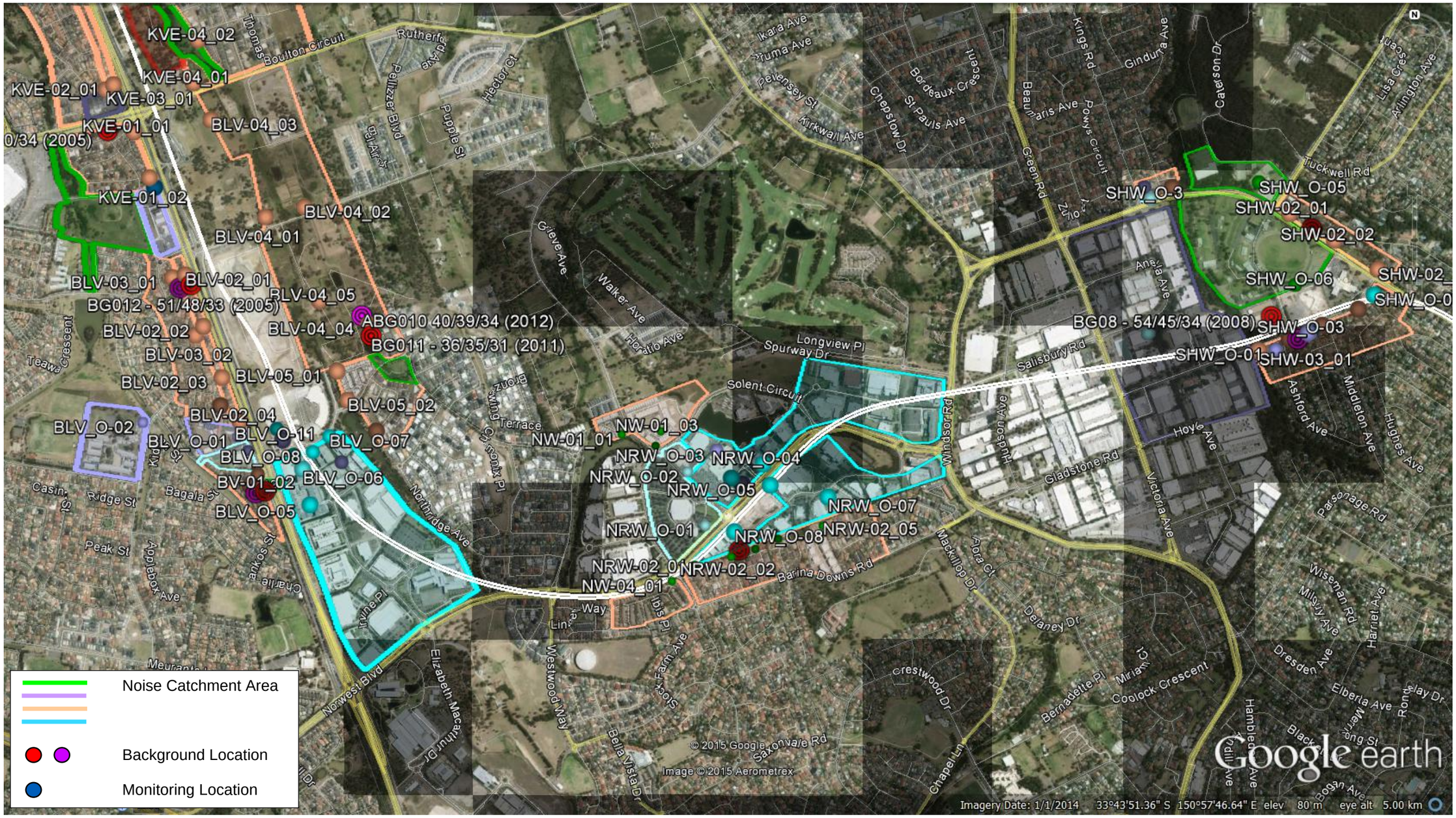
Sydney Metro Northwest: Noise Catchment Areas and Monitoring Locations – RTRF to Kellyville



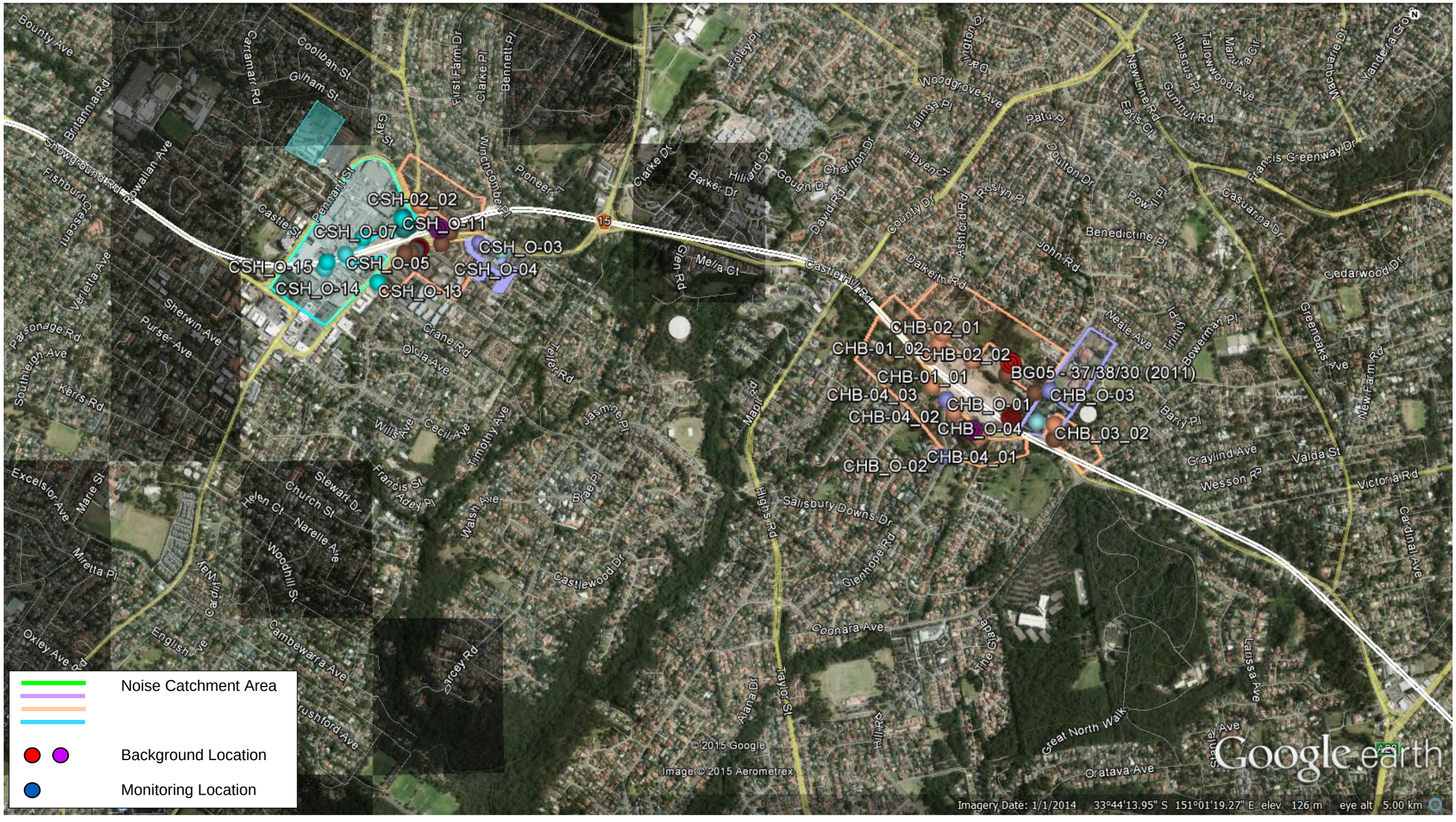
Sydney Metro Northwest: Noise Catchment Areas and Monitoring Locations – Kellyville to Bella Vista



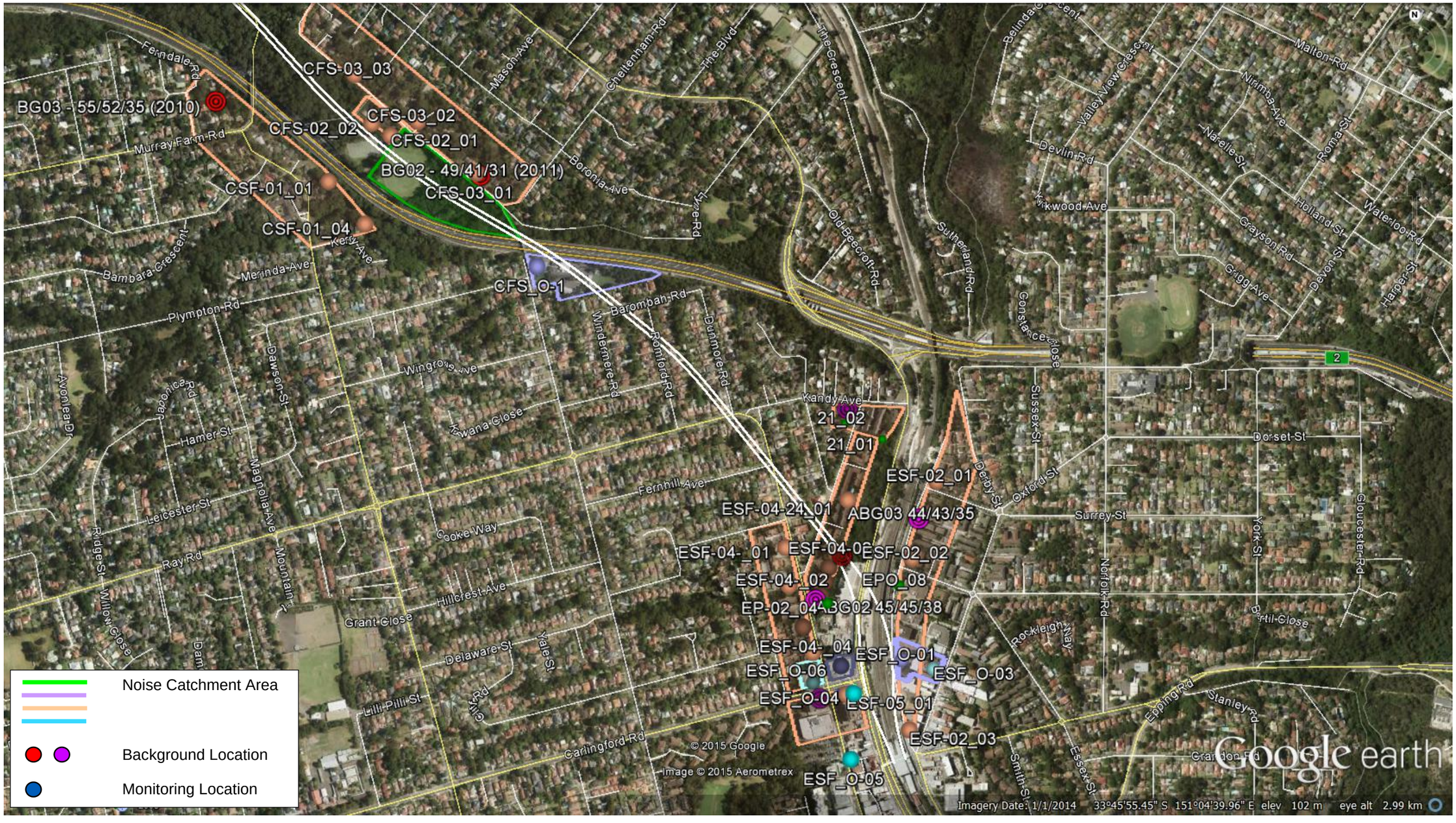
Sydney Metro Northwest: Noise Catchment Areas and Monitoring Locations – Kellyville to Norwest

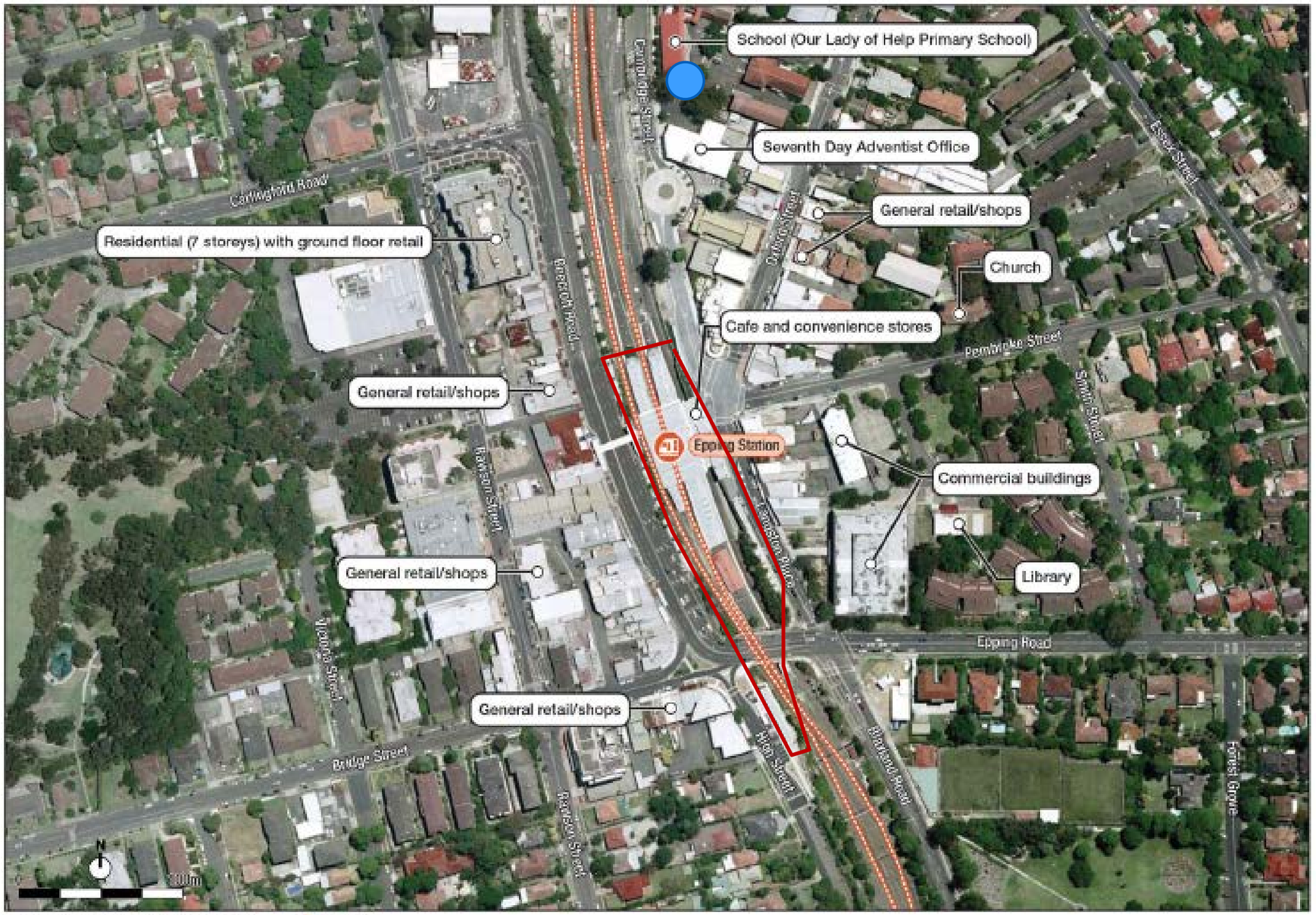


Sydney Metro Northwest: Noise Catchment Areas and Monitoring Locations – Castle Hill to Cherrybrook



Sydney Metro Northwest: Noise Catchment Areas and Monitoring Locations – Cheltenham to Epping





Epping to Chatswood railway Station

Land use – Epping Station

Monitoring Point

Indicative area of works

Epping to Chatswood railway (underground) Station

Land use – Macquarie University Station

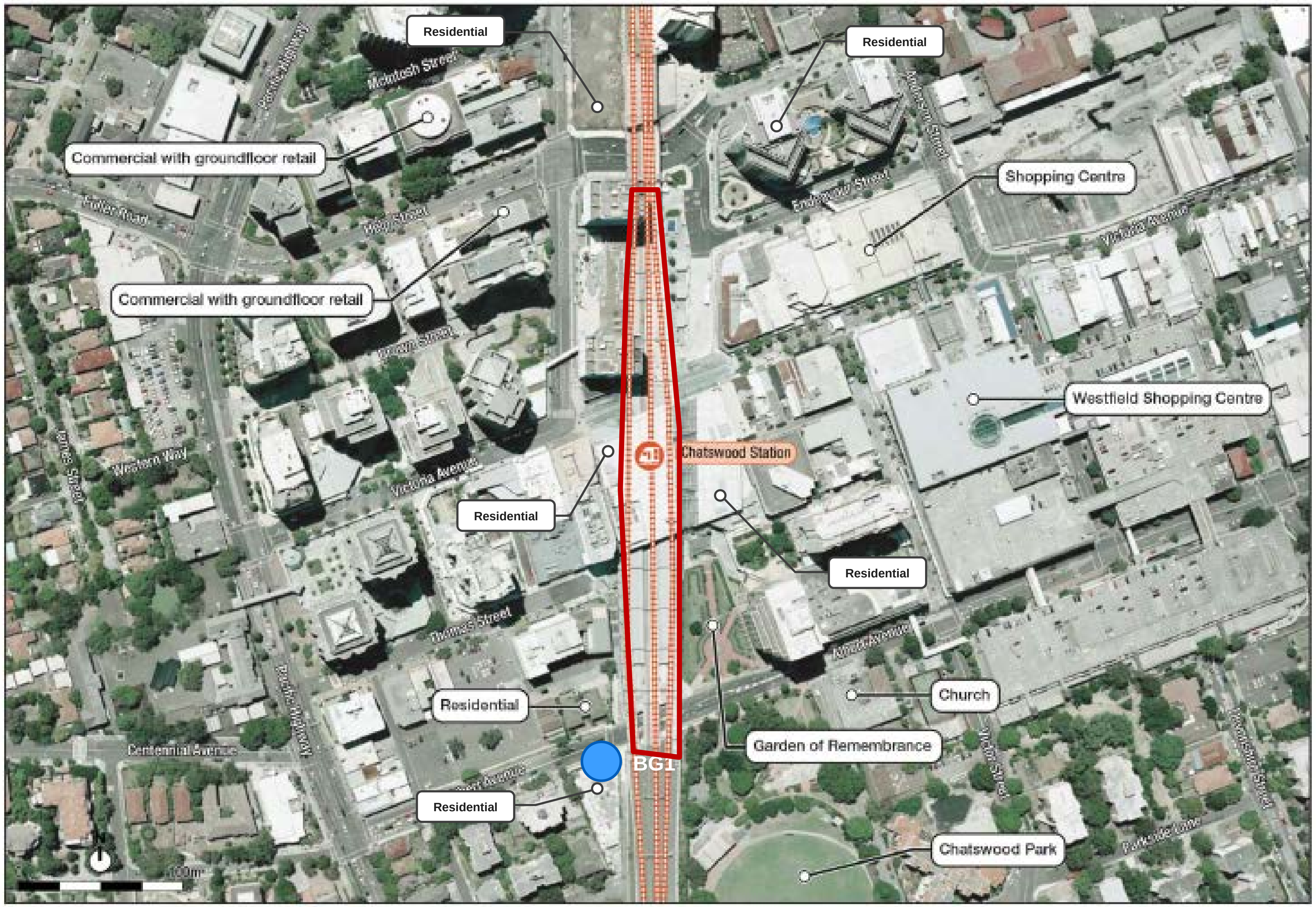
Monitoring Point

Indicative area of works

Land use – Macquarie Park Station

Indicative area of works

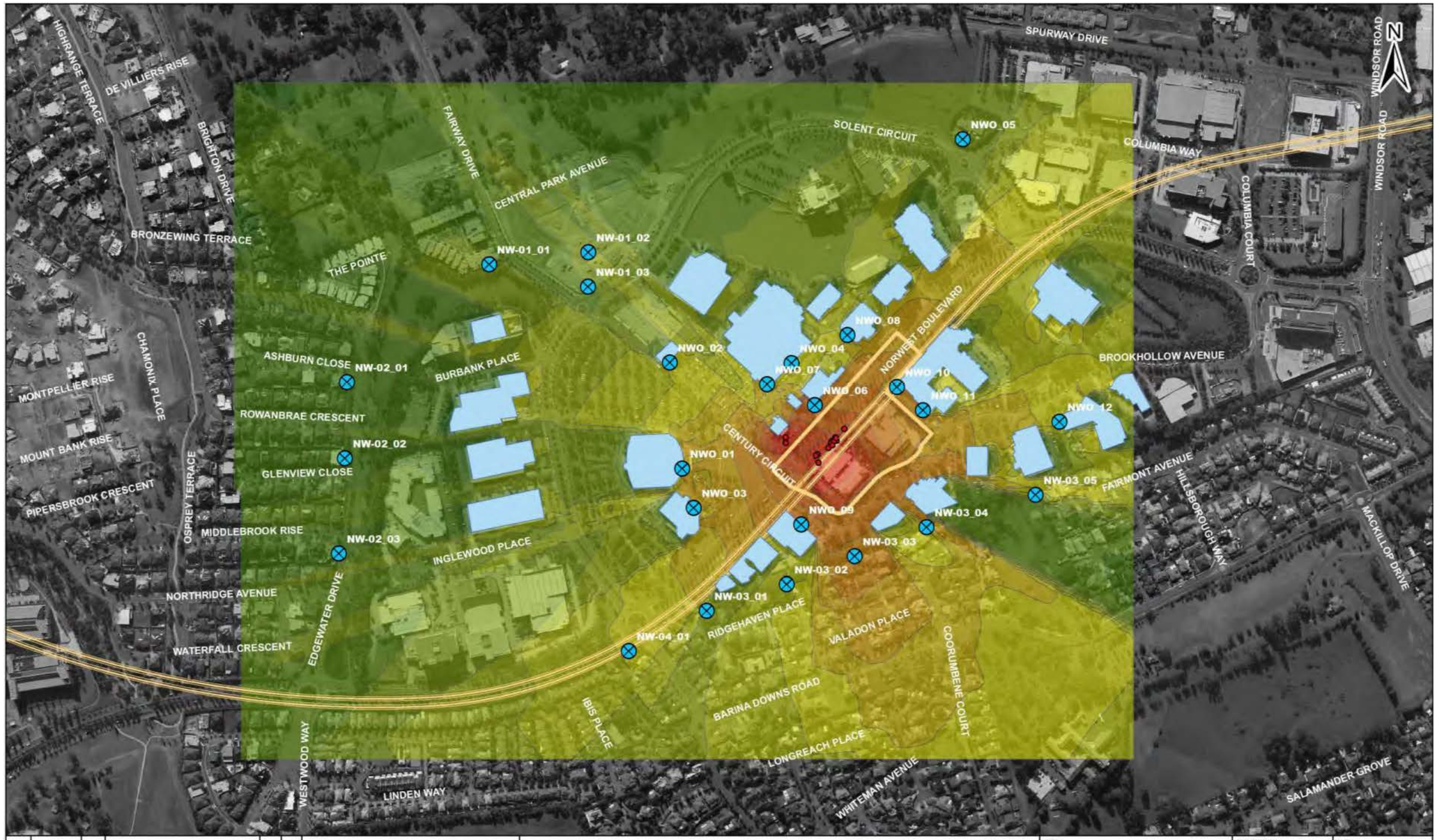

Vacant land
M2 Motorway
Macquarie Park Cemetery and Crematorium
Epping Road
Delhi Road
North Ryde Station
BG4
Vacant land
M2 Motorway
Epping Road
Commercial buildings
Shirley Street
Marsfield Street
Bergman Street
Donald Street
Blenheim Street
N
100
Epping to Chatswood railway (underground)
Station
Land use – North Ryde Station
Monitoring Point
Indicative area of works


Residential
Residential
Commercial with groundfloor retail
Shopping Centre
Commercial with groundfloor retail
Westfield Shopping Centre
Chatswood Station
Residential
Residential
Residential
Church
Garden of Remembrance
BG1
Residential
Chatswood Park
Mcintosh Street
Pacific Highway
Fuller Road
Help Street
Endeavour Street
Victoria Avenue
Brown Street
Western Way
Victoria Avenue
Thomas Street
Albert Avenue
Centennial Avenue
Pacific Highway
Anderson Street
Victor Street
Orchard Road
Parkside Lane
100m
Epping to Chatswood railway
Station

Land use – Chatswood Station

Monitoring Point

Indicative area of works



REV	DATE	BY	DESCRIPTION	AC
A	19/02/15	NF	Issue for submission	AC

DRAWING STATUS:

ISSUE FOR CNVIS

Legend

- Noise Source
- Receiver
- Commercial Building
- Project Boundary
- Construction Boundary EIS1
- Construction Boundary EIS2
- Concept Alignment: EIS2Sub

Free Field Level (dB)

<40	52-55	73-76
40-43	55-58	76-79
43-46	58-61	>79
46-49	61-64	
49-52	64-67	
	67-70	
	70-73	

CLIENT: Transport for NSW	DESIGN DRAWN: NF	DATE: February 2015
PROJECT: Norwest Station Subsurface Northern Pedestrian Link	SCALE: 1:5,116 @ A3 — 0 20 40 80 120 160 200 Meters	
TITLE: Noise Contour Map Subsurface Works Norwest Station Subsurface Northern Pedestrian Link	DRAWING No: APPENDIX A1	REV: A

Sydney Metro Northwest – Receiver Locations for drilling under Gore Hill Freeway


Assessment Location 4
Assessment Location 3
Assessment Location 2
Assessment Location 1
R24
R22
R23
R25
R21
R20
R19
R18
R15
C13
C12
C11
R17
C10
R12
R16
C9
R14
C8
R13
C7
R11
R10
R9
R8
R7
C6
Cable route

Sydney Metro Northwest – Receiver Locations for Mowbray Road, Chatswood Crossing

Annexure C. Out of Hours Procedure

This Out of Hours Works (OOHW) Protocol applies to all works to be undertaken outside the standard construction hours or respite periods under the EPL.

C.1. OOHW Justification

All proposed OOHW require a full justification as to why the works are required to be undertaken outside standard construction hours. Where it is considered possible (safe and reasonable) for works to be undertaken during standard hours, OOHW proposals will not be further actioned by the Environment Manager (EM) and/or the Environmental Planning and Approvals Manager (EPM).

The ICNG identifies five categories of works that may be required to be undertaken outside the standard construction hours:

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

For the last two categories, clear justification for the proposed OOHW is required as part of the CNIS process.

C.2 OOHW Noise and Vibration Assessment

OOHW Construction Noise Impact Statement (CNIS) will be prepared as required by the Project EPL to assess the extent of noise and/ or vibration impact the construction activities will have upon the community/ residential receivers. The level of assessment will be determined by the Project EPL requirements. The CNIS will be prepared in accordance with the guidelin.. CNISs are to be developed by an appropriately qualified person experienced in assessing the impacts of noise and vibration from civil engineering works.

As part of the assessment process:

- Any exceedance of the construction noise/ vibration objectives will be identified

- The level of noise/ vibration impact will be evaluated and classified, following the procedure in Section 3.4.2
- Appropriate noise/ vibration management and mitigation measures will be determined as detailed in Section 4
- An appropriate noise/ vibration monitoring program will be developed to satisfy the EPL.

C.3 OOHW Documentation

All out of hours works (except in emergency situations) will be documented through the Out of Hours Works Form and managed in compliance with the EPL.

NRT will develop an OOHW application for submission to the EPA requesting a variation to the Project EPL where required. The application is to provide all required detail about the OOHW including the CNIS, as detailed above.

C.4 OOHW Community Notifications

Notification to specific impacted noise-sensitive receivers will be provided a minimum of 7 days prior to commencing any OOHW activity with the potential to impact on stakeholders, in accordance with Scope and Performance Requirements (SPR) Appendix 51, Clause 2.7.2 (d). Any additional notification requirements set by the EPA in the issuing of an EPL variation is to be undertaken.

Any additional management measures identified for the works that require community notification are to be undertaken as detailed in Section 4.2, and may include:

- Letterbox drop and/ or email
- Phone calls
- Individual briefings
- The offering of alternate accommodation or other measures for respite.

C.5 EPA Approval of OOHW and Implementation of OOHW EPL Conditions

On receipt of the EPA approval (EPL variation granted), any specific conditions that relate to the OOHW are to be:

- Actioned for implementation (such as any additional notification to the community).
- Tool-boxed to relevant workforce and site personnel before each shift to introduce/ reinforce works restrictions, management measures and expected workforce behaviour. These will include any EPL conditions.
- Implemented during works and monitored by NRT.

C.6 OOHW Enquiries/ Complaints Management

All complaints are to be managed by the Project Stakeholder and Community Team through the process detailed in the Community Liaison Implementation Plan (CLIP) and as outlined in Section 5 of this report.

C.7 OOHW Monitoring

Attended noise and vibration monitoring is to be undertaken to verify that noise levels resulting from OOHW are in accordance with the levels predicted in the CNIS and the EPL conditions.

Noise and vibration monitoring is to follow the procedures outlined in Section 4.3 of this plan.

Annexure D. Monitoring Specifications

D.1 Specification for Determining the Sound Power of Construction Plant and Equipment

D.1.1 Scope

This document specifies methods for determination of sound power levels for construction plant including earthmoving equipment and other ancillary plant and equipment used during construction.

D.1.2 Referenced Standards

- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;
- AS 2012.1 Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise
- ISO 3744 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane
- ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions
- ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions

D.1.3 Testing Procedures – Earthmoving Machinery

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

Each significant plant item shall be tested in terms of both the ‘stationary’ and the ‘dynamic’ testing procedures detailed below.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 2004 “Electroacoustic - Sound Level Meters” and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the meters shall be checked in the field before and after the noise measurement period.

D.1.4 Stationary Testing

Stationary measurements shall be performed on all earthmoving plant according to the method of AS 2012.1 and/or ISO 6393.

In addition to measuring overall A-weighted noise levels, octave band frequency LAeq,T noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band LAeq,T noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the LAeq,T and LA10,T noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

All measured noise level data and determined sound power levels shall be included in the test reports.

D.1.5 Dynamic Testing

Details of equipment operation during testing will vary depending on the equipment type. Dynamic measurements shall be performed on all earthmoving plant according to the method in International Standard ISO 6395.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in International Standard ISO 6395.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed to establish octave-band sound power levels.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and LA10,T noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

All measured noise level data and determined sound power levels shall be included in the test reports.

D.1.6 Testing Procedures – Other Construction Plant

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 'Electroacoustic - Sound Level Meters'. The calibration of the meters shall be checked in the field before and after the noise measurement period.

Noise measurements shall be performed on all non-earthmoving construction plant according to the methods of either ISO 3744 or ISO 3746, whichever is applicable to the items of plant being tested.

Machinery shall be operated at high idle speed. In the case of drilling, boring and rock-breaking machines, the testing location shall allow for these machines to be operated in rock of characteristics that are typical for the project site.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A10,T}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures. All measured noise level data and determined sound power levels shall be included in the test reports.

D.2 Specification for Construction Noise Monitoring

D.2.1 Scope

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

D.2.2 Referenced Standards & Guidelines

- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;
- AS 1055 Acoustics - Description and Measurement of Environmental Noise;
- DECCW NSW Interim Construction Noise Guideline 2009; and
- EPA NSW Industrial Noise Policy 2000.

D.2.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in AS IEC 61672.1 2004 'Electroacoustic - Sound Level Meters - Specifications' and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters and computers housed in weather resistant enclosures. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option.

All environmental noise measurements shall be taken with the following meter settings:

- Time Constant - FAST (i.e. 125 milliseconds)
- Frequency Weightings - A-weighting
- Sample Period - 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise should be disregarded when it is raining and/or the wind speed is greater than 5 m/s (18 km/HR).

D.2.4 Long-term (unattended) Monitoring

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, whilst shielded as much as possible from non-construction site noise (e.g. road traffic, rail noise and other surrounding noise).

Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum

range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels: Lmin, L90, Leq, L10, L1 and Lmax.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Meteorological conditions such as wind velocity, wind direction and rainfall shall also be either monitored on site or recorded from the nearest weather station to the project site, over the entire noise monitoring period.

D.2.5 Short-term (attended) Monitoring

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported are the following A-weighted noise levels: Lmin, L90, Leq, L10, L1 and Lmax.

In addition to measuring and reporting overall A-weighted noise levels, statistical L90, Leq, L10 noise levels shall also be measured and reported in third-octave band frequencies from 31.5Hz to 8kHz.

Outdoor noise monitoring is to be undertaken at least 3.5m from any reflecting structure other than the ground. The preferred measurement height is 1.2-1.5m above the ground. Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and about 1.5m from windows.

Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover shall also be recorded during short-term noise monitoring.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

The following information shall be recorded:

- Date and time of measurements
- Type and model number of instrumentation
- Results of field calibration checks before and after measurements
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day)
- Sketch map of area
- Measurement location details and number of measurements at each location

- Weather conditions during measurements
- Operation and load conditions of the noise sources under investigation
- Any adjustment made for presence or absence of nearby reflecting surfaces
- Noise due to other sources (e.g. traffic, aircraft, trains, dogs barking, insects etc.)

D.3 Specification for construction vibration monitoring

D.3.1 Scope

This document specifies methods for undertaking vibration monitoring during the construction phase of the project.

D.3.2 Referenced Standards and Guidelines

- AS 2775 Mechanical Mounting of Accelerometers
- AS 2670.2 Part 2: Evaluation of human exposure to whole body vibration
- DECC NSW Assessing Vibration: A Technical Guideline
- DIN 4150.3 Structural Vibration in Buildings – Effects on Structures
- BS 7385:1 Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
- BS 7385:2 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration
- ISO 4866 Mechanical Vibration & Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings

D.3.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be calibrated at least once every two years to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The monitoring system should also have a measurement frequency range down to 1Hz.

Short-Term (Attended) Monitoring

Vibration monitoring shall be undertaken at the following locations:

- at the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so to refine the indicative minimum working distances and provide a site-specific table of minimum working distances
- vibration sensitive locations determined to fall within the 'buffer distances' established for each item of plant. Areas likely to require vibration monitoring are identified in this report; and
- where vibration complaints or requests from relevant authorities, at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities.

Vibration monitoring shall be undertaken over the following period(s):

- for plant operating within the 'buffer distances', during the commencement of use of each plant on site until site-specific minimum working distances are established; and
- for complaints or requests from relevant authorities, during the of use of requested plant until site-specific minimum working distances are established.

All attended short-term vibration monitoring shall be recorded over 15 minute sample intervals. The magnitude of vibration is to be recorded at a minimum rate of 10 samples per second. The following minimum range of vibration metrics should be stored in memory and reported:

- Vibration Dose Values (VDVs)
- root-mean-square (rms) – maximums and statistical levels
- peak-particle velocity (ppv) – maximums and statistical levels.

In addition to measuring and reporting overall vibration, statistical vibration shall also be measured and reported in third-octave band frequencies from 1Hz to 250Hz.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- the surface should be solid and rigid in order to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel

washer, plate or bracket which shall be either fastened or glued to the surface of interest; and

- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.

The following information shall be recorded:

- Date and time of measurements;
- Type and model number of instrumentation;
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day);
- Sketch map of area;
- Measurement location details and number of measurements at each location;
- Operation and load conditions of the vibrating plant under investigation; and
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic, etc.).

D.3.4 Long-Term (Unattended) Monitoring

Vibration monitoring shall be undertaken at vibration sensitive locations determined to fall within the 'minimum working distances' established for each item of plant during the commencement of use of each plant on site.

Vibration monitoring shall be undertaken over the following period(s):

- continuously whilst the vibrating plant is operational within the pre-determined 'minimum working distance' from the potentially affected building.

Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.

Vibration is to be recorded at a minimum rate of 10 samples per second. The data is to be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- Vibration Dose Values (VDVs)
- vector-sum root-mean-square (rms) – maximums and statistical metrics; and
- vector-sum peak-particle velocity (ppv) – maximums and statistical metrics.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- the surface should be solid and rigid in order to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using bees wax or a magnetic mounting plate onto a steel plate or bracket either fastened or glued to the surface of interest;
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that; and
- a flashing light alarm should be attached in a visible position from the construction work area. When vibration exceeds the set threshold, the light will flash notifying the operator that works in that area should cease immediately.

Annexure E. Consultation

Condition of Approval SSI-5931	Condition of Approval SSI-5414	CEMP Document	Agency Consultation	Status	Comments	NRT Response
Phase 1						
E29(b)	E35(b)	Construction Noise and Vibration Management Plan	Environment Protection Authority	Closed	EPA has notified by email (5/1/15) that they do not review and endorse management plans and as such will not be providing comment on the plan.	N/A
Phase 2						
N/A	E35(b)	Construction Noise and Vibration Management Plan	Environment Protection Authority	Closed	EPA has notified by email on12 October 2015 that they do not approve or endorse management plans and as such will not be providing comment on the plan.	N/A

Annexure F. Glossary

Term	Definition
ABL	Assessment Background Level, is the single figure background level representing each assessment period – day, evening and night – over each 24 hour period of monitoring. Determination of the ABL is by the tenth percentile method as prescribed in EPA policies.
Acoustic Barrier	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise, without eliminating it.
AEC	Areas of Environmental Concern
Air-borne noise	This refers to noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise and receiver.
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
ANZECC	Australian and New Zealand Environment Conservation Council (check reference)
AMS	(Construction) Activity Method Statement
AS	Australian Standard
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
BS	British Standard
CEMF	Construction Environmental Management Framework (Appendix B of Submissions Report)
CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
CNVIS	Construction Noise And Vibration Impact Statement
CNVMP	Construction Noise and Vibration Management Plan
Decibels [dB]	The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen. The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound is heard. The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping. Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of

Term	Definition
	decibels. The following are examples of the decibel readings of every day steady or quasi-steady sounds; 0dB the faintest sound we can hear 20dB quiet bedroom at night or recording studio 30dB quiet library or quiet location in the country 40dB living room 50dB typical office space or ambience in the city at night 60dB normal conversational speech 70dB a car passing by 80dB kerbside of a busy road 90dB truck passing by 100dB nightclub 110dB rock band or 2m from a jackhammer 120dB 70m from a jet aircraft 130dB threshold of pain 140dB 25m from a jet aircraft
dB(A); A-weighted decibels	The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched in is denoted as dB(A). Practically all noise is measured using the A filter.
DECC	Department of Environment and Climate Change (now OEH and EPA)
DECCW	Department of Environment and Climate Change and Water (now OEH and EPA)
Diffraction	The distortion around solid obstacles of waves travelling past.
DIN	German Standard
ECRL	Epping to Chatswood Rail Link
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EIS 1	EIS for NWRL Early Works and Major Civil Construction Works (Incorporating Staged Infrastructure Modification Assessment) (SSI 5100)
EIS 2	EIS for Construction works associated with SSI 5100 including construction and operation of stations and wider precincts, service facilities, rail infrastructure and systems (SS! 5414)
RTRF EIS	EIS for the Rapid Transit Rail Facility approval application (SSI 13_5931)
EMS	Environmental Management System developed within the framework of AS/NZS ISO 14001:2004
EPA	Environment Protection Authority
EPL	Environment Protection Licence
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
ER	Environmental Representative
Fluctuating Noise	Noise that varies continuously and to an appreciable extent over the period of observation.
Frequency	Of a periodic quantity: the time rate of repetition. The reciprocal of the period. Frequency is measured in Hertz (Hz).
Ground-borne noise	Ground-borne noise propagating through the ground as vibration and then radiated by vibrating building elements such as wall and floor surfaces. This

Term	Definition
	noise is normally noticeable only in areas that are well protected from airborne noise.
IC	Independent Certifier
Loudness	A 3dB increase represents a doubling of the sound pressure, however an increase of about 10dB is required before the sound will subjectively appear to be twice as loud. That is, a sound of 85dB is twice as loud as a sound of 75dB which is twice as loud as a sound of 65dB and so on. That is, the sound of 85dB is four times as loud as a sound of 65dB. The smallest change which can be readily heard is approximately 2dB. An increase beyond 5dB is considered to represent the level at which a change in loudness begins to be clearly perceived.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
Leq	Equivalent sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCA	Noise Catchment Area – an area of receivers grouped by similarities in existing or likely noise exposure levels, distance setback from noise source/s, geographical layout, shielding from noise source/s, types of development, building types or other features.
NHMRC	National Health and Medical Research Council
NML	Noise Management Level, as set out in the NSW 'Interim Construction Noise Guideline' (ICNG), Department of Environment and Climate Change, 2009
Noise	Sound which a listener does not wish to hear.
Noise Monitor	See "sound level meter".
NRT	Northwest Rapid Transit
NWRL	North West Rail Link (*now renamed as* 'Sydney Metro Northwest')
OTS PPP	Operations, Trains and Systems Public Private Partnership (the Project, including delivery and operation)
POEO Act	Protection of the Environment Operations Act 1997
The Project	The North West Rail Project
Project Approval	Minister for Planning and Infrastructure's Approval for the North West Rail Link Stage 1: Major Civil Works dated 25 September 2012
RBL	Rating Background Level, is the overall single figure background noise level representing each assessment period – day, evening and night – over the whole monitoring period. The RBL is determined by taking the median of the assessment background levels (ABLs) for each day, evening and night periods (see ABL for definition), as set out in EPA policies.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path
REMM	Revised Environmental Mitigation Measures.
RFT	Request for Tender
RTRF	Rapid Transit Rail Facility
RMS	Root Mean Squared

Term	Definition
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	An alteration in pressure, stress, particle displacement, or particle velocity which is propagated in an elastic material or the superposition of such propagated alterations.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of sound pressure, expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Spoil	All material generated by excavation into the ground including the excavation of station boxes and tunnels
Structure-borne noise	Vibration propagating through solid structures in the form of compressional or bending waves, heard as sound.
SEP	Site Environment Plan
SEPP	State Environmental Planning Policy
SSI	State Significant Infrastructure
SVC	Surface Viaduct and Civil Works for the North West Rail Link Project
TBM	Tunnel Boring Machine
TfNSW	Transport for New South Wales
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.
TRA	Task Risk Assessment
TSC Works	Tunnels and Station Civil Works for the North West Rail Link Project
VDV	Vibration Dose Values
WAD	Works Authorisation Deed
WTP	Water Treatment Plant
WRA	Workplace Risk Assessment
ITP	Inspection and Test Plan