Parkes to Narromine Project
Environmental Impact Statement
Technical Report 5: *Noise & Vibration Assessment*

TECHNICAL REPORT 5:
Noise & Vibration Assessment

Australian Rail Track Corporation

Inland Rail - Parkes to Narromine
Noise and Vibration Assessment

June 2017

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Glossary

Absolute rail noise	The absolute rail noise refers to noise levels emitted by rail only, that is without the contribution of any other noise source.
Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise is removed. This is described using the L_{A90} descriptor. (see also Rating background level).
dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
EPA	Environmental Protection Authority of New South Wales
Feasibility	Relates to engineering considerations (what can be practically built). These engineering considerations may include: • the inherent limitations of different techniques to reduce noise emissions from road traffic noise sources • safety issues such as restrictions on road vision • road or rail corridor site constraints such as space limitations • floodway and stormwater flow obstruction • access requirements • maintenance requirements • the suitability of building conditions for at property treatments.
Groundborne vibration	Groundborne vibration is vibration transmitted from source to receiver via the medium of the ground.
$L_{A90\ (Time)}$	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$.
$L_{Aeq\ (Time)}$	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.
$L_{Aeq\ (15\ hr)}$	The L_{Aeq} noise level for the period 7.00 to 22.00 hours.
$L_{Aeq\ (9\ hr)}$	The L_{Aeq} noise level for the period 22.00 to 7.00 hours.
$L_{Aeq\ (1hr)}$	The highest hourly L_{Aeq} noise level during the day and night periods.
$L_{A90(period)}$	The sound pressure level exceeded for 90% of the measurement period.
L_{Amax}	The maximum sound level recorded during the measurement period.
L_{AFmax}	The maximum sound level recorded during the measurement period using a fast time response.
Mitigation	Reduction in severity
Noise sensitive receiver	An area or place potentially affected by noise including residential dwellings, schools, child care centres, places of worship, health care institutions and active or passive recreational areas.
OEH	The Office of Environment and Heritage (OEH). Formerly the Department of Environment and Climate Change (DECC), later known as the Department of Environment Climate Change and Water (DECCW).
Operation	Operation of trains between Melbourne and Brisbane on the completed Inland Rail alignment.

Out of Hours Works (OOHW)	(Proposal definition) Out of hours works includes times of day outside of the primary proposal construction hours. Noise sensitive receivers are expected to be more sensitive to noise during the out of hours work period as they are typically used for rest and sleep. The out of hours work period for the proposal has been defined as 6 pm to 6 am.
Peak Particle Velocity (PPV)	Current practices for assessments of the risk of structural damage to buildings use measurements of Peak Particle Velocity (PPV) in millimetres per second. The PPV is the maximum speed, in mm/s, that occurs from a vibration at the mid point between maximum displacements in each direction", the existing statement could be added after the definition to provide context of typical use.
Project	For the purposes of the noise and vibration assessment, the term 'Project' is synonymous with 'Proposal'.
Proposal	The construction and operation of the Parkes to Narromine section of Inland Rail. This is the 'Project' for the purposes of the Rail Infrastructure Noise Guideline.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes.
Reasonable	Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure. To make such a judgement, the following should be considered: • Noise impacts: - Existing and future levels, and projected changes in noise levels. - Level of amenity before the project, e.g. the number of people affected or annoyed. - Any noise performance criteria for the development, e.g. internal noise levels for certain rooms. - The amount by which the triggers are exceeded. • Noise mitigation benefits: - The amount of noise reduction expected, including the cumulative effectiveness of proposed mitigation measures - ideally, a noise wall/mound should be able to reduce noise levels by at least 5 dB. - The number of people protected. • Cost effectiveness of noise mitigation: - The total cost of mitigation measures, taking into account the physical attributes of the site, e.g. topography, geology, and the cost variation to the project given the expected benefit. - Noise mitigation costs compared with total project costs, taking into account capital and maintenance costs. - Ongoing operational and maintenance cost borne by the community, e.g. running air conditioners or mechanical ventilation. • Community views: - Engage with affected land users when deciding about aesthetic and other impacts of noise mitigation measures. - Determine the views of all affected land users, not just those making representations, through early community consultation. - Consider noise mitigation measures that have majority support from the affected community.
Receiver	A noise modelling term used to describe a map reference point where noise is predicted. A sensitive receiver would be a home, work place, church, school or other place where people spend time.

RMS or Vrms	Root Mean Square (velocity)
Short-term vibration	Vibration that occurs so infrequently that it does not cause structural fatigue nor does it produce resonance in the structure.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micro Pascals.
Tonality	Noise containing a prominent frequency or frequencies characterised by a definite pitch.
Vibration dose value (VDV)	As defined in BS6472 – 1992, the vibration dose value is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

List of abbreviations

AVTG	Assessing Vibration: A Technical Guideline (DEC 2006)
ARTC	Australian Rail Track Corporation
CNS (Rail Projects)	Construction Noise Strategy (Transport for NSW, 2012)
CNVIS	Construction Noise and Vibration Impact Statement
CoRTN	Calculation of Road Traffic Noise (UK Department of Transport Welsh Office 1988)
EPA	Environment Protection Authority
EIS	Environmental impact statement
ICNG	*Interim Construction Noise Guideline* (DECC 2009)
km/h	kilometres per hour
INP	*Industrial Noise Policy* (EPA 2000)
mm/s	millimetres per second
m/s	metres per second
NMT	Nordic Prediction Method for Train Noise (TemaNord 1996:524).
NVRF	Sydney Trains Environmental Management System Guide for Noise and Vibration from Rail Facilities
RING	*Rail Infrastructure Noise Guideline*
RNP	*Road Noise Policy* (DECCW 2011)
SEARs	Secretary's Environmental Assessment Requirements
SEL	Sound exposure level
TfNSW	Transport for NSW

Executive summary

The proposal

Australian Rail Track Corporation Ltd (ARTC) is seeking approval to construct and operate the Parkes to Narromine section of Inland Rail ('the proposal').

The proposal would involve upgrading the existing rail line between Parkes and Narromine, including new crossing loops, some track realignment and replacement of culverts. The proposal also includes a new north to west connection between Inland Rail and the Broken Hill line (Parkes north west connection). Ancillary works will include upgrading, closing or consolidating level crossings, upgrading signalling and communications, establishing new fencing or upgrading existing fencing along the rail corridor, and relocating/protecting services and utilities.

This report

This report provides an assessment of the potential noise and vibration impacts of the proposal. The scope of the assessment has been undertaken in response to the Secretary's Environmental Assessment Requirements (SEARs) issued on 8 November 2016 and guided by relevant legislation and various industry guidelines and standards.

Operational noise

Operational noise has been assessed having regard to the NSW *Rail Infrastructure Noise Guideline* (RING) and included modelled operational scenarios at current and future horizon timeframes for both the 'no-build' case that assumes the proposal does not proceed and the 'build' case that incorporates the proposal and corresponding growth in train movements.

The RING criteria for redeveloped rail lines provide trigger levels for noise at residential receivers (L_{Aeq} and L_{Amax}), as well as an increase in noise levels resulting from the project. To qualify for mitigation consideration, the proposal must both increase noise levels at a receiver and exceed the noise trigger levels set out in the guideline.

A total of 28 residential receivers were found to exceed the criteria established by the RING. These included:

- 1 receiver in Parkes
- 16 receivers in Peak Hill
- 3 receivers in Tomingley
- 8 receivers in Narromine

A number of potential mitigation options have been reviewed and may be effective, subject to being shown to be reasonable and feasible for this project. Details of potential mitigation options can be found in Section 6.1 of this report.

Operational vibration

Operational vibration impacts with consideration to structural damage are not considered likely to result from the proposal. While a proportional increase in vibration due to increased axle loads is likely, vibration is predicted to remain within acceptable levels considering the distance to nearby receivers. Additionally, improved ballast/sleeper heterogeneity and rail surface smoothness may also reduce transmitted vibration and assist to offset increases in vibration due to axle loading and speed.

Daytime vibration levels are predicted to be within the acceptable range for human comfort impacts at distances of more than 11 metres from the track, while night time levels are predicted to be acceptable at distances of more than 17 metres from the track.

The nearest vibration sensitive receiver is located approximately 45 metres from the track. Therefore, no receivers are expected to trigger the day or night criteria. Adverse reaction from operational vibration of the proposal are thus considered unlikely.

Construction noise

Noise emissions from construction have been assessed during standard construction hours and outside the standard construction hours. An assessment has been carried out in accordance with the *Interim Construction Noise Guideline* (ICNG).

- In relation to construction activities:
  - Activities such as pre-possession works (construction scenario S1), skim track reconditioning (construction scenario S2), full depth reconditioning (construction scenario S3), and drainage construction, are likely to produce the greatest level of impacts due to the closest proximity to receivers and high predicted noise activities.
- In relation to working hours and construction noise management levels:
  - The highly affected level of 75 dB(A) L_{Aeq} is not likely to be exceeded.
  - Rail line redevelopment construction activities carried out during standard hours are predicted to exceed the noise management level at receivers nearest to the construction footprint. Impacted receivers are within about 400 metres of the works and include up to 89 identified residential receiver locations. Noise levels are predicted to exceed the standard hours criteria by up to 28 dB.
  - New rail line construction works undertaken during standard construction hours at the Parkes north west connection are predicted to exceed the noise management level by up to 13 dB at eight residential receivers.
  - Brolgan road overbridge construction is predicted to exceed the noise management level by about 13 dB at one residential receiver during standard construction hours.
  - Construction activities during standard hours are not expected to exceed the noise management level at non-residential receivers including educational, child care and hospital facilities. Construction noise management levels are applicable as an internal level only when the facilities are in use.
  - Construction activities are not expected to exceed the noise management level at recreational areas when these areas are in use. Note that non-residential criteria apply only when the properties are being used.
  - Rail line redevelopment construction activities undertaken outside of standard working hours are predicted to exceed the noise management level at receivers nearest to the construction footprint. Impacted receivers are within about 700 metres of the works and include up to 228 identified residential receiver locations. Noise levels are predicted to exceed the out of hours criteria by up to 33 dB.
  - New rail line construction works undertaken outside standard construction hours at the Parkes north west connection are predicted to exceed the noise management level by up to 18 dB at 23 residential receivers.
  - Brolgan road overbridge construction is predicted to exceed the noise management level by about 18 dB at two residential receivers for works undertaken outside standard construction hours.

The noise and vibration mitigation measures detailed in Section 6.3.2 should be implemented where feasible and reasonable and all potentially affected receivers should be informed of the nature of the works, expected noise levels, duration of works and a method of contacting site management.

Construction vibration

General construction activities

In relation to vibration from general construction activities, the expected magnitude of ground vibration is not expected to be sufficient to cause damage if the equipment operates at distances greater than 18 metres from standard residential buildings or structures of similar construction.

Many heritage structures near to the proposal consist of station buildings, sidings and silos which are directly adjacent to the track and bridges that are on the actual alignment. The expected magnitude of ground vibration is not expected to be sufficient to cause damage if the equipment operates at distances greater than 35 metres from heritage buildings and structures. However, many items are potentially within this distance from the works and may therefore be affected.

The noise and vibration mitigation measures detailed in Section 6.3 should therefore be implemented to manage potential construction vibration impacts.

Piling

Vibration impacts due to piling activities have the potential to exceed structural vibration values for standard dwellings at distances of 100 metres from the activity for impact piling, 30 metres for vibratory piling and 17 metres for bored piling.

Piling activities have the potential to exceed structural vibration values for heritage structures at distances of 180 metres from the activity for impact piling, 50 metres for vibratory piling and 35 metres for bored piling.

In the event that sensitive receivers fall within these buffer distances, other methods may need to be investigated such as press-in hydraulic piling or jacked-in piling to reduce the potential for impact. These methods generally exhibit much lower vibration levels compared to impact, vibratory and bored piling.

Human comfort

Humans are capable of detecting vibration at levels well below those causing risk of damage to buildings. Based on a conservative assessment, it is possible that construction vibration for general construction activities may be perceptible at distances up to 140 metres from the works. The mitigation measures detailed in Section 6.3 should therefore be considered where feasible and reasonable to reduce the potential for impact.

1. Introduction

1.1 Overview

The Australian Government has committed to delivering a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor. The Inland Rail programme (Inland Rail) involves the design and construction of a new inland rail connection, about 1,700 kilometres long, between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland. Inland Rail would enhance Australia's existing national rail network and serve the interstate freight market.

Australian Rail Track Corporation Ltd (ARTC) has sought approval to construct and operate the proposal.

The proposal requires approval from the NSW Minister for Planning under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This report has been prepared by GHD Pty Ltd (GHD) as part of the environmental impact statement (EIS) for the proposal. The EIS has been prepared to accompany the application for approval of the proposal, and address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 8 November 2016 and the terms of the assessment bilateral agreement between the Commonwealth and the State of New South Wales under the EPBC Act.

1.2 The proposal

1.2.1 Location

The proposal is generally located in the existing rail corridor between the towns of Parkes and Narromine, via Peak Hill. In addition, a new connection to the Broken Hill rail line ('the Parkes north west connection') is proposed outside the existing rail corridor at the southern end of the proposal site near Parkes. The location of the proposal is shown in Figure 1-1.

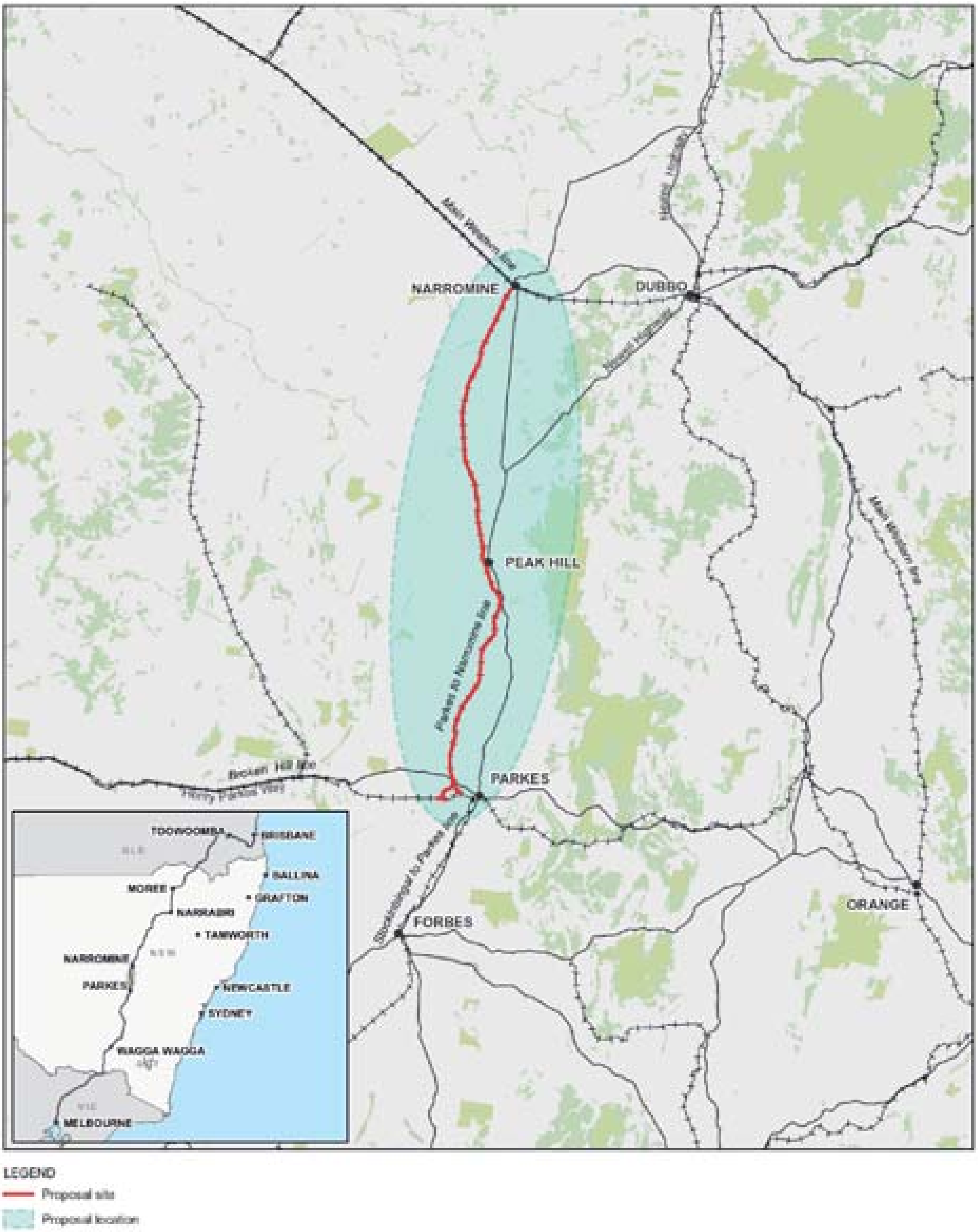
1.2.2 Key features

The key features of the proposal involve:

- Upgrading the track, track formation, and culverts within the existing rail corridor for a distance of 106 kilometres between Parkes and Narromine.
- Realigning the track where required within the existing rail corridor to minimise the radius of tight curves.
- Providing three new crossing loops within the existing rail corridor, at Goonumbla, Peak Hill, and Timjelly.
- Providing a new 5.3 kilometre long rail connection to the Broken Hill Line to the west of Parkes ('the Parkes north west connection'), including a road bridge over the existing rail corridor at Brolgan Road ('the Brolgan Road overbridge').

The key features of the proposal are shown in Figure 1-2.

Ancillary work would include works to level crossings, signalling and communications, signage and fencing, and services and utilities.



LEGEND

Proposal site

Proposal location

Rail lines

Main roads

Paper Size A4

0 5 10 20 30

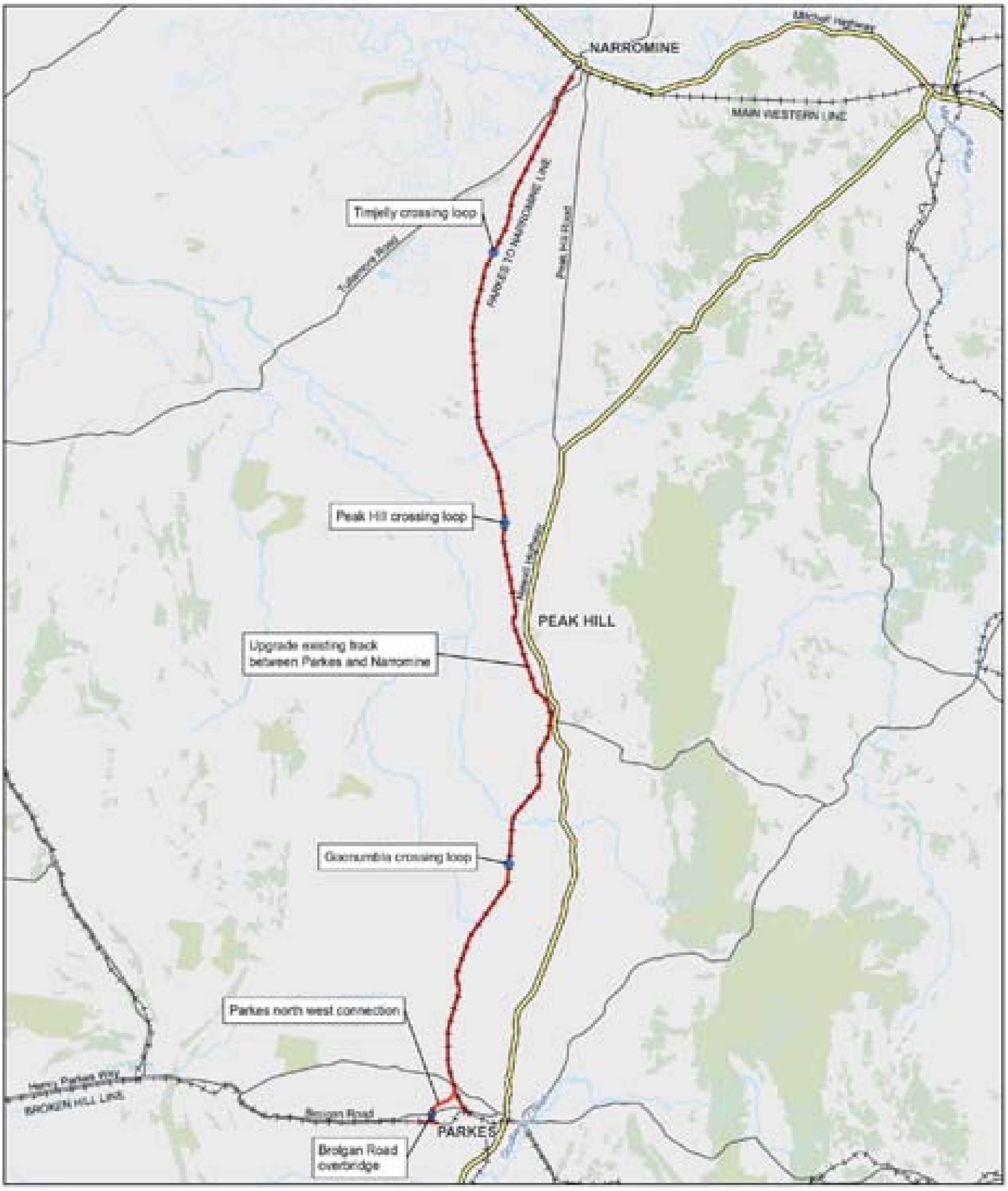
Kilometers

Australian Rail Track Corporation
Inland Rail Track Alignment

Job Number 2217516
Revision 0
Date 30 Nov 2016

Location of the proposal

Figure 1-1



LEGEND

- New bridge
- Crossing loop
- The proposal
- Railway
- Highway
- Road

Paper Size A4

0 2.5 5 10 15

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

Australian Rail Track Corporation
Inland Rail Track Alignment

Job Number 2217916
Revision 0
Date 19 Jun 2017

Key features of the proposal

Figure 1-2

Data source: Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3, 2006

Further information on the proposal is provided in the EIS.

1.2.1 Timing

Subject to approval of the proposal, construction is planned to start in early to mid 2018, and is expected to take about 18 months. Existing train operations along the Parkes to Narromine line would continue prior to, during, and following construction. Inland Rail as a whole would be operational once all 13 sections are complete, which is estimated to be in 2025.

1.2.2 Operation

Prior to the opening of Inland Rail as a whole, the proposal would be used by existing rail traffic, which includes trains carrying grain and ore at an average rate of about four trains per day. It is estimated that the operation of Inland Rail would involve an annual average of about 8.5 trains per day in 2025, increasing to 15 trains per day in 2040. The trains would be a mix of grain, intermodal (freight), and other general transport trains.

1.3 Purpose and scope of this report

The purpose of this report is to assess potential noise and vibration issues from the operation and construction of the proposal, and where required, identify feasible and reasonable mitigation measures.

This noise and vibration assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs). Table 1-1 outlines the requirements relevant to this assessment.

Table 1-1 Relevant SEARs

Requirements for Noise and Vibration	
Noise and vibration – Amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise). 2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.
Noise and vibration – Structural Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings, items including Aboriginal places and environmental heritage, and nearby road infrastructure. Increases in noise emissions and vibration affecting environmental heritage as defined in the Heritage Act 1977 during operation of the project are effectively managed.	1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage). 2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.

The scope of the noise and vibration assessment involved:

- Identification of key noise and vibration sensitive receivers.
- Measurement and presentation of existing noise and vibration levels in the subject area.
- Identification of the likely principal noise sources during operation of the proposal.
- Identification and derivation of the applicable construction noise and vibration criteria from relevant guidelines and existing background noise levels.
- Identification of applicable operational rail noise criteria.
- Assessment of the potential construction noise and vibration impacts of the proposal on the surrounding environment based on indicative construction methodology and equipment.
- Assessment of the potential operational noise and vibration impacts of the proposal on the surrounding environment.
- Identification and discussion of potential noise and vibration mitigation measures with consideration to the proposal noise and vibration criteria.

Operational road traffic noise was not assessed for the proposed Brolgan Road overbridge as it is anticipated that road traffic volumes and associated road traffic noise levels would remain unchanged due to the proposal.

1.4 Study area

The study area subject to this assessment is the rail corridor and adjacent land between Parkes and Narromine. The study area encompasses the operational and construction footprints, including areas which could be indirectly impacted by the proposal. The study area including sensitive receiver locations is shown in Appendix C and described further in Section 2.2.

1.5 Structure of this report

The structure of the report is provided in Table 1-2.

Table 1-2 Report structure

Section	Details
1	Provides an introduction to the report
2	Describes the existing ambient and background noise environment
3	Details the relevant noise and vibration criteria
4	Describes the operational rail noise and vibration assessment
5	Describes the construction noise and vibration assessment
6	Describes the mitigation measures
7	The report conclusion summarising key outcomes from the assessment

2. Existing environment

2.1 Existing operations

Parkes is located on the Broken Hill line, which forms part of the trans-continental railway from Sydney to Perth. The Broken Hill line extends from the Main Western line at Orange, travels to Broken Hill, and then to Adelaide. The Broken Hill line carries transcontinental freight and is used by the Indian Pacific passenger train, and a weekly passenger train.

Narromine is located on the Main Western line. Narromine Station is now closed to passenger services.

The Parkes to Narromine line forms a cross-country link between the Main Western and the Broken Hill lines. The Parkes to Narromine line, which connects to the Broken Hill line at Goobang Junction (about 3.5 kilometres west of Parkes Station), is closed to passenger services and serves freight only.

Physical characteristics

The track between Parkes and Narromine was originally constructed for light traffic but while it has been re-ballasted and maintained over time, no significant improvements have been made to the track formation. Sections of track pass through low lying, flood prone areas and the maintenance access track is not continuous and can be impassable by two wheel drive vehicles following wet weather.

The rail track was built with minimal earthworks and includes a number of 1:100 grades in short lengths between Peak Hill and Parkes. In some locations, the original timber sleepers have been replaced with steel, new ballast has been laid, and damaged culverts replaced.

There are about 16 sidings between Parkes and Narromine that provide access to and from the main line for private operations.

Existing use

The Parkes to Narromine line is used by minerals, general freight and grain trains at an average rate of two to three trains per day. These trains carry about two million tonnes of grain per year. The line has a capacity for trains up to lengths of 1,800 metres, however typical existing scheduled trains are between 400 and 600 metres long[1]. Train speeds are limited to a maximum of 100 km/h, with local speed restrictions due to limitations associated with the existing track. Train speeds are described further in Section 4.1.4.

2.2 Location of the study area

The area surrounding the proposal consists of open space, rural land, residential land and commercial land. The proposal passes through several small rural towns.

For the operational rail noise assessment, the study area was defined as the area that extends about 2 kilometres either side of the rail corridor and bounded by the extent of works. Noise and vibration sensitive receiver receivers were identified within the operational assessment study area and are shown in Figure 2-1.

For the construction noise and vibration assessment study area, a 2 kilometre buffer from the proposal in all directions was used to identify sensitive receiver locations. The construction assessment study area therefore extends beyond the northern end of the proposal to include some receiver locations within Narromine and at the southern end includes some receivers within Parkes. The construction noise and vibration study area is shown in Figure 2-1.

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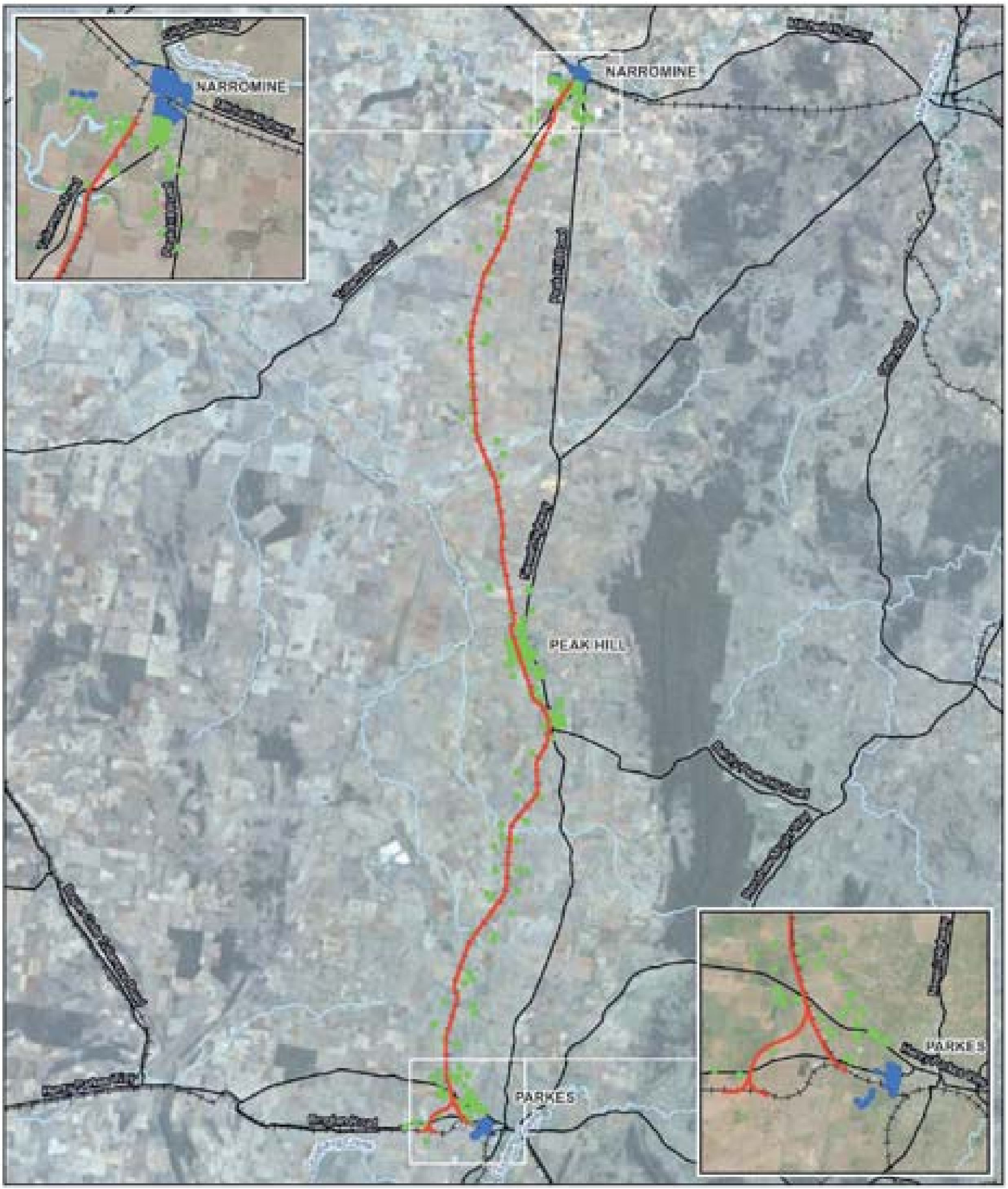
[1] ARTC Master Train Plan, NSWHVR 600 Parkes-Gulgong-Werris Creek / NSWHVR 600 Werris Creek-Gulgong-Parkes, effective 12th June 2016



LEGEND

- Construction receiver
- Construction and operational receiver
- The proposal
- Road
- Railway
- Watercourse

Paper Size A4

0 2.5 5 10 15

Kilometers

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

GHD

Australian Rail Track Corporation
Inland Rail - Parkes to Narromine

Job Number 22-17916
Revision 0
Date 01 Dec 2016

Construction and operational sensitive receiver locations

Figure 2-1

The noise and vibration assessment study areas are able to be reduced where receivers are not present for a given section of the proposal, but may also need to be extended where impacts may occur beyond two kilometres, for instance where construction traffic may extend beyond these bounds.

The extent of both the operational and construction assessment study areas have been reviewed and confirmed following noise and vibration modelling to ensure that they are sufficient to include all potentially affected receiver locations.

2.3 Identification of sensitive receivers

Within the study area, residential sensitive receivers include dwellings located within towns such as Parkes, Peak Hill and Narromine, or are scattered across large areas between the major towns. Noise sensitive receiver locations were identified using aerial imagery and geospatial information.

For the operational noise and vibration assessment (section 4), 662 residential receivers were identified within the operational assessment study area. 14 non residential noise receivers were also identified including: two places of worship, three educational facilities, one medical facility, six active and two passive recreation areas. For the operational noise assessment all residential receivers will have their own specific noise criteria based on their exposure to noise from the proposal and existing exposure to rail noise. This is discussed in more detail in Section 3.1. The receivers are individually identified in Appendix C.

Non-residential receivers including schools, places of worship (churches) and outdoor recreation areas are summarised in Table 2-1.

For the construction noise and vibration assessment (section 5), a total of 1,122 residential receivers and 14 non residential receivers were identified. This differs from the operational noise assessment because some construction activities have the potential to impact a wider area than rail operation. The non residential noise receivers are the same as those identified within the operational assessment study area. A number of commercial and industrial facilities are also located adjacent to the rail corridor and are subject to assessment for construction noise only.

Identification of receivers in this assessment was based principally on inspection of aerial imagery. Where receivers have been identified as qualifying for noise mitigation from this proposal, a more detailed review will be undertaken when further information is available to verify the number of receivers affected and which should be considered for mitigation. Similarly, for non-residential receivers, qualification for noise mitigation will be dependent upon the results of façade testing to determine if the internal noise criteria are exceeded.

Table 2-1 Non-residential receivers

Receiver ID	Description	Receiver Type	Easting	Northing
P2N_REA_0001	Peak hill war memorial pool	Open Space- Active	611346	6378430
P2N_REA_0002	Tennis courts	Open Space- Active	611300	6378535
P2N_REA_0003	Peak hill paceway	Open Space- Active	610416	6378088
P2N_REA_0004	Peak hill showground	Open Space- Active	610279	6377995
P2N_REA_0005	Bowling greens	Open Space- Active	616569	6432186
P2N_REA_0006	Peak hill bowling club	Open Space- Active	611481	6378802
P2N_REA_0007	Lindner oval	Open Space- Active	611356	6378274
P2N_REP_0001	Memorial park	Open Space- Passive	611454	6378883
P2N_EDU_0001	St Joseph's school	School	611919	6377926
P2N_EDU_0002	Peak hill central school	School	611638	6378217
P2N_EDU_0003	Peak hill central school	School	611742	6378144
P2N_HOS_0001	Narromine hospital and community health	Hospital Ward	616743	6431996
P2N_WOR_0001	Place of worship	Worship	611631	6378275
P2N_WOR_0001	Catholic church	Worship	611854	6378051

2.4 Baseline monitoring

2.4.1 Unattended noise monitoring

Baseline unattended noise monitoring took place at nine residential locations and eight locations within the rail corridor between 2 September 2015 and 6 April 2016 in accordance with procedures in the *Industrial Noise Policy* (INP) guideline. Logger locations were selected to capture noise characteristics at a variety of locations throughout the study area. Selection considerations included land topography, distance from rail activities and contribution from other noise activities, such as road noise. The logger locations used for the assessment were considered to be representative of the existing background and ambient noise environment in the study area and can be seen in Appendix B.

Noise monitoring locations were constrained to locations where access was possible on the day of deployment. Access constraints included train schedules precluding track access by HiRail. Security against theft and vandalism were also important considerations when choosing noise monitoring locations.

The objectives of the monitoring were to measure the existing background noise levels in the areas surrounding the proposal site and to measure rail noise from train pass-bys.

The noise loggers were programmed to accumulate L_{A90}, L_{A10}, L_{Aeq} and L_{Amax} noise descriptors continuously over sampling periods of 15 minutes for the entire monitoring period. Two attended noise measurements were also conducted at each logger location for 15 minute durations in order to identify ambient noise sources and validate logger data. Instantaneous noise levels for operator-identified noise sources were observed and noted during the measurements.

Several of the noise loggers were programmed to record the noise descriptors at more frequent time intervals. The more frequent time intervals were used to enable recording of individual train pass-bys and for determination of the relevant rail noise descriptors.

Prior to deployment, a calibration check was performed on the noise monitoring equipment using a Bruel and Kjaer Type 4231 sound level calibrator (serial number 2542101). At completion of the measurements, the equipment was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dB(A).

The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 metre per second, or when rainfall occurred in accordance with the INP. Concurrent half hourly weather data was sourced from the Bureau of Meteorology's (BoM) Dubbo automatic weather station (AWS) and Parkes automatic weather station to identify any periods of weather which may have affected the monitoring results.

All sampling activities were undertaken with consideration to the specifications outlined in AS 1055 (1997) *Acoustics - Description and Measurement of Environmental Noise* and the *Industrial Noise Policy* (INP). Table 2-2 provides details of the noise loggers utilised for unattended monitoring.

Table 2-2 Unattended noise logger locations and details

Noise Logger	L01P2N	L02P2N	L03P2N	L04P2N	L05P2N
Location	80 Backwater Rd, Narromine, approximate chainage 555.4 km	53 Wright St, Narromine, approximate chainage 554.5 km	Approximate chainage 546.6 km	380 Tullamore Rd, Narromine, approximate chainage 553.1 km	Approximate chainage 528.5 km
Equipment type (serial)	SVAN 955 (27621)	SVAN 955 (27615)	SVAN 955 (27623)	SVAN 955 (27625)	SVAN 955 (27622)
Measurement started	21/3/2016, 18;15	21/3/2016, 19.00	2/9/2015, 13:45	21/3/2016, 17:15	2/9/2015, 16.00
Measurement ceased	6/4/2016, 11:30	6/4/2016, 11:45	16/9/2015, 12:20	6/4/2016, 11:20	16/9/2015, 12:30
Frequency weighting	A	A	A	A	A
Time Response	Fast	Fast	Fast	Fast	Fast
Photo					

Noise Logger	L06P2N	L07P2N	L08P2N	L09P2N	L10P2N
Location	Approximate chainage 515.6 km	37 Station Lane, Peak Hill, approximate chainage 498.3 km	1 Jackson St, Peak Hill, approximate chainage 497.4 km	60 Trewilga Rd, Peak Hill, approximate chainage 490.8 km	Chainage 486 km, off Mickibri Rd
Equipment type (serial)	SVAN 955 (36821)	Rion NL-21 (00852196)	SVAN 955 (27623)	SVAN 955 (27612)	SVAN 955 (27624)
Measurement started	2/9/2015, 15:30	22/3/2016, 18:15	22/3/2016, 17:30	22/3/2016, 17.00	3/9/2015, 9:15
Measurement ceased	16/9/2015, 13.00	5/4/2016, 13:30	5/4/2016, 14:15	5/4/2016, 15:15	16/9/2015, 14.00
Frequency weighting	A	A	A	A	A
Time Response	Fast	Fast	Fast	Fast	Fast
Photo					

Noise Logger	L11P2N	L12P2N	L13P2N	L14P2N	L15P2N
Location	Approximate chainage 478.150 km	Approximate chainage 468.500 km	503 Nanardine Ln, Parkes, approximate chainage 457.7 km	Candobolin Rd, Parkes, approximate chainage 452.5 km	Approximate chainage 454.7 km
Equipment type (serial)	SVAN 977 (36819)	SVAN 977 (36820)	SVAN 977 (36820)	SVAN 955 (27613)	SVAN 955 (27625)
Measurement started	3/9/2015, 15:30	3/9/2015, 15:15	22/3/2016, 15:30	22/3/2016, 14:15	3/9/2015, 13:45
Measurement ceased	16/9/2015, 15:15	16/9/2015, 15:45	5/4/2016, 11:15	5/4/2016, 13:45	16/9/2015,16:45
Frequency weighting	A	A	A	A	A
Time Response	Fast	Fast	Fast	Fast	Fast
Photo					

Noise Logger	L16P2N	L17P2N
Location	Goobang Junction, Parkes, approximate chainage 449 km	Approximate chainage 457 km, Parkes
Equipment type (serial)	SVAN 977 (36821)	SVAN 955 (27624)
Measurement started	22/3/2016, 11.00	22/3/2016, 12:05
Measurement ceased	5/4/2016, 11.00	05/04/2016, 10:45
Frequency weighting	A	A
Time Response	Fast	Fast
Photo		

2.4.2 Attended noise monitoring

Baseline attended noise measurements were conducted at the above monitoring locations to supplement the unattended noise monitoring data and assist with noise source identification. Attended noise measurements were conducted between 21 March 2016 and 6 April 2016 using a B&K 2250 Sound Level Meter (SLM). This SLM is capable of measuring continuous sound pressure levels and is able to record L_{A90}, L_{A10}, L_{Aeq} and the maximum sound level recorded during the measurement period (L_{Amax}) noise descriptors.

Prior to deployment, the meter was calibrated using a B&K Type 4231 Class 1 acoustic calibrator (serial number 2542101) with a sound pressure level of 94 dB at one kilohertz. Calibration was checked prior to the commencement and at completion of the measurements. The difference was less than the acceptable tolerance of +/- 0.5 dB.

All sampling activities were undertaken with consideration to the specifications outlined in AS1055 (1997) *Acoustics - Description and Measurement of Environmental Noise* and the NSW *Industrial Noise Policy* (EPA, 2000).

2.4.3 Ground vibration monitoring

Long term vibration measurements were undertaken at one monitoring location in the vicinity of the proposal as shown in Appendix B. Vibration measurements were conducted using a Instantel Minimate Plus (serial number BE12721) vibration logger with tri-axial geophones to monitor ground vibration peak particle velocity (PPV) in each axial direction. The Instantel Minimate Plus has a range of 31.7 millimetres per second and a sample rate of 2048 samples per second. The Minimate unit has an inbuilt data logger, downloadable to PC where analysis can be performed using Blastware software. The vibration monitor was set up approximately 15 metres from the nearest track. Details of the vibration logger are provided in Table 2-3.

Table 2-3 Unattended ground vibration logger details

Vibration Logger	V01P2N
Location	Approximate chainage 450 km, Parkes
Model (Serial Number)	Instantel Minimate (BE12721)
Photo	

2.4.4 Ambient noise monitoring results

Unattended monitoring

A summary of the calculated rating background level (RBL) $L_{A90(period)}$ and $L_{Aeq(period)}$ noise monitoring results are shown in Table 2-4. The RBL represents the existing background noise environment in the area of the proposal. Detailed noise monitoring charts are provided in Appendix A.

Table 2-4 RBL $L_{A90\ (period)}$ and $L_{Aeq\ (period)}$ noise monitoring results, dB(A)[2,3]

Location	L_{A90} RBL noise levels			L_{Aeq} ambient noise levels		
	Day	Evening	Night	Day	Evening	Night
L01P2N	27	29	25	53	49	49
L02P2N	29	27	27	48	44	43
L03P2N	26	30	20	53	49	51
L04P2N	29	30	32	51	52	45
L05P2N	20	20	19	53	47	48
L06P2N	22	19	18	56	44	53
L07P2N	26	26	21	58	45	42
L08P2N	27	24	20	49	44	42
L09P2N	28	23	20	47	48	46
L10P2N	22	22	21	56	56	54
L11P2N	24	21	18	52	51	52
L12P2N	25	27	20	57	50	51
L13P2N	25	19	18	53	49	50
L14P2N	27	18	18	48	49	46
L15P2N	23	20	20	59	54	50
L16P2N	30	31	28	53	54	55
L17P2N	25	20	20	59	56	55

[2] The NSW INP states that where the RBL is less than 30 dB(A), then it is set to 30 dB(A). The INP also states that the evening RBL should not be higher than the day time RBL, and that the night time RBL should not be higher than the evening RBL.

[3] The NSW INP defines day as the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays. Evening is defined as the period from 6 pm to 10 pm. Night time is defined as the remaining period.

Attended monitoring

A summary of the attended noise monitoring results are listed in Table 2-5.

Table 2-5 Attended monitoring results

Location and date	Measurement Time		Measured noise levels dB(A)			Identified noise sources and instantaneous noise levels dB(A)
	Start	Stop	L_{90}	L_{10}	L_{eq}	
L01P2N, 21-03-16	18:05	18:20	41	50	47	Wind, 42-50 Birds, 45-55 Banging/hammering, 41-44 Aircraft, 40-45 Dog (barking), 40-45 Road noise, 42-61
	18:21	18:36	37	43	42	Wind, 38-46 Road noise, 35-40 Dog (barking), 38-42 Insects, <30 Birds, 36-45 Road noise, 42-47
L02P2N, 21-03-16	18:52	19:07	35	44	44	Birds, 40-65 Road noise, 38-43 Horses, 50-60 Sheep, 47-51 Dog (barking), 45-50
	19:08	19:23	31	42	41	Birds, 35-40 Road noise, 32-38 Horses, 55-56 Conversations, 32-36 Insects, 40-45 Sheep, 45-50
L03P2N 2-9-2015	13:38	13:53	43	52	49	Wind through trees dominant Birds audible
L04P2N, 21-03-16	17:10	17:25	41	51	48	Road noise, 40-52 Birds, 40-45 Insects, 30 Wind, 40-55 Nearby silo, 45-51
	17:26	17:41	40	50	47	Road noise, 45-50 Birds, 40-47 Silo fan, 42-48 Wind, 42-55 Dog (barking), 47-49
L05P2N, 2-9-2015	16:00	16:15	25	37	34	Wind through grass and fields dominant. Distant voices briefly audible. Distant motorbike and truck on local road.
L06P2N, 2-9-2015	15:02	15:17	31	43	42	Wind through trees dominant. Birds occasionally audible. Car tyres on nearby gravel road.
L07P2N, 5-04-16	12:55	13:10	40	51	48	Wind noise, 45-55 Insects, <35 Road noise, 35-41 Birds, <35
	13:15	13:30	40	54	49	Wind noise, 45-58 Insects, 40-50 Banging/hammering, 43 Road noise, 40- 47 Birds, 36-38

Location and date	Measurement Time		Measured noise levels dB(A)			Identified noise sources and instantaneous noise levels dB(A)
	Start	Stop	L_{90}	L_{10}	L_{eq}	
L08P2N, 5-04-16	13:47	14:02	37	48	44	Wind noise, 45-53 Road noise, 40-46 Dog (barking), 38-40 Birds, <35 Insects, <35
	14:04	14:19	34	46	43	Wind noise, 42-47 Dog (barking), 38-40 Road traffic, 39-42 Insects, 35-44 Insects, 35-37
L09P2N, 5-04-16	14:42	14:57	38	48	44	Road noise, 38-50 Wind noise, 43-50 Pig, 38-40
	14:59	15:14	40	47	46	Animals, 38-40 Road noise, 42-52 Wind noise, 43-47
L10P2N, 16-9-2015	13:53	14:08	25	34	34	Wind through trees dominant Distant small plane audible Birds occasionally audible
L11P2N, 16-9-2015	15:06	15:21	28	40	39	Wind through trees dominant Distant small plane audible Birds occasionally audible
L12P2N, 16-09-2015	15:42	15:57	30	41	39	Wind noise, 35-40 Birds, 38-48
L13P2N, 22-03-16	15:18	15:33	34	51	48	Wind noise, 50-56 Front end loader, 30-40
	15:34	15:49	33	58	48	Wind noise, 45-52
L14P2N, 22-03-16	14:10	14:25	38	50	50	Wind noise, 40-45 Road noise, 48-57 Birds, 30-40
	14:30	14:45	36	50	47	Wind noise, 42-50 Road noise, 45-58
L15P2N, 3-9-2015	13:33	13:48	33	44	41	Wind through grass/trees dominant. Sheep occasionally audible. Two cars passed on nearby local road during measurement.
L16P2N, 22-03-16	10:47	11:02	42	50	47	Bob cat, 40-55 Birds, 40-50 Road noise, 35-40 Radio, 38-40
	11:06	11:21	38	48	45	Bobcat, 40-55 Bird noise, 40-50 Road noise, 35-40 Radio, 38-40
L17P2N, 22-03-16	12:01	12:16	26	40	47	Birds, 25-47 Road noise, 40-62
	12:18	12:33	26	36	40	Aircraft, 30-33 Birds, 30-48

The background noise monitoring and site observations indicate that the background noise levels are dominated by natural sounds, usually wind through long grass or trees. When they occur, the occasional train pass-by is expected to be the dominant influence on the L_{Aeq} level due to the close proximity of the loggers to the track.

2.4.5 Train pass-by noise levels

Data from the unattended noise loggers located adjacent to existing rail lines were reviewed and analysed to identify train pass-by events which occurred during the monitoring period. The relevant train noise parameters were calculated and are summarised in Table 2-6.

Table 2-6 Identified train pass-by summary

Monitoring Location	Approximate distance to nearest rail track (m)	Train type	Average noise level SEL dB(A)	Maximum noise level L_{Amax} dB(A)	Average duration (s)
L01P2N- 80 Old Backwater Rd	35	Freight	97	81	33
L02P2N- 53 Wright Rd	420	Freight	80	80	53
L03P2N- Chainage 546.6 km	15	Freight	93	91	74
L04P2N- 380 Tullamore Rd	125	Freight	82	78	69
L05P2N- Chainage 528.5 km	15	Freight	91	88	56
L08P2N- 1 Jackson St	95	Freight	90	89	58
L09P2N- 60 Trewilga Rd	75	Freight	84	81	60
L10P2N- Chainage 486 km	10	Freight	97	96	41
L11P2N- Chainage 478.150 km	15	Freight	95	94	59
L12P2N- Chainage 468.5 km	17	Freight	93	94	24
L13P2N- 503 Nanardine Lane	50	Freight	92	85	24

The results from the noise monitoring were used to determine the L_{Aeq} over the relevant time period (day and night) for rail pass-by noise during the monitoring period and is further discussed in Section 4.2.

2.4.6 Unattended vibration levels

Vibration logger V01P2N was set up approximately 15 metres from the existing rail line. No construction or industry was noted in the vicinity of the vibration logger. Site observations indicated road traffic was unlikely to have a significant contribution to the ground vibration levels in the area. Existing rail movements were therefore most likely to be the dominant source of vibration levels in the area. Comparison with the identified train pass-bys (detailed in Section 2.4.5) indicated that elevated vibration levels of approximately 1.0-1.3 millimetres per second corresponded to freight train pass-bys. A summary of the vibration levels logged from 22 March 2016-23 March 2016 is shown in Figure 2-2.

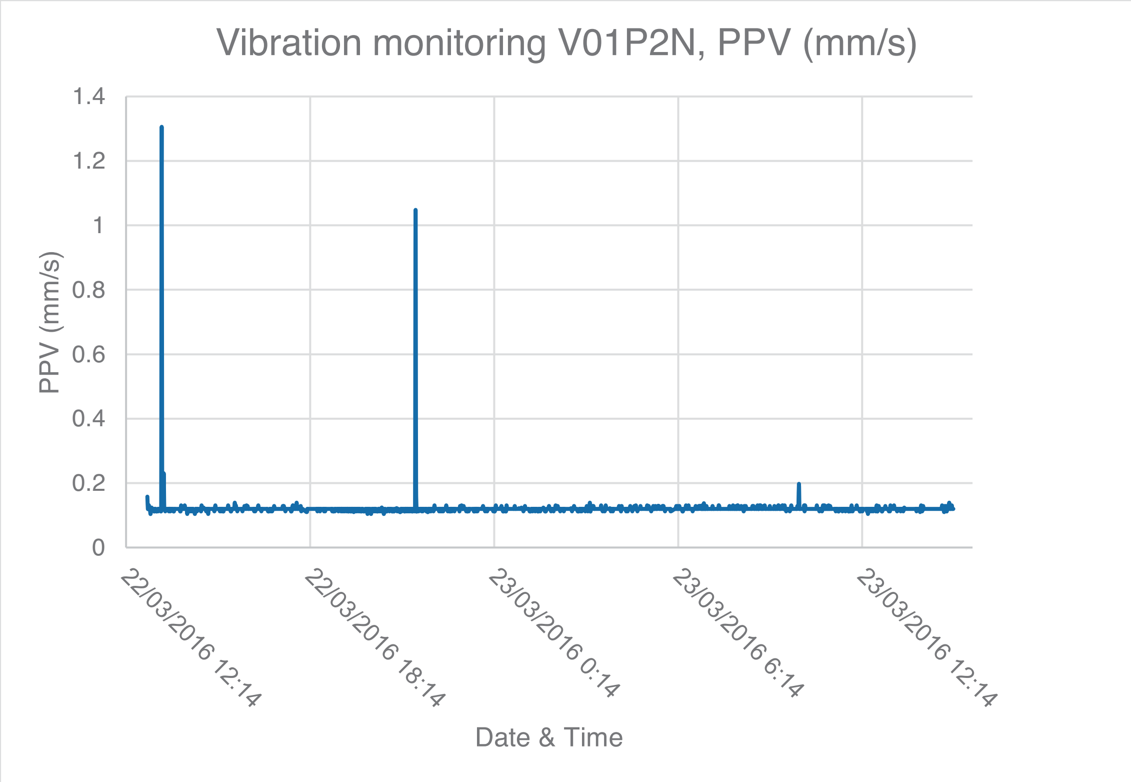


Figure 2-2 Vibration monitoring at location V01P2N- PPV

While long-term vibration monitoring was undertaken to capture PPV vibration velocities, train event vibration levels expressed in terms of Vrms allows calculation of Vibration Dose Value (VDV) which is more appropriate for evaluation of human comfort vibration impacts from intermittent events typical of railway operations. These results and discussion are presented in Section 4.5.2 and 4.5.3 in the context of operational vibration targets.

3. Relevant legislation and guidelines

3.1 Operational rail noise criteria

Operational rail noise criteria are derived from the *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013).

This guideline presents non-mandatory noise criteria for receivers affected by the proposal. Where receivers are predicted to exceed the relevant noise criteria, an assessment of possible mitigation measures to ameliorate these impacts would be conducted. These mitigation measures would be considered if they can be reasonably and feasibly implemented.

The RING applies to both light and heavy rail infrastructure proposals and distinguishes between 'new' or 'redeveloped' heavy rail lines in terms of the criteria which apply.

Heavy rail is considered to be rail infrastructure and its associated rolling stock which may be electrified or hauled by diesel locomotives that operates in dedicated rail corridors for either passenger and/ or freight transportation.

A 'new' heavy rail line development is one where rail infrastructure is to be developed on land that is not currently an operational rail corridor and where more stringent noise criteria apply. According to the RING, a 'redevelopment' of a heavy rail line occurs where a rail infrastructure proposal is to be developed on land that is either:

- Located within an existing and operational corridor, where a rail line is or has been operational.
- Immediately adjacent to an existing operational rail line which may result in widening of an existing corridor.

Typically, the works associated with the 'redevelopment' of an existing rail line will increase its capacity to carry rail traffic or alter the alignment through design changes. In such cases, the 'redevelopment of existing rail line' noise criteria apply.

For this assessment, ARTC considers the Inland Rail proposal to be a 'redevelopment of an existing heavy rail line' as the proposal will be developed on land within an existing operational rail corridor. Therefore the 'redevelopment of existing rail line' criteria listed in Table 3-1 apply to this assessment.

The additional Parkes north west connection consists of a five kilometre section of new track between Inland Rail and the Broken Hill line. This section of track is considered a 'new rail line development' for the purposes of the operational noise assessment and the corresponding criteria listed in Table 3-1 apply.

For residential receivers, the noise trigger levels for absolute levels of rail noise have two components, L_{Aeq} and L_{Amax}. The L_{Aeq} contribution level of rail noise is assessed over the day or night period and the maximum noise level (L_{Amax}) from pass-by events. The trigger values listed in Table 3-1 need to be exceeded to initiate an assessment of rail noise impacts and investigate potential mitigation measures.

Table 3-1 Airborne rail traffic noise trigger levels for residential land uses

Type of Development	Noise Trigger Levels dB(A) (External)	
	Day (7.00–22.00)	Night (22.00–7.00)
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more and predicted rail noise levels exceed	
	65 $L_{Aeq(15h)}$ OR 85 L_{AFmax}	60 $L_{Aeq(9h)}$ OR 85 L_{AFmax}
New rail line development	Predicted rail noise levels exceed:	
	60 $L_{Aeq(15h)}$ OR 80 L_{AFmax}[4]	55 $L_{Aeq(9h)}$ OR 80 L_{AFmax}

Source: *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013).

In accordance with the RING, other non-residential sensitive land uses including hospitals, schools and outdoor recreational areas have their own specific noise trigger levels for heavy rail redevelopments that are applicable when the facility or space is in use. Noise trigger levels for these receivers are applicable as internal or external levels depending on the land use. For internal noise criteria, the acoustic performance of the building façade affects the transmission of noise into the premises. As construction materials and the façade acoustic performance of these buildings is unknown and may vary, a conservative 10 dB reduction in noise between the external level and internal level has been assumed[5]. The RING criteria for non-residential land uses are shown Table 3-2.

Table 3-2 Airborne rail traffic noise trigger levels for non-residential land uses

Land use type	Noise Trigger Levels dB(A) (When in use)	
	New rail line development	Redevelopment of existing rail line
	Resulting rail noise levels exceed:	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more ***and*** resulting rail noise levels exceed:
Schools, educational institutions and child care centres	40 $L_{Aeq(1h)}$ Internal	45 $L_{Aeq(1h)}$ Internal
Places of worship	40 $L_{Aeq(1h)}$ Internal	45 $L_{Aeq(1h)}$ Internal
Hospital wards	35 $L_{Aeq(1h)}$ Internal	40 $L_{Aeq(1h)}$ Internal
Hospitals – other uses	60 $L_{Aeq(1h)}$ External	65 $L_{Aeq(1h)}$ External
Open space – Passive use	60 $L_{Aeq(15h)}$ External	65 $L_{Aeq(15h)}$ External
Open space – Active use	65 $L_{Aeq(15h)}$ External	65 $L_{Aeq(15h)}$ External

Source: *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013).

[4] The L_{AFMAX} level is the L_{AMax} level using a fast time response

[5] See RING - Technical notes to tables 1,2 and 3 – Technical note 6. Allows that a window may be opened to provide adequate ventilation.

3.2 Construction noise criteria

The ICNG (DECC 2009) provides recommended standard hours for construction activities as follows:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- No work on Sundays or Public Holidays

ARTC operates its rail network in accordance with an Environmental Protection Licence (EPL) administered by the EPA. The licence sets out performance standards and criteria for discharges to air, water and land, including noise from construction and operation of the network.

In accordance with EPL 3142, the upgrade of existing rail infrastructure is classified as “maintenance”. EPL 3142 condition O4.1 states maintenance work should be undertaken within recommended standard hours “where to do so would not adversely affect ARTC’s ability to provide safe and reliable services or a safe working environment”. EPL 3142 condition O4.1 defines the same standard working hours as the ICNG.

EPL 3142 condition O4.3 states:

> *Where maintenance activities are undertaken, including outside of the hours specified in condition O4.1, noise impacts must be managed in accordance with those provisions of the Interim Construction Noise Guideline (DECCW, 2009) which require the licensee to:*
>
> - *identify noise sensitive receivers that may be affected at least 7 days prior to the proposed commencement date; except where the licensee first becomes aware of the need to undertake the railway maintenance activities less than 7 days prior to the proposed commencement date, in which case the identification must be undertaken as soon as practicable after becoming aware of the need to undertake the railway maintenance activities;*
> - *identify hours for the proposed activities;*
> - *identify noise impacts at noise sensitive receivers;*
> - *select and apply reasonable and feasible work practices to minimise noise impacts; and*
> - *notify the noise sensitive receivers at least 5 days prior to the commencement of railway maintenance activities undertaken outside of the hours specified in Condition O4.1, except where the licensee first becomes aware of the need to undertake those railway maintenance activities less than 5 days prior to the proposed commencement date, in which case the notification must be provided as soon as practicable after becoming aware of the need to undertake the railway maintenance activities.*

The construction of new track on the Parkes north west connection segment of the proposal and construction of crossing loops is considered a ‘construction’ activity under EPL 3142. The EPL states that:

> *O4.6 So far as is reasonably practicable and where to do so would not adversely affect ARTC's ability to provide safe and reliable services or a safe working environment, construction activities must be undertaken: a) between the hours of 7.00 am and 6.00 pm Mondays to Friday b) between the hours of 8.00 am and 1.00 pm Saturday; and c) not on Sundays or public holidays.*

O4.9: When construction activities are required to be undertaken outside of the hours specified in Condition O4.6, any high noise generating works must only be undertaken: a) between the hours of 8.00 am and 10.00 pm Monday to Friday; b) between the hours of 8.00 am and 6.00 pm Saturdays and Sundays; and c) where the high noise impact generating works are likely to impact the same noise sensitive receivers, in blocks of no more than 3 hours, with at least a 1 hour respite between each block of work.

O4.10: Where construction activities are undertaken, including outside of the hours specified in Condition O4.6, noise impacts must be managed in accordance with those provisions of the Interim Construction Noise Guideline (DECCW, 2009) which require the licensee to: a) identify noise sensitive receivers that may be affected at least 7 days prior to the proposed commencement date; b) identify hours for the proposed activities; c) identify noise impacts at noise sensitive receivers; d) select and apply reasonable and feasible work practices to minimise noise impacts; and e) notify the noise sensitive receivers as per Condition O4.11.

Table 3-3 and Table 3-4 list the ICNG (DECC 2009) construction noise criteria at surrounding residential and industrial receivers.

The 'noise affected' management level represents the point above which there may be some community reaction to noise. Where the noise affected management level is exceeded, all feasible and reasonable work practices to minimise noise need to be applied and all potentially affected receivers informed of the nature of the works, expected noise levels, duration of works and a method of contact. The noise affected management level is the background noise level plus 10 dB(A) during recommended standard hours and the background noise level plus 5 dB(A) outside of recommended standard hours.

The 'highly noise affected' management level represents the point above which there may be strong community reaction to noise. Where noise is above this management level, any feasible and reasonable ways to reduce noise below this level would be applied. If no quieter work method is feasible and reasonable, the affected residence would be advised of the duration and noise levels of the works and any respite periods that will be provided. The highly noise affected management level for standard working hours is 75 dB(A).

The ICNG defines what is considered to be feasible and reasonable as follows:

'Feasible - A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Reasonable - Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.'

Table 3-3 ICNG construction noise criteria for residential receivers, dB(A)

Time Period	Background Level $L_{A90(period)}$	ICNG Management Level $L_{Aeq(15\ min)}$
Recommended standard hours: Day Mon-Fri (7 am – 6 pm) Sat (8 am – 1 pm) Sun/Pub Hol. (Nil)	30 dB(A)	Noise affected level: 40 dB(A) Highly noise affected level (all residential receivers) - 75 dB(A).

Time Period	Background Level $L_{A90(period)}$	ICNG Management Level $L_{Aeq(15\ min)}$
Outside of standard hours: Evening Mon-Fri (6 pm – 10 pm) Sat (1 pm – 10 pm) Sun/Pub Hol (8 am – 6 pm)	30 dB(A)	Noise affected level – 35 dB(A)
Outside of standard hours: Night Mon-Fri (10 pm – 7 am) Sat (10 pm – 8 am) Sun/Pub Hol (6 pm – 7 am)	30 dB(A)	Noise affected level – 35 dB(A)

Source: Interim Construction Noise Guideline (DECC 2009)
Note 1: The INP states that where the RBL is less than 30 dB(A), then it is set to 30 dB(A)

Table 3-4 ICNG construction noise criteria for industrial premises, dB(A)

Time period	Background level $L_{A90(period)}$	ICNG management level $L_{Aeq(15\ min)}$
When in use	NA	75 dB(A)

Source: Interim Construction Noise Guideline (DECC 2009)

3.2.1 Proposal specific construction noise management level

Construction of the proposal is expected to be undertaken during and outside standard construction hours and individual activities may span across time periods. The preferred approach for the proposal is that the more stringent level of 35dB(A) will be adopted as the proposal specific construction management level.

Table 3-5 ICNG construction noise criteria for residential receivers, dB(A)

Time Period	Proposal specific construction noise management level $L_{Aeq(15\ min)}$
All periods	35dB(A)

The EIS provides further details on the anticipated work hours and construction methodology.

3.3 Construction traffic noise criteria

The *Road Noise Policy* (RNP) (OEH 2011) provides non-mandatory traffic noise assessment criteria for land use developments with the potential to create additional traffic on existing freeways, arterial, sub-arterial and local roads.

The relevant construction traffic noise criteria are listed in Table 3-6.

Table 3-6 Construction traffic noise criteria for residential land uses

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

Source: Road Noise Policy (OEH 2011)

Note: Section 2.4 of the RNP indicates that where existing road traffic noise levels already exceed the assessment criteria, an increase of less than 2 dB represents a minor impact that is barely perceptible to the average person.

The accepted application of Section 2.4 of the RNP is that where existing road traffic noise levels already exceed the assessment criteria, an increase of less than 2 dB represents a minor impact that is barely perceptible to the average person.

3.4 Vibration criteria

3.4.1 Human comfort criteria

The OEH's publication, *Assessing vibration: A technical guideline* 2006 outlines methods of assessing potential impacts and ways to manage vibration from construction activities as well as rail operations such as ground-induced vibration created by rolling stock movements.

Assessing vibration: a technical guideline is based on guidelines contained in British Standard BS 6472:1992 *Evaluation of human exposure to vibration in buildings* (1–80 Hz).

Typically, construction works generate ground vibration of an intermittent nature. In accordance with BS 6472–1992, intermittent vibration is assessed using the Vibration Dose Value (VDV). Further, operational vibration produced by train pass-bys are classified as intermittent vibration. Acceptable VDV's, as outlined in *Assessing vibration: A technical guideline*, are listed in Table 3-7.

Table 3-7 Acceptable vibration dose values for intermittent vibration

Location	Daytime[1] ($m/s^{1.75}$)		Night-time[1] ($m/s^{1.75}$)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Source: Table 2.4 Assessing vibration: A technical guideline (OEH 2006)

Notes:

1. Daytime is 7.00 to 22.00 and night-time is 22.00 to 7.00.
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Whilst the assessment of response to vibration in BS 6472-1:1992 is based on VDV and weighted acceleration, for construction-related vibration, it is considered more appropriate to provide guidance in terms of PPV, since this parameter is more likely to be routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels well below those that risk causing damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in British Standard BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* as listed below in Table 3-8.

Table 3-8 Guidance on the effects of vibration levels

Approximate Vibration Level	Degree of Perception
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.30 mm/s	Vibration might be just perceptible in residential environments.
1.00 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.00 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Source: BS 5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2: Vibration

3.4.2 Structural damage criteria

Currently, there is no Australian Standard that sets criteria for the assessment of building damage caused by vibration. Consistent with other major projects of a similar type, guidance on limiting vibration values has been obtained by reference to German Standard *DIN 4150-3: 1999-02 Structural Vibration – Part 3: Effects of vibration on structures.* Short-term vibration guideline values are listed in Table 3-9.

Table 3-9 Guideline values for short term vibration on structures

Line	Type of Structure	Guideline Values for Velocity, vi(t)[1] [mm/s]		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50Hz to 100Hz[2]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy.	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (such as heritage listed buildings under preservation order).	3	3 to 8	8 to 10

Source: German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: Effects of vibration on structures

Notes:

1. The term v_i refers to vibration levels in any of the x, y or z axes
2. At frequencies above 100 Hz the values given in this column may be used as minimum values

3.5 Other standards and guidelines

The following additional standards and guidelines have been referenced in this assessment:

- Environmental Noise Management Manual (ENMM) (RTA 2001).
- *Industrial Noise Policy* (INP) and Application Notes, EPA, 2000.
- Construction Noise Strategy (CNS), TfNSW, 2012.
- Environmental Management System Guide: Noise and Vibration from Rail Facilities (NVRF), Sydney Trains, 2013.
- Development near rail corridors and busy roads – interim guideline, Department of Planning, 2008.
- Australian Standard AS 1055 - 1997 Acoustics – Description and Measurement of Environmental Noise.
- Australian Standard AS 2436 – 2010 Guide to noise and vibration control on construction, demolition and maintenance sites.
- *Transit noise and vibration impact assessment,* US Department of Transportation Federal Transit Administration (FTA), 2006.

4. Operational rail noise and vibration assessment

4.1 Methodology

4.1.1 Overview

The approach to assessing operational rail noise can be summarised as follows:

- Identify the existing and proposed rail traffic volumes and speeds for the study area (provided by ARTC).
- Calculate L_{Aeq} and L_{Amax} using noise logger data obtained at the monitoring locations.
- Validate noise model using the calculated noise levels from noise loggers.
- Model operational rail (L_{Aeq} and L_{AMax}) noise for the agreed scenarios.
- Assess operational rail noise predictions (L_{Aeq} and L_{AMax}) against the relevant RING trigger levels.
- Consider noise mitigation options where exceedances of the trigger levels are predicted.

Note that the predicted rail noise levels (termed the 'absolute rail noise levels') refers to noise levels emitted by rail only, that is without the contribution of any other noise source.

4.1.2 Noise modelling scenarios

The operational rail noise scenarios used in the assessment were developed to clearly identify noise levels resulting from existing operations and future rail operations with the inclusion of the proposal. A scenario was also developed which identifies the likely future rail operations noise without the proposal so that the effect of the proposal can be clearly identified.

The RING states that noise trigger levels are to be evaluated at two points in time: Immediately after operations commence and for a design year, typically 10 years later. The Inland Rail project is composed of a number of individual brownfield and greenfield proposals, each with their own planning conditions. Therefore, for the proposal, assessment timeframes should consider changes in operations within the study area that are enabled by the Inland Rail project as a whole.

Inland Rail through connection operation will occur once all component proposals are completed, therefore completion of a single brownfield proposal will have minor impact on train numbers and speeds in the years immediately after completion other than improvements in local operating conditions. After through connection is established in 2025 by completion of the remaining brownfield and greenfield proposals, through connection will commence, generating an overall increase in train volumes on each proposal. Because each proposal is subject to individual approval conditions, the impacts of both the individual proposal in isolation and the overall Inland Rail programme need to be assessed against the RING trigger levels.

Consequently, the following three assessment timeframes have been evaluated within the proposal's operational assessment study area for both build and no build scenarios:

1. Proposal: the individual proposal to which the planning conditions apply
   - No build and build scenarios at the proposal opening year, 2020.
2. Through connection: the estimated time at which Inland Rail through connection between Brisbane and Melbourne is anticipated
   - No build and build scenarios within the proposal's operational assessment study area at the through connection year, 2025.
3. Design year: a future scenario that reflects the normal operation of the Inland Rail project
   - No build and build scenarios within the proposal's operational assessment area at the design year, 2040.

Rail operational volumes and speeds are not expected to change within the operational assessment study area if the proposal is not implemented (no build scenario), therefore only one no build model is needed, which represents the no build assessment scenarios at 2020 proposal opening year, 2025 Inland Rail through connection year and 2040 Inland Rail design year.

For the proposal opening year, the primary difference in operating conditions between the 2020 no build and 2020 build scenarios are the speed increases enabled through track improvements, while train volumes remain unchanged. For through connection and design years, operating volumes increase at 2025 when through connection is established, then gradually grow through to 2040.

Noise modelling was also completed to demonstrate the existing noise environment and validate predictions. For this proposal, the existing operations were modelled for the year 2016.

The noise modelling scenarios used for the assessment are described in Table 4-1.

Table 4-1 Noise modelling scenarios

Time Frame:	Proposal build	Proposal no build
	Includes: - Higher growth in projected volumes due to the proposal - Increases in train speeds due to the proposal	Includes: - Lower growth in projected volumes due to natural growth only without the proposal - No increases in train speeds
2016 – model for calibration against noise logger data		L_{Aeq}
2020 – Proposal opening year	L_{Aeq}	L_{Aeq}
2025 – Through connection opening year	L_{Aeq} and L_{Amax}	L_{Aeq} and L_{Amax}
2040 – Proposal design year[1]	L_{Aeq}	L_{Aeq}

Notes:

1. L_{Amax} levels are unrelated to volumes, therefore equivalent at 2025 and 2040 assessment timeframes.

4.1.3 Existing and future rail capacity

Rail volumes have been provided by ARTC for the current conditions as well as for the future conditions. Note that the volumes used in this assessment are different from those provided in the EIS Chapter 7. The noise assessment has been based on a more conservative estimate (greater numbers) of projected train volumes.

An equal split of day/night train movements was assumed over each 1-hour period. The data used for noise modelling inputs are listed in Table 4-2, Table 4-3 and Table 4-4 below.

Table 4-2 Proposal rail volumes - Redeveloped line (trains per 24 hours)

	2020 - Proposal opening year		2025 - Through Connection		2040 - Design Year	
Train type	no build	build	no build	build	no build	build
Link	0.43	0.43	0.43	0.43	0.43	0.43
Grain	2.12	2.12	2.12	2.12	2.12	2.12
Intercapital	-	-	-	8.42	-	18.02
Mineral	0.43	0.43	0.43	0.43	0.43	0.43

Source: ARTC

Table 4-3 Proposal rail volumes - Parkes north west connection (trains per 24 hours)

	2020 - Proposal opening year		2025 - Through Connection		2040 - Design Year	
Train type	no build	build	no build	build	no build	build
Link	-	-	-	-	-	-
Grain	-	-	-	-	-	-
Intercapital	-	-	-	2.86	-	4.57
Mineral	-	-	-	-	-	-

Source: ARTC

Table 4-4 Proposal train lengths (metres)

	2020 - Proposal opening year		2025 - Through Connection		2040 - Design Year	
Train type	no build	build	no build	build	no build	build
Link	450	830.6	450	830.6	450	830.6
Grain	710	710	710	710	710	710
Intercapital	-	-	-	1800	-	1800
Mineral	450	830.6	450	830.6	450	830.6

Source: ARTC

4.1.4 Train speeds

For the purposes of this assessment, train speeds have been taken from ARTC's Route Access Standard for Dubbo to Goobang Junction (RAS I5, version 1.5, February 2016). Train speed graphs along the proposal track section are shown in Figure 4-1 and Figure 4-2. These speed profiles have been used in the noise model.

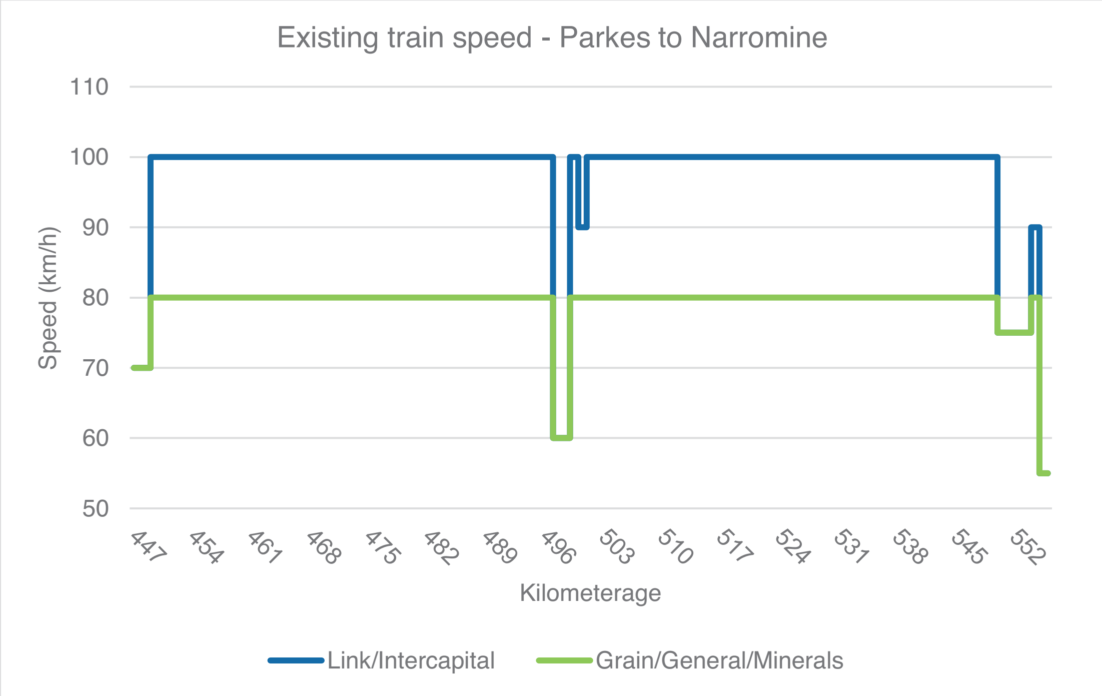


Figure 4-1 Train speeds in the down direction (Parkes to Narromine)

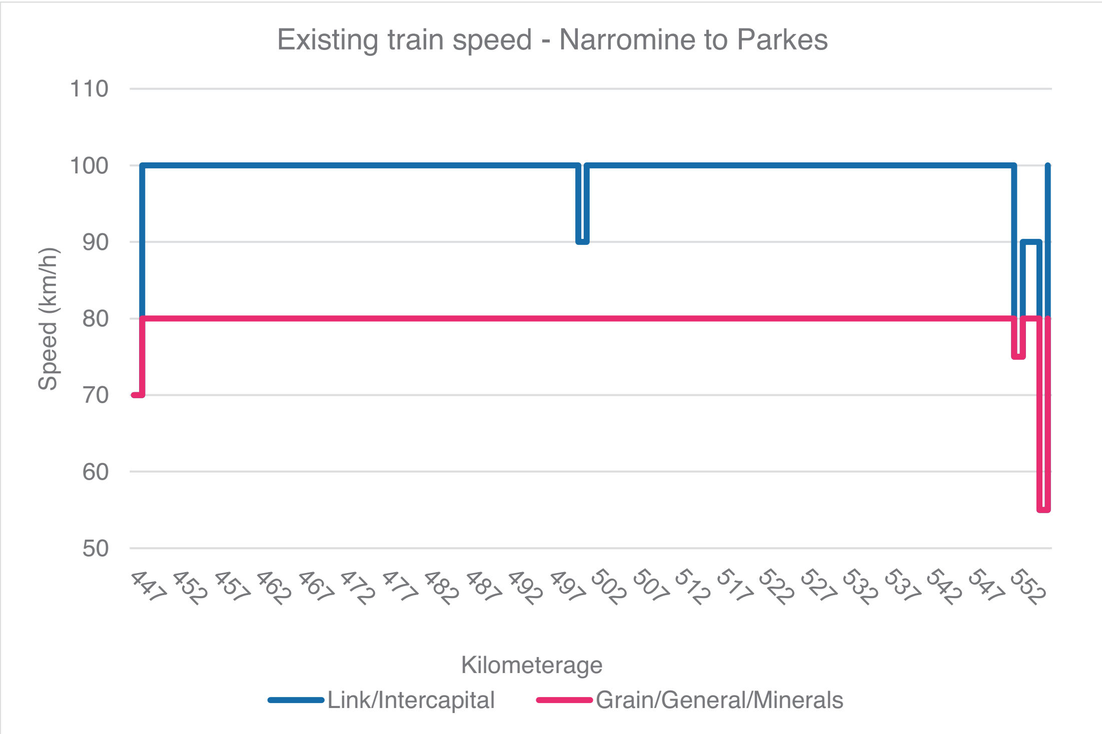


Figure 4-2 Train speeds in the up direction (Narromine to Parkes)

4.1.5 Proposal design speeds

The proposal will allow for an increase of train speeds up to 115 kilometres per hour. For some sections of track, speed will be limited due to curves, turnouts, crossings, crossing loops and sidings. As details of speed board locations were not available at the time of this assessment, the noise modelling adopts the track design speed which is limited by track geometry only and this will result in the assessment being conservative and over-predicting future noise levels. For each train type, the modelled speed is the lower of the design speed at a given location on the track and the train type speed limitations shown in Table 4-5. Track design speeds are shown in Figure 4-3 and apply to both up and down directions.

Table 4-5 Train type maximum speeds

Train type	Link	Grain	InterCap	Minerals
Type speed	110	80	115	80

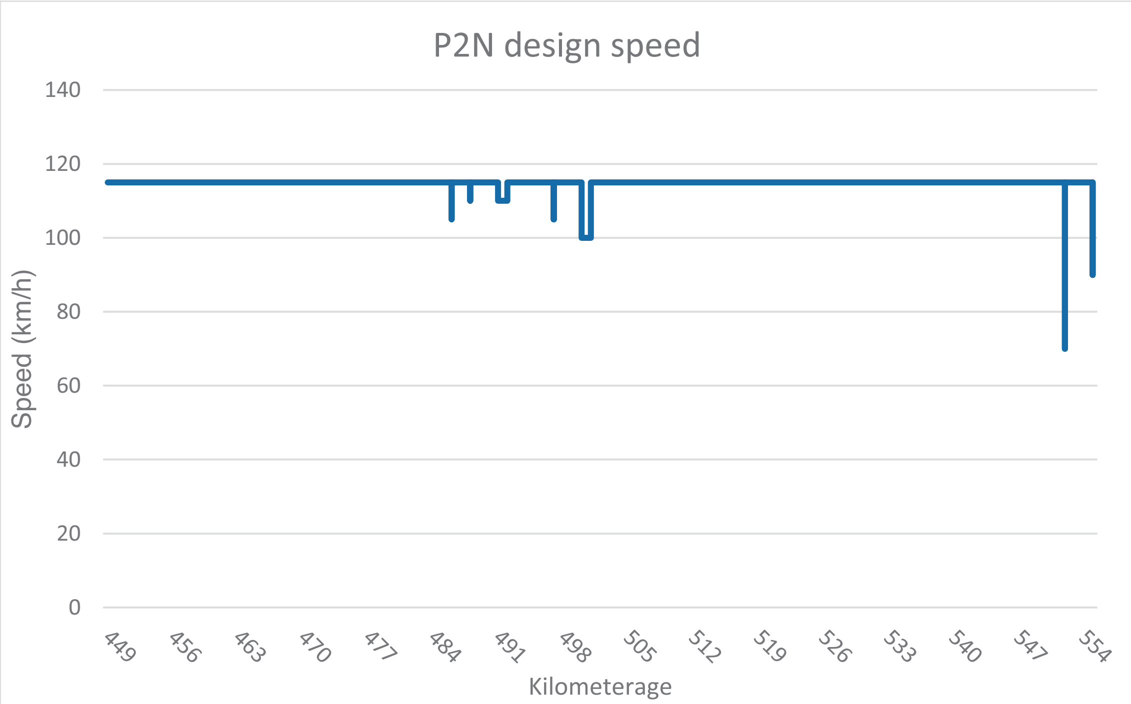


Figure 4-3 Proposal Design Speeds

4.1.6 Rail noise model setup

Acoustic modelling was undertaken using the computer prediction software Computer Aided Noise Abatement (CadnaA) version 4.6 to predict the effects of rail traffic noise from the proposal. The Nordic prediction method (ThemaNord 1996:524) was used for modelling as this is able to produce L_{Aeq} and L_{AmaxF} levels.

The proposed development has been modelled based on available data at the time of the assessment, and as such, should be used for comparison purposes only. In particular, the model reflects the status of the design at the time of the assessment.

Model configuration

The following assumptions were made with regard to the model configuration:

- A general ground absorption coefficient of 1.0 was used.
- Atmospheric conditions of 15°C and 70 per cent humidity were adopted.
- Neutral weather and atmospheric conditions were assumed.
- Topographical information was based on Lidar data provided by ARTC.
- Only single storey receivers were modelled at a height of 1.5 metres above ground.
- Buildings close to the rail line have been modelled as single storey buildings at a height of 4.5 metres. Building geometry was estimated based on aerial imagery.
- Existing rail alignments were based on data provided by ARTC.

Rail traffic assumptions

The following rail traffic assumptions have been made in the model:

- Rail capacity and speeds are as described in Section 4.1.3 and 4.1.4 and represent a conservative operational rail scenario for predicting noise impacts.

Track corrections

The following track corrections have been made in the model:

- +3 dB correction for partial track length on bridges with ballast (ThemaNord 1996:524).
- +6 dB correction for partial track length on bridges without ballast (ThemaNord 1996:524).
- +6 dB correction per 10 metres track length for each unit of switches and crossings (ThemaNord 1996:524).
- +3 dB correction for track curves with radius of 300-500 metres (Schall 03, 2006).

Based on information provided by ARTC, the following assumptions have been made for noise produced in crossing loops:

- 25 per cent of the total trains will utilise each crossing loop.
- All loops were modelled as being utilised equally.
- An indicative source level of 90 dB(A) at 15 metres from the rail source has been assumed for bunching noise.
- Bunching noise events have been modelled as 1 second duration events between each wagon.
- An indicative source level of 70 dB(A) at 15 metres from the rail source has been assumed for idling noise.
- Train idling durations have been assumed to be 20 minutes.

4.2 Existing rail noise levels and model validation

Existing rail noise levels were calculated using the results from the baseline monitoring described in Section 2.4. With consideration to the RING, the existing rail noise L_{Aeq}'s at the monitoring locations are determined as follows:

$$L_{Aeq(T)} = 10 \times \log_{10}(1/T \times (\Sigma (n_i \times t_i \times 10^{0.1L_{Aeq(i)}})))$$

Where:

- T is the total time in the relevant period (day or night) in seconds
- t_i is the average time of each type of event in seconds
- n_i is the number of each type of event

$L_{Aeq(i)}$ is the representative L_{Aeq} level for each type of event as measured at the receiver and is summed over the different types of events.

Noise modelling was undertaken for the existing 2016 scenario for comparison to measured existing rail noise levels to confirm the model's accuracy and validity for assessing the subsequent modelling scenarios.

Table 4-6 presents the measured 2016 rail noise levels and modelling results for the existing 2016 scenario to demonstrate the calibration of the noise model achieved.

Table 4-6 Measured existing rail noise levels and model validation

Location	Measured 2016 rail noise levels (dB)		Noise model predicted levels, 2016 existing scenario (dB)		Difference (dB)
	Day L_{Aeq} (15hr)	Night L_{Aeq} (9hr)	Day L_{Aeq} (15hr)	Night L_{Aeq} (9hr)	
L01P2N	48.2	48.2	48.8	48.8	+0.6
L02P2N	36.7	36.7	35.3	35.3	-1.4
L03P2N	48.4	48.4	50.0	50.0	+1.6
L04P2N	37.6	37.6	38.6	38.6	+1.0
L05P2N	46.6	46.6	47.8	47.8	+1.2
L08P2N	45.2	45.2	44.3	44.3	-0.9
L09P2N	39.7	39.7	40.2	40.2	+0.5
L10P2N	52.8	52.8	53.7	53.7	+0.9
L11P2N	50.3	50.3	51.1	51.1	+0.8
L12P2N	48.7	48.7	50.3	50.3	+1.6
L13P2N	47.2	47.2	47.3	47.3	+0.1

Note: Due to the proportional day/night split of train movements assumed (i.e. the same number of trains per each 1-hour period), the LAeq(15hr) and LAeq(9hr) model noise levels are equal.

As indicated by the above table, the predicted 2016 noise levels are within 2 dB of the measured rail noise levels with the difference ranging between -1.4 to +1.6 dB. Therefore, the model is considered to be validated.

4.3 Operational rail noise model results

4.3.1 Redeveloped rail line

Table 4-7 presents a summary of the modelling results where the RING trigger levels are predicted to be exceeded. In order to qualify for mitigation, L_{Aeq} noise levels must exceed the relevant day/night criteria and the level at receivers must also increase by 2 dB or more from the no build scenario. Receivers also qualify for mitigation where there is a predicted increase of 3 dB or more due to the proposal at an assessment timeframe and L_{Amax} levels are predicted to exceed 85 dBA.

Note that due to the proportional day/night split of train movements assumed (i.e. the same number of trains per each 1-hour period), the $L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$ model noise levels were equal. The RING night time trigger levels are 5 dB lower than daytime and therefore provides the controlling criteria for identification of receivers that qualify for consideration of noise mitigation measures.

Non-residential receivers including schools, places of worship (churches) and outdoor recreation areas have different RING noise criteria for operational noise. Despite this, none of the non-residential receivers identified in Section 2.3 were found to exceed the RING criteria.

For the year 2040 scenario, the following number of residential receivers were found to have qualified for mitigation consideration under the RING:

- 1 receiver in Parkes
- 16 receivers in Peak Hill
- 3 receivers in Tomingley
- 8 receivers in Narromine

Table 4-7 Predicted rail noise levels for residential receivers exceeding RING trigger levels - Parkes to Narromine (dBA)

Receiver ID	Easting	Northing	Locality	L_{Aeq} No Build	L_{Aeq} 2025 Build	L_{Aeq} 2040 Build	L_{Amax} Existing	L_{Amax} Design	L_{Amax} increase	L_{Aeq} RING Triggered-2025	L_{Aeq} RING Triggered-2040	L_{Amax} RING Triggered
P2N_Rx0213	603861	6341031	Parkes	51	62	66	86	88	2.2	Y	Y	
P2N_Rx0248	613680	6371376	Peak Hill	50	62	66	85	88	2.6	Y	Y	
P2N_Rx0260	612090	6374070	Peak Hill	53	64	67	88	91	2.5	Y	Y	
P2N_Rx0272	611077	6377096	Peak Hill	54	65	68	90	92	2.3	Y	Y	
P2N_Rx0281	611198	6377287	Peak Hill	48	59	62	82	84	2.5		Y	
P2N_Rx0283	611167	6377310	Peak Hill	50	61	65	85	87	2.5	Y	Y	
P2N_Rx0285	611222	6377410	Peak Hill	46	58	61	79	81	2.7		Y	
P2N_Rx0297	610871	6377720	Peak Hill	50	62	65	86	88	2.3	Y	Y	
P2N_Rx0323	610790	6377918	Peak Hill	47	60	64	83	86	2.9		Y	
P2N_Rx0373	610945	6378052	Peak Hill	48	61	65	84	87	2.9	Y	Y	
P2N_Rx0380	610781	6378068	Peak Hill	52	65	68	89	92	3.0	Y	Y	Y
P2N_Rx0424	610935	6378282	Peak Hill	46	59	62	79	82	2.9		Y	
P2N_Rx0462	610869	6378513	Peak Hill	45	58	61	77	80	2.8		Y	
P2N_Rx0464	610751	6378523	Peak Hill	51	63	67	87	90	2.3	Y	Y	
P2N_Rx0517	610469	6378788	Peak Hill	48	61	64	83	85	2.5	Y	Y	
P2N_Rx0527	610429	6378859	Peak Hill	46	59	62	81	83	2.3		Y	
P2N_Rx0600	610229	6381700	Peak Hill	49	61	64	83	86	2.4	Y	Y	
P2N_Rx0608	607948	6395686	Tomingley	47	58	62	79	81	2.5		Y	
P2N_Rx0613	606477	6401469	Tomingley	45	57	61	77	80	2.6		Y	
P2N_Rx0630	612699	6426394	Narromine	47	59	62	80	82	2.8		Y	
P2N_Rx0644	614475	6430567	Narromine	47	59	62	78	83	5.4		Y	
P2N_Rx0651	615161	6431074	Narromine	47	59	62	80	83	3.3		Y	
P2N_Rx0702	615518	6431910	Narromine	55	66	69	91	93	2.3	Y	Y	
P2N_Rx0747	615523	6432090	Narromine	47	58	61	80	82	2.6		Y	

Receiver ID	Easting	Northing	Locality	L_{Aeq} No Build	L_{Aeq} 2025 Build	L_{Aeq} 2040 Build	L_{Amax} Existing	L_{Amax} Design	L_{Amax} increase	L_{Aeq} RING Triggered-2025	L_{Aeq} RING Triggered-2040	L_{Amax} RING Triggered
P2N_Rx0752	615657	6432115	Narromine	55	66	69	91	93	2.4	Y	Y	
P2N_Rx0762	615611	6432191	Narromine	48	58	61	81	84	2.6		Y	
P2N_Rx0804	615795	6432424	Narromine	54	65	68	89	92	2.9	Y	Y	
P2N_Rx1309	606476	6401590	Tomingley	46	58	61	78	80	2.6		Y	

Notes:

$L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$ model predictions were equal. The results are provided as one value for L_{Aeq} which represents both $L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$.

The 'increase' in noise should be calculated to a single decimal place before comparing it with the 2 dB and 3 dB noise-increase trigger levels. However, the absolute noise levels should be calculated to the nearest whole decibel number before comparing them with the absolute trigger (RING).

The L_{AMax} levels do not depend on train volumes. Therefore, the L_{Amax} levels for design years 2025 and 2040 will be equal.

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4.3.2 New rail line

For a new rail line development, the noise trigger levels 60 dB(A) $L_{Aeq, 15 hour}$, 55 dB(A) $L_{Aeq, 9 hour}$ and 80 dB(A) L_{AFmax}. These levels are 5 dB lower for each period than those for redevelopment, however as there is no existing rail line there is no check for an increase in rail noise due to the new rail proposal. Based on the rail volumes, no trains are expected to operate on the Parkes north west connection until 2025, therefore no 2020 scenario was assessed.

Table 4-8 presents a summary of the affected receivers for the Parkes north west connection rail line. None of these receivers were found to exceed RING criteria for a new rail development.

Table 4-8 Predicted rail noise levels for residential receivers - Parkes north west connection (dBA)

Receiver	Easting	Northing	L_{Aeq} 2025 Build	L_{Aeq} 2040 Design	L_{Amax} 2025/2040
P2N_Rx0181	605642	6334456	35	37	61
P2N_Rx0183	605417	6334604	37	39	63
P2N_Rx0185	605390	6334678	38	40	64
P2N_Rx0187	606439	6334927	30	32	52
P2N_Rx0188	605085	6335096	43	45	70
P2N_Rx0189	605855	6335140	34	36	61
P2N_Rx0192	606037	6335405	33	35	59
P2N_Rx0193	606091	6335446	33	35	59
P2N_Rx0194	603678	6335637	40	42	67
P2N_Rx0195	603391	6335737	38	40	64
P2N_Rx0196	604200	6335810	50	52	77
P2N_Rx0197	604109	6335849	48	50	75
P2N_Rx0198	606166	6335910	32	34	58
P2N_Rx0199	603613	6335917	40	42	67
P2N_Rx0200	606348	6336046	30	32	55
P2N_Rx0201	603442	6336202	37	39	65
P2N_Rx0202	605719	6336662	33	35	60
P2N_Rx0203	603335	6336953	32	34	62
P2N_Rx0204	605018	6337152	34	36	63
P2N_Rx0205	604431	6337320	33	35	65
P2N_Rx0206	602580	6337450	26	28	51
P2N_Rx0207	605121	6337526	30	32	59
P2N_Rx0208	606000	6337667	26	28	50
P2N_Rx0209	604305	6337785	29	31	59
P2N_Rx0210	603315	6337945	26	28	54
P2N_Rx0211	605270	6338406	24	26	49
P2N_Rx1301	602007	6332895	50	52	76
P2N_Rx1302	601053	6333120	39	41	65
P2N_Rx1303	600081	6332659	32	34	62
P2N_Rx1304	602135	6331333	40	42	65
P2N_Rx1305	603288	6333817	47	49	74

Note: The L_{Amax} levels do not depend on train volumes. Therefore, the L_{Amax} levels for years 2025 and 2040 will be the same.

4.3.3 Discussion

In general, for a largely homogeneous rail line with consistent volumes, constant speeds and few tight radius curves, the level of rail noise exposure for any given receiver is a function of the distance to the track, the angle of view and the presence or absence of any shielding terrain or objects.

Most of the RING exceedances for the redeveloped track were around the Peak Hill area, with the remainder scattered throughout the proposal area. This is due to the higher density of receivers in the Peak Hill area that are located in close proximity to the rail line. Section 6.1 provides an assessment of reasonable and feasible mitigation measures to reduce noise levels at receivers found to exceed RING criteria.

The accuracy of noise predictions depends on a variety of factors. It is important to note that the modelling is largely dependent on the model inputs and assumptions detailed in Section 4.1.

Full operational noise results are presented in Appendix D. Noise contour plots showing receiver locations are presented in Appendix E for L_{Aeq} levels and Appendix F for L_{Amax} levels.

4.4 Horn noise

Horns are an important safety device and are a normal part of train operation. Trains are generally required to sound their horns as they pass through level crossings and additionally at other times. ARTC's *Locomotive Specific Interface Requirements (WOS 01.300)* provides minimum and maximum levels for horn noise. The purpose of these prescribed noise levels is to provide safe operating conditions for people close to the rail line. It is acknowledged that noise emitted by train horns can be a source of annoyance for the general public.

For a rail redevelopment project to trigger the RING's L_{Amax} level of 85 dB(A) at an noise sensitive receiver, a 3 dB or greater increase in L_{Amax} level is required. The minimum distance from the horn source to be below this level has been estimated in Table 4-9. The minimum distance has been estimated using basic distance attenuation calculations for a point source. Note that horns generally propagate sound in a particular direction and sound will not radiate equally in all directions. Therefore, the minimum distance calculation is expected to provide a conservative estimate.

Table 4-9 Estimated distance from train horn to achieve RING L_{Amax} criteria

	High Noise Level Horn	Low Noise Level Horn	
Speed	Stationary	Stationary	Stationary
External noise limit[6]	88 dB(A) minimum, measured 200 m in front	85 dB(A) minimum, measured 100 m in front	90 dB(A) maximum, measured 100 m in front
Minimum distance to achieve L_{Amax} 85 dB(A)	282 m	100 m	180 m

[6] Minimum and maximum required levels for horn noise according to ARTC's Locomotive Specific Interface Requirements (WOS 01.300). Note that high noise level horns have minimum requirements, while the low noise level horns have minimum and maximum levels.

An appreciable difference in the number of horn events is expected due to the projected volume growth. For example, in the year 2040, there is expected to be approximately 21 trains per 24 period, increasing from the existing approximately 3 trains per 24 hour period. It is expected that the number of horn noise events would be comparable to the increase in trains per day (i.e. a location experiencing 3 train horn events per 24 hour period may experience 21 horn events per 24 hour period in the design year). It should be noted that a number of existing level crossings would potentially be closed as a result of the proposal. Therefore, the number of locations requiring horn usage would potentially decrease overall along the total length of the line. Additionally, no level crossings are expected to be constructed on the Parkes north west connection line. Thus, there are not expected to be frequent mandatory horn events on this new section of track.

While receivers within 282 metres from horn usage locations may exceed 85dB(A) L_{Amax} noise levels, there are no additional proposed locations of horn usage in the proposal and the RING redevelopment trigger of 3dB increase in L_{Amax} levels is not expected to be achieved by horns. Therefore mitigation of horn noise is not required under RING.

4.5 Vibration prediction

4.5.1 Methodology

Vibration from the operation of heavy rail infrastructure can adversely affect sensitive receivers located near a rail line. Vibration can cause buildings, windows and other fixtures to shake; contribute to annoyance and impacts on residents and other land uses; and interfere with vibration-sensitive equipment. Building damage is not usually likely for operation of rail infrastructure, however annoyance can occur at significantly lower vibration levels which are often only slightly higher than the limits of human perception. Therefore, human comfort goals provide the controlling criteria for operational vibration for the proposal.

The level of vibration at a receiver is generally a function of the energy of the vibration source, the propagation through the ground and the coupling of the ground to the receiver, structure or building.

Vibration generation from rail traffic is generally a function of the following:

- Wheel-rail interface including wheel defects, acceleration and braking
- The quality of the rail
- Track geometry
- Variations in sleepers and ballast
- Axle load
- Geometry and composition of the train
- Speed

Propagation and perception of vibration is further influenced by the soil, geological conditions and building characteristics such as:

- Soil stiffness
- Ground internal damping
- Depth of bedrock
- Depth of water table
- Building mass

- Building coupling to the ground
- Propagation of vibration through the building

4.5.2 Operational vibration assessment

Axle loading

The increase to 30 tonne axle load capacity from an existing 23 tonnes is not expected to result in substantially increased vibration levels as the proposed intercapital trains have axle loads of 21 tonnes while bulk freight is expected to have 25 tonne axle loads. Typically, a doubling of axle load can be expected to double vibration, and a proportional increase in vibration due to increased axle loading is likely.

Track condition

For the main alignment, vibration levels may decrease (or possibly offset any increase) as a result of the proposal due to improved ballast/sleeper heterogeneity and rail surface smoothness, both features which have greater potential to influence rail-induced vibration levels than axle loading or speed alone. Additional reductions in vibration may also be realised by reducing the need for acceleration and braking as more constant speeds would be achieved through a removal of some level crossings and lifting of existing temporary speed restrictions at sections of track, for instance dilapidated bridges being replaced as part of the proposal.

Speed

The US Federal Transition Administration's "Transit Noise and Vibration Impact Assessment" report provides a method for estimating the ground surface vibration levels near rail lines. The process involves selecting a base curve for typical ground-surface vibration levels. The base curve assumes rail equipment is in good condition and operating at speeds of 80 kilometres per hour. Correction factors are then applied to account for different speeds, geological conditions, etc.

The report notes that vibration levels are approximately proportional to 20 $\log_{10}$ (speed/speed_{ref}). although the relationship can be as low as 10 to 15 $\log_{10}$ (speed/speed_{ref}). A speed relationship of 20 $\log_{10}$ (speed/speed_{ref}) has been adopted for this assessment.

Distance attenuation

Vibration measurements for train pass-bys along the existing line were undertaken on 16 September 2015 and 21-23 March 2016.

These measurements were compared with GHD's internal vibration database from similar rail projects. For example, monitoring undertaken for the Maitland to Minimbah project in the Hunter Valley recorded loaded coal trains travelling at 60 kilometres per hour and unloaded coal trains at 80 kilometres per hour past residences at 30 and 35 metres from the track.

The distance attenuation relationship of ground vibration measurements was derived from the FTA base curve for locomotive-powered freight/passenger trains. Vibration measurements for this proposal, as well as measurements from similar rail proposals undertaken by GHD, can be seen in Figure 4-4. Note that these values have been adjusted to the reference speed of 80 kilometres per hour, using the 20 $\log_{10}$(speed/speed_{ref}) relationship.

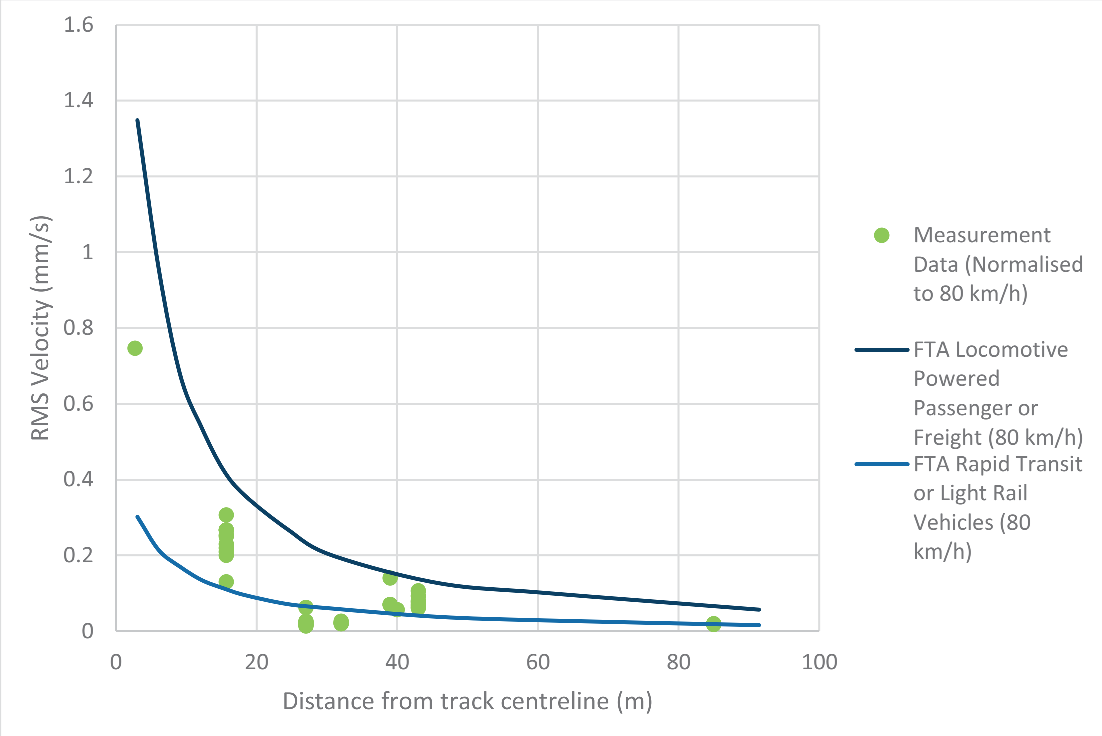

Figure 4-4 Ground vibration levels

Vibration measurements are highly variable and are largely dependent on local geological conditions. Further, track irregularities may significantly increase vibration levels (for example, at crossovers and joints). A significant variation in vibration levels for similar systems are not uncommon and the FTA curves represent the upper range of measurement data for well-maintained systems. The measured vibration data presented in Figure 4-4 are consistently lower than that upper-range vibration curve from the FTA guideline. Therefore, the use of levels from the FTA locomotive curve are expected to provide a conservative estimate of vibration levels.

For the purposes of this assessment, the track has been assumed to be in good condition and track irregularities such as joints or crossovers have not been assessed due to the current lack of design detail. An assessment of these factors should be completed once the detailed design has been finalised.

4.5.3 Human comfort assessment

Human comfort for operational vibration has been assessed in accordance with British Standard BS 6742-1:1992. The Vibration Dose Value (VDV) provides a cumulative descriptor of the vibration level received for a given period.

British Standard BS 6472 provides a method to calculate the estimated VDV using RMS vibration velocity. The estimated VDV is calculated as:

$$eVDV = 0.07 \times V_{rms} \times t^{0.25} \ (m/s^{1.75})$$

Where t= duration of the event.

The eVDV's for this proposal have been estimated by adjusting vibration levels for speed, duration and distance from the track.

The following assumptions have been made:

- Maximum train lengths as specified in Table 4-4
- Maximum train speeds as specified in Table 4-5

- Track in good condition with no track irregularities
- Train volumes specified in Section 4.1.3
- Proportional day/night splits of trains

These assumptions are expected to provide a conservative estimate of future vibration levels. The predicted future eVDV values for day and night-time, as well as the respective residential criteria, can be seen in Figure 4-5 and Figure 4-6.

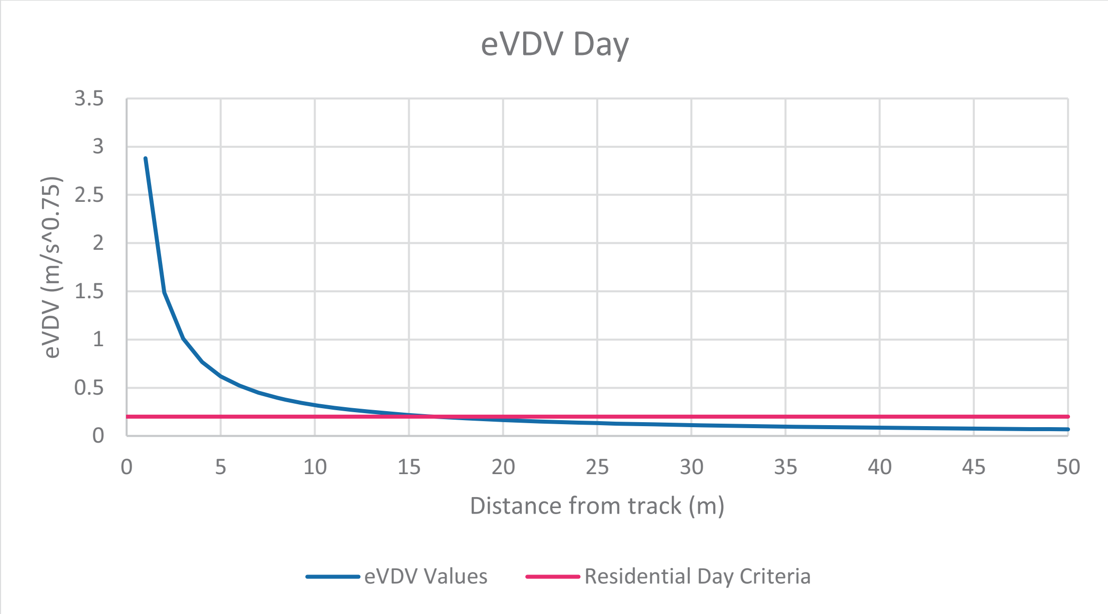

Figure 4-5 Daytime VDV levels (2040)

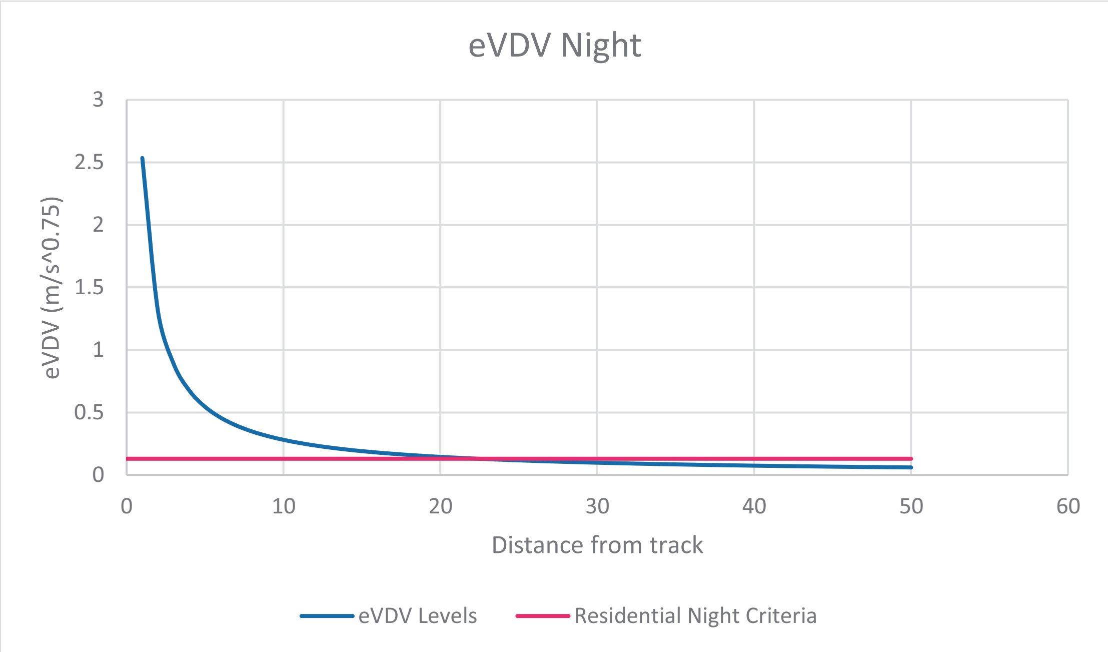

Figure 4-6 Night-time VDV levels (2040)

The nearest receiver is located approximately 45 metres from the track. Therefore, estimated vibration levels are not expected to trigger the day or night-time human comfort criteria. Adverse reactions from operational vibration of the proposal are thus considered unlikely.

5. Construction noise and vibration assessment

5.1 Construction methodology

5.1.1 Construction timing and duration

Construction staging

Construction of the proposal would commence once all necessary approvals are obtained, and the detailed design is complete. It is anticipated that construction would take about 18 months, commencing in early to mid 2018, and concluding in late 2019.

Construction along the existing rail corridor would depend on the possession strategy however it is anticipated that progress would be from south to north, and involve three main stages:

- Stage 1 – Parkes to Goonumbla
- Stage 2 – Goonumbla to Narwonah
- Stage 3 – Narwonah to Narromine

Construction of the Parkes north west connection and the Brolgan Road overbridge would be undertaken in parallel with the above stages.

Proposal construction hours

Construction work would be undertaken during the following primary proposal construction hours:

- Monday to Friday: 6.00 am to 6.00 pm
- Saturday: 6.00 am to 6.00 pm
- Sundays and public holidays: 6.00 am to 6.00 pm

Some minor works may also be undertaken during scheduled rail corridor possession (that is, the times that the movement of trains along the rail corridor are stopped for maintenance or construction). This could include, for example, the connection of the tracks at either end of each stage, and some finishing works. During possessions, works may need to be undertaken on a 24 hour basis.

Out of hours works protocol

An out-of-hours work protocol would be developed to guide the assessment and management of works outside the primary proposal construction hours. The out of hours works protocol would:

- Address the requirements of consent conditions allocated to the proposal relating to works outside of standard construction hours.
- Provide details on what would need to be considered to justify works being undertaken outside standard work hours.
- Describe the assessment process for out of hours works against relevant noise and vibration criteria.
- Provide specific mitigation measures for any residual impacts (in addition to general mitigation measures).

- Describe the communication plan including notification arrangements for potentially impacted receivers.
- Detail how exceedances or non-conformances would be handled.

5.1.2 Construction activities

The proposed track formation works and structure renewals are located between Parkes and Narromine. Temporary works include access into and out of the construction impact zone (CIZ). Table 5-1 lists the site establishment activities, Table 5-2 lists the main upgrading construction activities and Table 5-3 lists the post-construction activities. The construction hours are also provided in these tables to indicate the activities that are generally expected to occur during proposal construction hours and the activities that are expected to occur during possessions.

Table 5-1 Site establishment activities

Activity	Works to be undertaken	Construction Hours
Site establishment	• consult land owners/occupants where required • install site environment management and traffic controls in accordance with the Inland Rail NSW Construction Noise and Vibration Framework and the CEMP • establish site compounds and facilities • clear vegetation • erect temporary fencing • establish site access roads where required • utility relocations as required • deliver and stockpile materials including rail, sleepers, ballast, culverts and structural fill.	• Proposal construction hours

Table 5-2 Main upgrading construction activities

Activity	Works to be undertaken	Construction Hours
Track upgrading - skim reconditioning	• remove fastenings, rail and sleepers and stockpile to one side of the rail corridor • trim and level the existing ballast bed and compact • place concrete sleepers and rail track on prepared ballast bed and weld up rails • place new ballast on top of the sleepers • tamp and profile the ballast around the sleepers and line to a smooth alignment.	• Proposal construction hours • During possessions when connecting stage sections

Activity	Works to be undertaken	Construction Hours
Track upgrading - track reconstruction	• remove fastenings, rail and sleepers and stockpile to one side of the rail corridor • excavate the existing ballast and earth formation • place new earth and recycled ballast into the excavated area and compact • place new ballast on top of the earth formation and compact • place concrete sleepers and rail tracks on prepared ballast bed and weld up rails • place new ballast on top of the sleepers • tamp and profile the ballast around the sleepers and line to a smooth alignment.	• Proposal construction hours • During possessions when connecting stage sections
Drainage construction	• prepare survey control points for planned excavation of cess drains • excavate earth material from the side of the existing track formation, and trim and compact base and sides of the drain • form spoil mounds.	• Proposal construction hours • During possessions when connecting stage sections
Level crossings - upgrade to Signalised Level Crossing	• remove existing controls, excavate to a suitable depth as required, place new formation material and ballast, replace track and surface panel as required • install new controls • provide standard road signs and road markings.	• Proposal construction hours • During possessions when connecting stage sections
Level crossings - upgrade passive protection (give way signs to stop signs)	• Remove give way signs • Install stop signs either side of track • Install road markings for upgrade.	• Proposal construction hours • During possessions when connecting stage sections

Activity	Works to be undertaken	Construction Hours
Level crossing - closure/removal	• remove fastenings, rail and sleepers to one side of the rail corridor • excavate the existing ballast and earth formation to a depth determined by geotechnical investigations and design • place new earth and recycled earth formation into the excavated area and compact using vibratory compaction rollers • place new and recycled ballast on top of the earth formation and compact • place concrete sleepers and rail on prepared ballast bed and weld up rails • place new ballast on top of the sleepers • tamp and profile the ballast around the sleepers and line to a smooth alignment • remove all level crossing signs and road markings.	• Proposal construction hours • During possessions when connecting stage sections
Culvert removal and replacement	• remove existing culvert structure (either concrete or steel pipes) • excavate to the required depth • place and compact bedding material • install substructure as required • place pre-fabricated culvert structures on the new formation area and fasten together • place ballast, sleepers and rail on top of the culverts and tamp and profile the ballast under and around the sleepers and weld up tracks.	• Proposal construction hours • During possessions when connecting stage sections
Crossing loop constructions	• excavate beside the existing track for the length of the crossing loop • place and compact formation material • place ballast, sleepers and rail tracks on top of the new formation • install signal equipment and associated equipment • testing and commissioning. Turnouts: • cut existing track, remove and dispose of existing turnout (at existing sidings only) • undertake formation improvement works as required • install ballast and rails • install control mechanisms (points motor, power supply etc) • testing and commissioning.	• Proposal construction hours

Activity	Works to be undertaken	Construction Hours
Parkes north west connection	• excavate to the required depth • place imported formation material into the excavated area and compact • place bottom ballast • place track consisting of fastenings, rail and sleepers on bottom ballast • place ballast on top of the track • tamp and profile the ballast around the sleepers and tracks • construct cess drainage.	• Proposal construction hours
Brolgan Road rail overbridge	Bridge works: • construct cast-in-place piles at abutments and piers • construct reinforced soil wall abutment on the northern and southern side of the bridge • construct column extensions and pier headstocks • install super T girders and construct reinforced concrete deck including end diaphragms • construct triangular cast in-situ segments on the four corners of the bridge structure • place precast barriers and complete in-situ pour • construct reinforced concrete approach slabs • install throw screens • install expansion joints and steel traffic barrier railing • install waterproof membrane and asphalt. Embankment and pavement works: • place bulk general fill to construct approach embankments • construct new pavement, including placing and compacting select fill, sub base and asphalt wearing surface • tie into existing Brolgan Road. Finishing and landscaping: • rehabilitate disturbed areas in accordance with the rehabilitation plan • line marking and sign posting • final site clean-up.	• Proposal construction hours

Table 5-3 Post-construction activities

Activity	Works to be undertaken	
Finishing works/ reinstatement	• demobilise site compounds and facilities • remove all materials, waste and redundant structures from the works sites • forming, and stabilising of spoil mounds • decommission all temporary work site signs • remove temporary fencing	• Proposal construction hours • During possessions

Activity	Works to be undertaken	
	• establish permanent fencing • decommission site access roads that are no longer required • restoration of disturbed areas as required, including revegetation where required.	

5.1.3 Construction compounds

Minor compounds/storage areas are areas that would be used temporarily for the assembly of adjacent infrastructure such as culverts and turnouts. These compounds would be located within the rail corridor.

Larger compound sites would be established for general construction activities associated with each stage of work. For the purposes of the EIS, it is assumed that temporary compounds would be sited outside the existing rail corridor every 4.5 to five kilometres Indicative compound locations are provided in the EIS and would be confirmed by the contractor prior to works commencing.

Each larger compound site would contain:

- Stockpiles
- Track infrastructure laydown area
- Bunded refuelling area
- Fencing as required
- Office area including parking, offices and ablutions
- Hazardous material storage.

Activities undertaken at compound sites would include the following:

- Site office operations
- Delivery and stockpiling of various construction materials including rail, sleepers, ballast, culverts and structural fill
- Movement of plant and equipment
- Maintenance of site environmental management controls.

Not all of the above activities would be undertaken at every compound site.

As locations for construction compounds have not yet been finalised, specific impacts could not be assessed on an individual basis. Instead the above compound activities have been accounted for within the modelled construction scenario S1 (site establishment) and impacts have been modelled for the entire alignment. Compounds would be located at least one kilometre from the nearest residence or other noise sensitive receiver where possible, and if required, compounds would be further assessed once locations are finalised.

5.1.4 Haul roads

While a detailed haulage program has not yet been developed, it is expected that the majority of the proposal's components would be delivered by rail from various locations. Other transport would be undertaken by heavy vehicles using the Newell Highway, Gwydir Highway/Alice Street and Kamilaroi Highway and then local roads and existing access roads along the rail corridor.

Table 5-4 Construction activities and corresponding equipment

Modelling scenario	General tasks	Representative equipment[1]	Equipment individual sound power level, L_W dB(A)	Adopted activity sound power level, L_W dB(A)[1]	Location
S1	Site establishment works	Hand tools	102	118	Full alignment
		Road truck	108		
		Excavator	110		
		Water cart	107		
		Grader	110		
		Dump truck	117		
S2	Track upgrading - skim reconditioning	Dump truck	117	118	Full alignment
		Rail saw	107		
		Vibratory roller	113		
		Front end loader	111		
		Grader	110		
		Tamper and regulator	112		
S3	Track upgrading –track reconstruction	Dump truck	117	118	Full alignment
		Rail saw	107		
		Vibratory roller	113		
		Front end loader	111		
		Grader	110		
		Tamper and regulator	112		
S4	Drainage construction	Excavator	110	118	Full alignment
		Dump truck	117		
		Franna crane	98		
		Vibratory roller	113		
S5	Level crossings - upgrade to signalised level crossing	Asphalt paver	108	115	Signalised level crossings
		Franna crane	98		
		Excavator	110		
		Vibratory roller	113		
		Hand tools	102		

Modelling scenario	General tasks	Representative equipment[1]	Equipment individual sound power level, L_W dB(A)	Adopted activity sound power level, L_W dB(A)[1]	Location
S6	Level crossing - upgrade passive protection (give way signs to stop signs)	Hand tools	102	109	
		Road truck	108		
S7	Level crossing - closure/removal	Hand tools	102	116	Level crossings for removal
		Excavator	110		
		Front end loader	111		
		Vibratory roller	113		
		Road truck	108		
		Tamper and regulator	112		
		Franna crane	98		
S8	Culvert removal and replacement	Crane	110	118	Culverts
		Excavator	110		
		Dump truck	117		
		Road truck	108		
		Vibratory roller	113		
		Tamper and regulator	112		
		Concrete truck	112		
S9	Crossing loop construction	Excavator	110	118	Crossing loops
		Dump truck	117		
		Vibratory roller	113		
		Front end loader	111		
S10	Post construction works (finishing works/reinstatement)	Road truck	108	113	Full alignment
		Hand tools	102		
		Crane	110		
		Excavator	110		
S11	Parkes north west connection – site establishment	Truck (medium rigid)	103	116	Parkes north west connection
		Crane	110		
		Chainsaw	114		
		Chipper	111		

It is likely that rail components, including sleepers, ballast, and track, would be transported to the work areas via dedicated rail trains; while pre-fabricated concrete units, fill and equipment deliveries would most likely be via road from suppliers or town centres.

5.1.5 Construction noise assessment methodology

The methodology for the construction noise and vibration assessment included:

- The rating background levels (RBL) for the proposal were calculated from the baseline noise monitoring data. The RBLs were used to establish the construction noise management levels in accordance with the ICNG. The proposal construction hours incorporate working hours that are outside of standard construction hours (as defined in the ICNG). The assessment has therefore adopted the construction management level for out of hours works as the proposal specific construction noise management level.
- A list of likely construction activities and machinery was provided. Representative sound power levels for the selected equipment were obtained from the TfNSW CNS and AS 2436 – 2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* and British Standard *BS 5228.1 Code of Practice for noise and vibration control on construction and open sites: Part 1 Noise.*
- Noise propagation calculations were carried out for the anticipated equipment.
- Vibration from construction plant and equipment was predicted and assessed with consideration to Assessing Vibration: A Technical Guideline and German Standard DIN 4150, Part 3: Structural Vibration in Buildings: Effects on Structures.
- Where noise and vibration levels were predicted to exceed the construction management levels, appropriate construction noise and vibration mitigation measures were provided to reduce potential impacts.

5.1.6 Construction plant and equipment

Noise emissions from construction activities have been assessed at identified sensitive receivers in the study area. A quantitative assessment has been carried out with consideration to the ICNG.

Plant and equipment to be used to construct the proposal would be confirmed by the construction contractor once appointed. At this stage of development, the plant and equipment have been selected using professional judgement. Construction equipment will move about the project site and will operate at maximum power for only brief periods. At other times, noise levels will be reduced as the machinery may not require full power or will operate in a different location. It is highly unlikely that all assumed construction equipment would be operating at maximum power simultaneously. For the purposes of this assessment, the two loudest construction plant are assumed to operate concurrently and used to predict the expected construction noise levels. A number of these assumptions therefore provide a degree of conservatism in the predicted results.

The predicted construction sound power levels are shown in Table 5-4 for the construction activities and the plant and equipment expected to be used for the proposal.

Modelling scenario	General tasks	Representative equipment[1]	Equipment individual sound power level, L_W dB(A)	Adopted activity sound power level, L_W dB(A)[1]	Location
S12	Parkes north west connection – earthworks	Jackhammer	118	120	Parkes north west connection
		Dozer	116		
		Compactor	113		
		Vibratory roller	113		
S13	Parkes north west connection – track works	Vibratory roller	113	116	Parkes north west connection
		Compactor	113		
		Front End loader	111		
		Excavator	110		
S14	Brolgan Road rail overbridge construction	Pavement laying machine	114	117	Brolgan Road over Parkes north west connection
		Compactor	113		
		Vibratory roller	113		
		Concrete truck	112		

Note 1: the adopted sound power level is calculated using the loudest two items of equipment

5.1.7 Construction noise prediction method

The noise emissions generated by construction activities have been determined using a computer software model Computer Aided Noise Abatement (CadnaA v4.6) to predict noise levels at the nearest sensitive receivers.

CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates sound propagation according to ISO 9613-2, "*Acoustics – Attenuation of sound during propagation outdoors*". The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.

Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

Model configuration

The noise model inputs and assumptions for the construction assessment are provided in Table 5-5.

Table 5-5 Construction noise modelling assumptions

Modelling component	Assumption
Prediction algorithm	*ISO 9613 – 2 Acoustics – Attenuation of sound during propagation outdoors*
Modelling period	Typical worst case 15 minute period of operation where the two loudest items of equipment are running at full power
Meteorology	ISO 9613 considers the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation
Ground absorption coefficient	G = 1.0 for rural areas
Atmospheric absorption	Based on an average temperature of 10 °C and an average humidity of 70 %
Receiver heights	1.5 m above building ground level (ground floor)
Operating intensity	Construction scenario sound power levels have been adopted

The magnitude of the noise levels associated with construction activities would be dependent upon a number of factors:

- The intensity and location of construction activities
- The type of equipment used
- Existing local noise sources
- Intervening terrain
- The prevailing weather conditions

5.2 Construction noise level prediction

Sound power levels presented in Table 5-4 were grouped into activity based noise levels for input into the noise model. Using the sound power level from the two loudest pieces of equipment operating simultaneously is considered a conservative approach. The predicted noise management level exceedances for each activity scenario are shown in Table 5-6 while the numbers of receivers exceeding each management level are presented in Table 5-7.

Table 5-6 Activity-based construction management level exceedances for residential receivers

Construction management level (CML)	CML $L_{Aeq\ 15min}$	Maximum predicted exceedance of construction management level (dBA)										
		Full alignment works: S1, S2, S3, S4, S12	S5: Signalised Crossing	S6: Give Way Crossing	S7: Level Crossing removal	S8: Culvert works	S9: Crossing loops	S10: Post construction	S11: NW Connection Establishment	S12: NW Connection Earthworks	S13: NW Connection Trackworks	S14: NW Connection Overbridge
Highly Affected	75	-	-	-	-	-	-	-	-	-	-	-
Proposal specific CML (all periods)	35	33	24	21	13	25	18	28	14	18	14	18

Table 5-7 Activity-based construction management level, number of exceedances

Construction management level (CML)	CML $L_{Aeq\ 15min}$	Number of predicted exceedances of construction management level										
		Full alignment works: S1, S2, S3, S4, S12	S5: Signalised Crossing	S6: Give Way Crossing	S7:Level Crossing removal	S8: Culvert works	S9: Crossing loops	S10: Post construction	S11: NW Connection establishment	S12: NW Connection Earthworks	S13: NW Connection Trackworks	S14: NW Connection Overbridge
Highly Affected	75	-	-	-	-	-	-	-	-	-	-	-
Proposal specific CML (all periods)	35	294	59	20	9	264	135	99	9	23	9	2

The construction impacts at the identified non-residential receivers were assessed. None of these receivers were found to exceed the relevant ICNG criteria.

5.2.1 Impacts of construction activities for the key proposal features

Based on the results listed in Table 5-6 and Table 5-7 the findings of the construction noise assessment in relation to the key features of the proposal are discussed below.

Track works

Activities that encompass the entire proposal site (ie the full alignment), such as pre possession works (S1), skim track reconditioning (S2), full depth reconditioning (S3), and drainage construction (S4), are predicted to exceed the construction noise management levels:

- Between Parkes and Peak Hill at 29 receivers with impacts up to 27 dB for works under taken during proposal construction hours.
- Within Peak Hill at 123 receivers with impacts up to 30 dB for works under taken during proposal construction hours.
- Between Peak Hill and Narromine at 76 receivers with impacts up to 33 dB for works under taken during proposal construction hours.

Construction would progress along the route, therefore, noise impacts would be experienced for a relatively short time at most locations.

Level crossing upgrades and removals

Construction activities of crossing signalisation (S5), give way crossing upgrades (S6), and level crossing removal (S7) are predicted to exceed the construction noise management levels:

- Between Parkes and Peak Hill at 9 receivers with impacts up to 13 dB for works during proposal construction hours.
- Within Peak Hill at 37 receivers with impacts up to 24 dB for works undertaken during proposal construction hours.
- Between Peak Hill and Narromine at 14 receivers with impacts up to 19 dB for works undertaken during proposal construction hours.

Culvert works

Replacement and upgrade of existing culverts and bridges (culvert works, S8) are predicted to exceed the construction noise management levels:

- Between Parkes and Peak Hill at 23 receivers with impacts up to 10 dB for works undertaken during proposal construction hours.
- Within Peak Hill at 119 receivers with impacts up to 18 dB for works undertaken during proposal construction hours.
- Between Peak Hill and Narromine at 67 receivers with impacts up to 25 dB for works under taken during proposal construction hours.

Crossing loops

Construction of crossing loops (S9) is predicted to exceed the construction noise management levels:

- Between Parkes and Peak Hill, 1 receiver with impacts up to 2 dB for works undertaken during proposal construction hours.
- Within Peak Hill at 105 receivers with impacts up to 17 dB for works undertaken during proposal construction hours.
- Between Peak Hill and Narromine at 7 receivers with impacts up to 18 dB for works undertaken during proposal construction hours.

Construction of the crossing loops would take around eight weeks to complete.

Parkes north west connection

Construction of the new track at the Parkes north west connection including site establishment (S11), earthworks (S12) and trackworks (S13) are predicted to exceed the construction noise management levels at 18 receivers with impacts up to 18 dB for works undertaken during proposal construction hours.

Parkes north west connection - Brolgan Road overbridge

Construction of the Brolgan Road overbridge is predicted to exceed the construction noise management levels at 2 receivers with impacts up to 18 dB for works undertaken during proposal construction hours.

5.2.2 Impacts of construction activities in relation to working hours

Works during proposal construction hours

The assessment indicates that:

- Rail line redevelopment construction activities are predicted to exceed the noise management level at receivers nearest to the construction footprint. Impacted receivers are within about 700 metres of the works and includes up to 228 identified noise sensitive residential receiver locations. Noise levels are predicted to exceed the proposal specific construction management level by up to 33 dB.
- New rail line construction works at the Parkes north west connection are predicted to exceed the proposal specific construction management level by up to 18 dB at 23 noise sensitive receivers.
- Brolgan road overbridge construction is predicted to exceed the proposal specific construction management level by about 18 dB at two residential receivers.

The noise and vibration mitigation measures detailed in Section 6.3 would be implemented where feasible and reasonable to protect the environment and reduce the potential for noise exceedances at receivers. All potentially affected receivers should be informed of the nature of the works, expected noise levels, duration of works and a method of contact.

5.3 Construction traffic noise

It is expected that vehicles will access working sites via arterial, sub-arterial and local roads.

Limited existing traffic volume data is available for most roads in and around the study area, although in most cases, volumes are expected to range between 50 vehicles per day for lower order roads, up to 2,000 vehicles per day on some of the more significant roads radiating from Parkes. The busiest road to be utilised by construction traffic from the proposal is the Newell Highway, which is discussed below.

The proposed works will temporarily increase truck movements on the roads mentioned above during construction. Predictions of the change in traffic noise level due to the addition of construction traffic were undertaken using the United Kingdom Department of Transport's 'Calculation of Road Traffic Noise' CoRTN algorithm.

The exact number of construction vehicles will vary at different stages of the construction works and will be confirmed when the construction contractor is appointed. However, it is estimated that during the busiest construction period, there will be approximately 400 vehicle movements, including 230 heavy vehicle movements and this peak volume has been used to provide a conservative analysis of the likely level of noise levels.

The traffic information and expected noise level increase from additional traffic on the Newell Highway is summarised in Table 5-8. It is anticipated that the contribution of additional construction traffic will have a minimal impact on the noise levels along the highway. The increase in noise levels due to construction traffic is estimated to be less than 1 dB which will not be noticeable at receivers.

Table 5-8 Construction traffic noise increase

Road	AADT	Existing heavy vehicle percentage	Approximate noise level increase (dBA)
Newell Highway-Tomingley (2015)	2,800	33%	0.9
Newell Highway-Peak Hill (2009)	6,100	31%[7]	0.5
Newell Highway-Parkes (2009)	2,800	31%	0.9

5.4 Sleep disturbance

The *Interim Construction Noise Guideline* (DECC, 2009) states that '*where construction works are planned to extend over more than two consecutive nights, the impact assessment should cover the maximum noise level from the proposed works*'.

Typically, $L_{A1(1minute)}$ or, L_{Amax} noise levels are around 5 dB to 10 dB greater than the $L_{Aeq(15minute)}$ noise levels. Typically, a standard window will provide a 10 dB reduction when partially open and a 20 dB reduction when closed. To be conservative, it is assumed that windows would be kept partially open during night-time construction activities.

The *Environmental Criteria for Road Traffic Noise* (OEH, 1999) acknowledges that based on the current level of understanding, no absolute noise level criteria have been established that correlate to an acceptable level of sleep disturbance. However, the RNP suggests that internal noise levels below 50 dB(A) L_{Amax} to 55 dB(A) L_{Amax} are unlikely to cause awakening reactions and one or two events per night, with internal noise levels of 65 dB(A) L_{Amax} to 70 dB(A) L_{Amax} (inside dwellings) are not likely to significantly affect health and wellbeing.

[7] Heavy vehicle percentage not available. An estimate of 31% has been adopted for this assessment based on traffic volumes at Parkes.

There is the potential for sleep disturbance impacts, with consideration to the RNP sleep disturbance levels, if construction activities occur during the night-time period. Table 5-9 lists each construction scenario and estimates the number of receivers where sleep disturbance could result.

Table 5-9 Sleep disturbance, number of exceedances

L_{AMax} internal level[8]	Number of predicted exceedances of sleep disturbance criteria										
	Full alignment works: S1, S2, S3, S4, S12	S5: Signalised Crossing	S6: Give Way Crossing	S7:Level Crossing removal	S8: Culvert works	S9: Crossing loops	S10: Post construction	S11: NW Connection Establishment	S12: NW Connection Earthworks	S13: NW Connection Trackworks	S14: NW Connection Overbridge
55 dB(A)	13	1	1	0	2	0	7	0	0	0	0

Given the potential for sleep disturbance impacts, construction activities likely to generate the highest levels of noise should be scheduled to occur at the beginning of the shift (before 11 pm) to minimise the potential for sleep disturbance. All workers should be briefed on the need to minimise noise as a result of their activities.

The noise and vibration mitigation measures detailed in Section 6.3 would be implemented to manage potential sleep disturbance impacts during construction.

5.5 Construction vibration assessment

5.5.1 Typical equipment levels

Energy from equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive, reciprocating, rolling or rotating equipment).
- The frequency content.
- The impact medium stiffness.
- The type of wave (surface or body).
- The ground type and topography.

Table 5-10 outlines typical vibration levels for different plant activities sourced from the RMS *Environmental Noise Management Manual* (ENMM) (2001), British Standard *BS 5228.1 Code of Practice for noise and vibration control on construction and open sites: Part 2 Vibration* and the *Construction Noise Strategy* (Transport for NSW 2012).

As stated in the ENMM (RMS 2001), it can be assumed that the vibration level of a source is inversely proportional to the distance source-receiver. Field variations show that the distance relationship generally varies between $d^{-0.8}$ and $d^{-1.6}$, rather than d^{-1}.

[8] 55 dB(A) internal level from the RNP. L_{AMax} levels were estimated as 10 dB greater than the LAeq(15minute) levels and external noise levels were assessed as 10 dB above internal levels.

Table 5-10 Typical vibration levels for construction equipment

Item	PPV at 10 m (mm/s)
Roller	5 - 6
15 tonne roller	7 - 8
7 tonne compactor	5 - 7
Dozer	2.5 - 4
Backhoe	1
Excavators, Scrapers, Graders etc	2.5[1]
Piling (impact)	30
Piling (vibratory)[2]	16.8
Piling (bored)[2]	7.4

Note 1: Based on levels derived at 8 m from: Tyan, A. E. *Ground Vibrations. Damaging effects to Buildings*. Road Research Board 1973
Note 2: Based on levels derived from BS5228-2. *Bored piling through stones or other obstruction*. Vibratory piling based on relationship provided in Table E.1

5.5.2 Construction vibration predictions

Based on the typical vibration levels listed in Table 5-10, the potential vibration levels due to the construction works at various distances are shown in Table 5-11.

Table 5-11 Predicted construction vibration levels

Vibration source	Distance to Source/ Peak Particle Velocity (mm/s)			
	10 m	20 m	50 m	100 m
Roller	6.0	3.4	1.7	1.0
15 tonne vibratory roller	8.0	4.6	2.2	1.3
7 tonne compactor	6.0	3.4	1.7	1.0
Dozer	4.0	2.3	1.1	0.6
Backhoe	1.0	0.6	0.3	0.2
Excavator	2.1	1.2	0.6	0.3
Piling (impact)	30	17.2	8.3	4.8
Piling (vibratory)[1]	16.8	7.3	2.4	1.1
Piling (bored)[1]	7.4	4.3	2.1	1.2

Note 1: Based on levels derived from BS5228-2. *Bored piling through stones or other obstruction*. Vibratory piling based on relationship provided in Table E.1

Construction vibration buffer distances

Predicted safe working buffer distances to comply with the human comfort, cosmetic damage, standard dwelling and heritage building structural damage criteria were calculated for typical vibration values and listed in Table 5-12. This table is based on advice given in British Standard BS 7385:1993 – *Evaluation and measurement of vibration in buildings.*

Vibration may be amplified in multi-level buildings through the structure to the upper floors. A doubling of the buffer distances provided in Table 5-12 would provide a conservative allowance for this possible effect.

Table 5-12 Vibration buffer distances

Activity	Human comfort BS 5228-2 criteria (1.0mm/s)	Structural damage	
		Heritage building/structure DIN 4150-3 criteria (3.0mm/s)	Standard dwellings DIN 4150-3 criteria (5.0mm/s)
General construction activities			
Roller	90 m	24 m	13 m
15 tonne vibratory roller	140 m	35 m	18 m
7 tonne compactor	90 m	24 m	13 m
Dozer	60 m	15 m	8 m
Backhoe	10 m	3 m	2 m
Excavator	25 m	7 m	4 m
Piling			
Piling (impact)	700 m	180 m	100 m
Piling (vibratory)[2]	110 m	50 m	30 m
Piling (bored)[2]	120 m	35 m	17 m

Note 1: Based on advice given in British Standard BS 7385:1993 – Evaluation and measurement of vibration in buildings.
Note 2: Based on levels derived from BS 5228-2. *Bored piling through stones or other obstruction*. Vibratory piling based on relationship provided in Table E.1

General construction activities

With consideration to structural damage vibration impacts from general construction activities, the expected magnitude of ground vibration should not be sufficient to cause damage if the equipment operates at distances greater than 18 metres from standard residential buildings or 35 metres from heritage structures.

The noise and vibration mitigation measures detailed in Section 6.3 should be implemented to reduce the potential for construction vibration impacts to occur.

Piling

Vibration impacts due to piling activities have the potential to exceed structural vibration values for standard dwellings at distances from the activity of 100 metres for impact piling, 30 metres for vibratory piling and 17 metres for bored piling.

In the event that these buffer distances are not possible to achieve, other methods may be investigated such as CFA piling, press-in hydraulic piling or jacked-in piling. These methods generally exhibit much lower vibration levels compared to impact, vibratory and bored piling.

5.5.3 Construction vibration impacts on heritage structures

Potentially sensitive heritage structures were identified as part of the heritage report undertaken for the EIS (refer Umwelt, 2017, *ARTC Inland Rail – Parkes to Narromine Non-Aboriginal Heritage Impact Statement*). These items are listed in Table 5-13 including their location and approximate distance to the proposal site for comparison to the structural damage buffer distances stated in Table 5-12.

Table 5-13 Heritage structures

Item name	Location	Distance to corridor/track
Narromine District Hospital	Bound by Dandaloo, Cathundral and Temain Streets Narromine	Approximately 900 m east
Peak Hill Courthouse	Derribong Street	Approximately 775 m east
Peak Hill Fire Station	130 Caswell Street	Approximately 975 m east
Peak Hill Police Station and Official Residence	80 Derribong Street	Approximately 750 m east
St. James Roman Catholic Church	Narra Street, Lots 17-20 DP 758832	Approximately 950 m east
Station – Goonumbla and grain siding and silos	Chainage 465.600	On alignment / Immediately adjacent
Station – Alectown West and Grain siding and Silo	Chainage 473.600	On alignment / Immediately adjacent
Station – Mickibri and Grain siding and Silo	Chainage 482.362	On alignment / Immediately adjacent
Station – Peak Hill	Chainage 498.400	On alignment / Immediately adjacent
Station – Tomingley West and Grain siding and Silo	Chainage 516.100	On alignment / Immediately adjacent
Tomingley West Cottage	Tomingley West Road	100 m west of main rail line
Station – Wyanga and Grain siding and Silo	Chainage 528.990	On alignment / Immediately adjacent
Wyanga Cottage	Chainage 528.990	On alignment / Immediately adjacent
Station – Narwonah and Grain siding and Silo	Chainage 547.050	On alignment / Immediately adjacent

General construction activities

Heritage structures in the proposal area include station buildings, sidings and silos. Many of these structures are directly adjacent to the track alignment. With consideration to structural damage, vibration impacts for general construction activities, the expected magnitude of ground vibration should not be sufficient to cause damage if the equipment operates at distances greater than 35 metres from heritage buildings and structures. Many items are potentially within this buffer distance. However, measured vibration levels by GHD on other projects in the Hunter Valley during removal and excavation of old track indicated a maximum recorded PVS of 2.87 millimetres per second. Tamping and ballast regulation generated a maximum PVS of 0.98 millimetres per second at the floor of the station building. These vibration velocities are within the DIN 4150-3 criteria for heritage structures of 3 millimetres per second. As identical works are proposed to be undertaken for the proposal, vibration damage for adjacent station structures is not anticipated, however it is recommended that the mitigation measures detailed in Section 6.3 be considered and implemented where feasible and reasonable.

Piling

Vibration impacts due to piling activities have the potential to exceed structural vibration criteria for heritage structures at distances from the activity of 180 metres for impact piling, 50 metres for vibratory piling and 35 metres for bored piling.

In the event that these buffer distances are not achievable, other methods may be investigated such as CFA piling, press-in hydraulic piling or jacked-in piling. These methods generally exhibit much lower vibration levels compared to impact, vibratory and bored piling.

5.5.4 Human comfort impacts

Humans are capable of detecting vibration at levels well below those causing risk of damage to buildings. The degree of perception for humans and sensitive areas are suggested by the vibration level categories given in British Standard BS 5228:2009 and shown in Table 3-8 and Table 3-9.

Based on the conservative estimates detailed in Table 5-12, it is possible that construction vibration from general construction work and at crossing loops may be perceptible at distances of up to 140 metres from the works. There are 20 residential receivers identified within this buffer distance including six near Narromine, ten near Peak Hill and the remaining four scattered along the alignment. Therefore it is recommended that the mitigation measures detailed in Section 6.3 be considered and implemented where feasible and reasonable.

Piling works are required to construct the Brolgan Road overbridge. Vibration impacts due to boring of the cast in-situ piles has the potential to impact receivers up to 120 metres from the work area. The piling activities are anticipated near the bridge span, which is more than 400 metres from the nearest vibration sensitive receiver, therefore human comfort impacts are not anticipated from these works.

6. Mitigation measures

6.1 Approach to mitigation

An operational noise and vibration review (ONVR) would be prepared to detail how the predicted operation impacts would be mitigated.

A Construction Environment Management Plan (CEMP) and activity specific Construction Noise and Vibration Impact Statements (CNVIS) would be developed based on the requirements and methodologies presented in the Inland Rail NSW Construction Noise and Vibration Framework. These documents provide the approach to managing noise and vibration during construction.

The proposal would be designed, constructed, and operated in accordance with the CEMP, the noise and vibration control strategy, the Inland Rail NSW Construction Noise and Vibration Management Framework (provided in the EIS), the conditions of approval for the proposal, and the environment protection licence for Inland Rail.

6.2 Operational noise and vibration

6.2.1 Noise control strategy

A noise and vibration impact assessment has been completed on the basis of the existing design and other information available for the proposal. While the assessment has been limited due to the preliminary nature and availability of design information, exceedances of the RING criteria are predicted and mitigation measures are therefore necessary to reduce the potential for impacts.

Identification of specific noise abatement measures is not possible during this stage of the project; however a range of abatement measures have been identified to reduce noise levels to below the RING trigger levels. Potential noise control options are listed in Table 6-1. The effectiveness and appropriateness of these measures will be considered following detailed design and community consultation.

Table 6-1 Potential noise control options

Noise control strategy	Mitigation option	Description
Controlling noise at source	Rail dampers	Rail dampers are preformed elements made of an elastic material containing steel strips. Dampers are placed on the sides of the rail, dampening the vibration of the rails as the train passes over them and thereby reducing noise emissions. Noise reduction in the order of 2 to 5 dBA is possible, depending on the rail roughness (the smoother the rail, the less attenuation). However, this is only valid when the wheel-rail interface is the main noise source. In the context of coal or freight train pass-bys, rail dampers would not attenuate L_{Amax} levels, which are normally dominated by locomotive noise, but would reduce wagon noise. This option could be considered for the proposal where small noise reductions are needed.

Noise control strategy	Mitigation option	Description
	Track lubrication	Trackside lubrication strategies can be employed to improve the performance of the rail track and reduce noise generated, particularly from rail squeal and flanging on tight curves. These strategies are as follows: • Improvements in grease transfer by placing trackside lubricators on moderate curves in advance of the sharp curves which are the main target • Improvements in the lubricant used by choosing a high performance product Track lubrication improves the rail/track interface and can reduce/eliminate curve squeal and flanging at affected locations. This can result in a substantial noise reduction in L_{Aeq}, L_{Amax} levels. Note that there are very few tight radius curves in the proposal, so track lubrication would have limited application.
Controlling noise on the transmission pathway	Noise barriers	Noise barriers are typically constructed on the edge of the rail corridor to shield sensitive receivers from rail vehicles. Depending on the situation, noise barriers can achieve 10 to 15 dBA attenuation. Noise barriers often result in significant costs and visual impacts. They are generally considered preferable where noise attenuation at a larger number of receivers is required and typically not cost-effective for small number of receivers.
	Earth mounds	Earth mounds are generally constructed at a distance from the near rail to shield sensitive receivers from rail vehicles. Earth mounds can provide effective mitigation of noise if sufficient spoil and space is available. However, earth mounds generally provide less attenuation of noise than noise barriers and require a larger area also. During detailed design the potential to utilise the proposed spoil mounds (described in the EIS) as noise barriers would be investigated.
Controlling noise at the receiver	Architectural treatment	Architectural treatment consists of reducing noise levels at affected residences in order to meet internal noise levels. Treatment could include retrofitting thicker window glazing, roof insulation, door and windows acoustic seals and the like. It could also include boundary fences if it would be effective in reducing external noise levels. Noise attenuation is substantially dependant on the condition and design of the existing residence. Note that architectural treatment may also include fitting of mechanical/forced ventilation so that windows can be kept closed if the occupant desires. Architectural treatment is often the most practical option where individual receivers require noise mitigation and where other mitigation options have been considered and exhausted.

An Operational Noise and Vibration Review (ONVR) shall be prepared for the project to confirm noise and vibration control measures based on the final proposal design and operation. The ONVR shall:

- Confirm predicted project noise and vibration levels at sensitive receivers. This may include the results of façade testing for non-residential receivers.

- Assess feasible and reasonable noise and vibration measures consistent with RING and in a hierarchical manner.
- Specify noise and vibration abatement measures for all relevant sensitive receivers.
- Include a consultation strategy to seek feedback from directly affected property owners on the proposed noise and vibration abatement measures.
- Include a timetable for delivery of abatement prior to operation of the Inland Rail.
- Outline post-operational monitoring to verify noise and vibration predictions.

Typically, a post construction noise and vibration assessment including monitoring would be undertaken to validate predicted noise levels and identify any unforeseen impacts, however as noise and vibration levels are not expected to appreciably change until Inland Rail through connection in 2025, it is considered appropriate to undertake the post construction noise and vibration assessment within three months following through connection. The assessment would be undertaken to confirm compliance with the predicted levels, or as modified by the reasonable and feasible review. If the results of modelling indicated that the predicted noise and vibration levels are exceeded, then additional reasonable and feasible mitigation measures would be implemented in consultation with the affected property owners.

Given the preliminary nature of information about the proposal, it is not possible to be definitive about the mitigation measures required. However, in broad terms there are three main strategies for reducing operational noise and vibration impacts:

- Controlling noise and vibration at the source
- Controlling noise and vibration along the transmission pathway
- Controlling noise and vibration at the receiver

The RING recommends that these control strategies are considered in this order so that all measures to reduce noise are exhausted before localised ‘at source’ mitigation measures are considered.

The RING also requires that feasible and reasonable mitigation measures are implemented. A feasible mitigation measure is a measure that can be engineered and is practical to build, given constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (e.g. reviewing idling times or speeds) to achieve noise reduction.

Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure. To make such a judgement, the following aspects are typically considered:

- Noise impacts:
  - Existing and future levels, and projected changes in noise levels.
  - Level of amenity before the proposal, e.g. the number of people affected or annoyed.
  - Any noise performance criteria for the development, e.g. internal noise levels for certain rooms.
  - The amount by which the trigger levels are exceeded.
- Noise mitigation benefits:
  - The amount of noise reduction expected, including the cumulative effectiveness of proposed mitigation measures.
  - The number of people protected.

- Cost-effectiveness of noise mitigation:
  - The total cost of mitigation measures, taking into account the physical attributes of the site, e.g. topography, geology, and the cost variation to the proposal given the expected benefit.
  - Noise mitigation costs compared with total proposal costs, taking into account capital and maintenance costs.
  - Ongoing operational and maintenance cost borne by the community, e.g. running air conditioners or mechanical ventilation.
- Community views:
  - Aesthetic and other impacts of noise mitigation measures with consideration to the affected land users.
  - Consider the views of all affected land users, not just those making representations, through early community consultation.
  - Consider noise mitigation measures that have majority support from the affected community.

Based on these considerations, the aim of the mitigation strategy is to strike a balance between the proposal's benefits for the wider community and the costs and benefits of mitigation measures.

6.3 Construction noise and vibration

The Inland Rail NSW Construction Noise and Vibration Management Framework (provided in the EIS) has been developed to show how construction noise and vibration will be managed for Inland Rail in NSW. It provides a framework for managing construction noise and vibration impacts in accordance with the ICNG, to provide a consistent approach to management and mitigation across Inland Rail.

Specifically the NSW Construction Noise and Vibration Management Framework identifies the requirements and methodology to develop Construction Noise and Vibration Impact Statements. These would be prepared prior to specific construction activities and based on a more detailed understanding of the construction methods, including the size and type of construction equipment, duration and timing of works, and detailed reviews of local receivers if required. A Construction Noise Impact Statement would include:

- A more detailed understanding of surrounding receivers, including particularly sensitive receivers such as education and child care, and vibration sensitive medical, imaging, and scientific equipment.
- Application of appropriate noise and vibration criteria for each receiver type.
- An assessment of the potential noise and vibration impacts as a result of different construction activities.
- Minimum requirements in relation to standard noise and vibration mitigation measures.
- Noise and vibration auditing and monitoring requirements.
- Additional mitigation measures to be implemented when exceedances to the noise management levels are likely to occur - these measures are aimed at pro-active engagement with potentially affected receivers, provision of respite periods, and alternative accommodation for defined exceedance levels.

The proposal would be constructed in accordance with the Construction Noise and Vibration Management Framework, the CEMP, site-specific Construction Noise and Vibration Impact Statements, the conditions of approval for the proposal, and the construction EPL.

Practical and reasonable measures would be implemented to reduce the noise and vibration levels at sensitive receivers. Section 6.3.1 outlines additional measures to manage noise where the construction noise assessment identified exceedances of the relevant management levels.

6.3.1 Management of construction noise and vibration exceedances

The approach to managing exceedances of noise management levels will be undertaken in accordance with ARTC's communication strategy for the Inland rail project.

Mitigation management practices are listed below and the contexts in which they should be implemented are described in Table 6-2 and Table 6-3.

Communication (CO)

Communication with affected stakeholders will be undertaken in accordance with the proposal's communication strategy. Communication measures are expected to include notification of affected stakeholders with appropriate lead time, level of personalization, and opportunity for feedback as appropriate for the specific situation.

Respite Offer (RO)

Residents subjected to lengthy periods of noise or vibration may be eligible for a respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level across two or more consecutive sleep periods.

The implementation of the above measures is determined by matching the predicted exceedance to the appropriate mitigation measures as detailed in Table 6-3 below. The specific details of communication are to be outlined in the communication strategy for the proposal.

Table 6-2 Additional mitigation measures – Airborne construction noise

Time Period		NML, dB(A)	Perception	Exceedance of NML, dB(A)	Mitigation Measures
All hours		-	Highly affected, >75 dB(A)	-	RO, CO
Proposal construction hours	6am – 6pm	35	Noticeable	<5	-
			Clearly audible	5-15	CO
			Moderately intrusive	15-25	CO
			Highly intrusive	>25	RO, CO
OOHW	6pm – 6am	35	Noticeable	<5	CO
			Clearly audible	5-15	CO
			Moderately intrusive	15-25	RO, CO
			Highly intrusive	>25	RO, CO

Notes: OOHW: Out Of Hours Work – Period 1 includes times of day typically used for rest including weekday evenings, Saturday afternoons and daytime during Sundays/public holidays. Period 2 includes times typically used for sleep and where the greatest sensitivity to noise exists including night times during weekdays/Saturdays and both evening and night times for Sundays/public holidays.
CO – Communication. RO – Respite Offer

Table 6-3 Additional mitigation measures – Construction vibration

Time Period		Mitigation Measures Predicted vibration levels exceed maximum levels
Proposal construction hours	6am – 6pm	RO, CO
OOHW Period 2	Mon –Fri (10 pm–7 am) Sat (10 pm–8 am) Sun/Pub Hol (6 pm-7 am)	RO, CO

Note 1: OOHW= Out-of-hours Work
CO – Communication. RO – Respite Offer

6.3.2 Standard construction noise and vibration mitigation measures

Table 6-4 lists the standard mitigation measures which would be implemented for the proposal.

Table 6-4 Standard construction noise and vibration management controls

No	Environmental Management Controls
1.1	All construction vehicles and machinery would be fitted with manufacturer supplied noise suppression devices and maintained.
1.2	All site workers would be informed of the potential for noise and vibration impacts upon local residents and encouraged to take practical and reasonable measures to minimise noise during the course of their activities.
1.3	Contact will be established with the local residents and the construction program and progress communicated on a regular basis, particularly when noisy or vibration-generating activities are planned. Affected receivers will be notified of the intended work, its duration and times of occurrence. This may include: • Website featuring updates on construction activities and consultation events • Community update newsletters • Community update newspaper advertisements • Local community update letters for specific construction activities.
1.4	A community liaison phone number and permanent site contact will be provided so that noise and/or vibration related complaints, if any, can be received and addressed in a timely manner.
1.5	For any work that will take place outside of proposed construction hours, such as track possessions, residents potentially affected by such activities will be notified at least seven days before hand.
1.6	Work methods would be reviewed with a preference for quieter and non-vibration generating methods wherever possible. This is particularly important for any out-of-hours and night-time activities.
1.7	Material dumps would be located as far as possible from the nearest residences, and whenever possible, loading and unloading areas would be located as far as possible from the nearest residences.
1.8	Where possible, materials dropped from heights into or out of trucks will be minimised.
1.9	Fixed equipment (pumps, generators, compressors) will be located as far as possible from the nearest residences.
1.10	Where possible, no plant or equipment will be left idling when operating in the vicinity of residential properties.
1.11	All vehicular movements to and from the site will comply with the requirements of the appropriate regulatory authority requirements for such activities.

No	Environmental Management Controls
1.12	Where practicable, all typically noisy construction activities will be kept within the daytime working hours.
1.13	Any noise and vibration monitoring will be undertaken by a qualified professional and with consideration to the relevant standards and guidelines.
1.14	Any complaints received would be responded to in accordance with a formalised complaint handling process.
1.15	If vibration-generating activities are conducted within 25 m of a residence alternative work methods will be implemented so the vibration impacts are reduced to acceptable levels.
1.16	If vibration generating activities (non-piling) are being undertaken within 35 m of the heritage listed structures, alternative work methods will be implemented so the vibration impacts are reduced to acceptable levels. For piling, this distance is increased to 180 m.
1.17	Dilapidation surveys - Prior to commencement of construction a dilapidation survey of the nearby heritage structures (within 35 m of the works) would be undertaken. These items must be protected from accidental damage for the duration of the works.
1.18	Based on the conservative estimate it is possible that construction vibration may exceed the guidance limits for critical and sensitive areas. The predictions do not account for possible reduced internal vibration levels which may be realised due to the structure of the buildings. It is not known how the structure will respond to external ground vibration sources. Specific consultation would be undertaken with potentially impacted receivers with sensitive equipment prior to commencement of vibration generating activities, and as required throughout the construction phase, with regards to potential detectable vibration levels and possible impacts on critical activities at the facility. Where required specific work practices or scheduling arrangements would be considered to minimise potential impacts on the facility.

6.3.3 Heritage Structures

A potential heritage item, Wyanga cottage, is located about 15 metres to the west of the existing tracks. Further information on heritage items in the study area is provided in the EIS. The heritage assessment notes that Wyanga cottage is in disrepair and at risk of collapse. If inadequately managed, vibration as a result of construction may impact the structure, particularly the movement of dozers, backhoes or excavators, as the cottage is located nearer to potential activities than the safe working distance for heritage buildings listed in Table 5-12. A dilapidation survey at Wyanga cottage would be undertaken prior to commencement of construction. Less vibration emitting construction methods would be used in the vicinity of the cottage where feasible and reasonable. Although the potential for indirect impacts on the cottage would be minimised as far as practicable, given the dilapidated state of the cottage, there remains the risk that it could collapse. As such, heritage mitigation measures are discussed in the EIS.

7. Summary and conclusion

Based on the modelling results and findings of this noise and vibration assessment, the following conclusions are made with consideration to the assumptions detailed in this report.

7.1 Operational noise and vibration

Operational noise modelling indicates that the RING $L_{Aeq\ day}$ and $L_{Aeq\ Night}$ rail noise trigger levels are predicted to be exceeded at a number of receivers near to the rail corridor and that increases in noise due to the proposal are more than 2 dB for a number of receivers. This indicates that the conditions for the consideration of noise mitigation have been triggered at these receivers with regards to the RING.

Further, noise modelling indicates that a number of receivers are expected to exceed the RING L_{Amax} trigger levels and that increases in noise due to the proposal are more than 3 dB for a number of receivers. Therefore, mitigation measures will be required for operational noise at the nearest identified receivers with consideration to L_{Amax} levels.

Based on train volumes and speeds provided by ARTC, a total of 28 residential receivers were found to exceed the redeveloped rail line RING criteria. Noise modelling indicated that no receivers in the vicinity of the proposed Parkes north west connection will exceed the RING trigger levels for a new rail development. The operational noise model is based on a number of conservative assumptions and the information available at the time of the assessment in relation to proposed operations, design and receiver locations and an updated assessment will be undertaken at subsequent stages of the proposal where additional detail is available.

A number of potential mitigation measures have been identified to address exceedances of the RING trigger levels. A feasible and reasonable assessment of these measures will be undertaken in consultation with the affected community, following completion of detailed design.

The proposal is not expected to increase operational vibration levels noticeably and is not expected to exceed structural damage or human comfort criteria. Therefore, no specific mitigation measures are considered necessary.

Post construction noise monitoring is to be undertaken at representative locations to verify the effectiveness of the applied mitigation measures with respect to the RING trigger levels.

7.2 Construction noise

During construction there is the potential for noise impacts to the surrounding community.

- In relation to construction activities:
  - Activities such as pre-possession works (S1), skim track reconditioning (S2), full depth reconditioning (S3), and drainage construction, are likely to produce the greatest level of impacts due to the closest proximity to receivers and high predicted noise activities.
- In relation to working hours and construction noise management levels:
  - The highly affected level of 75 dB(A) L_{Aeq} is not likely to be exceeded.
  - Construction activities are not expected to exceed the noise management level at non-residential sensitive receivers including educational, child care and hospital facilities. Construction noise management levels are applicable as an internal level only when the facilities are in use.
  - Construction activities are not expected to exceed the noise management level at recreational areas when these areas are in use.

- Rail line redevelopment construction activities undertaken during proposal construction hours are predicted to exceed the noise management level at receivers nearest to the construction footprint. Impacted receivers are within about 700 metres of the works and includes up to 228 identified noise sensitive residential receiver locations. Noise levels are predicted to exceed the proposal specific construction management level by up to 33 dB.
- New rail line construction works undertaken during proposal construction hours at the Parkes north west connection are predicted to exceed the noise management level by up to 18 dB at 23 noise sensitive receivers.
- Brolgan road overbridge construction is predicted to exceed the noise management level by about 18 dB at two residential receiver for works undertaken during proposal construction hours.

It is recommended that the mitigation measures detailed in Section 6.3 be considered and implemented where feasible and reasonable to reduce construction noise impacts.

7.3 Construction vibration

General construction activities

In relation to vibration from general construction activities, the expected magnitude of ground vibration is not expected to be sufficient to cause damage if the equipment operates at distances greater than 18 metres from standard residential buildings or structures of similar construction.

Heritage structures in the proposal area include station buildings, sidings and silos. Many of these structures are directly adjacent to the track alignment. The expected magnitude of ground vibration is not expected to be sufficient to cause damage if the equipment operates at distances greater than 35 metres from heritage buildings and structures. However, many items are potentially within this distance from the works and may therefore be affected.

The noise and vibration mitigation measures detailed in Section 6.3 should therefore be implemented to manage potential construction vibration impacts.

Piling

Vibration impacts due to piling activities have the potential to exceed structural vibration values for standard dwellings at distances of 100 metres from the activity for impact piling, 30 metres for vibratory piling and 17 metres for bored piling.

Piling activities have the potential to exceed structural vibration values for heritage structures at distances of 180 metres from the activity for impact piling, 50 metres for vibratory piling and 35 metres for bored piling.

In the event that sensitive receivers fall within these buffer distances, other methods may need to be investigated such as press-in hydraulic piling or jacked-in piling to reduce the potential for impact. These methods generally exhibit much lower vibration levels compared to impact, vibratory and bored piling.

Human comfort

Humans are capable of detecting vibration at levels well below those causing risk of damage to buildings. Based on a conservative assessment, it is possible that construction vibration from general construction activities may be perceptible at distances up to 140 metres from the works. The mitigation measures detailed in Section 6.3 should therefore be considered where feasible and reasonable to reduce the potential for impact.

7.4 Conclusion

The Australian Rail Track Corporation (ARTC) has engaged GHD Pty Ltd (GHD) to prepare a Noise and Vibration assessment for the proposed upgrade of the Parkes to Narromine section of the inland rail proposal. This upgrade is located in between Parkes and Narromine, New South Wales.

Based on the findings of this assessment, it is considered that the noise and vibration impacts associated with the proposal can be satisfactorily managed from both the construction and operation of the infrastructure provided that the mitigation measures outlined in this report are implemented.

7.5 Limitations

This report has been prepared by GHD for Australian Rail Track Corporation and may only be used and relied on by Australian Rail Track Corporation for the purpose agreed between GHD and the Australian Rail Track Corporation as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Australian Rail Track Corporation arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (Sections 1.1, 4 and 5). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Australian Rail Track Corporation and others who provided information to GHD, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

It is not the intention of the assessment to cover every element of the acoustical environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the acoustic assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that not all variations in environmental conditions can be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

Appendices