Technical and Approvals Consultancy Services: Parkes to Narromine

Operational Noise and Vibration Review

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Prepared for

Australian Rail Track Corporation

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Inland Rail Design Joint Venture

World Square
Level 27,
680 George Street, Sydney
New South Wales, 2000
Tel: +61 7 3854 6200

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Reviewed by	Simon Moore	Date: 13/08/2019	Signature:	Held on file
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Glossary

‘A’ Frequency Weighting	Frequency weighting applied to sound levels to approximate the relative loudness of different frequencies perceived by the human ear.
ARTC	Australian Rail Track Corporation
Decibel, dB	Unit of sound. 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure.
EIS	Environmental Impact Statement
Equivalent Continuous Sound Level, L_{Aeq}	Many sounds, such as rail noise, vary repeatedly in level over a period of time. The L_{Aeq} is the A weighted single figure noise level which represents the same amount of energy as the time varying signal over a period of time. The decibel scale is a logarithmic ratio, so the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.
‘F’ (Fast) Time Weighting	Standardised time averaging constant of 0.125 seconds.
IRDJV	Inland Rail Design Joint Venture (WSP|MM DJV legal entity)
Maximum Noise Level, L_{AFmax}	The Root-Mean-Square maximum sound pressure level measured with sound level meter using the ‘A’ frequency weighting and the ‘F’ (Fast) time weighting.
‘S’ (Slow) Time Weighting	Standardised time averaging constant of 1 second.
Maximum Noise Level, L_{ASmax}	The Root-Mean-Square maximum sound pressure level measured with sound level meter using the ‘A’ frequency weighting and the ‘S’ (Slow) time weighting.
Peak Particle Velocity, PPV	Highest instantaneous particle velocity during a given time interval, measured in mm per second.
Rating Background Level	The overall single figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period as defined in the Noise Policy for Industry (EPA, 2017).
RMS	Roads and Maritime Services
Sound Exposure Level, SEL	A parameter closely related to L_{Aeq} for assessment of events such as trains that have similar characteristics but are of different duration. The SEL value contains the same amount of acoustic energy over a ‘normalised’ 1-second period as the actual noise event under consideration.
Sound Pressure Level, SPL	The basic unit of sound measurement is the sound pressure level. The pressures are converted to a logarithmic scale and expressed in decibels (dB).

Sound Power Level, SWL	Sound power represents the inherent sound energy of a source. The sound power level is a logarithmic measure of the sound power in comparison to a specified reference level (dB).
Statistical Noise Levels, Ln	Noise which varies in level over a specific period of time ‘T’ (standard measurement times are 15 minute periods) may be quantified in terms of various statistical descriptors. The noise level, in decibels, exceeded for 1 % of the measurement time period, when ‘A’ frequency weighted and ‘F’ time weighted is reference to as $L_{AF1, T}$. This may be used for describing short-term noise levels such as could cause sleep arousal during the night. The noise level, in decibels, exceeded for 10 % of the measurement time period, when ‘A’ frequency weighted and ‘F’ time weighted is reference to as $L_{AF10, T}$. The noise level, in decibels, exceeded for 90 % of the measurement time period, when ‘A’ frequency weighted and ‘F’ time weighted is reference to as $L_{AF90, T}$. It is used to describe the background noise level.
Vibration Dose Value, VDV	The VDV is given by the fourth root of the integral with respect to time of the fourth power of the acceleration after it has been weighted.
WSP|MM	WSP Australia | Mott MacDonald DJV trading as IRDJV

Executive Summary

The Project is a redevelopment of the existing Australian Rail Track Corporation (ARTC) railway section between Parkes and Narromine. The upgrade of the existing railway forms part of the Inland Rail project, connecting Brisbane to Melbourne. The southern end of the Parkes to Narromine section is located to the north of Goobang Junction, west of Parkes, and the northern end is located approximately 8 km south of Narromine. This section of Inland Rail mainly involves the upgrade of 99 km of existing track within the existing ARTC rail corridor. In addition, a new Parkes North-West Connection line is proposed at the southern end of the section near Parkes. The proposed Parkes North-West Connection will provide a link between the existing Broken Hill line and Inland Rail. It involves constructing approximately 5.3 km of new corridor through greenfield areas, including track and civil works and a level crossing at the intersection with Brolgan Road.

A noise and vibration assessment was prepared by GHD Pty Ltd, as part of the Environmental Impact Statement for the Parkes to Narromine section. As part of the Conditions of Approval for the Project, an Operational Noise and Vibration Review, to be submitted to the NSW Department of Planning and Environment, is required to confirm the final mitigation measures to be implemented for operational noise and vibration.

This Operational Noise and Vibration Review outlines the predicted noise impacts upon the sensitive receivers and presents mitigation measures for receivers where the predicted, unmitigated noise levels exceed the trigger level.

A noise model was generated for this Operational Noise and Vibration Review and the modelling results were compared to the outputs of the noise model prepared for the Environmental Impact Statement for year 2016 (i.e. no build). Receivers located at various distances from the existing tracks, not influenced by noise from level crossings and crossing loops, and located in the vicinity of the previous noise monitoring locations, were manually selected to compare the rail noise component of both models. The results of the comparison showed a good agreement between both models.

The entire Inland Rail project is divided into multiple sections, each having their own approval process. The various sections are proposed to be constructed within different timeframes, between 2018 and 2025. The construction of the Parkes to Narromine section is expected to be finalised in 2020, which is therefore considered the actual opening year. The whole alignment is expected to be finalised in 2025, which is therefore the year of “through connection”, where the overall traffic through the whole alignment will start to increase. The design year is 2040.

The noise model developed for year 2016 was updated to include a representative version of the 100% Detailed Design rail track alignment. Noise predictions were then undertaken for the actual opening year (2020), for the “through connection” year (2025), and the design year (2040):

- Noise predictions for year 2020 identified no exceedances of the noise trigger level;
- Noise predictions for year 2025 identified one daytime exceedance of the noise trigger level and eight night-time exceedances of the noise trigger level; and
- Noise predictions for year 2040 identified four daytime exceedances of the noise trigger level and 20 night-time exceedances of the noise trigger level.

Three noise mitigation options were investigated to assess the residual impacts. The first mitigation option investigated was rail dampers. It was determined that the inclusion of a 1 km stretch of rail dampers adjacent to each of the receivers eligible for noise mitigation would not sufficiently mitigate the predicted noise levels to meet the noise trigger levels.

Noise barriers were also investigated. It was determined that eight noise barriers of various heights and lengths are required to achieve compliance with the noise trigger levels. Each of these barriers were designed to bring a single receiver into compliance with the noise trigger levels and therefore not considered reasonable.

The final noise mitigation option that was investigated is at property treatments. It was determined that a stakeholder engagement consultant as well as an architect, a builder and an acoustic consultant should be engaged to provide advice on treatment for each individual dwelling, as retrofitting an existing property to reduce noise impacts will depend on the existing structure and the condition of the property.

The eight dwellings predicted to exceed the noise trigger levels for year 2025 are exceeding by up to 10 dBA for year 2040, hence at property treatment is a feasible noise mitigation option. The general building construction and condition (e.g. wall and roof construction, window and door locations) and the surroundings of the eight affected properties have been inspected. Following the site inspections, at-property treatments to mitigate the noise impacts associated with the Project were recommended. These at-property treatments mainly involve:

- Architectural treatments;
- A combination of property fence upgrades and architectural treatments for one property; and
- A property fence upgrade for one poorly maintained building deemed not suitable for architectural treatments.

ARTC will endeavour to reach agreement with all affected property owners and that the carrying out of mitigation measures will be dependent on appropriate authorisation being obtained.

1 Project Background

1.1 The Project

The Project refers to the existing 99 km Parkes to Narromine section to be upgraded and the 5.3 km Parkes North-West Connection to be built.

The Parkes to Narromine section of the Project, is a brownfield section of Inland Rail between Parkes and Narromine, NSW. The southern end is located at 449.142 kilometres on the line (measured from Sydney Central Station) to the north of Goobang Junction. The northern end is located at 547.550 kilometres on the line, which is 8 km south of Narromine.

The Parkes North-West Connection will provide a link between the existing Broken Hill line and Inland Rail at Parkes. It involves constructing approximately 5.3 km of new rail corridor on greenfield land, including track and civil works, approximately 21.3 hectares of property acquisition and a level crossing at the intersection with Brolgan Road west of Parkes.

1.2 Noise and Vibration Assessment

Technical Report 5 – Noise and Vibration Assessment was previously prepared and formed part of the Environmental Impact Statement for the Parkes to Narromine section. The main outcomes of Technical Report 5 – Noise and Vibration Assessment are as follows:

- Operational airborne noise levels were anticipated to exceed the relevant trigger levels for 28 residential receivers;
- Operational vibration impacts with consideration to human comfort and structural damage were not considered likely; and
- A number of potential mitigation options may be effective to control operational airborne noise, subject to being shown to be reasonable and feasible for the Project.

In the Technical Report 5 – Noise and Vibration Assessment, the operational airborne noise modelling was undertaken using the Nordic Prediction Method TemaNord 1996:524, as implemented in the computer prediction software CadnaA version 4.6.

1.3 Operational Noise and Vibration Review

As part of the Conditions of Approval for the Project (refer to Section 1.5), an Operational Noise and Vibration Review shall be prepared to confirm the final mitigation measures for operational noise and vibration that would be implemented. The present document is a draft Operational Noise and Vibration Review, to be submitted to the NSW Department of Planning and Environment.

The present Operational Noise and Vibration Review highlights the following:

- Changes to the predicted airborne noise levels identified in the Environmental Impact Statement, a result of the re-modelling of the “no build” scenario in line with the methodology described in Section 4.4;
- Changes to the predicted airborne noise levels identified in the Environmental Impact Statement, a result of the detailed design process;
- Changes to the vibration levels identified in the Environmental Impact Statement as a result of the detailed design process;
- All reasonable and feasible noise and vibration mitigation measures consistent with the Rail Infrastructure Noise Guideline;

- Specific physical and other mitigation measures for controlling noise and vibration at the source and at the receiver including location, type and timing of implementation of the proposed operational noise and vibration mitigation measures;
- Process to seek feedback from directly affected receivers on the final mitigation measures proposed in the review; and
- Procedures for the management of operational noise and vibration complaints.

This Operational Noise and Vibration Review was prepared by a suitably qualified and experienced noise and vibration engineer with over 17 years of experience in noise and vibration and Member of the Australian Acoustical Society. It has been internally peer reviewed by a suitably qualified and experienced noise and vibration engineer with over 18 years of experience in noise and vibration and Member of the Australian Acoustical Society. The Quality Management System employed conforms with the requirements of ISO 9001:2015. In addition, this Operational Noise and Vibration Review has also been externally peer reviewed by a suitably qualified and experienced noise and vibration engineer engaged by ARTC as a Technical Advisor.

This Operational Noise and Vibration Review was prepared in consultation with the NSW Environment Protection Authority (EPA), with a copy of the Operational Noise and Vibration Review provided to the EPA on 26 February 2019. Email feedback from the EPA was provided to ARTC on 29 March 2019, following this a teleconference was held between the EPA and ARTC on 7 May 2019. The teleconference discussed and addressed the EPA's initial comments resulting in an agreed consensus that the proposed methodology outlined above (i.e. revision activities undertaken in accordance with Condition E13) was an acceptable methodology to assess those receivers at year 2040. No other comments or issues were raised by the EPA and EPA confirmed acceptance of the Operational Noise and Vibration Review by email on the 31 July 2019.

1.4 Standards and Guidelines

The following standards and guidelines were used to conduct this assessment:

- Australian Standard AS 1055:2000 – Acoustics - Description and Measurement of Environmental Noise;
- Australian Standard AS 2377:2002 – Methods for the Measurement of Railbound Vehicle Noise;
- Australian Standard AS 2670:1990 – Evaluation of Human Whole Body Exposure to Vibration;
- British Standard BS 6472:1992 – Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz);
- British Standard BS 7385-2:1993 – Evaluation and measurement for vibration in buildings - Guide to damage levels from groundborne vibration;
- Transport for NSW – Rail Noise Database (T MU EN 00002 TI), 2015;
- Nordic Prediction Method - TemaNord 1996:524 (Nordic Noise Group), 1996;
- Nordic Rail Prediction Method – Kilde Report 130 (Ringheim), 1984;
- NSW Department of Environment and Conservation – Assessing Vibration: A Technical Guideline, 2006;
- NSW Environment Protection Authority – Noise Policy for Industry, 2017;
- NSW Environment Protection Authority – Rail Infrastructure Noise Guideline, 2013;
- NSW Roads and Traffic Authority - Environmental Noise Management Manual, 2001; and
- United States of America Department of Transportation Federal Transit Administration – Transit Noise and Vibration Impact Assessment Manual, 2006.

1.5 Conditions of Approval

The Conditions of Approval for the Project have been prepared by the NSW Department of Planning and Environment in May 2018. Conditions E11, E12 and E13 are relevant to operational noise and vibration management. Compliance with these conditions is detailed in Table 1.1.

Table 1.1 Conditions of Approval

Condition	Description	Section in report
E11	The Proponent must prepare an Operational Noise and Vibration Review to confirm noise and vibration control measures that would be implemented for the operation of the CSSI. The Operational Noise and Vibration Review must be prepared in consultation with the EPA and impacted sensitive receivers. Where barrier options (e.g. noise walls or mounds) are proposed to be implemented, consultation must also be undertaken with the relevant councils.	This report
E11 a)	Confirm the appropriate operational noise and vibration objectives and levels for adjoining development, including existing sensitive receivers	Section 3
E11 b)	Confirm the operational noise and vibration predictions based on the final design. Confirmation must be based on an appropriately calibrated noise model (which has incorporated additional noise monitoring, and concurrent traffic counting, where necessary for calibration purposes).	Section 4.6 Section 4.5
E11 c)	Identify sensitive receivers at which the criteria set out in the Rail Infrastructure Noise Guideline (EPA, 2013) are predicted to be exceeded once the CSSI is operational and in 2040.	Section 4.6 Appendix C
E11 d)	Review the suitability of the operational noise mitigation measures identified in the EIS and Submissions Report and, where necessary, investigate and identify additional feasible and reasonable noise and vibration mitigation measures required to achieve the noise criteria outlined in the Rail Infrastructure Noise Guideline.	Section 4.2 Section 4.3 Section 4.7
E11 e)	Describe the final suite of noise and vibration mitigation measures that will be implemented, including the timing of implementation in accordance with Condition E12.	Section 4.8 Section 6
E11 f)	Include a consultation strategy to seek feedback from directly affected landowners on the noise and vibration mitigation measures.	Section 6
E11 g)	Procedures for the management of operational noise and vibration complaints.	Section 7
E12	Operational noise mitigation measures identified in Condition E11 (such as at-property architectural treatments) that will not be affected by construction works, must be implemented within six months of the commencement of construction, or at other times during construction to minimise construction noise impacts, unless an alternative timeframe is agreed by the Secretary	Not a design condition, but linked to Section 6
E13	Within 12 months of, and at 10 years after, the commencement of operation of the CSSI, the Proponent must undertake monitoring of operational noise to compare actual noise performance of the CSSI against the noise performance predicted in the review of noise mitigation measures required by Condition E11. The Proponent must prepare an Operational Noise Compliance Report (ONCR) to document this monitoring.	Not a design condition but linked to Section 4.5 and to Section 4.7.

2 Sensitive Receivers

2.1 Existing Receivers

The sensitive receivers situated within the Project area are all residential dwellings, except for receivers within Peak Hill, where there is a mixture of residential and non-residential receivers. Peak Hill is a township situated approximately halfway between Parks and Narromine. The Newell Highway traverses Peak Hill in a north south direction and runs parallel to the rail track. However, the two major transport arteries are separated by approximately 1 km.

The non-residential receivers within Peak Hill comprise three schools, two churches, one park and six active recreational areas, such as sports fields. Majority of the residential receivers within the Project area are isolated, apart from a significant number of receivers situated within the Peak Hill township, which are grouped together on the eastern side of the rail track. There are also some sensitive receivers located on the western side of the rail track in Peak Hill, however, these are generally isolated receivers.

The Technical Report 5 – Noise and Vibration Assessment which forms part of the Environmental Impact Statement identified the sensitive receivers situated along the proposed and the existing rail alignment. The present assessment has included the same receivers identified in Technical Report 5 – Noise and Vibration Assessment.

Appendix A shows a list of the receivers assessed in this report, as well as a figure showing the locations of the assessed receivers.

No heritage listed structure, utilities or vibration sensitive infrastructure have been identified within the vicinity of the rail corridor.

2.2 Proposed Receivers

A search of the Parkes Shire Council DA tracking database[1] was undertaken on multiple occasions between the dates of August 2018 and 25 July 2019 to identify and capture any new sensitive receivers that may occur within the areas surrounding the alignment. The results of the search identified the following new developments/properties that occur within close proximity to the alignment:

- 111 Boori Street, Peak Hill (Shed) – August 2018. This development is for a carport/garage structure and is not determined to be a new sensitive receiver;
- 169 Calwell Street, Peak Hill (Shed) – October 2018. This development is for a carport/garage structure and is not determined to be a new sensitive receiver;
- 3951 Newell Highway, Peakhill (Shed) – April 2019. This development is for a shed-related structure and is not determined to be a new sensitive receiver;
- 339 Brolgan Road, Parkes (Commercial Development). This development is for an office building used for commercial purpose and is not determined to be a new sensitive receiver; and
- Boori Street, Peak Hill (specific location unknown) (Detached House) – April 2019. This potentially noise sensitive development is located approximately 640m away from the alignment, where all criteria are predicted to be achieved.

Finally, it is noted that informal consultation has occurred sporadically between ARTC and the general public (i.e. areas outside of the identified impacted noise zones) throughout the project but have not resulted in the identification of any further sensitive receivers based upon the current noise modelling results.

[1] www.my.parkes.nsw.gov.au/T1PRProd/WebApps/eProperty/P1/eTrack/eTrackApplicationSearch.aspx

2.3 Existing Noise Environment

The acoustic environment along the rail corridor is relatively quiet, with the alignment situated in a very rural area or situated along smaller roads, such as Railway Parade south of Peak Hill and Peak Hill Railway Road south of Narromine. The rail corridor is generally located 2 to 5 km from Newell Highway; however, for a 4 km stretch south of Peak Hill, it is located 350 m to 500 m from Newell Highway, which is the smallest separation distance between the rail corridor and Newell Highway in the study area.

Noise measurements were not undertaken as part of this assessment, however, Technical Report 5 – Noise and Vibration Assessment identified that the rating background noise level at the 17 monitoring locations, were between 18 and 32 dBA. This indicates that the acoustic environment is quiet, which is expected in a rural area.

Technical Report 5 – Noise and Vibration Assessment identified an equivalent ambient noise level at the 17 monitoring locations between 47 to 59 dBA during the daytime and between 42 to 56 dBA during the evening and night time periods. This indicates that the acoustic environment is not constantly quiet, rather, the acoustic environment is influenced by non-steady sources such as road and rail traffic.

3 Project Criteria

The operational noise and vibration criteria are described in the following sections.

3.1 Operational Airborne Noise Trigger Levels

The main section of the Project is an existing and operational rail corridor proposed to be upgraded. The upgraded alignment is located within the existing and operational rail corridor, and as such, it is considered as a redevelopment of an existing rail line, for the purpose of the operational noise assessment.

The proposed Parkes North-West Connection is connecting two existing rail corridors. The alignment of the connection is outside both rail corridors, and therefore, is considered as a new rail line, for the purpose of the operational noise assessment.

The NSW Rail Infrastructure Noise Guideline defines airborne noise trigger levels for heavy rail for residential land uses as per Table 3.1. Triggers for non-residential receivers are provided in Table 3.2.

These numbers represent external or internal levels of noise that trigger the need for an assessment of potential noise mitigation measures to reduce noise levels from a rail infrastructure project.

For the majority of receivers assessed (453 receivers out of 463 total), the residential “Redevelopment of existing rail line” trigger levels have been applied. The ”New rail line development” trigger levels have been specifically applied at five residential receivers to the west of Parkes, being P2N_Rx1301, P2N_Rx1302, P2N_Rx1303, P2N_Rx1304 and P2N_Rx1305. Educational and places of worship trigger levels were applied at P2N_EDUx0001, P2N_EDUx0002, P2N_EDUx0003, P2N_WORx0001 and P2N_WORx0002 and a 10 dB attenuation has been considered between external and internal noise levels for these receivers.

Table 3.1 Airborne noise trigger levels for residential land uses

Type of development	Noise trigger level, dBA (external) [1]	
	Day 7am-10pm	Night 10pm-7am
New rail line development	Predicted rail noise levels exceed:	
	60 $L_{Aeq,15hr}$ or 80 L_{AFmax}	55 $L_{Aeq,9hr}$ or 80 L_{AFmax}
Redevelopment of existing rail line	Development increases existing $L_{Aeq,period}$ [2] 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 $L_{Aeq,15hr}$ or 85 L_{AFmax}	60 $L_{Aeq,9hr}$ or 85 L_{AFmax}

Note 1: Noise trigger levels are assessed at 1m in front of the most affected building façade.
Note 2: $L_{Aeq,period}$ means $L_{Aeq,15hr}$ for the day-time period and $L_{Aeq,9hr}$ for the night-time period.

Table 3.2 Airborne noise trigger levels for sensitive land uses other than residential

Other sensitive land uses	Noise trigger level, dBA (when in use)	
	New rail line development	Redevelopment of existing rail line
	Resulting rail noise levels exceed:	Development increases existing rail noise levels by 2 dB or more in L_{Aeq} for that period and resulting rail noise levels exceed:
Schools, educational institutions and child care centres	40 $L_{Aeq,1hr}$ internal	45 $L_{Aeq,1hr}$ internal
Places of worship	40 $L_{Aeq,1hr}$ internal	45 $L_{Aeq,1hr}$ internal
Hospital wards	35 $L_{Aeq,1hr}$ internal	40 $L_{Aeq,1hr}$ internal
Hospitals other uses	60 $L_{Aeq,1hr}$ external	65 $L_{Aeq,1hr}$ external
Open space – passive use (e.g. parkland, bush reserves)	60 $L_{Aeq,15hr}$ external	65 $L_{Aeq,15hr}$ external
Open space – active use (e.g. sports field, golf course)	65 $L_{Aeq,15hr}$ external	65 $L_{Aeq,15hr}$ external

3.2 Operational Ground-Borne Trigger Levels

The NSW Rail Infrastructure Noise Guideline defines ground-borne noise trigger levels for heavy rail for residential and sensitive land uses as per Table 3.3.

Table 3.3 Ground-borne noise trigger levels for residential and sensitive land uses

Sensitive land use	Time of day	Internal noise trigger levels, dBA
		Development increases existing rail noise levels by 3 dBA or more and resulting rail noise levels exceed
Residential	Day 7am-10pm	40 L_{ASmax}
	Night 10pm-7am	35 L_{ASmax}
Schools, educational institutions, places of worship	When in use	40 – 45 L_{ASmax} (1)

Note 1: For schools, educational institutions and places of worship, the lower value of the range is most applicable where low internal noise levels are expected, such as in areas assigned to studying, listening and praying.

3.3 Operational Vibration Trigger Levels

Operational vibration can lead to:

- Loss of amenity due to perceptible vibration, termed human comfort;
- Cosmetic building damage (and structural damage in extreme cases); and
- Impacts on the condition and structural integrity of key infrastructure.

3.3.1 Human Comfort

Vibration in buildings associated with rail network operations, can cause disturbance and complaints in a similar manner to noise. The NSW Rail Infrastructure Noise Guideline refers to the NSW Environment Protection Authority separate vibration guideline, *Assessing vibration: a technical guideline* to quantify acceptable levels of intermittent vibrations for human comfort. The guideline defines preferred and maximum values of vibration dose for intermittent vibration. The preferred values are considered to be the triggers which initiate an assessment of feasible and reasonable mitigation measures under the NSW Rail Infrastructure Noise Guideline.

Table 3.4 Vibration trigger levels for human comfort

Location	Vibration dose values for intermittent vibration, $m/s^{1.75}$	
	Day 7am-10pm	Night 10pm-7am
Critical areas	0.10	0.10
Residences	0.20	0.13
Offices, schools, educational institutions and places of worship	0.40	0.40
Workshops	0.80	0.80

3.3.2 Cosmetic Damage

Th Rail Infrastructure Guideline does not provide any trigger levels for the assessment of cosmetic building damage. There is also no Australian Standard that provides guidance for cosmetic damage due to vibration. Therefore, the evaluation of vibration in relation to cosmetic damage to buildings from vibrational energy is proposed to be conducted in accordance with *British Standard BS 7385-2:1993 - Evaluation and measurement for vibration in buildings - Guide to damage levels from groundborne vibration*. Table 3.5 presents the guideline limits for cosmetic damage for short term vibration.

Table 3.5 Vibration trigger levels for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 – 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The guide values in Table 3.5 relate predominantly to transient vibration, which does not give rise to resonant responses in structures and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3.5 may need to be reduced by up to 50%.

Cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. It is described as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks, and separation of partitions or intermediate walls from load bearing walls. If there is no significant risk of cosmetic building damage, then structural damage is not considered a significant risk and is not assessed.

4 Airborne Noise Impacts

4.1 Outcomes of the Environmental Impact Statement

The outcomes of the Environmental Impact Statement are detailed in the Technical Report 5 – Noise and Vibration Assessment. These are summarised below:

- The previous Environmental Impact Statement identified that the operational airborne noise levels were anticipated to exceed the relevant trigger levels for 28 residential receivers; and
- The Environmental Impact Statement also outlined various mitigation options that potentially could control operational airborne noise, subject to being shown to be reasonable and feasible for the Project.

4.2 Potential Mitigation Measures for Airborne Noise

The Rail Infrastructure Noise Guideline defines feasible and reasonable as follows:

A feasible mitigation measure is a noise mitigation measure that can be engineered and is practical to build, given project constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (e.g. changing timetable schedules) to achieve noise reduction.

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

- *Noise impact;*
- *Noise mitigation benefits;*
- *Cost effectiveness of noise mitigation; and*
- *Community views.*

The potential airborne noise mitigation measures and the associated impacts are discussed individually below.

- Track realignment:
  - The Parkes to Narromine section of the Project is a 99 km brownfield section with limited opportunities to upgrade the track alignment. For the Parkes North-West Connection and where possible for the Parkes to Narromine section, the proposed alignment has considered the distance between the track and the receivers and maximised this distance where feasible within the design constraints. The proposed track layout represents a reasonable and feasible mitigation measure already implemented as part of the design and model;
- Minimise change of grade:
  - The Parkes to Narromine section of the Project is a 99 km brownfield section with limited opportunities to change the grade. For the Parkes North-West Connection and where possible for the Parkes to Narromine section, the propose alignment has considered the impact of the change of grade on the airborne noise emissions and seeks to minimise the grade to below 1% where feasible within the design constraints. The proposed track layout represents a reasonable and feasible mitigation measure already implemented as part of the design and model;
- Straighten curves:
  - All curve radii are greater than 500 m, which is expected to reduce the squealing noise, and therefore, have a positive effect in terms of minimising the overall noise emissions. The proposed track layout represents a reasonable and feasible mitigation measure already implemented as part of the design and model;

- Reduce maximum operating speeds:
  - The purpose of the Project is to increase capacity and operating speed on the Parkes to Narromine section. Therefore, it is not considered reasonable to decrease the maximum operating speed;
- Reduce number of trains or trains lengths:
  - The purpose of the Project is to increase capacity on the Parkes to Narromine section. Therefore, it is not considered reasonable to decrease the number of trains or the train length;
- Restrict operating hours:
  - The purpose of the Project is to increase capacity on the Parkes to Narromine section. Therefore, it is not considered reasonable to restrict the operating hours;
- Minimise rail/wheel roughness:
  - Wheel and rail roughness will be controlled as part of the locomotive / wagon maintenance regime, and track maintenance regime (such as rail grinding). This represents a reasonable and feasible mitigation measure;
- Track lubrication:
  - Track lubrication may be beneficial for curves with very tight radii. The alignment has been modified to increase the curve radius and therefore, track lubrification is therefore not likely to provide any significant noise reduction;
- Rail dampers:
  - Rail dampers are pre-formed elements attached to the sides of the rails. They improve the rail's ability to decay noise-inducing vibrations resulting from the rolling contact between the wheel and rail. These are only efficient for wagon noise, which are dominated by wheel / rail interaction noise. Rail dampers require maintenance and may therefore result in significant maintenance cost over the lifetime of the rail track. The potential effectiveness of rail dampers is investigated in this assessment;
- Noise barriers:
  - Noise barriers are an effective noise mitigation option. However, noise barriers are relatively expensive and are therefore typically only considered reasonable where the noise barrier provides noise mitigation for groups of closely spaced receivers. Noise barriers can be constructed of various materials; some cheaper construction materials such as timber fences are likely to require more frequent maintenance compared to more expensive noise barriers such as steel and concrete. The potential effectiveness of noise barriers has been investigated in this assessment; and
- At property treatments:
  - At property treatments are also an effective noise mitigation option, particularly where noise sensitive receivers are sparsely located resulting in noise barriers being an unreasonable mitigation option. At property treatments may consist of short sections of noise barriers installed adjacent to the building to provide shielding locally to the affected receiver, upgrades to the building façade such as retrofitted glazing, acoustically treated ventilation paths and installation of insulation, or a combination of both. Generally, at property treatments are considered as a last resort once all other mitigation options have been exhausted. At property treatments have been investigated in this assessment.

4.3 Summary of the Design Changes for the Detailed Design Process

The alignment and velocity profile have been updated for the detailed design of the Project; airborne noise levels are affected by the design changes. Therefore, the 3D noise model incorporates the following:

- Track realignment. The final alignment has optimised the distance between tracks and receivers where feasible within the design constraints;

- Minimise change of grade. The final alignment has optimised the change of grade and minimised the grade below 1% where feasible within the design constraints;
- Straighten curves. All curves have been straightened to increase the radii above 500 m, which has a positive effect in terms of reducing wheel squeal and noise emissions; and
- Minimise rail/wheel roughness. It is assumed rail roughness will be managed by ARTC and rolling stock wheels will be maintained by train operators.

4.4 Development of a New Noise Model

4.4.1 Noise Modelling Methodology

The existing junctions and proposed alignment were modelled in SoundPLAN Version 7.4 using the Nordic Rail Prediction Method (Kilde Report 130). Model parameters and correction factors are detailed in Table 4.1.

Table 4.1 Noise model parameters and correction factors

Parameter	Value
Ground effect	Soft ground between rail and receiver (ground absorption set to 1)
Curve	< 300m: +8 dBA for L_{Aeq} and +21 dBA for L_{Amax} 300m to 500m: +3 dBA for L_{Aeq} > 500m: No correction
Track	Continuous welded rail: No correction Mechanical or uneven glued jointed: +3 dBA over 10m Slab track: +2 dBA
Turnout / Crossing	Fixed nose turnout: +6 dBA over 10m Diamond crossing: +10 dBA over 10m
Bridges	Open transom, fabricated steel web, no side screens: +10 dBA Open transom, fabricated web forming side screens: +8 dBA Ballasted, steel box girder, no side screens: +4 dBA Ballasted, fabricated web forming side screens: +4 dBA Concrete trackbed, concrete box girder, no side screens: +3 dBA Ballasted, concrete span, no side screens: No correction Concrete trackbed, concrete box girder, concrete side screens: -2 dBA Ballasted, concrete span, concrete side screens: -5 dBA
Façade	For free-field measurements, the measured level is to be adjusted by +2.5 dB to account for the façade reflection effect
Meteorological conditions	Zero wind speed Zero degrees Celsius per 100 metre atmospheric temperature gradient 15 degrees Celsius temperature 70 per cent relative humidity

It is noted that a soft ground has been modelled between the rail and receivers. Whilst not in accordance with the requirements of the NSW Rail Infrastructure Noise Guideline, this has been implemented in accordance with the Nordic Rail Prediction Method (Kilde Report 130) that states that soft surfaces are considered to be “cultivated fields and grass-covered ground”, which is representative of the land surrounding the alignment. This ground absorption coefficient is also consistent with the coefficient used in the Technical Report 5 – Noise and Vibration Assessment prepared for the approved Environmental Impact Statement.

4.4.2 Noise Modelling Scenarios and Inputs

4.4.2.1 Years

The Rail Infrastructure Noise Guideline states that noise trigger levels shall be assessed for opening year and for a design year typically 10 years after opening. The construction of the Parkes to Narromine section is expected to be finalised in 2020, which is therefore considered the actual opening year.

The entire Inland Rail project is divided into various sections each having their own approval process. The various sections are proposed to be constructed within a different timeframe between 2018 and 2025. Year 2025 is therefore the year of "through connection" where the overall traffic through the whole alignment will start to increase. Year 2040 is the design year.

In summary, four different years have been modelled:

- 2016 – For model verification, the "no build" scenario. The existing Parkes to Narromine section is modelled with the existing traffic and existing conditions for model verification;
- 2020 – Represents the year in which the rail track construction is complete and permits existing operations to reoccur. A representative version of the 100% Detailed Design rail track alignment is modelled with the existing rail traffic volumes but with increased rail speeds;
- 2025 – Represents the opening year when the whole of Inland Rail will be connected and operational (i.e. double-stacked, 1800m long trains). The proposed Parkes North-West Connection and redeveloped Parkes to Narromine section are modelled with the proposed traffic and conditions for Year 2025; and
- 2040 – Project design year. The proposed Parkes North-West Connection and redeveloped Parkes to Narromine section are modelled with the proposed traffic and conditions for Year 2040.

4.4.2.2 Rail Traffic

Existing and proposed rail traffic considered for the noise modelling of airborne operational noise are detailed in Table 4.2 and Table 4.3.

Table 4.2 Existing and proposed daily rail traffic - Parkes to Narromine section

Train type	Year 2016 and 2020		Year 2025		Year 2040	
	No build	Build	No build	Build	No build	Build
Grain	2.12	2.12	2.12	2.12	2.12	2.12
Mineral	0.43	0.43	0.43	0.43	0.43	0.43
Link	0.43	0.43	0.43	0.43	0.43	0.43
Intercapital	-	-	-	8.42	-	18.02

Table 4.3 Proposed daily rail traffic - Parkes North-West Rail Connection

Train type	Year 2016 and 2020		Year 2025		Year 2040	
	No build	Build	No build	Build	No build	Build
Grain	-	-	-	-	-	-
Mineral	-	-	-	-	-	-
Link	-	-	-	-	-	-
Intercapital	-	-	-	2.86	-	4.57

It is not possible to provide a schedule for train movements for year 2025 (commencement of operations) or year 2040 (future operations). Train operators are not able to enter into contracts with potential customers until Inland Rail is complete in year 2025 and therefore ARTC is unable to schedule train movements.

Train movements have therefore been evenly distributed across 24 hours in line with the approach defined in the Technical Report 5 – Noise and Vibration Assessment prepared for the approved Environmental Impact Statement. This is considered a reasonable and conservative approach to estimating the movement of trains across the day and night period. The daytime period in the NSW Rail Infrastructure Noise Guideline is 15 hours and the night time period is only 9 hours creating the distribution of 62.5% of train movements during the day, and 37.5% during the night – this means that every hour has the same number of trains.

To provide further confidence that the distribution of trains used in this assessment is appropriate, ARTC reviewed traffic movements on the Hunter Valley Coal Network over a 12-month period. This identified that 62% of coal train movements occurred during the day-time period and 38% occurred at night.

4.4.2.3 Trains Lengths

The length of the existing Link, Grain and Mineral trains on the Parkes to Narromine section and of all trains on the Parkes North-West Connection and redeveloped Parkes to Narromine section are listed in Table 4.4.

Table 4.4 Train lengths

Train type	Year 2016 and 2020		Year 2025 and 2040	
	No build	Build	No build	Build
Grain	710	710	710	710
Mineral	450	830.6	450	830.6
Link	450	830.6	450	830.6
Intercapital	-	-	-	1800

4.4.2.4 Trains Speeds

The maximum speed of the existing Link, Grain and Mineral trains on the Parkes to Narromine section and the proposed maximum speed of all trains on the Parkes North-West Connection and redeveloped Parkes to Narromine section are listed in Table 4.5.

Table 4.5 Train speeds

Train type	Rail section	Year 2016	Year 2020	Year 2025 and 2040
Grain	P2N[1]	80 km/h	80 km/h	80 km/h
Mineral	P2N	80 km/h	80 km/h	80 km/h
Link	P2N	100 km/h	115 km/h	115 km/h
Intercapital	P2N	-	-	115 km/h
Intercapital	PNWC[2]	-	-	80 km/h

Note 1: P2N denotes Parkes to Narromine

Note 2: PNWC denotes Parkes North-West Connection

Existing speed restrictions have been included in the noise model, it is understood that the existing speed restrictions are a result of bends and at grade crossings. Figure 4.1 and Figure 4.2 shows the modelled train speeds for year 2016.

Figure 4.3 and Figure 4.4 shows the modelled train speeds for year 2020.

Figure 4.5 and Figure 4.6 shows the modelled train speeds for year 2025 and 2040.

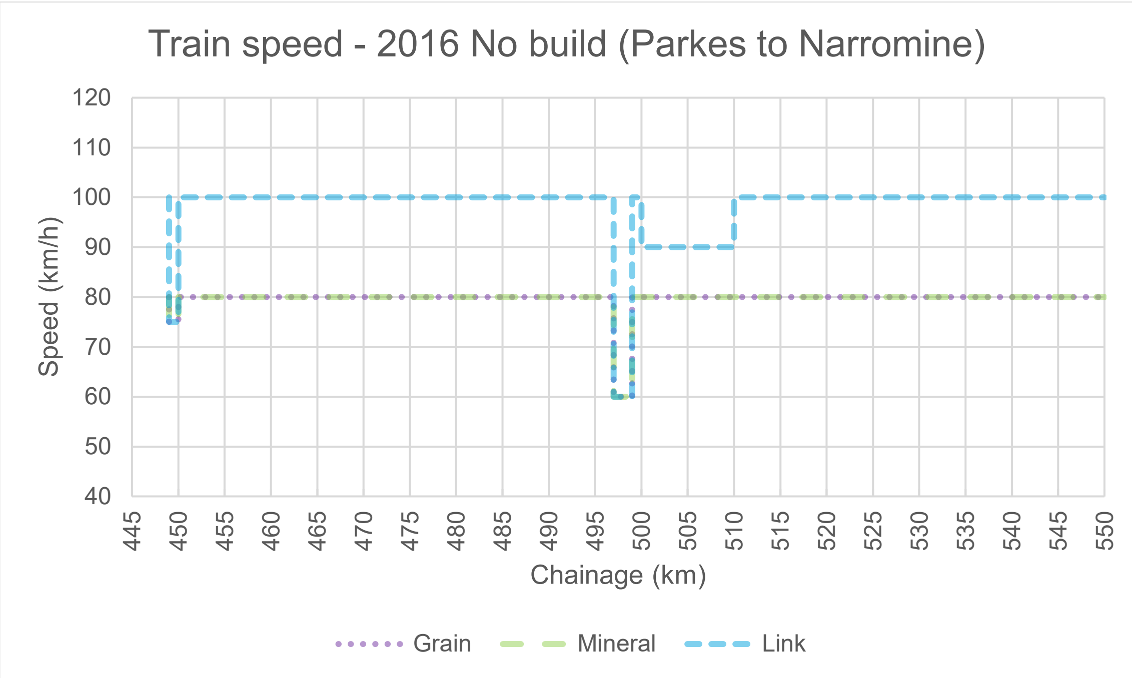


Figure 4.1 Existing speed profile of the Parkes to Narromine rail section

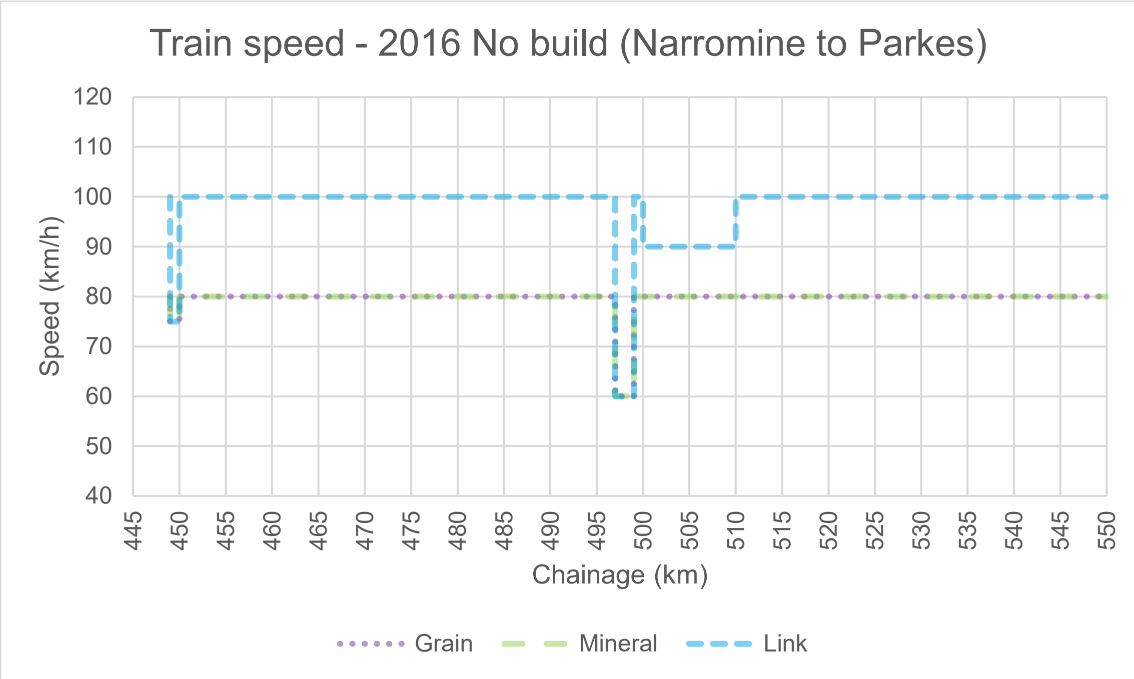


Figure 4.2 Existing speed profile of the Narromine to Parkes rail section

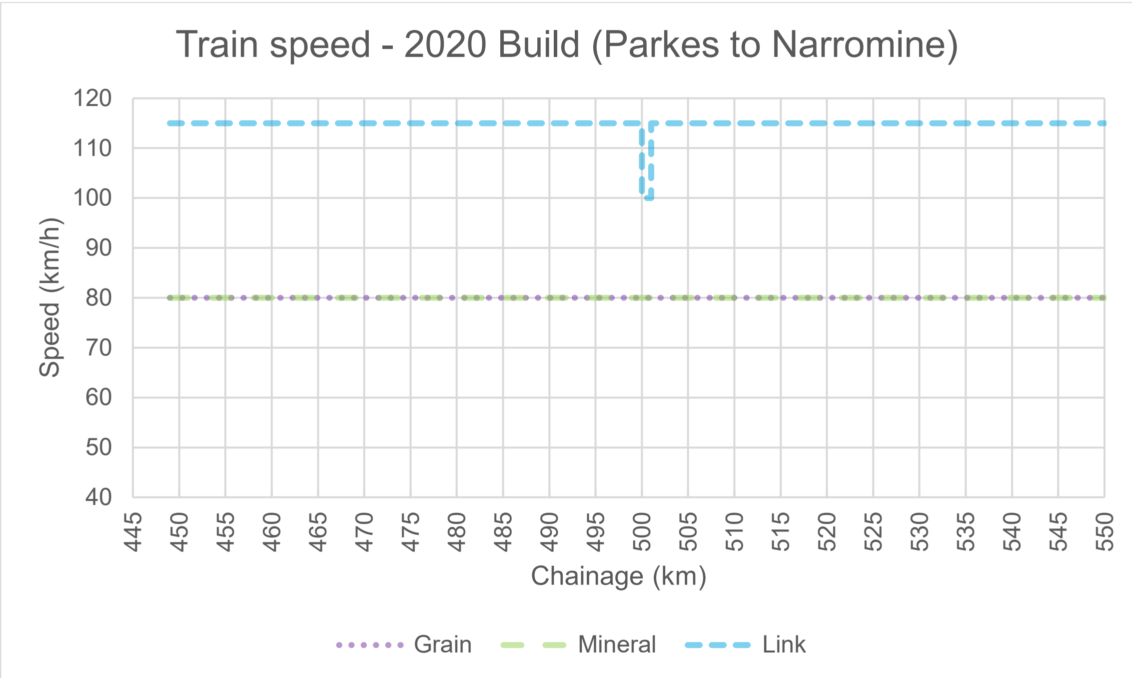


Figure 4.3 Modelled speed profile of the Parkes to Narromine rail section year 2020

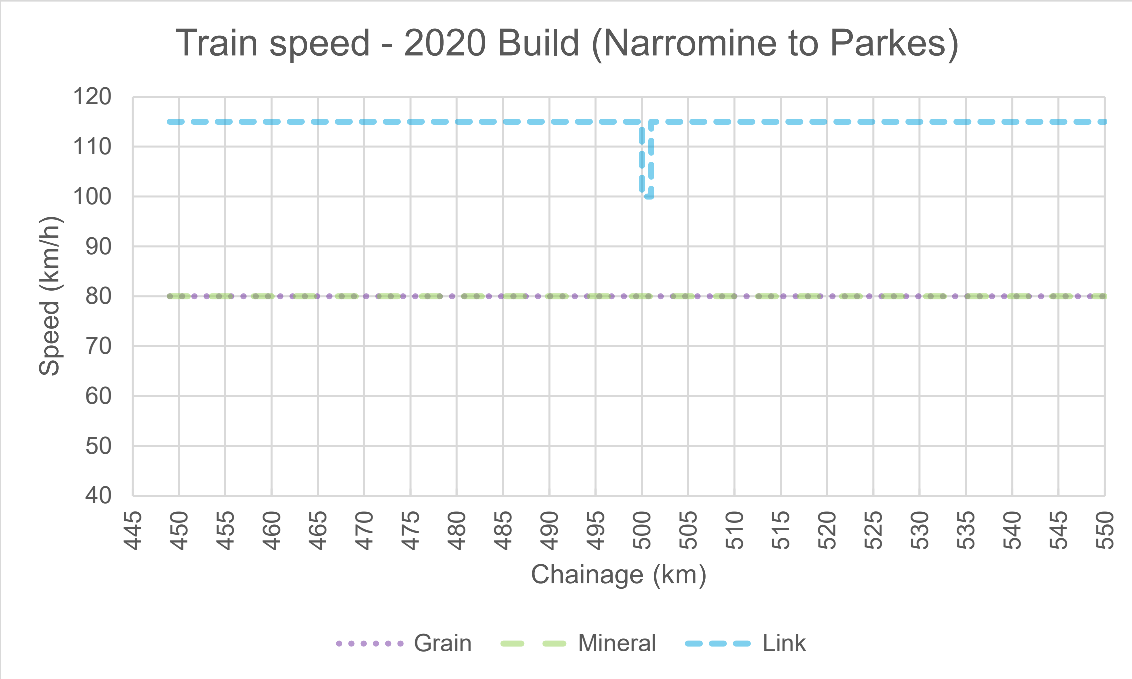


Figure 4.4 Modelled speed profile of the Narromine to Parkes rail section year 2020

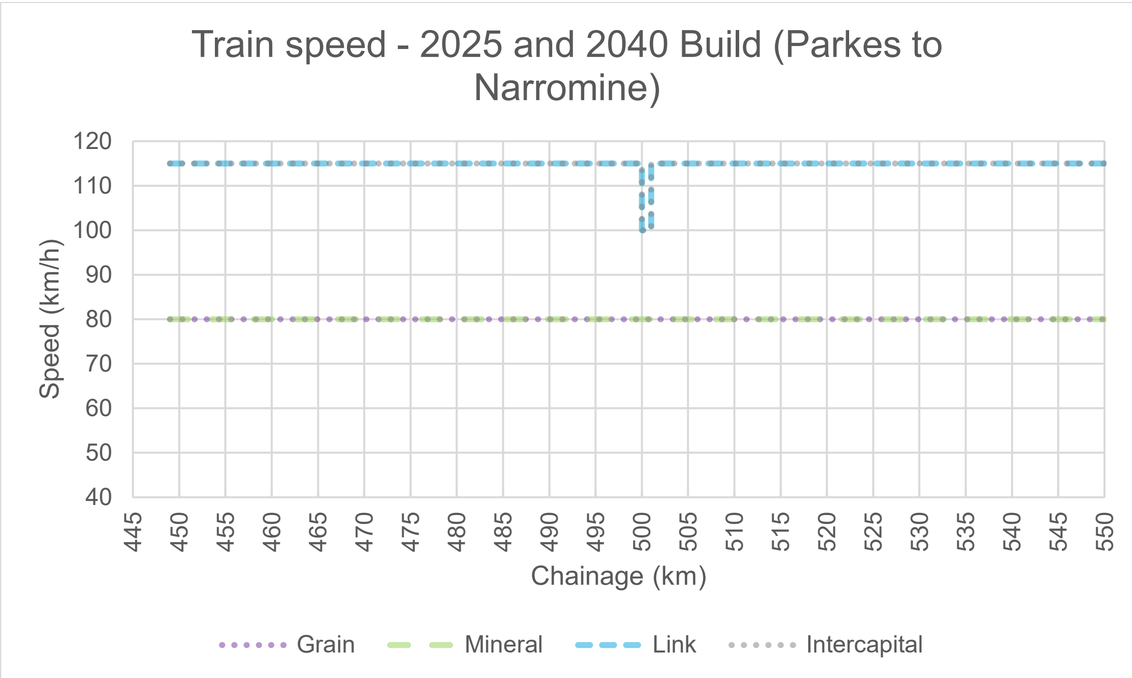


Figure 4.5 Modelled speed profile of the Parkes to Narromine rail section year 2025 and 2040

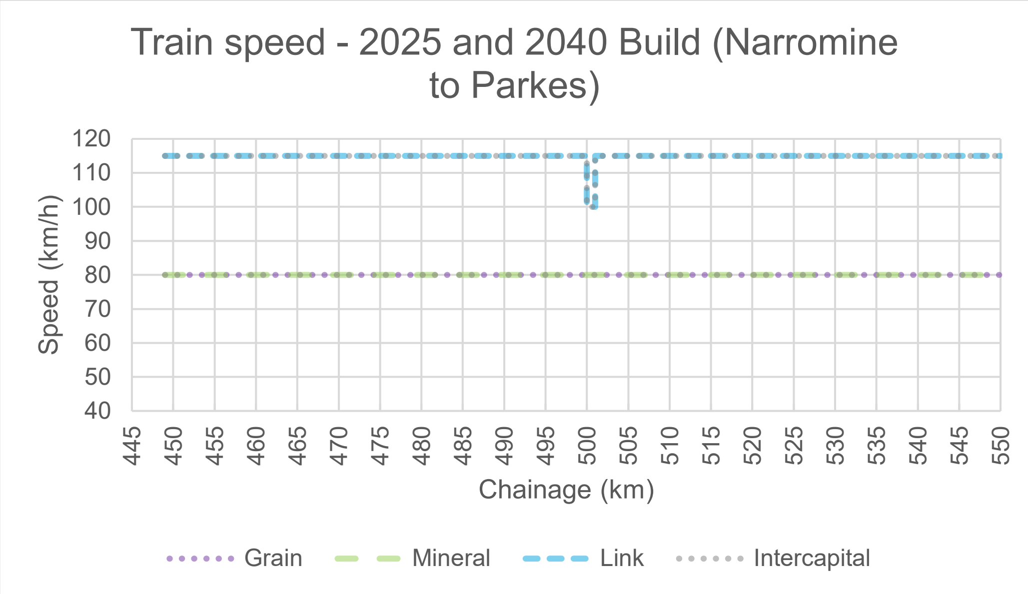


Figure 4.6 Modelled speed profile of the Narromine to Parkes rail section year 2025 and 2040

4.4.2.5 Trains Noise Source Levels

The train noise source levels for the Parkes North-West Rail Connection and the redeveloped Parkes to Narromine section are detailed in Table 4.6.

Table 4.6 Train noise source levels

Train type	Loco class	Number of locos	SEL at 100m dB/m				L_{Amax} at 10m			
			5th percentile	Linear average	Log average	95th percentile	5th percentile	Linear average	Log average	95th percentile
Grain	82	2	67.1	72.3	74.3	78.7	74.1	80.7	83.1	87.9
Mineral	TT	1	68.2	75.7	77.9	82.6	76.1	84.3	86.8	91.7
Link	TT	1	68.2	75.7	77.9	82.6	76.1	84.3	86.8	91.7
Intercapital	NR	3	69.8	74.7	75.9	79.9	78.8	83.8	85.1	89.4
Wagons	-	-	-	-	77.2	-	-	82.0	-	87.2

The 5th percentile, linear average, logarithmic average and 95th percentile values presented for SEL and L_{Amax}, are considered to be approximately equivalent to Notch Settings 2, 4, 6, and 8 respectively, for locomotives. Particularly, no speed corrections are made when determining the locomotive source level and the following guidance is applied:

- The 5th percentile is used for downhill segments where dynamic braking does not occur. Downhill segments are considered to have a negative grade > 1%;
- The linear average is used for flat sections with speeds up to 70 km/h;
- The logarithmic average is used for flat sections with speeds greater than 70 km/h; and
- The 95th percentile is used for uphill segments, downhill segments where dynamic braking is expected and any other area where the loco would reasonably be expected to utilise a high notch setting, for example pass-by loops where the loco would be expected to accelerate away. Uphill segments are considered to have a positive grade > 1%.

For wagons:

- Speed correction is applied for all source levels to adjust from the 80km/h data presented in Table 4.6 to the relevant speed for each section of track being modelled;
- The SEL linear average level (SEL 77.2 dB) is used when determining the source level for prediction of L_{Aeq};
- The linear average (L_{Amax} 82 dB) is used for determination of typical L_{Amax} levels; and
- The 95th percentile (L_{Amax} 87.2 dB) is used for determination of 1 in 20 L_{Amax} levels.

4.4.2.6 Crossing Loops and Level Crossings

Train horn noise was modelled at 90 dBA at 100 m. For L_{Aeq} calculations, horns are assumed to be used for a maximum duration of 1s per pass-by at the public level crossings only.

Idling noise at crossing loops was modelled at 70 dBA at 15 m. For L_{Aeq} calculations, it is assumed 25% of the total trains are using each loop, and each of these trains are idling 20 minutes at each loop and all loops are used equally.

4.5 Validation of Rail Noise Levels for the No Build Scenario (Year 2016)

A noise model was developed for the Environmental Impact Statement and is detailed in the Technical Report 5 – Noise and Vibration Assessment. This model was validated using existing pass-by rail noise levels measured in 2016. Further noise monitoring was not considered necessary for the Operational Noise and Vibration Review, noting the very low sample size of existing traffic and the sufficient data captured as part of the Environmental Impact Statement.

A maximum of three trains per day (i.e. a 24-hour period) currently use the existing railway. Following the completion of Inland Rail, train volumes will increase significantly to 11 trains per day in 2025 and 21 trains per day in 2040. In addition, new rollingstock (Inland Rail Intercapital trains) will be introduced to the rail network and will control noise impacts at receivers. The contribution of the new rollingstock, the dominant noise sources for year 2025 and year 2040, cannot be validated.

As detailed in Section 4.4, a dedicated noise model has been developed for the detailed design stage of the Project. Predicted noise levels for the rail noise component (i.e. excluding noise sources such as idling locomotives and train horns) for day and night periods from the noise model developed for this Operational Noise and Vibration Review have been manually compared with the predicted levels for the no build scenario for year 2016 detailed in the Technical Report 5 – Noise and Vibration Assessment. Receivers located at various distances from the existing tracks, not influenced by noise from level crossings and crossing loops, and located in the vicinity of the previous noise monitoring locations, have been selected to compare the rail noise component of the model. The results of the comparison show a good agreement between both models.

In accordance with condition E13 of the Conditions of Approval, operational noise will be monitored within 12 months of the commencement of operations to compare actual noise performance with predicted levels detailed in this report. This monitoring will enable comparison of the actual noise performance (including the new rollingstock) with the predicted levels and subsequent validation of the noise model. The outcomes will be detailed in the Operational Noise Compliance Report.

4.6 Predicted Noise Levels for the Build Scenarios (Years 2020, 2025 and 2040)

The noise model developed for the Operational Noise and Vibration Review for the Project was used to predict noise levels to the noise sensitive receivers within the Project area. Appendix B shows predicted airborne noise contours for year 2016 (the no build scenario), 2020, 2025 and 2040. Appendix B shows the noise contours for both the predicted L_{Aeq} and the predicted L_{Amax} for all the assessed years.

The table in Appendix C presents the predicted noise levels for all the assessed receivers for year 2016, 2020, 2025 and 2040. The table also shows the applicable criteria for the assessed receivers as well as the receivers exceeding the noise trigger level and therefore eligible for noise mitigation.

The table also indicates that the noise trigger level will not be exceeded at any of the noise sensitive receivers in year 2020. The table indicates that one receiver is predicted to exceed the noise trigger level for the daytime period in year 2025 and that a total of eight receivers are predicted to exceed the noise trigger level during the night time in year 2025. It is seen that the predicted increase in traffic volumes on the rail track in year 2025 results in greater emitted rail noise, which accounts for the requirements for noise mitigation at the most exposed noise sensitive receivers.

It also indicates that the predicted increased traffic volumes for year 2040 results in additional receivers eligible for noise mitigation. For year 2040 four receivers are eligible for noise mitigation during the daytime whereas 20 receivers are eligible for mitigation during the night time. The table also indicates that the noise sensitive receivers predicted to exceed the noise trigger level all are residential receivers.

Further analysis of the 20 receivers exceeding the night time noise trigger level in year 2040 identifies that seven of the receivers are isolated receivers and that the remaining 13 receivers are located close to the rail track in Peak Hill. Six of the 13 receivers are located on the western side of the rail track in Peak Hill and the other seven are located on the eastern side of the rail track in Peak Hill.

4.7 Mitigation Options

As outlined in Section 4.2, three mitigation options have been considered to mitigate the noise levels emitted from the rail track. These mitigation options are discussed further in the following sections.

It is noted that a total of eight receivers are predicted to exceed for year 2025 and further twelve receivers are predicted to exceed for year 2040. With exception of two locations in Peak Hill where a maximum of three receivers are within 300m, all other receivers are scattered along the alignment and mitigation measures can be considered independently from each other.

At this stage of the project, mitigation measures are designed and will be implemented for receivers predicted to exceed the noise trigger levels for year 2025 but will also be designed to meet the noise trigger levels for year 2040 (i.e. the noise mitigation will be future-proofed).

In accordance with Condition of Approval E13, ARTC will undertake monitoring of operational noise 10 years after the commencement of operations and compare actual noise levels against the noise levels in year 2040 predicted in this document. The noise model prepared for this Operational Noise and Vibration Review will be recalibrated using actual rail traffic volumes and noise measurements and will be used to re-predict noise levels for all receivers along the alignment. Where residual impacts are predicted for year 2040, additional reasonable and feasible noise mitigation measures will be designed and implemented as per condition E13 (f).

4.7.1 Rail Dampers

Rail dampers are attached to the rail tracks to provide a faster decay of vibrations in the rail resulting in less emitted audible noise. Rail dampers only provide noise attenuation from the rolling contact between the wheel and rail, hence noise from engines is not attenuated.

A research paper from 2010 titled: “Rail Dampers – The First Australian Field Trial” by Andrew Parker and Conrad Weber identified a reduction in noise levels of 1 to 1.5 dBA on the rolling stock in NSW. The paper identified that the Australian trackform is relatively stiff compared to the European trackform and that rail dampers therefore only showed relatively low noise reduction compared to European tests where 4 to 5 dBA noise reductions have been measured.

To investigate the potential effectiveness of rail dampers all wagons in the noise model were applied with a 1.5 dBA noise reduction for a 1 km rail section adjacent to each of the sensitive receivers eligible for consideration of noise mitigation.

The noise model predicted a decrease by approximately 1 dBA at the affected noise sensitive receivers. The full 1.5 dBA noise reduction was not achieved as engine noise remains unaffected by the noise attenuation provided by the rail dampers.

Table 4.7 shows the predicted noise levels with included rail dampers for a 1 km stretch of rail track near receivers eligible for noise mitigation. Only the eight noise sensitive receivers eligible for noise mitigation for year 2025 for the unmitigated scenario have been included in Table 4.7. However, noise levels have been predicted for year 2025 and year 2040.

Table 4.7 Predicted noise levels with the inclusion of rail dampers

Receiver	Predicted Noise Level L_{Aeq}, dBA Year 2025 with inclusion of rail dampers	Compliance with night time noise trigger level	Predicted Noise Level L_{Aeq}, dBA Year 2040 with inclusion of rail dampers	Compliance with night time noise trigger level
P2N_Rx0213	60	**Yes**	64	**No**
P2N_Rx0248	61	**No**	64	**No**
P2N_Rx0260	62	**No**	65	**No**
P2N_Rx0272	66	**No**	69	**No**
P2N_Rx0283	59	**Yes**	63	**No**
P2N_Rx0297	60	**Yes**	64	**No**
P2N_Rx0380	62	**No**	66	**No**
P2N_Rx0464	62	**No**	65	**No**

Table 4.7 shows that a noise reduction of 1 dBA is unlikely to provide sufficient noise reduction to achieve compliance with the noise trigger levels for year 2040. For this reason, rail dampers are not considered to be a reasonable mitigation measure.

4.7.2 Noise Barriers

The SoundPLAN module “Wall Design” was used to determine the required noise barrier sizes and height to achieve compliance at the eight noise sensitive receivers eligible for noise mitigation for year 2025. The noise model identified that eight noise barriers are required for these eight isolated receivers.

Table 4.8 shows the minimum required noise barrier sizes to achieve compliance at the eight noise sensitive receivers eligible for noise mitigation for year 2025.

Table 4.8 Minimum required noise barrier sizes to achieve compliance

Barrier Name	Wall Height (m) (1)	Wall Length (m)	Wall Area (m^2)	Noise barrier designed to protect receiver	Other receivers exceeding for year 2040 benefiting from the noise barriers designed to protect receivers exceeding for year 2025
Barrier 1	5	317	1585	P2N_Rx0464	
Barrier 2	5	320	1600	P2N_Rx0380	P2N_Rx0323
Barrier 3	3.5	300	1050	P2N_Rx0297	P2N_Rx0323

Barrier Name	Wall Height (m) [1]	Wall Length (m)	Wall Area (m^2)	Noise barrier designed to protect receiver	Other receivers exceeding for year 2040 benefiting from the noise barriers designed to protect receivers exceeding for year 2025
Barrier 4	4	390	1560	P2N_Rx0283	P2N_Rx0281, P2N_Rx0285 and P2N_Rx0287
Barrier 5	5	232	1160	P2N_Rx0272	
Barrier 6	3.5	691	2419	P2N_Rx0260	
Barrier 7	3.5	735	2573	P2N_Rx0248	
Barrier 8	3	812	2436	P2N_Rx0213	

Note 1: Indicative height. The height of the finished barrier will be influenced by the materials it is constructed from.

Despite achieving compliance with the trigger levels for year 2040 at the eight receivers under investigation, each of these eight noise barriers is designed to protect the amenity of a single isolated receiver, and as such, is not considered a reasonable mitigation measure.

It is noted that the noise barriers required for the eight receivers under investigation also benefit to 4 additional receivers predicted to exceed the noise trigger levels for year 2040.

4.7.3 At Property Treatment

As rail dampers and noise barriers are not considered reasonable, at property treatment has been considered for the eight noise sensitive receivers eligible for noise mitigation for year 2025.

At property treatment typically consists of upgrades to the façades impacted by rail noise. Façade upgrades may include double glazing for the windows, increased thickness of the cladding and or insulation in cavity walls. At property treatment may also include an upgrade of the property fence.

Architectural acoustic treatment can generally be expected to provide between 3 and 20 dBA internal noise reduction, depending on the dominant type of railway noise source in that location and the existing type of building façade construction. Architectural acoustic treatment is most effective for rolling noise and wheel squeal noise whereas the effectiveness of architectural acoustic treatment is limited for low-frequency noise such as train idling noise, which is not a primary noise source for the eight receivers under investigation.

Retrofitting an existing property to reduce noise can be a difficult process. A determination on whether a treatment is feasible and reasonable/practicable should be made initially based on the condition of the building. Poorly maintained buildings (e.g. broken windows, holes in walls) or properties where internal access is restricted or unsafe (e.g. hoarding) may not be considered eligible for an architectural treatment.

Each house is different, and an acoustic consultant will be engaged to provide advice on treatment for each individual dwelling. This is further discussed in Section 6.

4.8 Final Mitigation Measures

The following table summarises the noise mitigation measures considered for the Project and for the eight receivers eligible for noise mitigation for year 2025. It is noted that as discussed in Sections 4.7.1 and 4.7.2, rail dampers and noise barriers are not considered reasonable for any of the eight receivers under investigation, and therefore, at property treatment has been investigated.

Table 4.9 Final mitigation measures

Mitigation option	Location	Feasible mitigation test	Reasonable mitigation test	Adopted / Disregarded
Mitigation at the source				
Track realignment	Project	Limited opportunity	Yes	Yes
Change of grades	Project	Limited opportunity	Yes	Yes
Straighten curves	Project	Yes	Yes	Yes
Reduce operating speeds	Project	Yes	No	No
Reduce number of trains	Project	Yes	No	No
Reduce trains length	Project	Yes	No	No
Restrict operating hours	Project	Yes	No	No
Minimise rail/wheel roughness	Project	Yes	Yes	Yes
Track lubrication	Project	Yes	No	No
Rail dampers	Eight receivers	Yes	No	No
Mitigation of the transmission path				
Noise barriers	Eight receivers	Yes	No	No
Mitigation at receiver				
Architectural treatment	Eight receivers	Yes	Yes	Yes
Upgrade of property fences	Eight receivers	Yes	Yes	Yes

5 Ground-Borne Noise and Vibration Impacts

5.1 Outcomes of the Environmental Impact Statement

The outcomes of the Environmental Impact Statement are detailed in the Technical Report 5 – Noise and Vibration Assessment. These are summarised below:

- Operational vibration impacts with consideration to human comfort and structural damage are not considered likely.

5.2 Potential Mitigation Measures for Ground-Borne Noise and Vibration

The potential ground-borne and vibration mitigation measures and the associated impacts are discussed individually below.

- Track realignment:
  - The Parkes to Narromine section of the Project is a 99 km brownfield section with limited opportunities to upgrade the track alignment. For the Parkes North-West Connection and where possible for the Parkes to Narromine section, the proposed alignment has considered the distance between the track and the receivers and maximised this distance where feasible within the design constraints. The proposed track layout represents a reasonable and feasible mitigation measure already implemented as part of the design and model;
- Reduce maximum operating speeds:
  - The purpose of the Project is to increase capacity and operating speed on the Parkes to Narromine section. Therefore, it is not considered reasonable to decrease the maximum operating speed;
- Minimise rail/wheel roughness:
  - Wheel and rail roughness will be controlled as part of the locomotive / wagon maintenance regime, and track maintenance regime (such as rail grinding). This represents a reasonable and feasible mitigation measure; and
- Rail dampers:
  - Rail dampers are pre-formed elements attached to the sides of the rails. They improve the rail's ability to decay vibrations resulting from the rolling contact between the wheel and rail.

5.3 Summary of the Design Changes for the Detailed Design Process

The alignment and velocity profile have been updated for the detailed design of the Project and ground-borne noise and vibration levels are affected by the design changes. Therefore, the assessment incorporates the following changes:

- Track realignment. The final alignment has optimised the distance between tracks and receivers where feasible within the design constraints; and
- Minimise rail/wheel roughness. It is assumed rail roughness will be managed by ARTC and rollingstock wheels will be maintained by train operators.

5.4 Assessment

Ground-borne noise and vibration from the trains passing-by have been assessed using the General Assessment methodology described in the United States of America Department of Transportation Federal Transit Administration - Transit Noise and Vibration Impact Assessment Manual, 2006.

The basic approach for the General Assessment is to define a curve that predicts the overall ground-surface vibration as a function of distance from the source, then apply adjustments to these curves to account for factors such as vehicle speed, rail conditions, building type, and receiver location within the building.

5.4.1 Ground Surface Vibration Level

The base curve for locomotive powered freight trains at 50 mph is provided in Figure 10-1 of the Federal Transit Administration manual. It is reproduced in Figure 5.1 below (Source: United States of America Department of Transportation Federal Transit Administration - Transit Noise and Vibration Impact Assessment Manual, 2006).

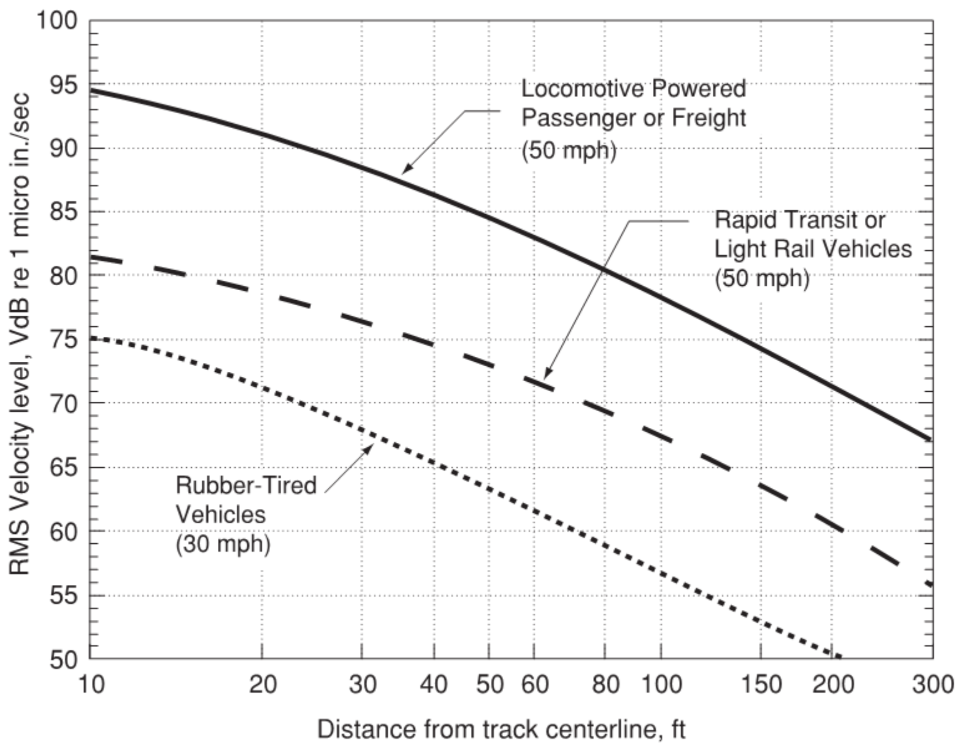


Figure 5.1 Generalised ground surface vibration curves

The following adjustments are made:

- +3 VdB to account for train speed of 115 km/h (vibration level is proportional to 20 x log (speed / reference speed));
- +8 VdB to account for stiff primary suspensions. Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. This correction is usually included when the primary suspension has a vertical resonance frequency greater than 15 Hz; and
- -5 VdB to account for coupling to building foundation for wood frame houses.

The adjusted curve for locomotive powered freight trains at 115 km/h and converted into units relevant for Australia is provided in Figure 5.2.

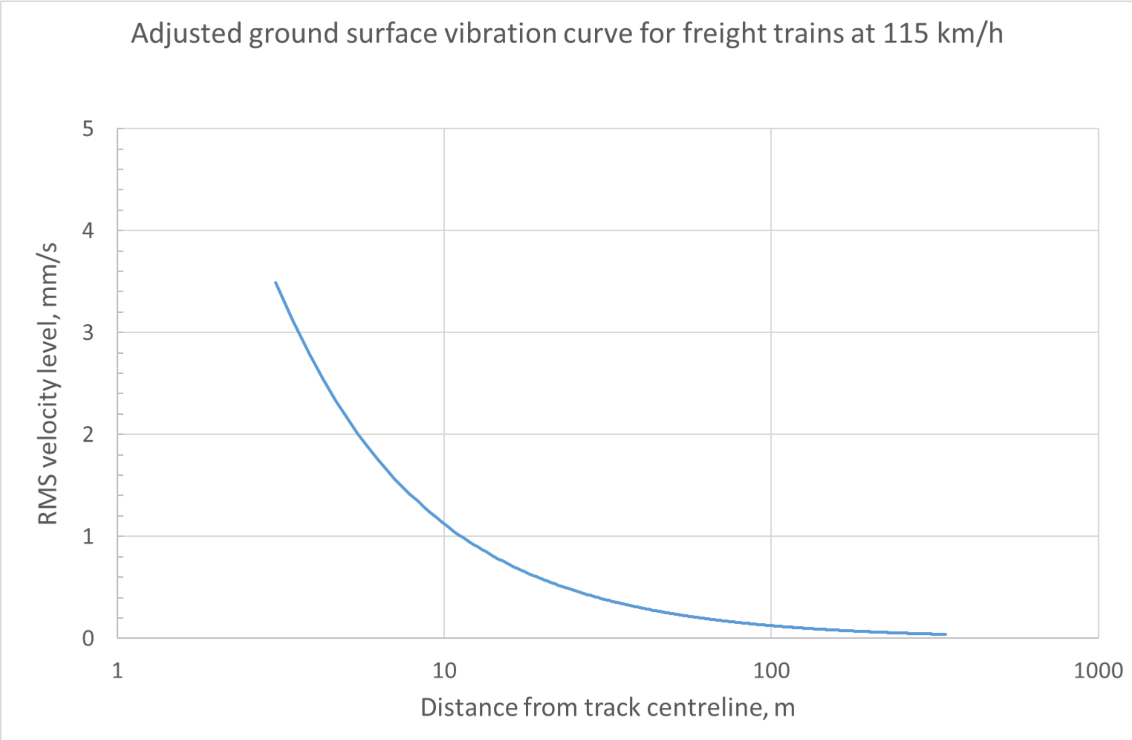


Figure 5.2 Adjusted ground surface vibration curve for freight train at 115 km/h

5.4.2 Ground-Borne Noise Levels

At the nearest and most exposed receiver located at 45 m from the track, the adjusted Roads and Maritime Services (RMS) velocity level is estimated to be approximately 0.27 mm/s or 80 VdB re: 1 micro inch/s. Assuming the peak frequency of ground vibration is lower than 30 Hz, which is the case for most surface tracks, the ground-borne noise at the nearest receiver is predicted to be lower than 30 dBA, which complies with the trigger levels listed in Table 3.3.

It is noted that ground-borne noise levels exceeding 40 dBA are expected at the nearest receiver with trains having worn wheels, worn tracks or corrugated tracks and as such, the tracks and wheels roughness is required to be maintained by ARTC and the train operators.

5.4.3 Vibration Levels for Human Comfort

The trigger levels for human comfort are expressed as a Vibration Dose Value providing a cumulative descriptor of the vibration level received during a given period.

In accordance with Appendix B2 of Assessing vibration: a technical guideline and British Standard BS 6472:1992, eVDV can be determined using the RMS velocity value as follows:

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

With the train traffic volumes, speeds and lengths provided in Table 4.2, Table 4.4 and Table 4.5, the eVDV at the nearest receiver is predicted to be 0.11×10^{-3} $m/s^{1.75}$ which complies with the trigger levels listed in Table 3.4.

5.4.4 Vibration Levels for Cosmetic Damage for Non-Heritage Receivers

The nearest receiver is located at 45 m from the tracks. At this distance, the predicted RMS velocity level of 0.26 mm/s complies with the cosmetic damage trigger levels listed in Table 3.5.

6 Process to Seek Feedback

All feasible and reasonable mitigation measures to control noise at the source, and via the propagation path, have been implemented as part of the design. Feasible and reasonable mitigation measures to control noise at the receiver, i.e. at property treatment, are investigated to control the residual exceedances.

At property treatment is considered to provide adequate acoustic amenity for the eight noise sensitive receivers eligible for noise mitigation for year 2025. Table 6.1 summarises the receivers, the noise levels for 2016, the opening year 2020, the completion year 2025 and the design year 2040 as well as the greatest exceedance of the trigger levels. It is noted that day and night-time noise levels are predicted to be the same for each year.

Table 6.1 Noise sensitive receivers eligible for at property treatment

Receiver	Predicted Noise L_{Aeq}, dBA Year 2016	Predicted Noise L_{Aeq}, dBA Year 2020	Predicted Noise L_{Aeq}, dBA Year 2025	Predicted Noise L_{Aeq}, dBA Year 2040	Exceedance of trigger levels, dBA
P2N_Rx0213	49	50	62	65	5
P2N_Rx0248	50	52	62	65	5
P2N_Rx0260	51	52	63	66	6
P2N_Rx0272	52	55	67	70	10
P2N_Rx0283	49	50	61	64	4
P2N_Rx0297	48	50	62	65	5
P2N_Rx0380	50	52	64	67	7
P2N_Rx0464	51	52	63	66	6

6.1 Design of At-Property Treatment

Formalised consultation was undertaken with each of the eight individual landowners by ARTC's project managers and specialist property consultants throughout 2019 to specifically identify what at-property treatments were available to the landowners and discuss the most appropriate options for each receiver. In certain cases, consultation within the landowners was also undertaken in conjunction with other government agencies who have planned upgrade works on their infrastructure within the same region.

The overall process, relevant to noise and vibration, includes the following actions:

- Conduct an initial site inspection at each of the affected properties eligible for at property treatment and visually inspect the building construction and condition (e.g. walls and roof construction, glazing type, glazing dimensions) and the surroundings;
- Consult with the affected property owners on their preferences for building treatment or the upgrade of the property fence;
- Based on the outcome of the consultation with the property owners and the initial site visit:
  - Assess the practicality of providing treatment; and
  - Conduct a preliminary cost assessment to determine whether upgrade of the property fence, building treatment or a combination of both might be offered; and
- Based on the practicability, the cost assessment and the property owners' preferences, identify specific treatment such as:
  - Fresh air ventilation systems and the sealing of wall vents;

  - Upgraded window and door seals;
  - Upgraded windows, glazing and doors;
  - Upgraded property fence; and
  - External screens.

The “at property” treatment scoping assessment has been conducted. The general building construction and condition (e.g. wall and roof construction, window and door locations) and the surroundings of the eight affected properties have been inspected. Following the site inspections, preliminary at-property treatments to mitigate the noise impacts associated with the Project were recommended. These at-property treatments mainly involve:

- Architectural treatments;
- A combination of property fence upgrades and architectural treatments for one property; and
- A property fence upgrade for one poorly maintained building deemed not suitable for architectural treatments.

The outcomes of these initial and follow up discussions with individuals occurring on 20 June, 17 July and 25 July 2019, resulted in the options outlined within the “At-property Treatment Scoping Assessment”, ranging from window upgrades (i.e. architectural treatments), planned installation of a noise wall (pending Council DA approval) and potential property acquisition. Due to the confidential nature of these discussions, additional information regarding acquisition is not discussed further within this document.

6.2 Next Steps

The following steps outside the scope of this Operational Noise and Vibration Review are being undertaken by ARTC and consist of the following:

- Conduct a second site inspection at all affected properties eligible for at property treatment with an architect and a builder; and
- Provide acoustic specification to support the design of specific treatment for each property;

In accordance with Condition E12 of the Conditions of Approval, at-property treatment will be implemented within six months of the commencement of construction.

At this stage of the consultation in which the preferred architectural treatments have been identified and agreed upon by ARTC and the landowners, but not yet installed (as the procurement of materials is currently out to tender), no consultation has occurred with any Council’s as of July 2019 regarding property modifications. It is important to note that the individual noise wall is located on private land and not proposed to be installed on any public land. It is recognised that the noise wall will require a Council DA to build as it is over 1.8m high, with this process to occur as soon as possible and will constitute the first instance of consultation with Council.’

6.3 Conclusion on At-Property Treatment Options

This Operational Noise and Vibration Review has outlined various operational noise mitigation measures which ARTC has assessed as being both reasonable and feasible. Any operational noise mitigation measures that are ultimately adopted will need to be discussed with property owners and agreed with them. To the extent that discussions with landowners indicate that proposed noise mitigation measures are not the preferred approach, it may be appropriate in some circumstances for ARTC to consider adopting other potential noise mitigation measures in consultation with the property owners on a case-by-case basis. Further, in the event that ARTC's current assessment of reasonableness and feasibility of potential mitigation measures is no longer current at the time at which the mitigation measures are proposed to be undertaken, it may be appropriate that different mitigation measures be adopted. ARTC proposes that any different mitigation measures would be discussed with the relevant landowners and will endeavour to reach agreement and that the carrying out of mitigation measures will be dependent on appropriate authorisation being obtained.

7 Management of Operational Noise and Vibration Complaints

Operational noise and vibration complaints will be managed as per the ARTC complaints process map provided in Figure 7.1, Figure 7.2 and Figure 7.3.

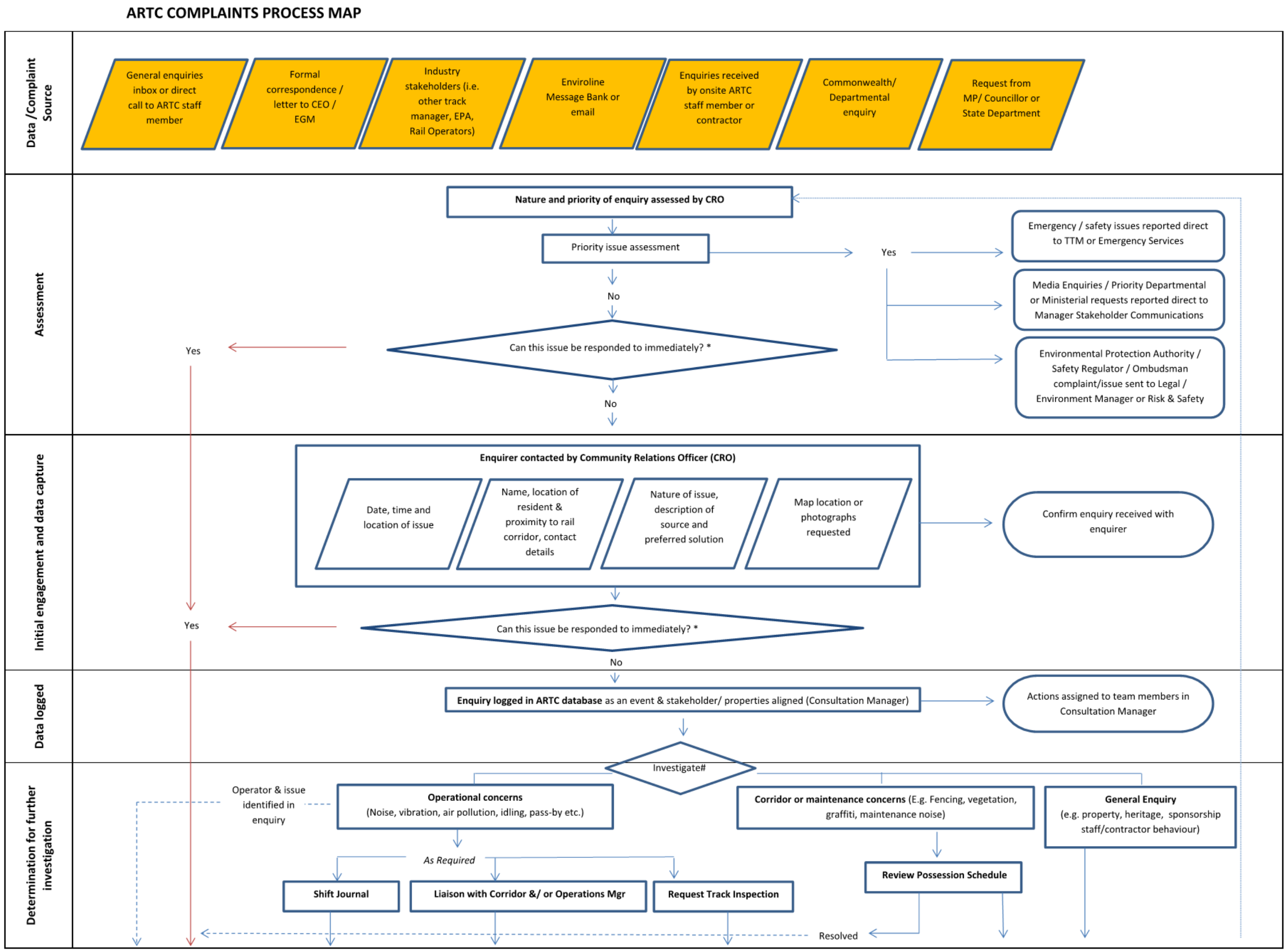


Figure 7.1 ARTC complaints process map (Part 1)

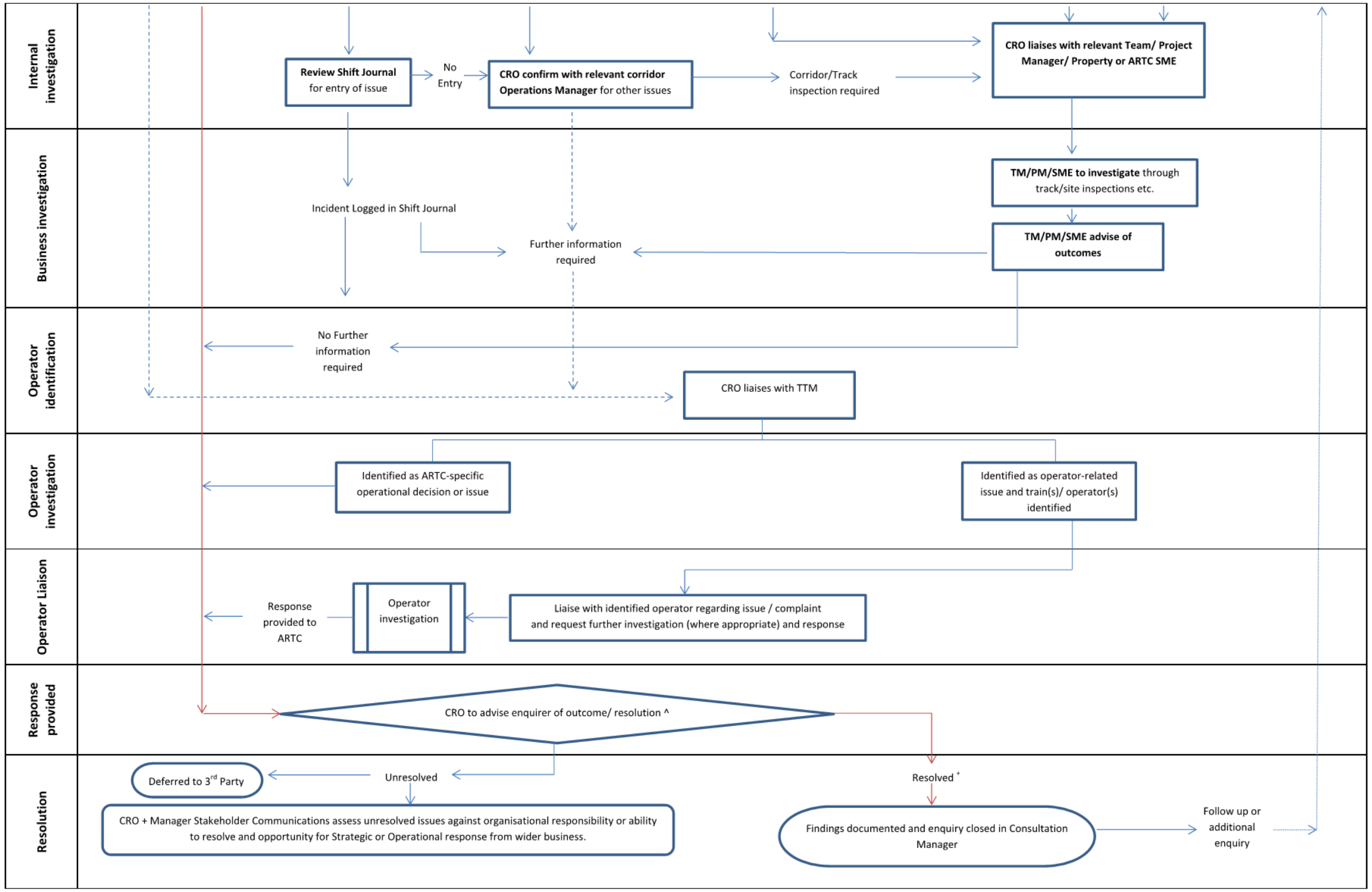


Figure 7.2 ARTC complaints process map (Part 2)

Notes to above

*Enquiries that can be immediately responded to without first stage investigation includes: not ARTC network related, issued already resolved, proforma response available, IT/employment/invoicing enquiry where automatic contact for these enquiries exist; if no contact details provided by the enquirer (e.g. in voicemail) the incident logged – investigation undertaken if required – but resolution will be the closure of the issue. Immediate response also often includes non-operational enquiries relating to ARTC website or a community group request.

As ARTC is licence holder for environmental concerns; operational reviews and track inspections receive priority over identification of train operators where the source of the complaint is unclear or where it may be a dual operational/corridor issue (e.g. wheel squeal)

^ CRO makes three attempts to contact enquirer (by phone/email or contact details provided and voicemails/or email are left). If no contact is able to be made, the item is noted and closed. Where incident not related to ARTC network or organisation, attempts are made to redirect the enquiry on the enquirers behalf, however ARTC does not take ownership of the enquiry and notes it as closed. For matters such as insurance claims, lease requests or issues relating to other sections of the business – the matter is logged and closed and deferred to relevant Business Group for further action / resolution.

+ Resolution is defined as ARTC identifying the source and detail of an issue reported to ARTC and providing a response to the enquirer including any action or steps ARTC can take with regards to the issue. This may or may not be to the satisfaction of the enquirer, but is in line with ARTC's responsibilities as an access holder or EPA licence condition.

→ Path of resolution

Acronyms CRO – Community Relations Officer TM – Team Manager PM – Project Manager
SME – Subject Matter Expert TTM – Train Transit Manager

Definitions

Term or acronym	Description
Complaint	A piece of feedback or comment received by ARTC outlining dissatisfaction in its actions, service, operations or impacts of operational activity on its network.
Contractor	External person, group, company or party engaged by ARTC to provide technical support, services, labour or work on ARTC's behalf.
Correspondence	A formal enquiry requesting information, seeking action or clarification – usually in written format, generally received from Ministers, official agencies, government departments
Enquiry	A piece of communication from a member of the community, on behalf of a group or a stakeholder – can include letters, emails, text messages, phone calls or verbally in-person.
Enquirer	Person who makes an enquiry, complaint or provides correspondence on behalf of themselves or another organisation.
Environmental Complaint	A concern relating to potential or known environmental incident including pollution, contamination, or damage to environmentally sensitive areas (common complaints include those relating to noise, dust and diesel emissions and vibration) –as defined by ARTC's requirements under EPL 3142.
Enviroline	The ARTC telephone line and email address that receives environmental complaints in accordance with ARTC's Environmental Protection Licence 3142 with NSW EPA. Phone Number: 1300 550 402 Email: enviroline@artc.com.au
Formal Enquiry or Correspondence	A formal piece of correspondence, usually written in a formal or official style that can be received from any individual or group, but are typically received from a legislative authority or body, Member of Parliament, Government Department or Agency (includes the Federal Department of Infrastructure and Transport).
Consultation Manager	The database for recording and managing general enquiries and Environmental complaints (including those received by Enviroline).
Government Agency or Department	Local, State or Commonwealth Government body or statutory authority, typically with legislative powers.
Informal enquiry	Enquiry received by an individual or individual on behalf of group often without set expectations around delivery or resolution and usually made verbally. Opposite to formal written correspondence that usually seeks explicit action.
Neighbour / Landowner	Landowner, tenant or property owner living near or adjacent to the ARTC rail corridor or ARTC premises or area of ARTC operations (such as provisioning centre or maintenance depot)
Priority or urgent request / complaint	Priority complaints generally come from three sources and are defined under two areas: 1. A complaint that has a high level of urgency required in response, that is driven by safety or reputational harm or has potential consequences that involve financial or legal liability or a non-compliance or legislative breach. Enquiries or requests by members of the Emergency Services should be considered as high priority in the first instance. 2. A request that has a pressing or immediate timeframe requiring information or response due to safety, operational, legislative, legal, media or Ministerial/Departmental requirements. The timeframes for providing a response or information to a priority request will be provided by the Community Relations Officer and will dependent on each individual request or enquiry.
Technical expert / Subject Matter Expert	Member of ARTC staff with specific skill set or technical expertise that they can provide in the event of an enquiry, complaint or receipt of formal correspondence which requires specialist information or advice
Unreasonable complainant or complaint	Challenging, vexatious, abusive or unreasonable enquiries or complaints from a single person or person(s) on behalf of a group.

Figure 7.3 ARTC complaints process map (Part 3)

8 Conclusion

A noise model was generated for the purpose of this Operational Noise and Vibration Review. Noise model outputs were compared to the outputs of the noise model prepared for the Environmental Impact Statement. Receivers located at various distances from the existing tracks, not influenced by noise from level crossings and crossing loops and located in the vicinity of the previous noise monitoring locations, were selected to compare the rail noise component of the model. The results of the comparison showed a good agreement between both models.

The noise model was updated to include a representative version of the 100% Detailed Design rail track alignment. Noise predictions were undertaken for the actual opening year (2020), for the "through connection" year (2025) and the design year (2040):

- Noise predictions for year 2020 identified no exceedances of the noise trigger level;
- Noise predictions for year 2025 identified one daytime exceedances of the noise trigger level and eight night-time exceedances of the noise trigger level; and
- Noise predictions for year 2040 identified four daytime exceedances of the noise trigger level and 20 night-time exceedances of the noise trigger level.

Three noise mitigation options were investigated to assess the residual impacts. The first mitigation option investigated was rail dampers. It was determined that the inclusion of rail dampers adjacent to each of the receivers eligible for noise mitigation would not sufficiently decrease the predicted noise levels to meet the noise trigger levels.

Noise barriers were also investigated. It was determined that eight noise barriers of various heights and lengths are required to achieve compliance with the noise trigger levels. Each of these barriers were designed to bring a single receiver into compliance with the noise trigger levels, and are therefore not considered reasonable.

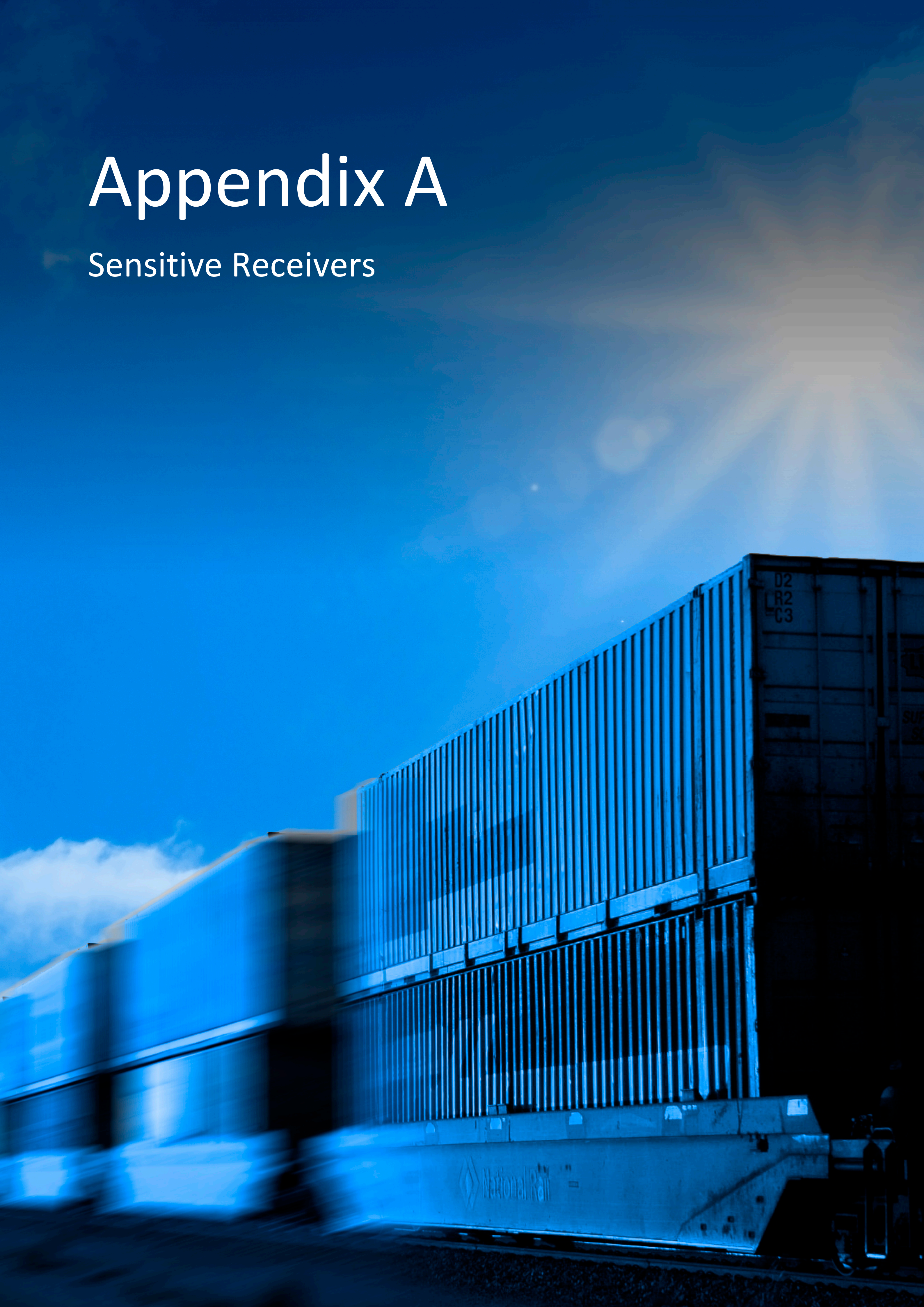
The final noise mitigation option that was investigated is at property treatment. It was determined that a stakeholder engagement consultant as well as an architect, a builder and an acoustic consultant should be engaged to provide advice on treatment for each individual dwelling as retrofitting an existing property to reduce noise depends on the existing structure and the condition of the property.

The eight dwellings predicted to exceed the noise trigger levels for year 2025 are exceeding by up to 10 dBA for year 2040, hence at property treatment is a feasible noise mitigation option. The general building construction and condition (e.g. wall and roof construction, window and door locations) and the surroundings of the eight affected properties have been inspected. Following the site inspections, at-property treatments to mitigate the noise impacts associated with the Project were recommended. These at-property treatments mainly involve:

- Architectural treatments;
- A combination of property fence upgrades and architectural treatments for one property; and
- A property fence upgrade for one poorly maintained building deemed not suitable for architectural treatments.

Appendix A

Sensitive Receivers



Appendix B

Predicted Airborne Noise Contours

Appendix C

Predicted Airborne Noise Levels