APPENDIX D

Operational Noise and Vibration Assessment

IR_1432

Technical and Approvals Consultancy Services: Narrabri to North Star

Operational Noise and Vibration Review Report

August 2019

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Prepared for

Australian Rail Track Corporation

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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	A logarithmic measurement scale. For sound pressure, is 20 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure. The decibel scale is a logarithmic ratio, so higher decibel levels have exponentially more sound energy.
EIS	Environmental Impact Statement
Equivalent Continuous Sound Level, L_{Aeq}	Noise descriptor. 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.
‘F’ (Fast) Time Weighting	Standardised time-weighting constant of 0.125 seconds. Where time-weighting is not specified, the fast time weighting is typically applied.
IRDJV	Inland Rail Design Joint Venture (WSP|MM DJV legal entity)
Maximum Noise Level, L_{AFmax}	Noise descriptor. The maximum Root-Mean-Square sound pressure level measured with sound level meter using the ‘A’ frequency weighting and the ‘F’ (Fast) time weighting.
Maximum Noise Level, L_{ASmax}	Noise descriptor. The maximum Root-Mean-Square sound pressure level measured with sound level meter using the ‘A’ frequency weighting and the ‘S’ (Slow) time weighting.
N2NS	Narrabri to North Star
Peak Particle Velocity, PPV	Vibration descriptor. Highest instantaneous particle velocity during a given time interval, measured in mm per second.
Rating Background Level	Noise descriptor. The single number background noise descriptor representing each assessment period (day/evening/night) over the whole monitoring period. Defined in the NSW Noise Policy for Industry (NSW EPA, 2017).
RMS	Roads and Maritime Services
‘S’ (Slow) Time Weighting	Standardised time weighting constant of 1 second.
Sound Exposure Level, SEL	Noise descriptor. 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	Noise descriptor. The basic unit of air borne noise measurement is the Sound Pressure Level. The pressures are converted to a logarithmic scale and expressed in decibels (dB).
Statistical Noise Levels, Ln	Noise descriptors which numerically describe the temporal characteristics of time-varying sound. They can be used to estimate the

	noise level of steady background noise or of other time varying components of a noise signal. For example: 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 often used to quantify the steady background noise level.
Vibration Dose Value, VDV	Vibration Descriptor. A vibration descriptor which considers frequency content, magnitude, duration, and total exposure time.
WSP|MM	WSP Australia | Mott MacDonald DJV trading as IRDJV

Executive Summary

The Narrabri to North Star Project is a section of the Inland Rail Programme which is proposed to be upgraded by Australian Rail Track Corporation (ARTC). The existing single bi-directional track was originally constructed for light traffic, running a variety of freight, grain and passenger trains. The upgrade of the existing railway forms part of the Inland Rail Programme, connecting Brisbane to Melbourne. The Inland Rail Programme is divided into multiple sections, each having their own approval process. The various sections are proposed to be constructed within different timeframes, commencing in 2019. The complete alignment is expected to be finalised in 2025, which is therefore the year of “through connection”.

From Narrabri Junction, the project area commences at Chainage 575km. The existing track extends up to Moree South, running parallel to the Newell Highway for about 93km, passing through the towns of Edgeroi, Bellata and Gurley. The track continues through the town of Moree and over the Mehi River, where there is a 1.5km greenfield re-alignment to remove the existing Camurra Hairpin. The total distance of this section is 13km. From Camurra, the track continues north within the existing corridor to North Star, a distance of approximately 80km.

A noise and vibration assessment was previously prepared for the Environmental Impact Statement (EIS) by GHD Pty Ltd. This Operational Noise and Vibration Review assesses operational rail noise, operational rail vibration, operational ground borne noise, and road traffic noise from the associated upgrade of Jones Avenue grade separation, in Moree. It 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.

Operational Rail Noise

Rail noise models were developed for existing alignment, the “through connection” year (2025), and the design year (2040), enabling noise mitigation design for the Project.

Predicted exceedances of the rail noise criteria were controlled by the L_{Aeq} noise descriptor, for the night time period as shown in the table below.

Table E.1 Predicted exceedances of the rail noise criteria

Receptor type	Year 2025	Year 2040
Residential	34	81
Educational	1	3
Worship	1	2
Passive recreation	0	1
Active recreation	0	0

Noise barriers and at-property treatment were considered in designing mitigation for exceedances of the noise criteria. Six noise barriers of various heights and lengths are required for noise mitigation. These are shown in Table 4.7. Barriers are located in areas such as townships, where receptors are closely spaced together. Where receptors are sparsely located, it is not considered feasible to mitigate criteria exceedances with noise barriers. The proposed noise barrier design reduces the number of receptors that are predicted to exceed the noise criteria to the numbers shown in the table below.

Table E.2 Proposed noise barrier design to reduce the number of receptors that are predicted to exceed the noise criteria

Receptor type	Year 2025	Year 2040
Residential	8	34
Educational	0	2
Worship	0	1
Passive recreation	0	0
Active recreation	0	0

It is recommended that receptors exceeding the noise criteria, with the proposed barrier design in place, are offered at-property treatment. These at-property treatments will mainly involve a combination of architectural treatments and property fence upgrades. This also applies to receivers, where it is not reasonable and feasible to place noise barriers. The assessment and design of at-property treatments is considered outside the scope of this Operational Noise and Vibration Review.

A stakeholder engagement consultant, architect, builder and an acoustic consultant should be engaged by ARTC to provide advice on at-property treatment for each individual dwelling. The efficacy of retrofitting noise treatment to existing properties to reduce noise impacts will depend on the existing structure and the condition of the property.

Operational Rail Vibration and Ground Borne Noise

An assessment of vibration and ground borne noise from railway pass-byes was undertaken using an approach based upon the US FTA rail vibration modelling methodology.

Both ground borne noise and ground borne vibration levels were predicted to be within the relevant criteria levels without the provision of any additional vibration mitigation.

Road Traffic Noise

A road traffic noise assessment was undertaken for the extension of Jones Avenue grade separation, in Moree. Jones Avenue is proposed to be extended as an overpass across the rail line, connecting with Tycannah Street.

Operational road traffic noise models were used to assess the noise levels with the road extension. The assessment was undertaken with an approach in line with the *NSW Road Noise Policy* and it was found that noise mitigation for the road extension was not necessary for 2020 and is not feasible or reasonable for a single marginal criterion exceedance in 2030.

1 Project Background

1.1 The Project

The Project refers to the Narrabri to North Star Inland Rail Project. The Narrabri to North Star Project is a brownfield section in northwest NSW within the Inland Rail Programme, extending from Narrabri Junction at kilometrage 575.000 and terminating at North Star approximately 186km north at kilometrage 760.460, at stop boards at the end of existing brownfield railway.

From Narrabri Junction, the existing track extends up to Moree South, running parallel to the Newell Highway for about 93km, passing through the towns of Edgeroi, Bellata and Gurley. The track continues through the town of Moree and over the Mehi River, where there is a 1.5km greenfield re-alignment to remove the existing Camurra Hairpin. The total distance of this section is 13km. From Camurra, the track continues north within the existing corridor to North Star, a distance of approximately 80km. The existing single bi-directional track was originally constructed for light traffic running a variety of freight, grain and passenger trains.

The key features of the project relevant to noise and vibration include:

- Upgrading approximately 186km of track, track formation, and culverts within the existing rail corridor;
- Constructing a 1.5km greenfield deviation at Camurra, to eliminate the existing hairpin curve;
- Realigning approximately 1.5km of the Newell Highway near Bellata, and constructing a new road overbridge above the rail corridor to cater for the required F plate double stacking clearance requirement;
- Constructing 5 new crossing loops at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo;
- Renewal/upgrade of existing turnouts on the main line. This includes 34 turnouts providing access to existing grain sidings etc.;
- Improvement works through Moree to minimise severance issues caused by the increased quantity and length of trains, including a new road over rail grade separation at the southern end of the town on Jones Avenue; and
- Upgrading, relocating or consolidating 86 level crossings on the existing brownfield alignment.

The project has been separated into three packages of work: Separable Package 1, Separable Package 2 and Separable Package 3. These are delineated by distance along the rail alignment:

- Separable Package 1 (entire alignment minus Separable Package 2) – Chainage 575 km through Chainage 666 km, and Chainage 681 km through Chainage 760 km;
- Separable Package 2 – Chainage 666 km through Chainage 681 km; and
- Separable Package 3 – Newell Highway Rail Overpass and Jones Avenue Grade Separation.

1.2 Noise and Vibration Assessment

Technical Report 5 – Noise and Vibration Assessment was previously prepared by GHD and formed part of the Environmental Impact Statement (EIS) for the Narrabri to North Star section.

In 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.

Operational vibration levels were predicted using the methodology outlined in the US Federal Transit Administration’s “Transit Noise and Vibration Impact Assessment” report. Predicted vibration levels using this methodology were compared to results of in-situ measurements of rail vibration to confirm the consistency of predicted levels with those measured in local conditions. Operational vibration levels predicted with this method were then converted to vibration descriptors compatible with the human comfort criteria.

The main outcomes of Technical Report 5 – Noise and Vibration Assessment are as follows:

- Operational rail airborne noise levels were anticipated to exceed the relevant trigger levels for:
  - 152 residential receivers;
  - 3 educational receivers;
  - 3 worship receivers;
  - 2 passive recreation receivers; and
  - 1 active recreation receiver;
- Operational vibration impacts with consideration to structural damage were not considered likely;
- Operational vibration impacts with consideration to human comfort were expected for 3 receivers;
- Operational road traffic noise impacts were not expected to adversely impact any sensitive receiver; and
- A number of potential mitigation options may be effective to control operational airborne noise and operational vibration, subject to being shown to be reasonable and feasible for the Project.

1.3 Operational Noise and Vibration Review

As per the recommendations in Technical Report 5 – Noise and Vibration Assessment, an Operational Noise and Vibration Review has been prepared to confirm the final mitigation measures for operational noise and vibration that would be implemented.

The Operational Noise and Vibration Review provides the following:

- Changes to the predicted airborne rail noise levels identified in the Environmental Impact Statement as 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 road and rail noise levels identified in the Environmental Impact Statement, as 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;
- Design of reasonable and feasible noise and vibration mitigation measures consistent with the Rail Infrastructure Noise Guideline and Road Noise Policy;
- Process to seek feedback from directly affected receivers on the final mitigation measures proposed in the review; and
- Procedures for the management of complaints regarding operational noise and vibration.

1.4 Standards and Guidelines

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

- Australian Standard AS 1055:2018 – 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 Department of Environment, Climate Change and Water – Road Noise Policy, 2011;
- NSW Roads and Maritime Services – Noise Criteria Guideline, 2015;
- NSW Roads and Maritime Services – Noise Mitigation Guideline, 2015;
- NSW Roads and Maritime Services – Noise Model Validation Guideline, 2018;
- NSW Roads and Traffic Authority - Environmental Noise Management Manual, 2001;
- ARTC Noise Modelling Methodology, dated 21 October 2016; and
- United States of America Department of Transportation Federal Transit Administration – Transit Noise and Vibration Impact Assessment Manual, 2006.

2 Sensitive Receivers

2.1 Rail Noise Assessment

Technical Report 5 – Noise and Vibration Assessment from the current Environmental Impact Statement identified the sensitive receivers situated along the proposed and the existing rail alignment. The ONVR assessment included the receivers identified in Technical Report 5 – Noise and Vibration Assessment, as well as undertaking a desktop review of aerial imagery available for the area surrounding the proposed alignment. The location of the sensitive receptors is shown on Maps in Appendix A.

2.2 Road Noise Assessment

The NSW Department of Environment Climate Change and Water's *Road Noise Policy* (RNP) requires road noise impacts to be considered for receivers within 600m of a Road Project.

For the Newell Highway Rail Overpass at Bellata, there is one noise sensitive receiver within this distance, shown in Figure 2.1.

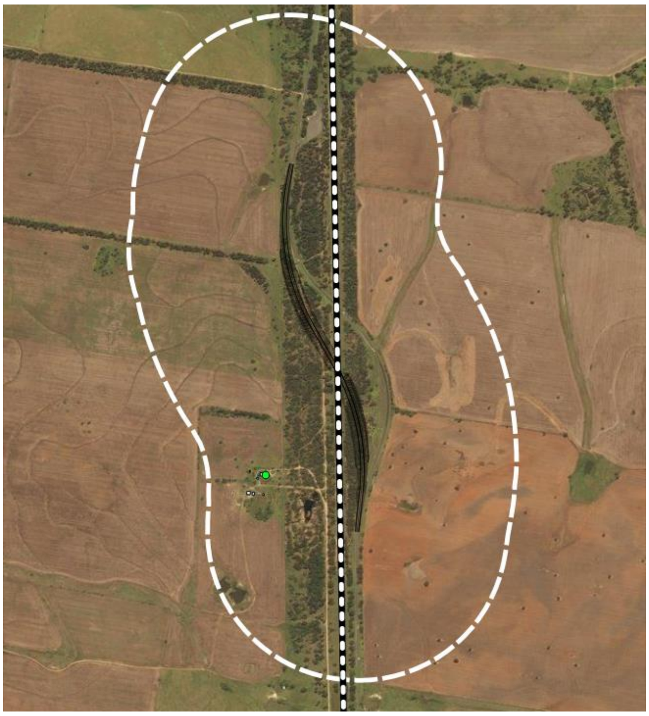


Figure 2.1 Bellata road overpass and sensitive receiver

This receiver is located approximately 410m from the existing Newell Highway alignment, with the proposed road overpass bringing the Newell Highway, within 380m at the closest point.
The change in road alignment is calculated to cause an increase in road traffic noise levels of 0.5 dB at this receiver. The distance to the road alignment is such that the receiver levels will not exceed the RNP criteria or cumulative noise exposure limits. As such, we are of the opinion that development of a noise model for a detailed road traffic noise assessment is not warranted for this road realignment.

For the noise assessment of the realignment of Jones Avenue, the Study Area is shown by the white dashed outline in Figure 2.2.

Figure 2.2 Jones Avenue assessment area

The Jones Avenue extension will create a new road alignment, passing adjacent to a number of residential receivers in Moree. The number of receivers and proximity of the proposed road alignment warranted a detailed assessment, which has been undertaken and documented in Section 5 of this report. As part of this assessment, noise measurements were undertaken of the existing acoustic environment. These are provided in Section 5.1

Appendix A provides figures which show the locations of the assessed receivers.

3 Project Criteria

The operational noise and vibration criteria relevant to the Project and used in this assessment are described in the following sections.

3.1 Operational Airborne Rail Noise Trigger Levels

The rail component of the Project is an existing and operational rail corridor proposed to be upgraded. The upgraded alignment is located within the existing 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.

One exception is the greenfield deviation at Camurra. Five noise sensitive receivers in the vicinity of the Camurra realignment are assessed against the rail noise trigger levels for New Rail Line Development. These receivers are four residential locations and an active recreation area and are shown on an aerial photo in Figure 3.1, and noted on the tabulated results in Appendix A.

Figure 3.1 Camurra greenfield deviation. Five New Rail Line Development receivers shown in yellow

The NSW Rail Infrastructure Noise Guideline (RING) defines airborne noise trigger levels for heavy rail.

These numbers represent external levels of noise that trigger the need for an assessment of potential noise mitigation measures to reduce noise levels from a rail infrastructure project. Noise trigger levels are assessed for a height of 1.5m above ground, at a location 1.0m in front of the most affected building façade. Predicted noise levels are to include a façade correction factor of +2.5 dB(A).

Triggers for residential land uses are provided in Table 3.1.

Table 3.1 Airborne noise trigger levels for residential land uses

Type of development	Noise trigger level, dB(A) (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 $L_{Aeq,}$ 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}

Triggers for non-residential receivers are provided in Table 3.2.

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

Other sensitive land uses	Noise trigger level, dB(A) (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

The noise modelling undertaken in this assessment is based upon external noise levels. Where the Noise Trigger Levels are provided as internal noise criteria, the design has converted these to equivalent external noise criteria assuming:

- A generic building envelope noise reduction of 10 dB(A); and
- The + 2.5 dB(A) façade correction factor applied to external noise levels is excluded.

This is in accordance with the RING, and accounts for noise reduction across a building façade, where windows are partially open.

The criteria levels provided for each receptor, in the Appendix B tabulated results, are based upon external noise levels.

3.2 Operational Airborne Road Noise Trigger Levels

Noise from road traffic in New South Wales is assessed at a project design stage in accordance with the NSW Roads and Maritime *Noise Criteria Guideline* (NCG) and NSW Department of Environment Climate Change and Water's *Road Noise Policy*.

The NCG details the implementation of the RNP assessment criteria, for sensitive receivers affected by road projects. The RNP provides the assessment criteria, methodology and noise mitigation requirements for managing noise from roads during the design stage of a project.

3.2.1 Noise Sensitive Receiver Types

The RNP defines noise criteria for noise-sensitive receivers within the study area which have the following land uses:

- Residential;
- School classrooms;
- Hospital wards;
- Places of worship;
- Open space (active or passive use);
- Childcare facilities; and
- Aged care facilities.

For residential receptors, the criteria apply at a distance of one metre from the façade of building and are assessed for each façade. For assessment locations without buildings, such as open space or outdoor recreation areas, the assessment location is at 1.5m above ground, at the worst affected location that is regularly used. Criteria are derived for each receiver based on the contribution from existing and proposed road noise sources and the type of road project.

3.2.2 Assessment Years

The RNP requires the assessment to consider the proposal at two points in time: Opening Year and Design Year.

Where noise levels in the opening year identify that receptors are eligible for consideration of noise mitigation, the mitigation must be designed based upon predicted noise levels for the Design Year.

3.2.3 Residential Receptors

Residential receivers for the road upgrade project are located in Moree, mostly North of Jones Avenue, in low-density residential dwellings which are predominantly single storey.

Table 3.3 provides a summary of the applicable criteria for the assessment of residential receivers affected by noise from new roads and existing roads.

Table 3.3 Road traffic noise assessment criteria for residential land uses

Road Category	Type of project/land use	Assessment criteria dBA	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial/collector roads	Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads	60 dBA $L_{eq(15hr)}$	55 dBA $L_{eq(9hr)}$
	Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	55 dBA $L_{eq(15hr)}$	50 dBA $L_{eq(9hr)}$
	Existing residences affected by noise from a **transition zone** between new and redeveloped roads	55 – 60 dBA $L_{eq(15hr)}$	50 – 55 dBA $L_{eq(9hr)}$

The extension of Jones Avenue joins Tycannah Street by extending it through the existing road and rail corridor and private land. The extended road joins to existing roads at either end. According to the definitions of New Road and Redeveloped Road in the NCG, the New Road criteria is applicable for the majority of the new alignment, and a noise criteria transition zone exists in the vicinity of the tie-ins to the existing roads.

The NCG provides guidance on defining the noise criteria for receivers in the transition zone. The criteria are determined for each receiver, based upon the Contribution Difference between the new road alignment and the existing road alignment. Contribution Difference is defined as:

Contribution Difference = New Road Contribution – Existing Road Contribution

The contributions of the new and existing road alignments are determined through noise modelling of the alignments, without the presence of shielding or reflections from built form such as noise barriers and buildings. The transition zone criteria are then determined from the Contribution Difference as shown in Table 3.4.

Noise modelling of the proposed road alignment for Jones Avenue showed that the existing road criteria is applicable at all receivers surrounding the road upgrade. The Contribution Difference noise contours and resulting noise criteria for the receptors in the Study Area is shown in Figure 3.2.

Table 3.4 Transition Zone Criteria

Contribution difference, dB	Assessment criteria, dBA	
	DAY (7AM-10PM)	NIGHT (10PM-7AM)
Contribution difference ≥ +3.0	55	50
+3.0 > Contribution difference ≥ +1.5	56	51
+1.5 > Contribution difference ≥ 0	57	52
0 > Contribution difference ≥ -1.5	58	53
-1.5 > Contribution difference ≥ -3.0	59	54
-3.0 > Contribution difference	60	55

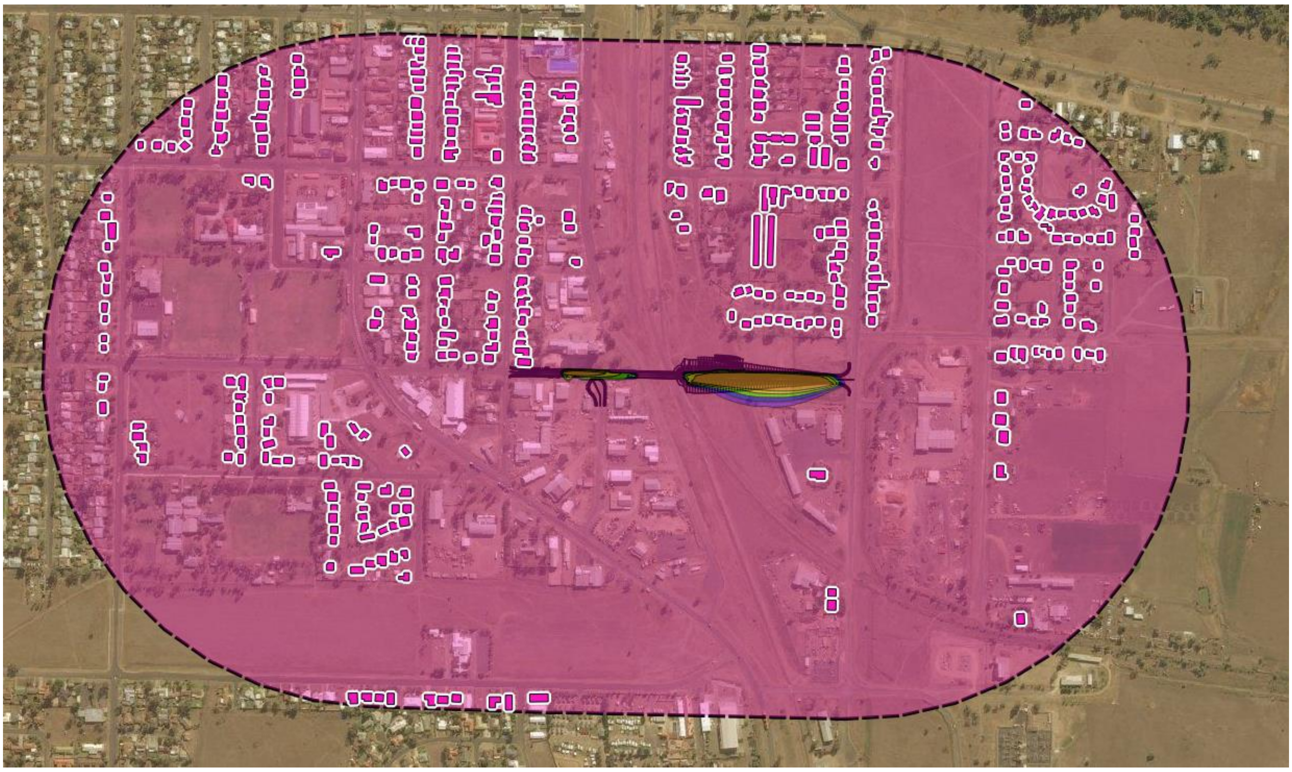


Figure 3.2 Modelled Contribution Difference (dB) and resulting noise criteria, colour coded to Table 3.4

The RNP also specifies Relative Increase Criteria (RIC) that are intended to protect residential amenity from excessive increases in noise from a newly operational road. Table 3.5 shows the relative increase criteria for residential land uses.

Table 3.5 Relative increase criteria for residential land uses

Road Category	Type of project/land use	Total traffic noise level increase dBA	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial/collector roads	New road corridor/redevelopment of existing road	Existing traffic $L_{eq(15hr)}$ +12 dB	Existing traffic $L_{eq(9hr)}$ +12 dB

3.2.4 Non-Residential Land Uses

There are several non-residential noise sensitive receivers in the road project study area, which are summarised in Table 3.6.

Table 3.6 Non-residential noise sensitive receivers

Receiver ID	Land Use	Approximate Minimum distance from proposal boundary (metres)
NNS_EDUx0001	School	435
NNS_EDUx0002	School	275
NNS_EDUx0009	School	345
NNS_REAx0001	Open Space – Active	335
NNS_REAx0002	Open Space – Active	415

Receiver ID	Land Use	Approximate Minimum distance from proposal boundary (metres)
NNS_REAx0009	Open Space – Active	185
NNS_REAx0010	Open Space- Active	340
NNS_REAx0013	Open Space – Active	450
NNS_REAx0016	Open Space – Active	570
NNS_REPx0006	Open Space – Passive	340
NNS_REPx0013	Open Space – Passive	510
NNS_WORx0001	Place of Worship	265
NNS_WORx0003	Place of Worship	240

Table 3.7 provides the RNP criteria for non-residential land use receptors.

Table 3.7 Road traffic noise assessment criteria for non-residential sensitive land uses

Existing sensitive land use	Assessment criteria (external)	
	Day (7am-10pm)	Night (10pm-7am)
Places of worship	50 dBA $L_{Aeq,1hr}$	50 dBA $L_{Aeq,1hr}$
Open space (active)	60 dBA $L_{Aeq,15hr}$	-
Open Space (Passive)	55 dBA $L_{Aeq,1hr}$	-
School	50 dBA $L_{Aeq,1hr}$	-

All noise assessment criteria have been presented as external noise levels. Similar to the Operational Rail Noise criteria, where land uses are assigned internal criteria in the RNP, a correction of +10 dB has been applied to convert these internal criteria to external criteria. The +10 dB correction approximates the difference between internal and external noise levels, assuming a window is partially open for ventilation.

3.2.5 Noise Mitigation Guideline

The Noise Mitigation Guideline (NMG) outlines Roads and Maritime's approach for the evaluation, selection and design of feasible and reasonable noise mitigation measures for operational road traffic noise.

Receivers are eligible for the consideration of mitigation, where they qualify under the NMG process (as shown in Figure 3.3) or when the contribution from the Project is acute.

An acute noise level is defined as the level of road traffic noise equal to or above 65 dBA $L_{eq,15hr}$ during the daytime period or 60 dBA $L_{eq,9hr}$ during the night-time period.

The cumulative limit is defined in the NMG as 5 dB above the NCG controlling criteria. This is intended to prevent receivers with existing high noise level exposure from remaining well above the criteria, if noise levels do not change sufficiently to trigger consideration of mitigation.

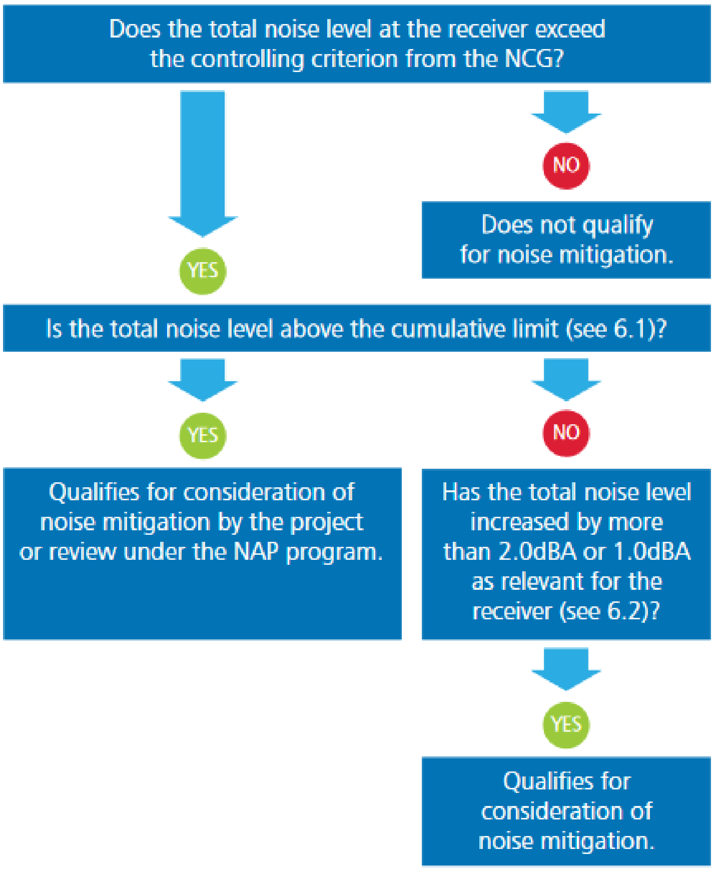


Figure 3.3 Process for determining eligibility for consideration of mitigation (Reproduced from NMG)

3.3 Operational Ground-Borne Rail Noise Trigger Levels

The RING defines ground-borne noise trigger levels for heavy rail for residential and sensitive land uses as per Table 3.8.

Table 3.8 Ground-borne noise trigger levels for residential and sensitive land uses

Sensitive land use	Time of day	Internal noise trigger levels, dB(A)
		Development increases existing rail noise levels by 3 dB(A) 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.

3.4 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.

3.4.1 Human Comfort

Vibration in buildings associated with rail or road network operations, can cause disturbance and complaints in a similar manner to noise. The RING as well as the RNP both refer 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 RING.

Table 3.9 Vibration trigger levels for human comfort

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

3.4.2 Cosmetic Damage

Th Rail Infrastructure Guideline and the Road Noise Policy do 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 ground-borne vibration*. Table 3.10 presents the guideline limits for cosmetic damage for short term vibration.

Table 3.10 Vibration trigger levels for cosmetic damage - transient

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 3.10 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 3.10 may need to be reduced by up to 50%.

Vibration from rail pass-byes is typically transient in nature. However, as the Proposal refers to rolling stock of significant length (1800m), IRDJV has elected to also compare vibration levels to adjusted criteria for continuous vibration to provide a conservative assessment. IRDJV is of the opinion that dynamic magnification and resonance is unlikely to occur due to train pass-byes from the Proposal and therefore, these criteria therefore represent a highly a conservative assessment of operational vibration. Values with a 50% reduction for continuous vibration are provided in Table 3.11.

Table 3.11 Vibration trigger levels for cosmetic damage - transient

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	25 mm/s at 4 Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above

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 Rail 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 current Environmental Impact Statement identified that the operational airborne rail noise levels were anticipated to exceed the relevant trigger levels for:
  - 152 residential receivers;
  - 3 educational receivers;
  - 3 worship receivers;
  - 2 passive recreation receivers; and
  - 1 active recreation receiver.

4.2 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 track grade to less than 1.5% where feasible within the design constraints; and
- Straighten curves. Most curves have been straightened where feasible to increase the radii above 500 m, which has a positive effect in terms of reducing wheel squeal and noise emissions.

4.3 Assessment Years – Rail

The RING 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 Narrabri to North Star section is expected to be finalised in 2020, which is therefore considered the actual opening year.

The entire Inland Rail programme is divided into various sections, each having their own approval process. The various sections are proposed to under construction through until 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.

The following years have been included in rail noise modelling:

- 2016 – For model verification. The existing Narrabri to North Star section is modelled with the existing rail traffic and existing conditions for model verification;
- 2020 - The “no build” scenario. The existing Narrabri to North Star section is modelled with natural growth in rail traffic and no change to the rail alignment;
- 2025 – Represents the opening year when the whole of Inland Rail will be connected and open. The proposed Narrabri to North Star section is modelled with the proposed traffic and conditions for Year 2025; and
- 2040 – Project design year. The proposed Narrabri to North Star section is modelled with the proposed traffic and conditions for Year 2040.

4.4 Development of the ONVR Rail 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 (SoundPLAN ground absorption parameter set to 1)
Track	Continuous welded rail: No correction Mechanical or uneven glued jointed: +3 dB(A) over 10m Slab track: +2 dB(A)
Turnout / Crossing	Fixed nose turnout: +6 dB(A) over 10m
Façade	For free-field predicted level is adjusted by +2.5 dB(A) 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

4.4.2 Rail Noise Modelling Scenarios and Inputs

4.4.2.1 Rail Traffic

Existing and proposed rail traffic considered in noise modelling are detailed in Table 4.2.

Table 4.2 Existing and proposed daily rail traffic

Train type	Year 2016	Year 2020	Year 2025		Year 2040	
	Narrabri to North Star		Narrabri to Moree	Moree to North Star	Narrabri to Moree	Moree to North Star
Grain	1.7	2	5.14	3.43	5.14	3.43
Passenger	1.8	2	2	0	2	0
Intercapital	-	-	4	4	4	4
General freight	-	-	4.86	4.86	11.43	11.43

In the absence of detailed schedule information, it is assumed that the rail traffic is proportionally distributed between the day (7pm to 10pm) and night (10pm to 7am) periods. This leads to 62.5% of the traffic during day and 37.5% of the traffic during night.

It is also noted that there is no natural growth in rail traffic anticipated between 2020 and 2025, as the line will not be operating as a through-route due to closures for construction.

4.4.2.2 Train Lengths

The length of the existing Grain and Passenger trains on the existing alignment and of all trains on the Narrabri to North Star section are listed in Table 4.3.

Table 4.3 Train lengths

Train type	Year 2016 and 2020	Year 2025 and 2040	
	Narrabri to North Star	Narrabri to Moree	Moree to North Star
Grain	710	630	660
Passenger	50	215	-
Intercapital	-	1750	1750
General freight	-	1750	1750

4.4.2.3 Train Speeds

The maximum speed of the existing Grain and Passenger trains on the existing and of all trains on the Narrabri to North Star section are listed in Table 4.4.

Table 4.4 Train speeds

Train type	Year 2016 and 2020	Year 2025 and 2040
Grain	100	115
Passenger	140	145
Intercapital	-	115
General freight	-	115

Speed restrictions have been included in the 2016 and 2020 noise models. It is understood that the existing speed restrictions are due to the existing horizontal alignment and at-grade crossings.

Figure 4.1 and Figure 4.2 shows the modelled train speeds for Year 2016. Figure 4.3 shows the modelled train speeds for year 2025, and Figure 4.4 shows the modelled train speeds for year 2040.

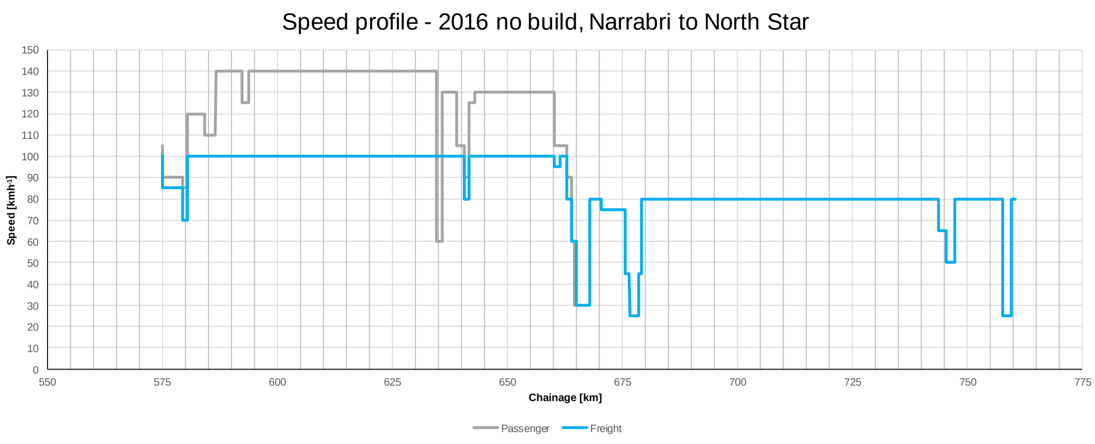


Figure 4.1 Modelled speed profile - Existing, Narrabri to North Star

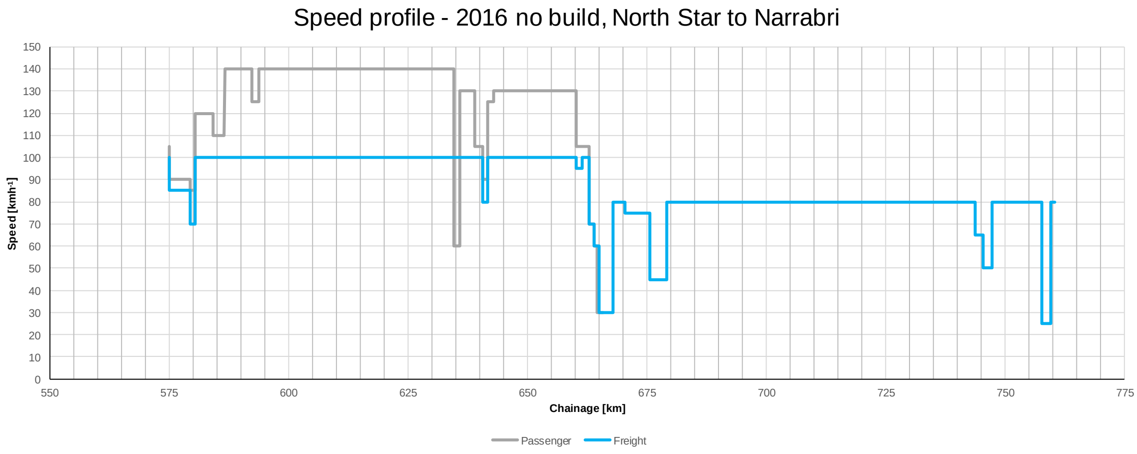


Figure 4.2 Modelled speed profile - Existing, North Star to Narrabri

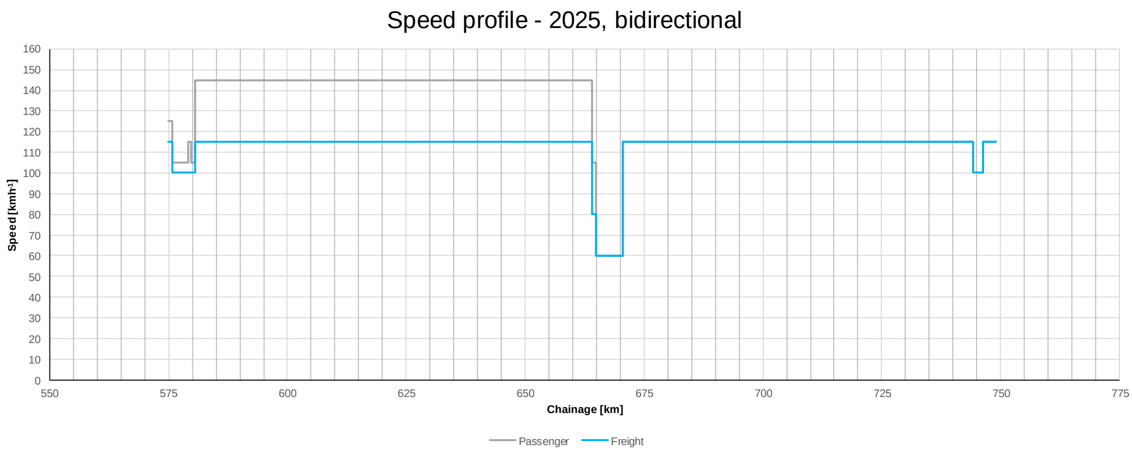


Figure 4.3 Modelled speed profile - Year 2025

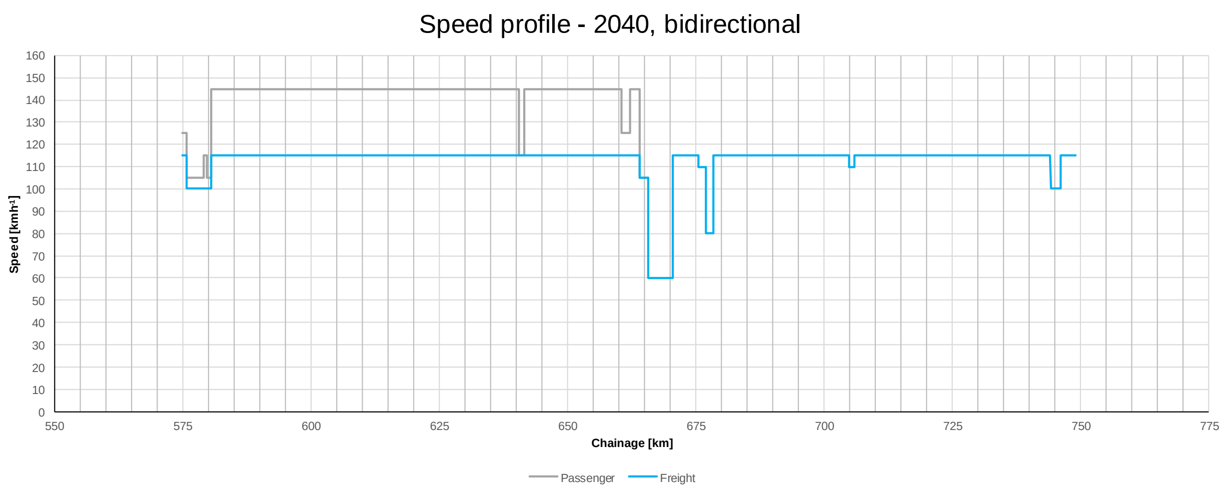


Figure 4.4 Modelled speed profile - Year 2040

4.4.2.4 Train Noise Source Levels

The train noise source levels for the Narrabri to North Star section are detailed in Table 4.5.

Table 4.5 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
Intercapital	NR	3	69.8	74.7	75.9	79.9	78.8	83.8	85.1	89.4
General	TT	1	68.2	75.7	77.9	82.6	76.1	84.3	86.8	91.7
Passenger	TT	1	68.2	75.7	77.9	82.6	76.1	84.3	86.8	91.7
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 > 1.5%;
- The linear average is used for flat sections with speeds up to 70km/h;
- The logarithmic average is used for flat sections with speeds greater than 70km/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 > 1.5%.

For wagons:

- Speed correction is applied for all source levels to adjust from the 80km/h data presented in Table 4.5 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.

4.4.2.5 Crossing Loops and Level Crossings

Train horn noise was modelled at 90 dB(A) at 100m. 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, approximately 15m away from the level crossings.

Warning crossing bell noise was modelled at 105 dB(A) at 3m. For L_{Aeq} calculations, warning bells are assumed to operate 30s prior to a train entering the level crossing and remain audible throughout the train pass-by.

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

Bunching and stretching noise was modelled at 90 dB(A) at 15m. For L_{Aeq} calculations, it is assumed that trains idling at crossing loops generates bunching noise when decelerating and stretching noise when accelerating, for a duration of 1s per wagon.

4.5 Validation of Rail Noise Levels for the Year 2016

Additional pre-construction rail noise monitoring has not been undertaken as part of this Operational Noise and Vibration Review as the dominant noise sources, Inland Rail Intercapital trains, are not operational and their contribution cannot be validated.

Operational noise will be monitored within 12 months of the commencement of Inland Rail service offering operations to compare actual noise performance with predicted levels detailed in this report. The model will be validated using these measurements and if calibration is required, outcomes will be detailed in the Operational Noise Compliance Report.

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

Table 4.6 summarises the number of noise sensitive receivers in each land use category, which exceed the relevant noise trigger levels without noise mitigation in place.

Table 4.6 Summary of noise criteria exceedances without mitigation

Receptor type	Year 2025	Year 2040
Residential	34	81
Educational	1	3
Worship	1	2
Passive recreation	0	1
Active recreation	0	0

The assessment outcome is driven by the L_{Aeq} descriptor. There are L_{Amax} exceedances at a small number of locations, but in these cases the L_{Aeq} exceedance is greater and so L_{Aeq} drives the outcome.

Noise mitigation is designed with the goal of achieve compliance with the noise trigger levels for these receivers for the year 2040, to the extent which is reasonable and practicable.

4.7 Potential Mitigation Measures for Airborne Noise

The Environmental Impact Statement outlined various mitigation options that potentially could control operational rail airborne noise, subject to being shown to be reasonable and feasible for the Project.

The RING 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 Narrabri to North Star section is a 186km brownfield section, with limited opportunities to upgrade the track alignment. For the Camurra deviation, 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 an alignment where reasonable and feasible mitigation measures have already been implemented as part of the design and model;
- Minimise change of grade:
  - The Narrabri to North Star section is a 186km brownfield section with limited opportunities to change the grade. For the Camurra deviation and where possible for the Narrabri to North Star 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 1.5%, where feasible within the design constraints. The proposed track layout represents an alignment where reasonable and feasible mitigation measures have already been implemented as part of the design and model;
- Straighten curves:
  - Most curve radii are designed to be greater than 500m, which is expected to reduce the squealing noise and therefore, have a positive effect in terms of minimising the overall noise emissions. The realignment of the Camurra Hairpin (previously shown in Figure 3.1) is an example of where track straightening will minimise noise emissions. The proposed track layout represents an alignment where reasonable and feasible mitigation measure have already been 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 Narrabri to North Star 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 Narrabri to North Star 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 Narrabri to North Star section. Therefore, it is not considered reasonable to restrict the operating hours;
- 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 rails ability to decay noise-inducing vibrations resulting from the rolling contact between the wheel and rail. These are only efficient for reducing wagon noise, where it is dominated by the wheel / rail interaction. The rail noise emission from trains on the Project will be comprised of multiple sources, including locomotive engines and exhausts, wheel/rail interactions, noise radiating from freight wagon bodies, braking noise, bunching noise, and horn noise. The limited effectiveness of rail dampers in mitigating noise sources beside wheel rail noise suggests that their implementation will provide limited benefit to mitigating noise from the Project. Furthermore, rail dampers require routine maintenance and may therefore result in significant maintenance cost over the lifetime of the rail track. For these reasons, we have not considered the implementation of rail dampers, as feasible noise mitigation 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 implementation 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.

4.8 Mitigation Options

As outlined in Section 4.7, two mitigation options have been considered. These mitigation options are discussed for receivers predicted to exceed the noise trigger levels for year 2025 but will be designed to best meet the noise trigger levels for year 2040 (i.e. the noise mitigation will be future-proofed) while remaining reasonable and feasible.

ARTC commits to reviewing the predicted noise levels at regular intervals towards year 2040 and mitigation measures for receivers predicted to exceed the noise trigger levels for year 2040 will be investigated at a later stage.

4.8.1 Noise Barriers

Noise barriers are a form of mitigation which should be considered for reducing criteria exceedance, where receptors are not isolated. For example, where there are groups of closely spaced dwellings or other noise sensitive areas, typically in townships. Where isolated receptors are predicted to exceed noise criteria, it is not typically cost-efficient to install barriers, when compared to the cost of at-property treatment.

Noise modelling identified that there are six locations along the N2NS alignment where noise barriers may provide effective, reasonable and feasible noise mitigation. These locations are typically in townships, namely:

- Bellata;
- Gurley;
- Moree;
- Croppa Creek; and
- North Star.

Wall locations were defined in consultation with the wider project team. The team has considered many non-acoustic matters, including utility services, constructability, sight lines to level crossings, safety in design factors and access to station platforms. Once barrier locations were confirmed, the SoundPLAN “Wall Design” module was then used to optimise the required noise barrier extents and heights. The following parameters were input to the optimisation:

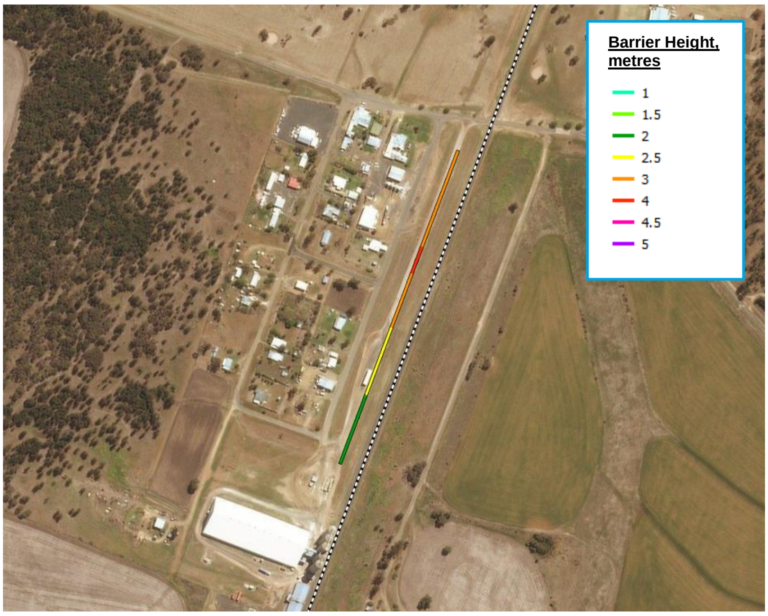
- Minimum barrier segment length of 20m;
- Minimum barrier height of 2m (relative to ground surface);
- Maximum barrier height of 5m (relative to ground surface; and

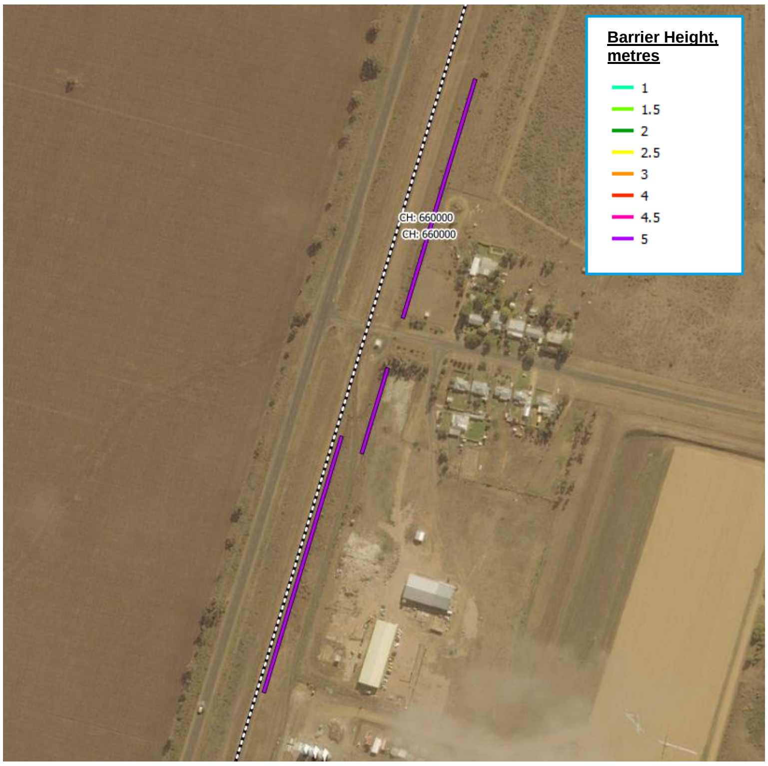
- Barrier height increments of 0.5m.

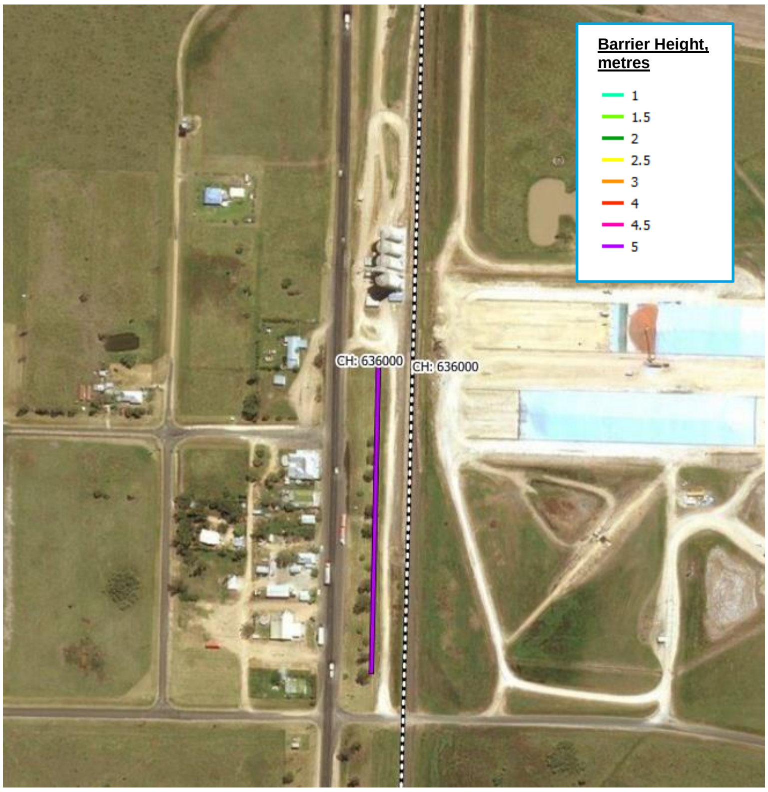
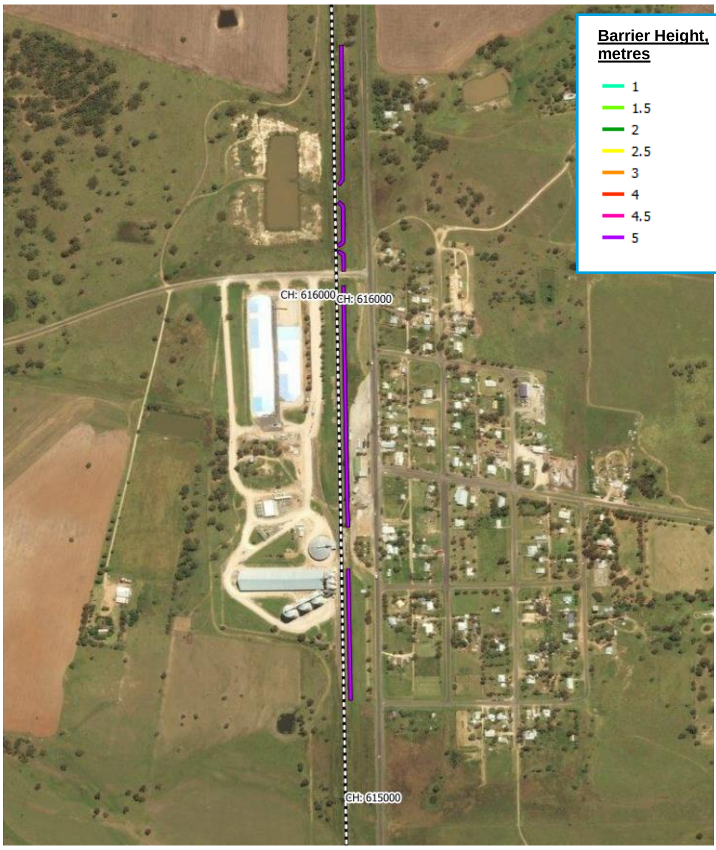
Table 4.7 shows the potential noise barrier extent (minimum height and footprint) to best achieve compliance at the noise sensitive receivers eligible for noise mitigation for year 2025. IRDJV note that this barrier design may be subject to further rationalisation. Rationalisation of barriers may occur through review of the detailed design, finalisation of surface water management, the constructability assessment and community engagement on noise management and mitigation. Where barriers are removed for rationalisation purposes the relevant receivers will require at-property treatment.

Note that the noise wall shown in Moree is required only when Inland Rail trains commence operation.

Table 4.7 Design noise barrier extent

Township / Locality Approximate chainage	Barrier footprint
North Star CH 758290-759050	
Croppa Creek CH 733430-733900	

Township / Locality Approximate chainage	Barrier footprint
Moree: Gwydir Highway CH 665950-665420 *Separable Portion 2 Only.* *Barrier required when Inland Rail trains commence operation.*	
Moree: Burrington Road CH 659480-660150	

Township / Locality Approximate chainage	Barrier footprint
Gurley CH 635720-636000 *Barrier is recommended if further ground-truthing identifies noise sensitive receptors present.*	
Bellata CH 615190-616300 *Recommended Barrier which is located North of Millie-Bellata Road is to be reviewed through stakeholder consultation process.*	

Barriers in Bellata, Gurley, and Moree are positioned on the opposite side of arterial roads (Newell Highway and Moree Bypass) to sensitive receiver locations. The use of noise walls in these locations will lead to a moderate increase in road traffic noise levels at the adjacent receivers, due to sound reflecting off the barrier. Calculations indicate that these increases will typically be of the order of 0.9 - 1.8 decibels for the barrier positioning shown. This magnitude of increase it not likely to be perceptible to the typical receptor.

This barrier design does not achieve compliance with rail noise criteria at all noise sensitive receivers. This is due to limitations on barrier height and placement and because some receptors are in isolated locations, where noise is not feasibly mitigated with barriers. Table 4.8 summarises the number of predicted residual criteria exceedances with the barrier design from Table 4.7 implemented.

Table 4.9 shows exceedances grouped by barrier location, showing the effectiveness of each of the barrier locations.

Table 4.8 Summary of residual exceedances with barrier design in place

Receptor type	Year 2025	Year 2040
Residential	8	34
Educational	0	2
Worship	0	1
Passive recreation	0	0
Active recreation	0	0

Table 4.9 Summary of criteria exceedances by barrier location (all receptor types)

Noise barrier	2025 without barriers	2025 residual exceedance with barriers
North Star	8	1
Croppa Creek	1	0
Moree	10	2
Moree (Burrington Road)	4	0
Gurley	2	0
Bellata	6	0
(Locations without a barrier)	5	5
Total	36	8

Receptors predicted to exceed the noise criteria with the recommended barrier in place will require additional at-property noise treatment as far is feasible and reasonable.

4.8.2 At-Property Treatment

At-property treatment has been considered for the noise sensitive receivers predicted to receive noise levels exceeding criteria.

At-property treatment typically consists of upgrades to the building 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 to an acoustically solid fence or increasing the height of an existing property fence.

Architectural acoustic treatment can generally be expected to provide between 3 and 20 dB(A) internal noise reduction, depending on the dominant type of railway noise source in that location and the existing type of building façade construction.

A determination on whether a treatment is feasible and reasonable/practicable should be made initially based on the condition of each building. Poorly maintained or dilapidated 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. An acoustic consultant should be engaged by ARTC to provide advice on the specific treatment methodology for each individual dwelling. This is further discussed in Section 7.1.

4.9 Final Rail Noise Mitigation Measures

The following Table 4.10 summarises the rail noise mitigation measures considered for the Project and for the receivers eligible for noise mitigation for year 2025.

Table 4.10 Final mitigation measures

Mitigation option	Location	Feasible mitigation test	Reasonable mitigation test	Mitigation selected
Mitigation at the source				
Track realignment	Project	Limited opportunity	Yes	Yes(1)
Change of grades	Project	Limited opportunity	Yes	Yes(1)
Straighten curves	Project	Limited opportunity	Yes	Yes(1)
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
Track lubrication	Project	Yes	No	No
Rail dampers	Project	No	Yes	No
Mitigation of the transmission path				
Noise barriers	Townships	Yes	Yes	Yes
Mitigation at receiver				
Architectural treatment	Exceeding receptors	Yes	Yes(2)	Yes
Upgrade of property fences	Exceeding receptors	Yes	Yes	Yes

Notes:

(1) Implemented during rail design

(2) Subject to case-by-case building condition assessment

5 Airborne Road Noise Impacts

This section describes the assessment of road traffic noise impacts from the construction of the Jones Avenue rail overpass in Moree.

5.1 Existing Environment

Existing noise levels in the vicinity of the proposed Jones Avenue overpass were quantified between 5 March 2019 to 14 March 2019, prior to construction, by means of unattended noise monitoring.

Monitoring was undertaken in accordance with the Australian Standard 1055:1997 – *Acoustics – Description and Measurement of Environmental Noise* (AS 1055) and the NSW Noise Policy for Industry (NPfI) (EPA, 2017).

The locations of the noise monitoring equipment are presented Table 5.1 and shown in Figure 5.1.

Table 5.1 Noise Monitoring Locations

Noise monitoring location	Description
19 Jones Avenue – NM1	Front garden of residential receiver. Free field measurement
45 Tycannah Street – NM2	Vacant lot. Free field measurement
60 Gosport Street – NM3	Secured parking area. Free field measurement

Figure 5.1 Noise Monitoring Locations

Monitoring equipment was fitted with manufacturer-supplied windshields and the calibration of each device was checked with a field calibrator before and after monitoring. No significant drift in calibration (± 0.5 dB) was noted for any of the noise equipment over the monitoring duration.

Noise monitoring data has been excluded when gathered during periods of adverse weather. This included where wind speeds at microphone height exceeded 5m per second or when significant rainfall was recorded.

Each item of noise monitoring equipment used carries a current certificate of calibration. Details of equipment utilised are presented in Table 5.2. Copies of the calibration certificates can be provided upon request.

Table 5.2 Noise Monitoring Equipment

Location	Measurement type	Manufacturer and Model No.	Serial No.	Calibration Due Date
19 Jones Avenue	Unattended measurement	ARL NGARA S-Pack	8780FB	16/10/2020
45 Tycannah Street	Unattended measurement	ARL NGARA S-Pack	878007	29/06/2019
60 Gosport Street	Unattended measurement	ARL NGARA S-Pack	87809E	16/06/2020
(All locations)	Calibrator	Rion NC 73	11248294	10/07/2019

Results of monitoring are summarised in Table 5.3.

Table 5.3 Summary of unattended noise monitoring results

Location	Median daily noise level, dba	
	Day $L_{eq,15hr}$	night $L_{eq,9hr}$
19 Jones Avenue	58.9	54.9
45 Tycannah Street	53.4	46.0
60 Gosport Street	55.9	50.6

5.2 Noise Modelling Methodology

Operational road traffic noise modelling was undertaken in SoundPLAN version 7.4, which implements the Calculation of Road Traffic Noise (CoRTN) (UK Department of Transport, 1988) algorithm for predicting noise levels from road traffic. SoundPLAN 7.4 implements an adaption of CoRTN algorithm specific to common NSW road noise modelling practices and RNP requirements, which the design has elected to use in the modelling.

The noise models utilising this algorithm predicts the road traffic noise levels by considering inputs of traffic volumes and composition, vehicle speed, road gradient, pavement surface, ground absorption, reflections and shielding from topography, buildings and barriers.

Models were created for “no-build” and “build” scenarios identified in Section 3.2.2, for the year 2020 and for 10 years post opening in 2030. These years correspond to the completion of the Jones Avenue overpass, as opposed to the wider Project.

Roads considered as noise sources in the models are limited to the main thoroughfares, as these have sufficient traffic flow to contribute to the traffic noise descriptors used in the assessment.

The roads and corresponding traffic flows input into the model are shown in Table 5.4.

Table 5.4 Traffic flows used in noise models

Road	AADT	Day			Night		
		TOTAL FLOW	HOURLY FLOW	CV%	TOTAL FLOW	HOURLY FLOW	CV%
2019 - Calibration							
Jones Avenue	481	460	31	12%	21	2	6%
Gosport Street	675	629	42	10%	46	5	14%
Tycannah Street	1538	1381	92	14%	157	17	11%
2020 – No Build							
Moree Bypass	2684	2442	162	25%	242	26	25%
Jones Avenue (Bridge Overpass)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jones Avenue (West of Newell Highway)	2827	2572	171	31%	255	28	31%
Jones Avenue (East of Newell Highway)	315	287	19	1%	28	3	0%
Tycannah Street (North of Jones Avenue)	1862	1964	113	18%	168	19	18%
Tycannah Street (South of Jones avenue)	1862	1964	113	20%	168	19	20%
Bullus Drive	2937	2672	178	23%	265	29	23%
2020 – Build							
Moree Bypass	2684	2442	162	25%	242	26	25%
Jones Avenue (Bridge Overpass)	1147	1044	70	0%	103	11	0%
Jones Avenue (West of Newell Highway)	3056	2781	185	31%	275	31	31%
Jones Avenue (East of Newell Highway)	1462	1330	89	1%	132	15	2%
Tycannah Street (North of Jones Avenue)	2580	2347	157	18%	233	26	18%
Tycannah Street (South of Jones avenue)	2292	2085	139	20%	207	23	20%
Bullus Drive	2507	2281	152	23%	226	25	23%
2030 – Build							

Road	AADT	Day			Night		
		TOTAL FLOW	HOURLY FLOW	CV%	TOTAL FLOW	HOURLY FLOW	CV%
Moree Bypass	2942	2677	178	25%	265	29	25%
Jones Avenue (Bridge Overpass)	1257	1144	76	0%	113	13	0%
Jones Avenue (West of Newell Highway)	3350	3048	203	31%	302	34	30%
Jones Avenue (East of Newell Highway)	1604	1459	97	1%	145	16	1%
Tycannah Street (North of Jones Avenue)	2829	2574	172	18%	255	28	18%
Tycannah Street (South of Jones avenue)	2514	2287	152	20%	227	25	20%
Bullus Drive	2749	2501	167	23%	248	28	23%

Notes: (1) Traffic data utilised for validation modelling, as sourced from traffic counts undertaken concurrently with noise measurements in February 2019

Traffic speeds modelled for existing roads adopted from sign-posted speed limits.

Traffic speeds on future roads were provided by the road designers. Moree Bypass was modelled with a speed limit of 60km/h, other roads were modelled with a speed limit of 50km/h.

Noise level predictions were made for receiver locations 1.5 metres above ground height, in the centre of each building façade, for any building façade of length greater than 2.5 metres. Noise levels are predicted at a perpendicular distance of 1 metre from the building façade.

Other inputs and parameters utilised in noise modelling for the assessment are provided in Table 5.5.

Table 5.5 Noise model inputs

Parameter	Details
CoRTN methodology	SoundPLAN implementation of NSW road modelling requirements. CoRTN low volume correction disabled Three source height model as required by RNP and NMVG: Light vehicle traffic flow modelled at 0.5m above road level with 0 dB correction Heavy vehicles traffic flow modelled at 1.5m above road level with a -0.6 dB correction, and at 3.6m above road level with a -8.6 dB correction
Ground topography	Topography for the project area as per the N2NS rail noise models
Pavement surfaces	Existing and proposed future pavement surfaces are modelled as 7 mm chip seal.

Parameter	Details
	A +2 dB correction is applied for this road surface type in accordance with the NMVG.
Traffic volumes and mix	Traffic data was provided by the Project team internally for the modelled roads within project area. Traffic noise model validation was performed using traffic count data collected concurrently with noise monitoring.
Existing structures and barriers	Building footprints with land use and building heights were sourced from a third party provider Footprints were defined from aerial photography, building heights from lidar datasets and site surveys.
Road gradient	Gradient calculated from supplied topographical data and road design model.
Ground absorption	Ground absorption factor of 0.75 used throughout; representative of rural/semi-rural areas.
Façade reflection correction	+2.5 dB for locations at 1 metre from the façade of a building
ARRB correction	-1.7 dB day time -0.7 dB night time
CoRTN L_{10} to L_{eq} correction	$L_{eq} = L_{10}$ -3 dB

5.3 Noise Model Validation

Validation of the noise model was undertaken using noise monitoring data and the concurrent traffic flow counts. A noise model was produced for existing (2019 pre-construction) conditions, allowing a comparison of predicted vs measured noise levels for the two noise monitoring locations, within the project area. The intention of this model is to confirm that the methodology and parameters used in road traffic noise modelling for the project are valid as representative of site conditions.

Table 5.6 summarises the measured and predicted noise levels for the validation noise model.

Table 5.6 Model validation

ID	Day (dBA, $L_{eq(15hr)}$)			Night (dBA, $L_{eq(9hr)}$)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
NM1	53.4	54.5	1.1	46	44.5	-1.5
NM2	55.9	57	1.1	50.6	50.4	-0.2
NM3	58.9	60.4	1.5	54.9	56.2	1.3
Median error			**1.1**			**-0.2**
Standard deviation			**0.2**			**1.4**

Median error is typically used as a measure of accuracy of model calibration on NSW projects in accordance with the RMS Noise Model Validation Guideline.

Measured noise levels were found have median error within ±1.1 dB(A) and random scatter was within ±2 dB(A). These are within acceptable tolerances discussed in the NMVG. As such, we are satisfied that the road traffic noise models are valid for predicting existing and future road traffic noise levels for noise sensitive receivers within the study area.

5.4 Assessment of Predicted Road Traffic Noise Level

Noise levels were predicted for each building façade for 2020 and 2030.using the methodology described in Section 5.2.

5.4.1 2020 Predicted Noise Levels, Without Mitigation

The results of road noise modelling for 2020 prior to design of any mitigation are summarised in Table 5.7. Tabulated noise modelling results for each receiver building are presented in Appendix D and noise contour plots are presented in Appendix E.

Table 5.7 Summary of noise modelling results without mitigation

Time period	Number of receptors					
	EXCEED RESIDENTIAL NCG CRITERION	EXCEED NCG CRITERION WITH PREDICTED INCREASE OF >2 DB FROM PROJECT	EXCEED RIC CRITERION	EXCEED CUMULATIVE LIMIT	EXCEED ACUTE NOISE LIMIT	ELIGIBLE FOR CONSIDERATION OF MITIGATION
Daytime	46	0	0	0	0	0
Night time	27	0	0	0	0	0

46 residential receivers were predicted to exceed the NCG criteria levels, however the increase in noise levels at each of these locations was less than 2 dB(A), and therefore these receivers are not eligible for noise mitigation. There were no receiver locations exceeding the RIC, Cumulative Limit, or Acute Limit criteria.

As such, there are no residential receivers eligible for consideration of road noise mitigation for the Project based on 2020 noise levels.

Table 5.7 presents a summary of predicted noise levels for non-residential receptors in the study area.

Table 5.8 Results for non-residential noise sensitive receivers

Location	Day $L_{Aeq,15hr}$ noise level, dBA	Night $L_{Aeq,9hr}$ noise level, dBA
NNS_EDUx0001	47	N/A
NNS_EDUx0002	42	N/A
NNS_EDUx0009	47	N/A
NNS_REAx0001	49	N/A
NNS_REAx0002	60	N/A
NNS_REAx0009	54	N/A
NNS_REAx0010	42	N/A

Location	Day $L_{Aeq,15hr}$ noise level, dBA	Night $L_{Aeq,9hr}$ noise level, dBA
NNS_REAx0013	49	N/A
NNS_REAx0016	53	N/A
NNS_REPx0006	39	N/A
NNS_REPx0013	38	N/A
NNS_WORx0001	42	40
NNS_WORx0003	49	43

There are no predicted exceedances of the noise criteria for non-residential noise sensitive receivers in 2020.

5.4.2 2030 Predicted Noise Levels, Without Mitigation

The results of road noise modelling prior to design of any mitigation are summarised in Table 5.9. Tabulated noise modelling results for each receiver building are presented in Appendix D and noise contour plots are presented in Appendix E.

Table 5.9 Summary of noise modelling results without mitigation

Time period	Number of receptors					
	EXCEED RESIDENTIAL NCG CRITERION	EXCEED NCG CRITERION WITH PREDICTED INCREASE OF >2 DB FROM PROJECT	EXCEED RIC CRITERION	EXCEED CUMULATIVE LIMIT	EXCEED ACUTE NOISE LIMIT	ELIGIBLE FOR CONSIDERATION OF MITIGATION
Daytime	49	0	0	0	1	1
Night time	36	0	0	0	0	0

49 residential receivers were predicted to exceed the NCG criteria levels, however the increase in noise levels at each of these locations was less than 2 dB(A), and therefore these receivers are not eligible for noise mitigation. There were no receiver locations exceeding the RIC, Cumulative Limit criteria. One receiver exceeds the Acute Limit criterion which is discussed below.

The receptor identified as NNS_Rx1328, located at 46 Jones Avenue was found to exceed the daytime Acute Limit criterion for 2030 and as such consideration of noise mitigation is required. This receptor is located on the Western side of Newell Highway / Frome Street. Figure 5.2 shows the receiver (highlighted yellow) in the context of the project footprint and surrounding noise sensitive receptors (blue outlined buildings).

In considering if noise mitigation should be provided to NNS_Rx1328, the feasibility and reasonableness of noise mitigation implementation is reviewed.

At NNS_Rx1328, The Acute limit is 65 dB $L_{Aeq,15hr}$ and the predicted daytime level is 65.7 $L_{Aeq,15hr}$, representing an exceedance of the criterion which is within the daytime Median Prediction Error for the noise model (1.1 dB).

Compared to the other three houses in the vicinity (42, 44, and 48 Jones Avenue) which are compliant with the Acute Limit criterion, NNS_Rx1328 is located with a slightly lesser setback to Jones Avenue, and due to Alcare Street has a slightly wider field of view of Jones Avenue.

Noise mitigation for such an exceedance would likely be provided by a sheet metal front fence, of up to 1.8 metres in height. None of the neighbouring properties have solid front fences.

From the above, it is not considered feasible to implement noise mitigation at this isolated receptor.

The implications of treating a single isolated receptor which is located a significant distance from the road project, compared to many receptors much closer to the road project which do not require noise mitigation, further suggest that this mitigation is not reasonable.

Figure 5.2 Receiver exceeding Acute limit

Table 5.7 presents a summary of predicted noise levels for 2030 for non-residential receptors in the study area.

Table 5.10 Results for non-residential noise sensitive receivers

Location	Day $L_{Aeq,15hr}$ noise level, dBA	Night $L_{Aeq,9hr}$ noise level, dBA
NNS_EDUx0001	48	N/A
NNS_EDUx0002	42	N/A
NNS_EDUx0009	48	N/A
NNS_REAx0001	48	N/A
NNS_REAx0002	61	N/A
NNS_REAx0009	52	N/A
NNS_REAx0010	41	N/A
NNS_REAx0013	47	N/A
NNS_REAx0016	53	N/A
NNS_REPx0006	38	N/A
NNS_REPx0013	37	N/A

Location	Day $L_{Aeq,15hr}$ noise level, dBA	Night $L_{Aeq,9hr}$ noise level, dBA
NNS_WORx0001	44	37
NNS_WORx0003	49	42

There are no predicted exceedances of the noise criteria for non-residential noise sensitive receivers, and therefore none of these receivers are eligible for road noise mitigation.

6 Ground-Borne Noise and Vibration Impacts

6.1 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 has been affected by these design changes. Therefore, a revised assessment has been undertaken incorporating these changes.

6.2 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 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.

6.2.1 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 Noise and Vibration Impact Assessment manual. It is reproduced in Figure 6.1.

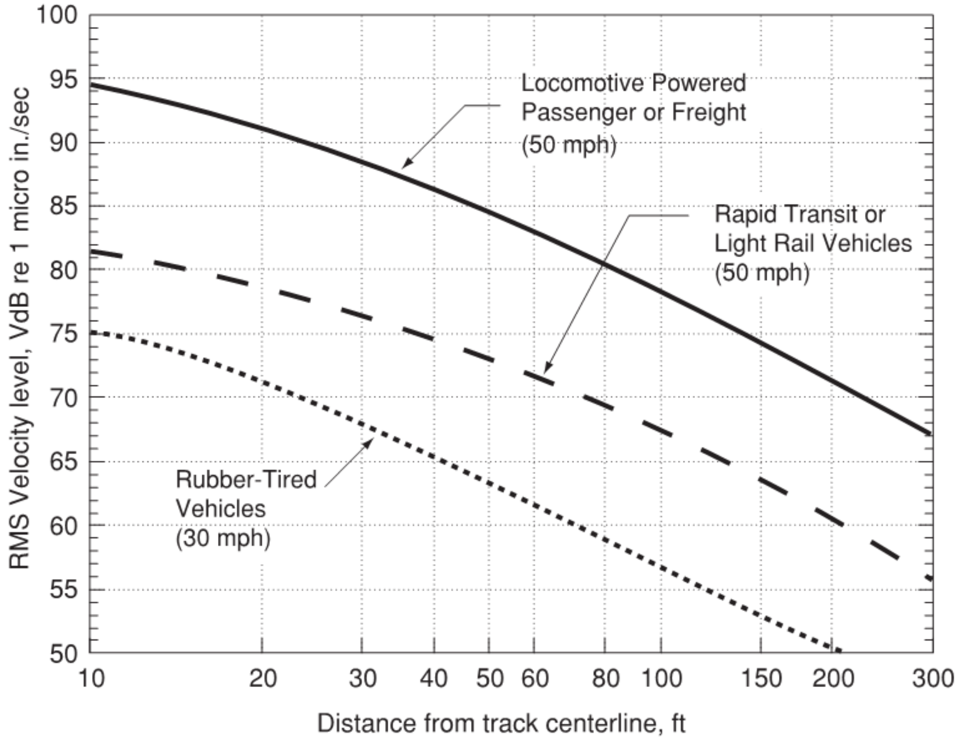


Figure 6.1 Generalised ground surface vibration curves

The following adjustments are made:

- Varying adjustment for train speeds up to 145 km/h (vibration level is proportional to 20 x log (speed / reference speed); at 145 km/h this adjustment is +5.1 VdB);
- +8 VdB to account for stiff primary suspensions. Transit vehicles with stiff primary suspensions have been shown to create high vibration levels.; and
- -5 VdB to account for coupling to building foundation for timber framed houses.

Curves showing predicted vibration levels vs distance, for locomotive powered freight trains at 145 km/h, are provided in Figure 6.2. Note that distance has been converted to metric units.

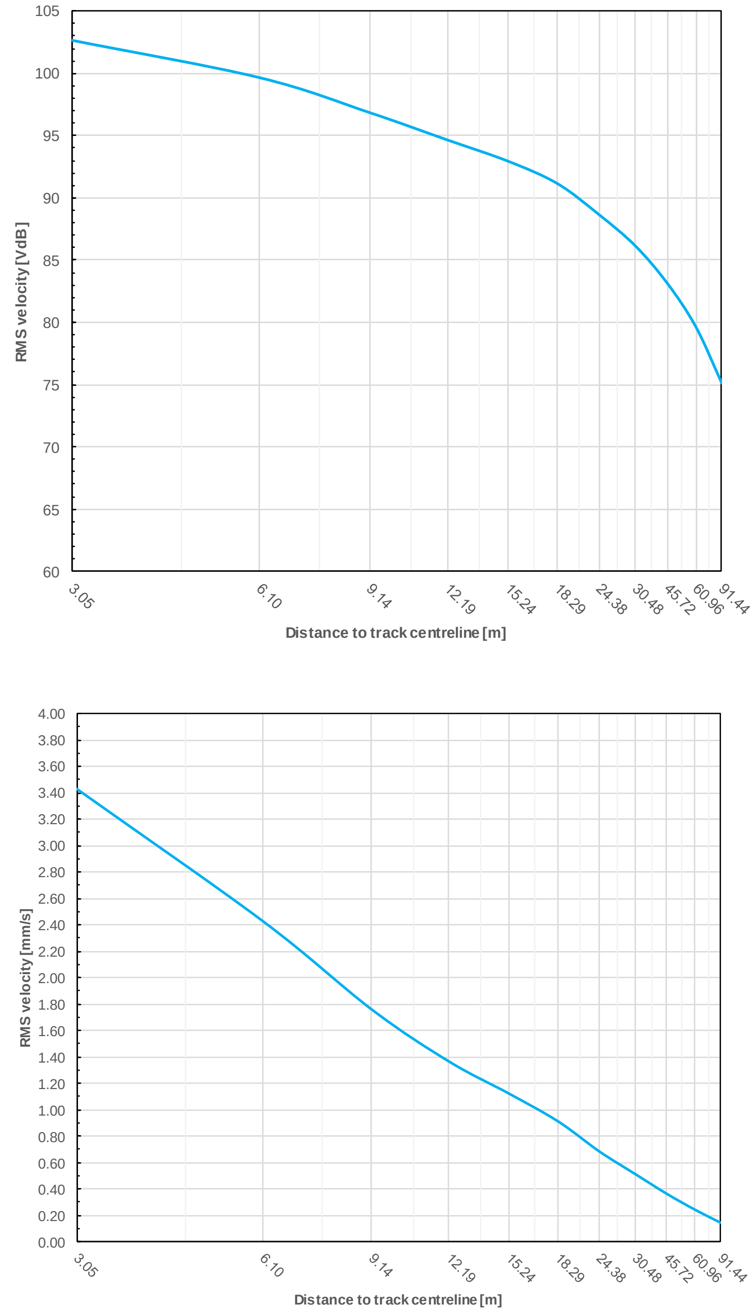


Figure 6.2 Adjusted ground surface vibration curve for freight train at 145 km/h

At the nearest and most exposed receiver located approximately 20m from the track, the adjusted root mean square vibration velocity level is estimated to be approximately 0.316mm/s for a train pass-by speed of 60km/h.

Receptors adjacent sections of track with higher speed limit are set back further from the rail line, and as such typically receive lower vibration levels despite the higher train speed.

6.2.2 Ground-Borne Noise Levels

Design train speeds and building separation distances vary throughout the Project. IRDJV have summarised the distances of the closest residential or educational properties to the line for each design speed in Table 6.1.

Table 6.1 Closest receiver for each train speed

Design train speed km/h	Distance to closest vibration sensitive receiver
60	20
80	300
100	1200
105	80
110	340
115	85
125	180
145	80

To predict ground borne noise levels in dB(A), the design has adopted the FTA methodology, with the assumption that the peak frequency of ground vibration is lower than 30 Hz. This is the case for most surface tracks. The resulting ground borne noise levels are shown in Table 6.2.

Table 6.2 Predicted highest ground-borne noise level for each train speed

Design train speed km/h	Predicted ground borne noise level, dB(A)
60	32
80	12
100	2
105	25
110	14
115	26
125	20
145	28

The highest predicted ground-borne noise level is 32 dB(A) which is compliant with the ground borne noise trigger levels listed in Table 3.8.

6.2.3 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 AVTG and British Standard BS 6472:1992, eVDV has been determined using the RMS velocity value as follows:

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

With the train traffic volumes and lengths provided in Table 4.2 and Table 4.4, and a pass-by speed of 60 km/h (longest vibration exposure duration), the eVDV at the nearest receiver is predicted to be $1.43 \text{x} 10^{-4}$ $\text{m/s}^{1.75}$, which complies with the trigger levels listed in Table 3.9.

Indicatively, for a location at 80 metres separation distance where trains on the alignment are travelling at 145 km/h (shorter pass-by times, larger separation distance, higher source vibration level), the eVDV is predicted to be $9.2 \text{x} 10^{-5}$ $\text{m/s}^{1.75}$.

6.2.4 Vibration Levels for Cosmetic Damage for Non-Heritage Receivers

The nearest receiver is located at 20 m from the tracks. At this distance, the predicted RMS velocity level of 0.32 mm/s is predicted to comply with the cosmetic damage trigger levels for continuous vibration sources which are listed in Table 3.11. Compliance is also predicted with the less stringent values for transient vibration provided in Table 3.10.

Predicted vibration levels for the closest receiver distances to each line design speed are shown in Table 6.3.

Table 6.3 Predicted ground vibration level for each train speed

Design train speed km/h	Ground borne PPV vibration level, mm/s
60	1.6
80	0.2
100	0.1
105	0.7
110	0.2
115	0.8
125	0.4
145	1.0

7 Process to Seek Feedback

7.1 Design of At-Property Treatment

At property treatment typically consists of upgrades to the building façades that are adversely impacted by rail noise and upgrades to the building ventilation. Façade upgrades may include, for instance, double glazing and acoustic seals for the windows and thicker doors with acoustic seals. Ventilation upgrades may include the provision of mechanical ventilation or air-conditioning for habitable spaces. At property treatment may also include an upgrade of the property fence. Other property specific treatments will be considered as appropriate.

Architectural acoustic treatments will provide a varying level of 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 locomotive noise.

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. Buildings in a state of disrepair (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.

Engagement with the affected property owners should be undertaken by a dedicated stakeholder engagement specialist engaged by ARTC and is considered outside the scope of this Operational Noise and Vibration Review.

8 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 8.1, Figure 8.2 and Figure 8.3.

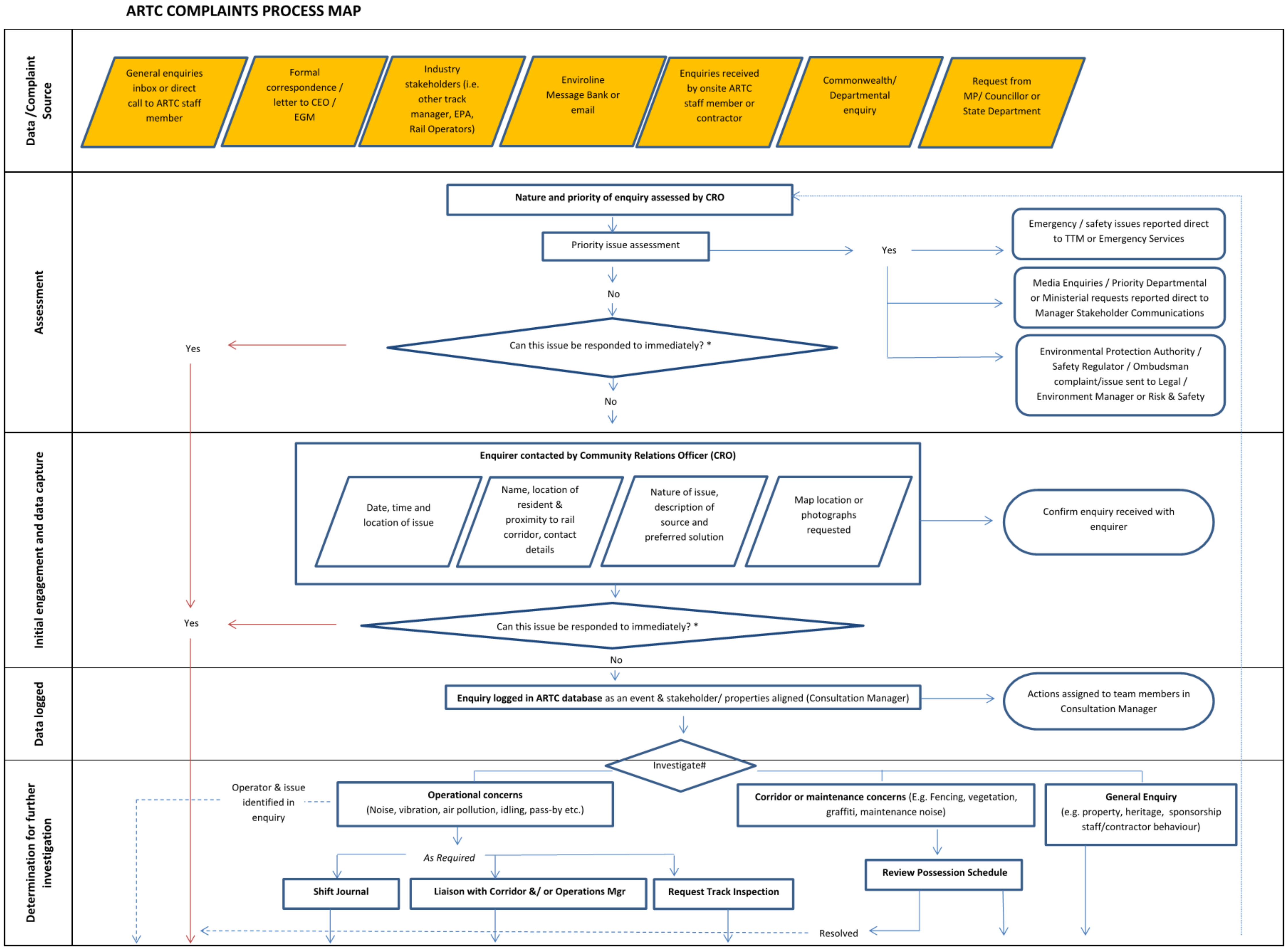


Figure 8.1 ARTC complaints process map (Part 1)

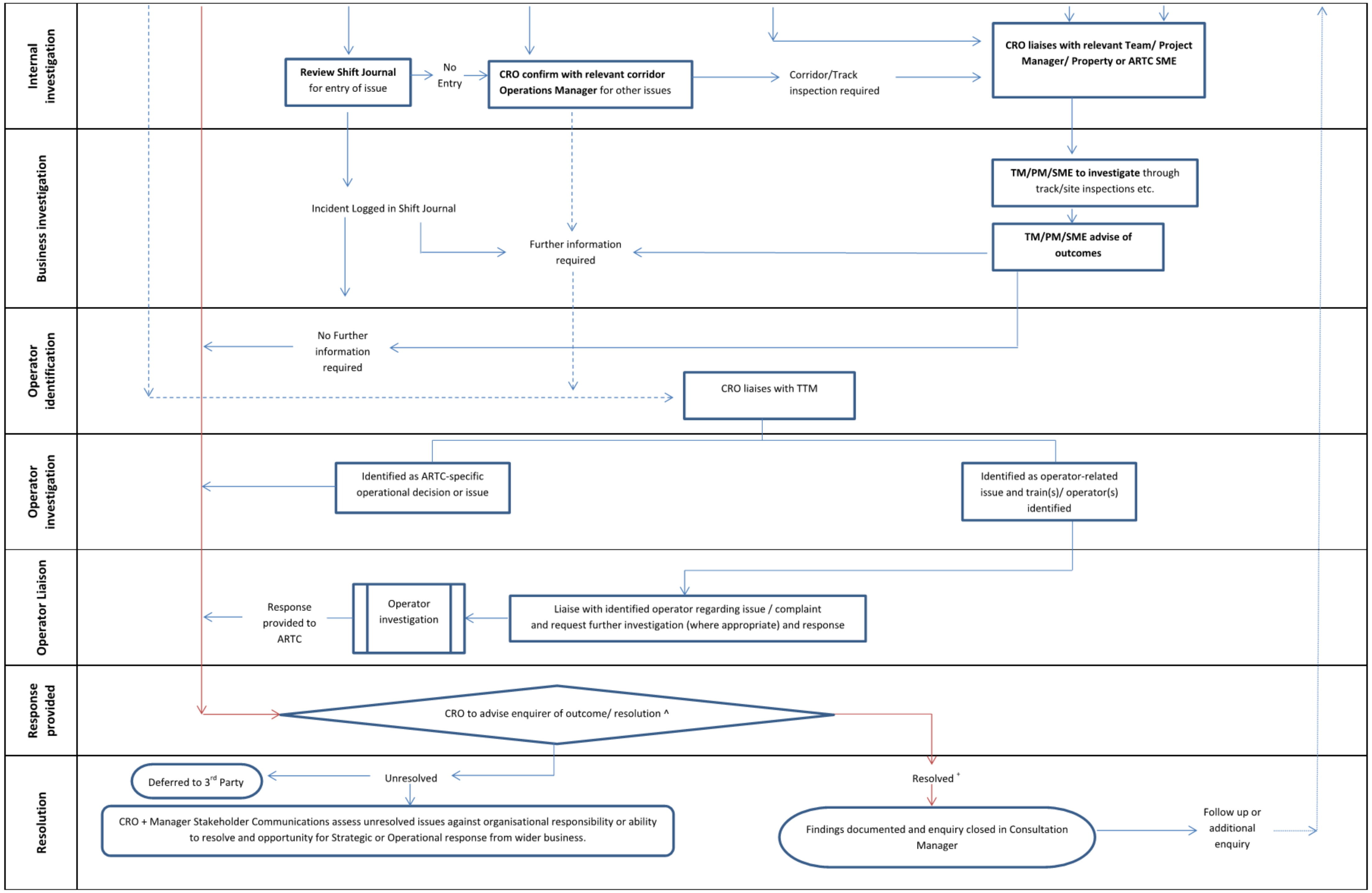


Figure 8.2 ARTC complaints process map (Part 2)

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 8.3 ARTC complaints process map (Part 3)

9 Conclusion

An Operational Noise and Vibration Review was undertaken for sensitive receptors adjacent the Narrabri to North Star Project.

The ONVR has considered operational rail noise, ground vibration and ground borne noise emanating from the rail alignment. Operational road traffic noise from the reconfiguration of Jones Avenue grade separation in Moree, has also been assessed.

A rail noise model was generated based upon a representative version of the 100% Detailed Design rail track alignment, with the later IFC design not changing significantly enough to affect noise modelling results or to warrant any form of remodelling. Noise predictions were undertaken for sensitive receivers identified adjacent to the railway alignment.

Predicted exceedances of the rail noise trigger levels were controlled by the L_{Aeq} noise descriptor, for the night time period:

- Noise predictions for year 2025 identified 34 exceedances of the night L_{Aeq} noise trigger levels; and
- Noise predictions for year 2040 identified 81 exceedances the night L_{Aeq} noise trigger levels.

Two noise mitigation options were considered in designing mitigation for exceedances of the noise criteria: Noise barriers and at-property treatment.

Six noise barriers of various heights and lengths were identified and are recommended for noise mitigation. They are located in areas such as townships where receptors are closely spaced together. Where receptors are sparsely located, it is not considered feasible to mitigate criteria exceedances with noise barriers. The proposed noise barrier design reduces the predicted number of receptors exceeding the trigger levels in 2040 from 81 to 34. IRDJV note that this barrier design may be subject to further rationalisation. Rationalisation of barriers may occur through review of the detailed design, finalisation of surface water management, the constructability assessment and community engagement on noise management and mitigation.

It is recommended that the remaining receptors with residual exceedance of the criteria (after noise barriers are built) are offered at-property treatment. A stakeholder engagement consultant as well as an architect, a builder and an acoustic consultant should be engaged by ARTC, 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. These at-property treatments will likely involve a combination of architectural treatments and property fence upgrades. Assessment and design of at-property treatments is considered outside the scope of this Operational Noise and Vibration Review.

Road traffic noise is predicted to satisfy the relevant criteria levels without provision of additional road noise mitigation for opening year. An isolated receptor marginally exceeds the acute noise level criterion for the 2030 design year, however it is not feasible or reasonable to provide noise mitigation for the marginal level of exceedance predicted.

Ground borne vibration levels from operation of the rail alignment are predicted to satisfy the relevant criteria for both structural damage and human comfort at vibration sensitive locations near the rail corridor without provision of additional rail vibration mitigation.

Ground borne noise levels within dwellings adjacent the corridor is predicted to satisfy the relevant criteria levels without provision of additional rail vibration mitigation.