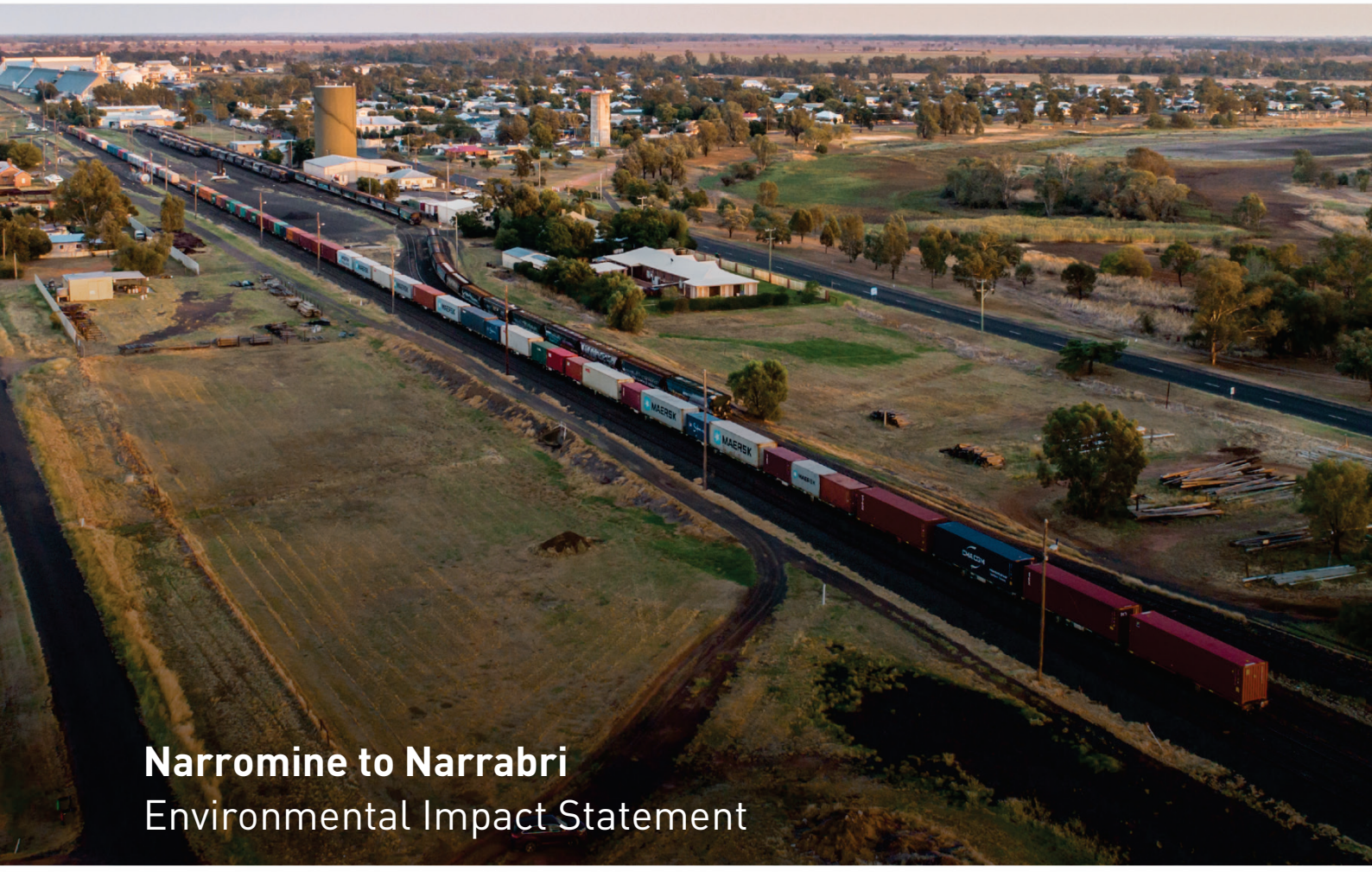
PART B
Impact assessment
proposal infrastructure

INLAND RAIL

CHAPTER B9
Noise and vibration (operation)



Narromine to Narrabri
Environmental Impact Statement

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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B9. Noise and vibration (operation)

This chapter provides a summary of the potential noise and vibration impacts of the Narromine to Narrabri project (the proposal) during operation. Two separate operational noise and vibration assessments of different aspects of the proposal were undertaken. The potential impacts of operating trains along the proposed rail infrastructure are described in Technical Report 9—Noise and vibration assessment—operational rail. The potential impacts of operating other proposed infrastructure (road infrastructure) are described in Technical Report 8—Noise and vibration assessment—construction and other operations. The results of both assessments are summarised in this chapter.

B9.1 Approach

A summary of the approach to the assessments is provided in this section, including the legislation, guidelines and/or policies driving the approach and the methodology used to undertake the assessments. A more detailed description of the approach and methodology is provided in technical reports 8 and 9.

B9.1.1 Legislative and policy context to the assessment

Relevant legislation, policies and guidelines

The assessments were undertaken in accordance with the SEARs and with reference to the requirements of relevant legislation, policies and/or assessment guidelines, including:

- The EP&A Act and POEO Act
- *Rail Infrastructure Noise Guideline* (NSW EPA, 2013)
- *Noise Policy for Industry* (NSW EPA, 2017a)
- *NSW Road Noise Policy* (DECCW, 2011)
- *Noise Criteria Guideline* (Roads and Maritime Services, 2015b)
- *Assessing Vibration: A Technical Guideline* (DEC, 2006a)
- *DIN 4150-3 Structural vibration--Effects of vibration on structures* (German Institute for Standardisation, 2016).

Further information on these, and other relevant standards and guidelines, is provided in section 2 of Technical Report 8 and section 3 of Technical Report 9.

Secretary's Environmental Assessment Requirements

The SEARs relevant to noise and vibration, together with a reference to where they are addressed in the EIS, are provided in Appendix A.

B9.1.2 Methodology

Study area

The study area for the assessment was developed based on the potential extent of noise and vibration impacts during operation. For operational rail noise, the study area was based on a 2 kilometre (km) buffer around the centreline of the new rail corridor. For operational road traffic noise, the study area was based on a 600 metre (m) buffer from the centreline of the outermost traffic lane to focus on the main area with the potential to be impacted.

Key tasks

The tasks used to describe the existing noise environment are summarised in section A8.1.2. The assessment of potential operational noise and vibration impacts involved:

- Identifying and classifying sensitive receivers
- Identifying potential operational noise sources
- Determining operational noise and vibration management levels/criteria in accordance with relevant guidelines
- Defining operational scenarios and assigning appropriate noise emission levels to each scenario
- Undertaking noise modelling for the identified scenarios and noise sources to calculate predicted noise emissions

- Assessing the significance of predicted noise levels by comparing modelling results to the management levels/criteria—the year 2025 was used to represent the commencement of rail operations and the year 2040 was used to represent the year where operations would be at the designed capacity
- Calculating potential ground-borne noise and vibration based on levels from comparable rail freight movements
- Recommending feasible and reasonable measures to mitigate predicted exceedances of the trigger levels.

It is noted that track maintenance was not considered by the operational noise and vibration assessment. The potential noise impacts of maintenance are regulated by ARTC's existing environment protection licence.

B9.1.3 Risks identified

The environmental risk assessment for the proposal (see Appendix E) included consideration of potential operational noise and vibration risks. Operational noise and vibration risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Noise impacts on sensitive receivers from the movement of trains along the new rail line
- Noise impacts from warning signals and train horns at level crossings.

The noise and vibration assessments considered the potential risks identified by the environmental risk assessment, in addition to potential risks and impacts identified by the scoping report (see section A9.1), the SEARs and relevant guidelines and policies (as appropriate).

B9.1.4 How potential impacts have been avoided/minimised

As described in section A6.2, the shortlist of route options for the proposal was subject to a detailed assessment, and the proposed alignment was refined, based on the evaluation of a range of considerations, including potential environmental and community impacts. The alignment avoids population centres and the associated potential for concentrated noise and vibration impacts. Potential impacts have also been avoided/minimised as far as practicable by modifying the alignment at South Narromine, Black Hollow and Curban, where an alternative route location was available with lower potential for community impacts.

The Inland Rail Noise and Vibration Management Strategy has been developed to guide the approach to further minimising the potential for impacts.

B9.2 Operation noise and vibration criteria

This section provides a summary of the criteria used to undertake the operational noise and vibration assessments, according to the potential operational noise sources described in section B9.4.1. Further information about how the criteria were derived is provided in section 2 of Technical Report 8 and section 3 of Technical Report 9.

B9.2.1 Amenity—train movements

Noise criteria

Airborne noise is defined as noise that reaches a receiver through the air. Operational (airborne) noise goals for the movement of trains on the proposed rail line were derived from the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013). The guideline provides non-mandatory noise goals that trigger the need for an assessment to be undertaken and identify where an investigation of noise mitigation would be required.

Residential receivers

In accordance with the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013), predicted noise levels need to exceed the trigger values in Table B9.1 to initiate an assessment of feasible and reasonable mitigation measures. The proposal was categorised as a new rail line development for the purposes of the assessment.

For residential receivers, the criteria have two components—L_{Aeq} (assessed over the day or night) and L_{Amax} (for train pass-by events).

TABLE B9.1 RAIL NOISE CRITERIA (AIRBORNE NOISE)—RESIDENTIAL RECEIVERS

Period	Noise trigger level (external) (dB(A))
Day (7am to 10pm)	60 $L_{Aeq(15hour)}$ 80 L_{Amax}
Night-time (10pm to 7am)	55 $L_{Aeq(9hour)}$ 80 L_{Amax}

Other sensitive receivers

The criteria for other sensitive receivers (for a new rail line) are also provided by the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) and are listed in Table B9.2. These criteria apply when the facility is in use.

TABLE B9.2 RAIL NOISE CRITERIA (AIRBORNE NOISE)—OTHER SENSITIVE RECEIVERS

Sensitive receiver	Criteria (dB(A))
Schools, educational institutions and childcare centres	40 $L_{Aeq(1hour)}$ (internal)
Places of worship	40 $L_{Aeq(1hour)}$ (internal)
Hospital wards	35 $L_{Aeq(1hour)}$ (internal)
Hospital other uses	60 $L_{Aeq(1hour)}$ (external)
Open space—passive use (e.g. parkland, bush reserves)	60 $L_{Aeq(15hour)}$ (external)
Open space—active use (e.g. sports field, golf course)	65 $L_{Aeq(15hour)}$ (external)

Ground-borne noise

Vibration generated through the ground from the movement of trains can cause the floors or walls of a structure to vibrate in some instances. This can result in an audible low frequency 'rumble' noise inside the structure, which is known as ground-borne or regenerated noise.

Trigger levels provided by the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) (see Table B9.3) usually only apply where internal ground-borne noise levels are higher than noise transmitted through the air.

TABLE B9.3 GROUND-BORNE NOISE CRITERIA

Sensitive receiver	Time of day	Trigger level (internal) (dB(A))
A development increases existing rail noise levels by 3 dB(A) or more and resulting rail noise levels exceed:		
Residential	Day (7am to 10pm)	40 $L_{Amax(slow)}$
	Night (10pm to 7am)	35 $L_{Amax(slow)}$
Schools, educational institutions, places of worship	When in use	40 $L_{Amax(slow)}$

The *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) does not include ground-borne noise criteria for other sensitive land uses. The criteria in Table B9.4 have been applied based on those used for other rail projects.

TABLE B9.4 GROUND-BORNE NOISE CRITERIA FOR OTHER SENSITIVE RECEIVERS

Sensitive receiver	Noise trigger level (dB(A))
Medical institutions	40 to 45 $L_{Amax(slow)}$
Retail areas	50 $L_{Amax(slow)}$
General office areas	45 $L_{Amax(slow)}$
Private offices and conference rooms	40 $L_{Amax(slow)}$
Cinemas, public halls and lecture theatres	35 $L_{Amax(slow)}$

Sleep disturbance

The night-time L_{Amax} rail noise management criteria in the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) have been applied to assess potential sleep disturbance impacts. The L_{Amax} criteria accounts for the highest level of noise during train pass-by events.

Vibration—human comfort

For intermittent events, such as train pass-by events, the vibration dose value is applied to assess potential impacts on human comfort. The vibration dose value provides a cumulative measure of the vibration levels associated with all rail operations in a day or night-time assessment period. The vibration dose value considers the combined effects of the level and duration of ground-borne vibration and is suitable for the assessment of transient sources, such as train pass-by events.

Human comfort vibration criteria from *Assessing Vibration: A Technical Guideline* are shown in Table B8.6. Suggested offset distances to achieve the vibration criteria (subject to detailed review) are shown in Table B9.5.

TABLE B9.5 ESTIMATED OFFSET DISTANCES TO MEET VIBRATION LEVELS

	Estimated offset distance to meet vibration criteria (metres)	
Year	**Day (0.2 m/s$^{1.75}$)**	**Night (0.13 m/s$^{1.75}$)**
2025	7	12
2040	8	13

B9.2.2 Amenity—other operations

Road traffic noise

Operational road traffic noise criteria have been defined based on the *NSW Road Noise Policy* (DECCW, 2011) and in accordance with the *Noise Criteria Guideline* (Roads and Maritime Services, 2015b), where applicable. The criteria, which apply externally, are provided in Table B9.6.

TABLE B9.6 OPERATIONAL ROAD TRAFFIC NOISE CRITERIA

Road class	Type of project	Day (7am to 10pm) (dB(A))	Night (10pm to 7am) (dB(A))
Freeway/arterial/ sub-arterial roads	Existing residences affected by noise from **new** arterial or sub-arterial roads.	55 $L_{Aeq(15\ hour)}$	50 $L_{Aeq((9\ hour)}$
	Existing residences affected by noise from **redevelopment** of an existing arterial or sub-arterial road. Existing residences affected by **additional traffic** on existing arterial and sub-arterial roads generated by land use developments.	60 $L_{Aeq(15\ hour)}$	55 $L_{Aeq(9\ hour)}$
Local roads	Existing residences affected by noise from **new or redeveloped** local roads. Existing residences affected by **additional traffic** on existing local roads generated by land use developments.	55 $L_{Aeq(1\ hour)}$	50 $L_{Aeq(1\ hour)}$

Vibration—human comfort

The criteria for potential human comfort vibration impacts are shown in Table B8.6.

B9.2.3 Structural vibration criteria

Train movements

Estimated vibration dose value levels for trains were applied to determine the minimum offset distance from the outer rail, where the vibration criteria would be expected to be achieved (see Table B9.5).

The levels of vibration required to cause cosmetic damage are at least 10 times higher than those at which people can perceive vibration. The criteria provided in section B9.2.1 were used to screen the potential for cosmetic damage impacts.

The criteria for heritage items were determined based on German Standard *DIN 4150-3 Structural vibration—Effects of vibration on structures* (German Institute for Standardisation, 2016) and are as listed in Table B8.8. The three millimetres per second vibration level has been adopted as the vibration objective to provide a conservative assessment of potential impacts on heritage items.

Other operations

The criteria for structural (cosmetic) damage are provided in section B8.2.2.

B9.3 Existing environment

The existing environment, including noise sensitive receivers and noise catchment areas, is as described in section B8.3. Noise catchment areas are shown in figure B8.1.

B9.4 Impact assessment—operation

B9.4.1 Potential noise sources

The following sections summarise the results of the assessment of potential noise and vibration impacts associated with operating:

- Trains (as a result of train movements along the proposed rail line and crossing loops)
- Other proposed infrastructure and activities, including traffic using roads altered as part of the proposal.

Potential noise sources associated with operating trains along the proposed rail line include:

- Movement of train wagons
- Locomotive noise
- Curving noise (such as wheel squeal) and braking
- Idling of trains at crossing loops
- Bunching or stretching of wagons
- Operation of warning bells/alarms at level crossings
- Use of train horns by train operators.

The results of the assessment of potential noise and vibration impacts associated with these noise sources are summarised in section B9.4.2.

Potential noise sources associated with other operational activities include:

- Traffic using the operational access roads, which are mainly located within the rail corridor
- Traffic using upgraded/realigned public roads.

The results of the assessment of potential noise and vibration impacts associated with these noise sources are summarised in section B9.4.3.

The operational maps in Part E show predicted noise levels for affected receivers.

B9.4.2 Noise generated by train operations

Airborne noise levels

Noise levels at 2025

The predicted noise levels during the day achieve the 60 dB(A) noise criterion at the majority of sensitive receivers. The predicted noise levels are two dB(A) above the criterion at one sensitive receiver. Noise from train operations (rolling noise) is the dominant noise source at most receivers.

The predicted noise levels during the night achieve the 55 dB(A) noise criterion at the majority of sensitive receivers. The predicted night-time levels are one 11 dB(A) above the noise criterion at 33 sensitive receivers. Noise from train operations (rolling noise) is the dominant noise source.

Maximum noise levels result from the highest discrete noise event generated by trains passing by, and train operations at level crossings and crossing loops. The predicted maximum noise levels exceed the 80 dB(A) maximum noise level criterion by 11 dB(A) at 35 sensitive receivers. Maximum noise levels may be exceeded for one receiver located near the Narromine West connection; however, this was based on a locomotive type that is not currently operating on this section of track.

Noise levels at 2040

The predicted noise levels during the day achieve the 60 dB(A) noise criterion at the majority of sensitive receivers. The predicted noise levels are two dB(A) above the noise criterion at one sensitive receiver.

The predicted noise levels during the night exceed the 55 dB(A) noise criterion at 58 receivers, with predicted noise levels 12 dB(A) above the criterion.

The predicted maximum noise levels exceed the 80 dB(A) maximum noise level criterion by 11 dB(A) at 35 sensitive receivers. Maximum noise levels may be exceeded for one receiver located near the Narromine West connection; however, this was based on a locomotive type that is not currently operating on this section of track.

Receivers eligible for consideration of noise mitigation

Sensitive receivers are eligible for consideration of noise mitigation where exceedances of the criteria are predicted. A total of 36 sensitive receivers are predicted to experience exceedances of the criteria at the commencement of operations in 2025. An additional 22 sensitive receivers (a total of 58 receivers) are predicted to experience exceedances at full operation in 2040.

The predicted noise levels exceed the assessment criteria by less than five dB(A) at the majority of these receivers (see Table B9.7). As noted above, the highest forecast noise level was 12 dB(A) above the relevant criteria. Exceedances were mainly caused by train movements during the night.

The receivers eligible for consideration of noise mitigation are listed in Table 27 of Technical Report 9 and shown in the operational maps in Part E. An investigation of feasible and reasonable noise mitigation measures to minimise the predicted noise levels at these receivers would be undertaken. Further information is provided in section B9.5.

TABLE B9.7 LEVEL OF EXCEEDANCES AT SENSITIVE RECEIVERS ELIGIBLE FOR CONSIDERATION OF NOISE MITIGATION

Level of criteria exceedance (dB(A))	Number of receivers exceeding criteria
Exceedances at year 2025 (proposal opening)	
1 to 3	23
Greater than 3 to 5	5
Greater than 5 to 10	7
Greater than 10	1
Total	**36**
Exceedances at year 2040 (full operation)	
1 to 3	35
Greater than 3 to 5	11
Greater than 5 to 10	9
Greater than 10	3
Total	**58**

Other potential airborne noise impacts

Trains accessing crossing loops

The assessment of noise levels included the contribution of train operations at the crossing loops. A review of the predicted noise levels at sensitive receivers identified that noise levels from the crossing loops are lower than levels from train pass-by events on the main line and are within the criteria. As the crossing loops are within 4.5 m of the main line, they are not expected to be the primary influence on overall noise levels at sensitive receivers.

Operation of the level crossings

The predicted noise levels were reviewed to determine if train horns and warning bells at level crossings exceeded the assessment criteria. In most cases, while the level crossings are a potential source of noise, predicted noise levels were mainly influenced by train pass-by noise.

Noise levels are predicted to exceed the criteria at sensitive receivers near a proposed level crossing on Cains Crossing Road. Train horns sounding on approach to the level crossing are the main source of noise associated with this crossing.

Potential for sleep disturbance

The predicted noise levels were above the L_{Amax} assessment criteria by up to 11 dB(A) within the night-time period at 35 sensitive receivers. The criteria is generally achieved where receivers are located further than 400 m from the rail corridor.

Guidance on sleep disturbance from the World Health Organization suggests that sleep quality can be preserved where internal noise levels are below a maximum level of 42 dB(A), which conservatively corresponds to a maximum outside level of 49 dB(A). Noise levels could be above L_{Amax} 49 dB(A) within about 1 km of the rail corridor. This distance is a guide to where night-time noise levels may have the potential to result in sleep disturbance impacts. Individuals respond to noise differently and just because rail noise can be audible does not mean it would cause disturbance or annoyance impacts.

Ground-borne noise

Ground-borne noise criteria would be achieved at a distance of greater than 50 m from the outer rail track. Five sensitive receivers are located about 50 m from the outer rail track. While ground-borne noise levels at the majority of sensitive receivers are within the assessment criteria, there can be a risk of minor perceptible ground-borne noise at sensitive receivers.

At this stage of the design, because the building construction of the sensitive receivers is not known, it is not possible to forecast with certainty the indoor ground-borne noise levels that could occur. As described in section B9.5, all noise levels, including ground-borne noise levels, would be reviewed during detailed design to confirm the assessment outcomes and need for mitigation.

B9.4.3 Noise generated by road noise

Operational road noise

Potential operational road traffic noise impacts have been considered for the 21 roads that are subject to more substantial realignments. Of these, five have no nearby receivers. The closest receivers are located at Cains Crossing Road (230 m from the road), Bardens Road (310 m from the road) and Munns Road (340 m from the road). Other receivers are located more than 700 m from the road. One new road is proposed to be constructed to allow for access to Brooks Road and Nalders Access Road off National Park Road. The access road would be provided via a road realignment located about 900 m south of the existing Brooks Road and National Park Road intersection.

Potential traffic noise impacts were modelled for the above roads. The modelling results indicate that no operational road traffic noise impacts are expected. The predicted noise levels are below the road traffic noise criteria at the nearest sensitive receivers.

The operational access roads would be used during maintenance and staff changeovers. It is estimated that this would generate light vehicle movements (estimated at up to two vehicles per day). This level of traffic would be unlikely to cause any noise impacts for surrounding receivers.

Vibration impacts—train operations

General structures

All sensitive receivers are located outside the 13 m offset distance (see section B9.2.3). As the vibration levels are predicted to achieve the criteria for managing human comfort vibration disturbance, the less stringent criteria for managing risk of cosmetic damage to buildings is also expected to be achieved.

Heritage structures

Based on the reference ground-borne vibration velocity for a freight train pass-by event, the peak particle vibration would be within the vibration targets for minimising potential impacts at a minimum distance of 15 m from the nearest rail track.

The non-Aboriginal heritage assessment for the proposal identified 2 listed and 10 potential heritage sites within 400 m of the proposal site. No structures on these sites are located within 15 m of the nearest track.

The potential for structural vibration impacts would be confirmed during detailed design as part of the operational noise and vibration review. This review would take into account condition surveys of potentially affected structures.

Vibration impacts—other operations

Other operations are not predicted to result in human comfort or structural vibration impacts.

B9.5 Mitigation and management

B9.5.1 Approach

Approach to mitigation and management

The key potential operational impact is the predicted exceedances of the noise criteria for train movements. Receivers that qualify for consideration of additional noise mitigation have been identified.

Mitigation measures have been developed with the aim of minimising or mitigating, where practicable, operational noise and vibration impacts. Key measures are described below.

Approach to managing the key potential impacts identified

Operational noise review and design refinements

As the design progresses, the proposal would continue to be refined to minimise the potential for operational impacts. The airborne noise, ground-borne noise, and vibration levels would continue to be assessed during detailed design.

An operational noise and vibration review would be undertaken to confirm noise and vibration predictions based on the final design and how predicted impacts would be mitigated. The operational noise and vibration review would define further design work and iterative modelling required to identify feasible and reasonable mitigation measures for operational noise and vibration. This would involve considering the mitigation options described below.

The operational noise and vibration review would:

- Confirm predicted noise and vibration levels at sensitive receivers, which may include the results of façade testing for non-residential receivers (if required)
- Assess feasible and reasonable noise and vibration measures in a hierarchical manner (as described below)
- Identify options for controlling noise and vibration at the source and/or receiver, including location, type, and timing of implementation
- Include consultation (in accordance with the communication management plan described in chapter A4) to seek feedback from directly affected stakeholders on the proposed measures
- Specify feasible and reasonable measures for affected sensitive receivers
- Include a timetable for delivery of measures prior to operation
- Outline post-operational monitoring to verify noise and vibration predictions.

The proposal would be operated in accordance with the operational noise and vibration review, the conditions of approval for the proposal and the environment protection licence for Inland Rail.

To validate the predicted noise levels, monitoring would be undertaken after the commencement of operation of Inland Rail as a whole. Monitoring would confirm compliance with the predicted noise levels, as modified by a review of feasible and reasonable measures undertaken at the completion of detailed design.

If the results of modelling indicate that the predicted operational noise and vibration levels are being exceeded, then additional feasible and reasonable measures would be identified in consultation with affected property owners (where appropriate) and implemented.

Options for train operation noise mitigation

Feasible and reasonable measures would be investigated where noise and/or vibration levels are determined to be above the criteria, and requiring mitigation, as an outcome of the operational noise and vibration review. Measures would be investigated according to the following hierarchy of control options defined by the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013):

1. Control of noise and vibration at source—measures are incorporated in the design of the rail infrastructure to control noise and vibration emissions
2. Control the pathway for noise to reach receivers—includes options such as noise barriers to screen noise emissions
3. Control of noise impacts at receivers—includes at-property treatments for noise-affected receivers.

Preliminary information on a range of potential noise mitigation options is provided in Table B9.8. These options would be considered during detailed design as part of the operational noise and vibration review. The review of options may determine that a combination of measures would be required to provide reasonable and practicable control of noise and vibration, targeted to achieving the assessment criteria and minimising potential impacts.

TABLE B9.8 KEY POTENTIAL NOISE MITIGATION OPTIONS

Mitigation option	Description
Noise barriers	Noise barriers are typically constructed on the edge of the rail corridor to shield sensitive receivers from noise generated by the movement of trains. Depending on the situation, noise barriers can achieve a 5–15 dB(A) reduction in noise levels, particularly where the line of sight between the sensitive receptor and the source(s) is fully impeded by the barrier structure. Noise barriers can result in visual and cost impacts. They are generally preferable where noise attenuation at a larger number of receivers is required and are not typically cost-effective for a small number of receivers. Earth mounds can sometimes be used as noise barriers and can provide effective mitigation of noise if sufficient spoil and space for the required mound height is available; however, earth mounds generally provide less attenuation of noise than structural barriers and require a larger area to reach a sufficient height.
Rail dampers	Rail dampers are pre-formed elements made of an elastic material containing steel strips. Dampers are placed on the sides of the tracks, dampening the vibration of the rails as the train passes over them, reducing noise emissions. Noise reduction in the order of 2–5 dB(A) can be achieved depending on the rail roughness (the smoother the rail, the less attenuation); however, this is only valid when the wheel–rail interface is the main noise source. In the context of freight train pass-by events, rail dampers would reduce wagon noise but would not attenuate L_{Amax} levels, which are normally dominated by locomotive noise.
Train horn noise	A wayside horn is an automated audible warning located at a level crossing. Instead of the train operator sounding the train horn on approach to a level crossing, the wayside horn automatically sounds to provide a targeted audible noise event for vehicles and pedestrians at the crossing. Use of a wayside horn can remove the need for a train operator to sound the train horn adjacent to sensitive receivers. This could reduce noise levels by more than 10 dB(A) at sensitive receivers and provide a notable improvement in loudness and potential risk of annoyance, particularly where there can be more than two train horn events every hour.
Level crossing warning bells	The design of level crossing alarm (warning) bells would be required to conform to specific design standards. Typically, loud tone alarm bells operate with a noise level of between 85 and 105 dB(A) at 3 m. A soft tone bell design, which has a lower noise emission level (between 75 and 85 dB(A)), could be used, where practicable, to reduce maximum noise levels. The L_{Aeq} noise level would have a more marginal improvement (less than 1 dB(A)) as the noise environment surrounding level crossings is primarily influenced by train pass-by events.
Property controls	The intrusion of rail noise within an affected property can be minimised by at-property measures. This includes architectural treatments, such as acoustic glazing, acoustic window and door seals, acoustic roof insulation and installing air conditioning. Appropriately designed measures, where windows are closed, can mitigate noise by more than 10 dB(A). These measures are most effectively used to control the intrusion of rolling noise. Fencing at the boundary of individual receivers can be upgraded by replacing part or all of the existing fencing with an 'acoustic' fence design. Compared to standard residential property fencing, an acoustic fence, such as aerated concrete (solid masonry), has an improved acoustic transmission loss performance. While the noise reduction performance would be specific to individual properties, upgrades to existing property fencing are likely to be suitable only where noise reductions of less than 10 dB(A) are required.

ARTC applies the following considerations to selecting feasible and reasonable noise mitigation measures:

- Noise barriers are generally only considered where there are groups of affected sensitive receivers. For isolated sensitive receivers, such as single dwellings in rural areas, noise barriers would generally not be considered.
- Noise mitigation for isolated sensitive receivers is expected to include:
  - At-property architectural treatments to the building to control rail noise inside building
  - Upgrades to the property boundary fencing to improve screening of rail noise.
- For two sensitive receivers on the same side of the track, the potential for a noise barrier or architectural treatment of the building would be considered on a case-by-case basis
- For three or more sensitive receivers in close proximity on the same side of the track, noise barriers would be considered as a primary noise mitigation option.

The selection and specification of noise mitigation also requires consideration of a range of other factors, including safety, community, visual amenity, constructability, environmental and cost factors.

Approach to managing other impacts

Validation of noise and vibration levels during operation

Once Inland Rail has commenced operation, operational noise and vibration compliance monitoring would be undertaken at representative locations to compare actual noise performance against that predicted by the operational noise and vibration review. The purpose of the monitoring would be to:

- Quantify the rail noise and vibration levels from the day and night-time rail operations and determine the $L_{Aeq(15hour)}$ day, $L_{Aeq(9hour)}$ night-time and L_{Amax} rail noise levels at the most affected sensitive receivers
- Provide an assessment of the effectiveness of mitigation measures
- Identify any additional measures required to meet the noise and vibration management criteria and relevant conditions of approval.

Expected effectiveness

The measures provide for the management of potential noise and vibration impacts by developing and implementing feasible and reasonable noise and vibration mitigation measures, in addition to ongoing design development. This approach would aim to avoid and minimise potential noise and vibration impacts as far as practicable.

The Inland Rail Noise and Vibration Strategy has been developed to provide a consistent approach to managing noise and vibration across the Inland Rail program and has been developed with consideration of relevant noise and vibration management requirements.

The measures provided have been identified as an outcome of the noise and vibration assessment. The proposed measures have been developed based on best practice, relevant standards and guidelines, and ARTC's experience managing the operation of its rail network. They are expected to be effective in that context.

Interaction between measures

Measures to manage the potential for noise and vibration impacts would assist in managing the potential for socio-economic (amenity) impacts during operation (see chapter B14).

B9.5.2 List of mitigation measures

Measures that will be implemented to address potential impacts on noise and vibration are listed in Table B9.9.

TABLE B9.9 NOISE AND VIBRATION (OPERATION) MITIGATION MEASURES

Stage	Ref	Impact/issue	Mitigation measures
Detailed design	ONV1	*Noise and vibration impacts during operation*	▸ An operational noise and vibration review would be undertaken to review the potential for operational impacts and guide the approach to identifying feasible and reasonable mitigation measures to be incorporated in the detailed design.
	ONV2	*Noise and vibration impacts during operation*	▸ Feasible and reasonable mitigation measures would be identified where exceedances of operational noise and vibration criteria are confirmed ▸ Measures would be identified in accordance with the outcome of the operational noise and vibration review and the Inland Rail Noise and Vibration Strategy ▸ Where at-property noise treatments are identified as the preferred mitigation option, these would be developed in consultation with individual property owners.
	ONV3	*Structural vibration impacts*	▸ If the operational noise and vibration review indicates that vibration levels are predicted to exceed the screening criteria at sensitive receivers, a more detailed assessment of the structure would be carried out ▸ For any heritage items with the potential to be affected, the detailed assessment would determine any specific sensitivities in consultation with a heritage specialist to ensure risks are adequately managed. If a heritage structure is found to be structurally unsound following inspection, a more conservative cosmetic damage objective (e.g. 2.5 mm/s peak component particle velocity for long-term vibration) would be considered.
Operation	ONV4	*Operational noise and vibration*	▸ The proposal would be operated with the aim of achieving the operational noise and vibration criteria identified by the operational noise and vibration review, the requirements of the conditions of approval, and the environment protection licence for Inland Rail.
	ONV5	*Operational noise and vibration*	▸ Operational noise and vibration compliance monitoring would be undertaken, once Inland Rail has commenced operation, at representative locations, to compare actual noise performance against that predicted by the operational noise and vibration review ▸ Compliance monitoring requirements would be defined by the operational noise and vibration review ▸ The results of monitoring would be included in an operational noise and vibration compliance report, prepared in accordance with the conditions of approval. The need for any additional feasible and reasonable mitigation measures would be identified as an outcome of the monitoring.

B9.5.3 Managing residual impacts

Residual impacts are impacts of the proposal that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections A7.2 and A8.1)
- Specific measures to mitigate and manage identified potential impacts (see sections B9.5.1 and B9.5.2).

The key potential construction noise and vibration issues and impacts originally identified by the environmental risk assessment (see section A9.1) are listed in Table B9.10. The (pre-mitigation) risks associated with these impacts, which were identified by the environmental risk assessment, are provided. Further information on the approach to the environmental risk assessment, including descriptions of criteria and risk ratings, is provided in section A9.1.

The potential issues and impacts identified by the environmental risk assessment were considered as part of the operational noise and vibration impact assessment, summarised in section B9.4. The mitigation and management measures (listed in Table B9.9) that would be applied to manage these impacts are also identified. The significance of potential residual impacts (after application of these mitigation measures) is rated using the same approach as the original environmental risk assessment. The approach to managing significant residual impacts (considered to be those rated medium or above) is also described.

TABLE B9.10 RESIDUAL IMPACT ASSESSMENT—OPERATIONAL NOISE AND VIBRATION

Assessment of pre-mitigated risk (see A9.1 and Appendix E)					Mitigation measures (see Table B9.9)	Residual impact assessment			
Phase	**Potential impacts**	**Likelihood**	**Consequence**	**Risk rating**		**Likelihood**	**Consequence**	**Risk rating**	**How residual impacts will be managed[1]**
Operation	Noise impacts on sensitive receivers from the movement of trains along the new rail line	Likely	Moderate	High	ONV1, ONV2, ONV4 and ONV5	Possible	Minor	Low	n/a
	Noise impacts from warning signals and horns at level crossings	Likely	Minor	Medium	ONV1, ONV2, ONV4, ONV5	Unlikely	Minor	Low	n/a

Note: 1. For residual impacts with a risk rating of medium or above.