CHAPTER 16

Noise and Vibration

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

Inland Rail is a subsidiary of
Australian Rail Track Corporation

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16.1 Scope and purpose of chapter

This chapter provides an assessment of potential noise and vibration impacts arising from the Inland Rail—Border to Gowrie Project (the Project).

This chapter addresses the 'noise and vibration' section of the Terms of Reference (ToR), inclusive of ToR items 11.117 to 11.126, and has been updated to address additional information requirements from the Office of the Coordinator-General following the public notification of the draft EIS.

The objectives of the noise and vibration impact assessments are to:

- Identify the land-uses and receptors that are categorised as being potentially sensitive to noise and vibration emissions from the construction and operation of the Project
- Establish criteria and objectives, consistent with regulations, codes of practice, relevant standards and guidelines, for the assessment of noise and vibration
- Provide a detailed assessment of the potential noise and vibration impacts associated with the Project construction works and operation of the Project
- Assess the potential noise and vibration levels against the adopted criteria to quantify noise and vibration levels at sensitive receptors
- Identify reasonable and practicable mitigation measures proposed for the Project and assess their effectiveness at reducing potential noise and vibration impacts.

A detailed description of the proposed construction activities and the future transport operations can be found in Chapter 5: Project Description of the EIS.

This chapter describes the potential noise and vibration associated with the Project. It should be read alongside the following technical reports, which detail the impact assessments that informed this chapter:

- Appendix V: Noise and Vibration Assessment—Construction and Road Traffic
- Appendix W: Noise and Vibration Assessment—Railway Operations.

16.2 Regulatory environment

The relevant policies, standards and guidelines for the regulation and management of noise and vibration in the context of the Project are described in Table 16-1.

Transport infrastructure projects in Queensland are primarily regulated by the codes of practice from the Department of Transport and Main Roads (DTMR) which are statutorily recognised under the *Transport Infrastructure Act 1994* (Qld) (TI Act) or the Environmental Protection Act (Qld) (EP Act).

These codes provide a framework to assess and manage noise and vibration associated with the construction of transport infrastructure and the operation of road transport and railway networks.

Adherence to the applicable requirements of these codes supports the demonstration of General Environmental Duty with respect to environmental harm and nuisance as defined in the EP Act. Discussion on the broader applicability of the EP Act and its regulation is presented in Chapter 3: Legislation and Project Approvals Process.

TABLE 16-1 POLICIES, STANDARDS AND GUIDELINES APPLICABLE TO THE ASSESSMENT OF NOISE AND VIBRATION

Policy, standard or guideline	Relevance to the Project
Transport Noise Management Code of Practice Volume 1—Road Traffic Noise (CoP Vol 1) (DTMR, 2013a)	The CoP Vol 1 is a standard under the TI Act and provides guidance and instruction for assessing and managing the impact of road traffic noise where the Project has delivered new and upgraded roads.
Transport Noise Management Code of Practice: Volume 2—Construction Noise and Vibration (CoP Vol 2) (DTMR, 2023a)	The CoP Vol 2 is gazetted under the EP Act as an applicable code of practice for demonstrating compliance with the general environmental duty and provides the framework for the assessment and management of construction noise and vibration on public amenity and safety.
Interim Guideline—Operational Railway Noise and Vibration: Government Supported Transport Infrastructure (DTMR, 2019c)	The Interim Guideline provides the framework for the assessment of noise and vibration emissions generated by the operation of rollingstock on railways and railway infrastructure.

Policy, standard or guideline	Relevance to the Project
Guideline—*Noise and Vibration from Blasting* (Department of Environment, Science and Innovation (DESI), 2024a)	This guideline sets out performance criteria to manage impacts to human comfort from airblast over pressure and ground vibration.
Application requirements for activities with noise impacts (Department of Environment and Science (DES), 2017)	This guideline advises regulators and operators of an Environmental Relevant Activity (ERA) on the environmental values of the acoustic environment, identifying impacts and risks to the environmental values, and outlines strategies to mitigate the identified impacts.
Noise and Vibration – EIS information guideline (Department of Environment, Science and Innovation (DESI), 2024a)	This guideline advises proponents about the information and assessment requirements in relation to noise and vibration when preparing an Environmental Impact Statement (EIS).
The health effects of environmental noise (enHealth Council – Department of Health, 2018)	This guideline is a review of the health effects of environmental noise. It includes a systematic review of international evidence on the influence of environmental noise on sleep, cardiovascular disease and cognitive outcomes.
Australian Standard 1055–2018 – *Acoustics—Description and measurement of environmental noise* (Standards Australia, 2018c)	The Australian Standard sets out general procedures for the description and measurement of environmental noise. It defines the quantities to be used for the description of noise in community environments and provides basic procedures for the determination of these quantities.
Australian Standard 2187.2-2006 *Explosives—Storage and Use: Use of Explosives* (Standards Australia, 2006a)	The Australian Standard specifies the requirements for the safe use of explosives. Relevant to this assessment, it provides procedures for the calculation of blast vibration and target levels for the management of ground vibration during blasting events.
British Standard BS 5228.1-2009 *Code of practice for noise and vibration control on construction and open sites—Part 1* (British Standards Institution, 2009a)	The British Standard provides best available information on the application of methods for the control of noise and vibration from construction sites. The Standard provides guidance on assessing noise and vibration, including a noise emission database.
British Standard BS 5228.2-2009 *Code of practice for noise and vibration control on construction and open sites—Part 2: Vibration* (British Standards, 2009b)	The British Standard provides methods of measuring vibration and assessing its effects on the environment. It gives recommended methods of vibration control relating to construction and open sites where work activities have the potential to generate vibration.
British Standard BS 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings* (British Standards Institution, 2008)	The British Standard provides best available information on the application of methods of measuring and assessing vibration to assess the likelihood of adverse impacts to building occupants.
Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council (ANZEC), 1990)	This guideline gives recommended criteria to minimise annoyance from blast overpressure and ground vibration, including approaches to limit the times for blasting and frequency of blasting events.
German Standard DIN 4150: Part 3 1999 *Structural Vibration in Buildings—Effects on Structures* (Deutsches Institut für Normung, 1999)	The German Standard is commonly referenced in Australia to establish guidelines levels to evaluate the effects of vibration on buildings and structures.

16.3 Background information

16.3.1 Description of noise and vibration

The terms ‘sound’ and ‘noise’ are interchangeable, with the term noise often used to describe sound that is unwanted. The most common form of noise experienced by people is from the transmission of sound through the air, which is termed airborne noise.

Human hearing does not perceive all frequencies of sound equally, so the measurement of sound often has an adjustment (A-weighting) applied so the sound level corresponds closely to the relative loudness perceived by the human ear. The level of sound is measured and quantified using decibels (dB). The unit ‘dBA’ is the level of sound in decibels with the A-weighting adjustment applied to account for human hearing response and is generally used as the relevant parameter for the measurement and assessment of community noise.

Human hearing response typically falls between the sound frequency range of 20 Hertz (Hz) to 20,000 Hz. The higher the frequency of a sound, the higher the pitch of the sound. A change in sound level of less than 3 dB is typically perceived as no change in loudness, a change of 3 dB to 5 dB can be a noticeable change in loudness and a change of 10 dB is an approximate doubling or halving of loudness; however, the perception of sound is a subjective matter and will vary between people.

Vibration is transmitted from its source to buildings and property via the intervening ground and can be perceived by building occupants when sitting, standing, or lying down. An individual's tolerance to vibration varies over a wide range and is usually influenced by the location, for example whether at home, at work or travelling in a vehicle.

Vibration experienced within buildings can result in audible effects such as ground-borne (regenerated) noise or rattling of building elements or contents. If levels of vibration are sufficiently high, cosmetic damage to buildings or structures can occur in certain circumstances.

In addition to the level of sound or vibration, human perception and response to noise and vibration is sensitive to the characteristics of the emissions and the time, duration, and repetition of the sound or vibration. The descriptors (metrics) of noise and vibration in this assessment consider both the exposure to noise and vibration over defined time periods and the maximum levels from individual events.

Noise and vibration that is clearly perceptible does not necessarily mean that it will be unpleasant, annoying, or disturbing in nature. Often the effects of noise and vibration are diminished (masked) by the sounds in the daily environment, and an individual's sensitivity to noise and vibration can be related to personal expectations, psychological attitudes, and social factors.

16.3.2 Sources of noise and vibration

Sources of noise and vibration from the Project are associated with the construction-phase activities, local road traffic, and the operation of the freight railway. The potential sources of noise and vibration emissions are outlined below and discussed in further detail within this chapter and in Appendix V: Noise and Vibration–Construction and Road Traffic and Appendix W: Noise and Vibration – Railway Operations.

16.3.2.1 Construction equipment

The construction of the Project requires major civil engineering works, such as the construction of viaducts and new rail track, to be carried out along the Project alignment. Supporting the construction works shall be additional services, such as concrete batching facilities and borrow pits to extract building materials.

During the construction phase, sources of noise and vibration include the operation of plant and machinery at the worksites, daily activities at the laydown areas and compounds, and unique events such as localised blasting for excavation. Depending on the complexity of the works, the noise and vibration emissions may vary considerably between construction activities and can vary throughout each day of the works.

An assessment has been prepared to identify the extent and nature of potential noise and vibration impacts at sensitive land-uses from the proposed construction activities. The findings of the assessment are applied to identify the measures required for the control of noise and vibration from construction.

16.3.2.2 Road traffic movements

To accommodate the railway infrastructure and improve access and safety, the Project requires the development of new roads, and realignment and upgrades of existing roads. Substantial changes to the local road network have the potential to influence road traffic conditions, which requires an assessment of future road traffic noise levels and noise-related impacts.

The construction phase has the potential to temporarily increase vehicle traffic on the local road networks. The potential for temporary changes in road traffic noise requires assessment to support the management of noise during the construction phase.

16.3.2.3 Railway movements

The Project introduces new railway operations to areas where there is no existing railway infrastructure and increases train movements where the Project is collocated within the South Western Line and Millmerran Branch Line rail corridors.

The main sources of noise for a freight train are the diesel engine of the locomotives, the engine exhaust located near the top of the locomotive, and the interaction of the wheels with the rails at the lower section of the train. The wheel-rail interaction results in rolling noise and vibration from both the locomotives and the wagons.

Discrete noise events can also occur as trains transfer between tracks at turnouts, and when trains travel uphill, downhill, or along curved track sections. At crossing loops, noise can be produced by idling locomotive engines, acceleration and braking operations, and wagon bunching.

16.4 Methodology

16.4.1 Overview

The assessment of noise and vibration included the following key elements:

- Review relevant policies, standards, guidelines, and legislation and adopt assessment criteria and objectives as the performance requirements for the Project
- Identify the sensitive land uses and receptors that may be potentially affected by noise and vibration generated by the Project
- Establish a noise and vibration study area that encompasses the identified sensitive land uses and receptors and provided an area large enough to assess compliance to the adopted criteria
- Determine suitable calculation methodologies for the prediction of noise and vibration impacts from construction activities, road traffic and rollingstock operations
- Develop construction noise assessment scenarios based on the proposed works
- For the construction noise assessment, determine suitable approaches and assumptions for the construction noise modelling, construction ground vibration modelling, blasting overpressure and vibration modelling, and construction road traffic noise modelling
- For the operational road traffic assessment, determine an approach based on initial screening assessments and follow-up detailed assessments
- For the operational railway noise and vibration assessment, determine suitable modelling parameters, in accordance with the Interim Guideline and other relevant guidelines.

Airborne noise from the construction, road traffic, and railway operations has been calculated using the SoundPLAN noise modelling software. SoundPLAN is widely applied in Australia for the prediction of noise from construction activities and transport infrastructure. The software produces a detailed 3D reproduction of the Project and its surrounding environment. It models airborne noise applying the methodologies described in the applicable regulations.

Ground-borne noise and vibration levels and blasting emissions were calculated using industry standard formulae that consider the propagation of ground vibration, and transmission of vibration within buildings and structures. The calculations include the vibration emission, the dominant frequencies of vibration energy, and the vibration amplification and loss effects within the environment and receptor buildings.

Each assessment method adopted a conservative approach to assess the expected worst-case levels of noise and vibration from construction activity, the road traffic and railway operations associated with the Project. Worst-case noise and vibration levels are anticipated during the most intensive activities, such as simultaneous use of all relevant construction plant, the busiest road traffic conditions, and the days when peak railway traffic occurs.

Conducting a worst-case assessment allows for the early identification of reasonable and practicable noise and vibration management measures required to comply with the regulatory regulations. It also proactively addresses the most severe potential impacts and ensuring compliance through strategic planning and mitigation.

16.4.2 Identifying sensitive receptors

A detailed review was undertaken to identify properties and structures for each land use that would be categorised as being sensitive to noise and vibration, in accordance with the codes of practice and regulatory guidelines. A variety of resources were relied upon to identify the individual land-uses and receptors within the study area, including:

- National geospatial datasets of building footprints and structures from Geoscape Australia
- LiDAR scan data
- High resolution aerial imagery.
- Land property information with the Queensland Property Database
- Review of development application approvals within the Goondiwindi and Toowoomba local government areas (LGAs)
- Identification of protected areas from the Queensland Government QSpatial Catalogue
- Observations made within the townships and public areas along the Project alignment
- Feedback on the location and type of various properties obtained by ARTC as part of the community and stakeholder consultation.

Structures such as sheds, garages and storage areas were identified and categorised as non-sensitive land uses and receptors.

The sensitive land uses and receptors identified within the noise and vibration study area are described in the existing environment section of this chapter (Section 16.5) and represented in the map series in Figure 16-7.

16.4.3 Noise and vibration study area

The study area for the noise and vibration assessment covers a region at least 2 km either side of the construction work areas, the proposed new and upgraded roads, and the railway corridor. The study area was sufficient to assess compliance with the adopted noise and vibration criteria and to evaluate the anticipated worst-case impacts from the Project's construction and operation. Further detail on the study is provided in Appendix V: Noise and Vibration – Construction and Road Traffic and Appendix W: Noise and Vibration Assessment – Railway Operation.

16.4.4 Construction noise and vibration assessment methodology

16.4.4.1 Assessed construction activities

The construction of the Project is expected to be undertaken in stages. The assessment of construction noise and vibration has categorised the construction stages based on the expected work activities and whether works would be in a fixed location, such as the construction of the laydown areas, or be required at multiple locations along the alignment, for example the earthworks and rail installation works.

The construction activities/stages of works have been broken into a series of construction scenarios; each defined as a set of activities involving several scheduled equipment items, each operating within a specific area of authority, during specified times.

16.4.4.2 Hours of Construction work

Primary hours of construction

The majority of the construction works for the Project will be undertaken during the day. To shorten the duration of the construction period as far as practicable and minimise potential impacts to the community the following primary construction hours are proposed:

- Monday to Sunday 6.00 am to 6.00 pm
- No work on public holidays
- Blasting activities would only be undertaken during the hours of:
  - Monday to Friday 9.00 am to 3.00 pm
  - Saturday 9.00 am to 1.00 pm
  - No blasting Sundays and public holidays.

The hours indicate the start and end times for daily construction work. Each day begins with preparation activities and mobilisation of work crews and ends with task completion and securing the work site. Intensive construction work begins once the initial daily setup is complete and concludes as part of the end-of-day shutdown tasks.

Works outside the primary hours of construction

Depending on the nature of the works some activities may need to be undertaken outside of the primary construction hours. Construction works outside of the primary hours may occur throughout the duration of the construction program in the following scenarios:

- Work during rail corridor possession. Where works are required within the active railway corridor of the South-Western system it will be necessary to undertake works under track possessions, during which the contractor has control over an existing railway corridor. Extended work hours may be required during this time to enable works to be undertaken safely and to shorten the overall duration of disruption to the rail industry during the necessary closure of the South-Western system during construction works.
- The delivery of oversized plant or structures that police or other authorities have determined requires special arrangements to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent or contain environmental harm
- Works to ensure construction personnel, road user or public safety
- In the event of significant weather approaching the construction site and protective works are required or weather sensitive works must be completed
- Delivery of 'in time' concrete, steel, and other construction materials and components delivered to site by heavy vehicles
- Movements of heavy plant and materials
- Transport, assembly, or decommissioning of oversized plant, equipment, components, or structures
- Works that require continuous construction support, such as continuous concrete pours, pipe-jacking or other forms of ground support necessary to avoid a failure or construction incident

- Works that cannot be undertaken during the day due to ambient daytime temperatures such as rail tamping where the stress-free temperature of the rail cannot be achieved during the primary hours of construction
- Haulage along the rail corridor
- Roadworks to local and arterial roads, including works required to maintain the safety of motorists and workers
- Traffic-control crews, including large truck mounted crash attenuator vehicles, medium rigid vehicles, and lighting towers
- Incident response including tow-trucks for light, medium and heavy vehicles
- Arrival and departure of construction staff during shift change-overs
- Where a negotiated agreement is reached with sensitive receptors (owners and occupiers) to carry out works in accordance with the construction hours specified in the negotiated agreement.

16.4.4.3 Modelled construction scenarios and associated equipment

The construction scenarios and the primary noise and vibration generating plant and equipment included in the assessment are detailed in Table 16-2. Detailed in the table are the overall sound emission levels for the construction, which represent the total level of sound emitted by all required plant and equipment.

The sound power level (SWL) data has been sourced from Australian Standard: AS 2436-2010: *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436) and British Standard (BS) 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* (BS 5228.1), which guides the assessment of noise and vibration from construction sites.

The emission data for the construction plant includes the reduction in noise achieved by the conventional mitigation measures adopted during the construction of transport infrastructure, such as the Project. This includes enclosures on generators, mufflers on exhausts, and the application of modern well-maintained equipment.

TABLE 16-2 CONSTRUCTION STAGES AND PROPOSED WORK ACTIVITIES

Construction stage	Activities	Plant and equipment	Overall SWL dB(A)
Site setup/ laydown areas	• Establishment of site compounds/laydown areas and site facilities • Potential construction of water storage dams to harvest/store construction water • Haul road and access roads construction	• Grader • Dump truck • 40 tonne (t) excavator • Water cart	• 122
Establishment of accommodation camps	• Construction of non-resident workforce accommodation at Lot 30 on MH721 (Cunningham Highway, Yelarbon), and Lot 5 on MH75 (Millmerran-Inglewood Road, Inglewood)	• Grader • Dump truck • 40 tonne (t) excavator • Water cart	• 122
Operation of accommodation camps	• Operation of the temporary accommodation camps at Lot 30 on MH721 (Cunningham Highway, Yelarbon) and Lot 5 on MH75 (Millmerran-Inglewood Road, Inglewood)	• Water treatment plant • Sewage treatment plant • Loading dock activities • Rooftop mechanical plant • Generator • Outdoor recreation • Air-conditioners	• 112
Operation of concrete batch plants	• Operation of the concrete batch plants at laydown areas B2G-LDN138.5 and B2G-LDN150.5	• Concrete batch plant • Front end loader • Concrete truck	• 116

Construction stage	Activities	Plant and equipment	Overall SWL dB(A)
Whetstone MDC site establishment	‣ Establishment of the Whetstone MDC site	‣ Excavator ‣ Dozer ‣ Dump truck ‣ Chainsaw ‣ Water cart ‣ Grader ‣ Scraper ‣ Compactor ‣ Roller ‣ Moxi truck	‣ 123
Whetstone MDC combined activity noise with laydown area activities	‣ Operation of the Whetstone MDC including stockpiling of rail (including occasional sand blasting), sleepers, ballast, workshop activities and laydown area activities	‣ Cranes ‣ Conveyors ‣ Electric motors ‣ Sand blasting equipment ‣ Grinding equipment ‣ Welding units ‣ Generators ‣ Forklift ‣ Locomotives ‣ Trucks	‣ 121 without sand blasting ‣ 126 with sand blasting
Borrow pit site establishment	‣ Establishment of the borrow pits at six locations	‣ Dozer ‣ Grader ‣ Road truck	‣ 117
Borrow pit site operations	‣ Excavator extraction of material from borrow pits ‣ Mechanical screening and grading of material (if required) ‣ Transporting of material from site	‣ 40 t excavator with rock breaker ‣ Tracked semi-mobile crusher (90 t) ‣ Road trucks ‣ Front end loader	‣ 125
Earthworks – clearing and grubbing	‣ Clearing and grubbing/topsoil stripping	‣ Dozers ‣ 40 t excavator ‣ Trucks ‣ Scraper ‣ Water cart ‣ Mulcher	‣ 121
Earthworks – cut and fill	‣ Cut to fill ‣ Import general fill ‣ Place and compact general fill ‣ Import structural fill ‣ Place structural fill	‣ Dozers ‣ Scraper ‣ Water cart ‣ Grader ‣ Compactor ‣ Padfoot roller ‣ Trucks	‣ 122
Earthworks – preparation for blasting	‣ Drilling of holes in preparation for blasting	‣ Drill rig ‣ 40 t excavator ‣ Trucks	‣ 119
Drainage	‣ Install cross drainage	‣ Backhoe ‣ 30 t excavator ‣ Hiab ‣ Compactor ‣ Concrete truck ‣ Concrete pump ‣ Franna crane	‣ 115

Construction stage	Activities	Plant and equipment	Overall SWL dB(A)
Structures - substructure	▸ Piling and construction of the bridge foundations	▸ 40 t excavator ▸ Bored piling rig ▸ Impact piling rig ▸ Concrete truck ▸ Concrete pump	▸ 118 bored piling of foundations ▸ 121 impact piling of foundations
Structures - piers	▸ Construction of the bridge piers	▸ 40 t excavator ▸ Crane ▸ Concrete truck ▸ Concrete pump ▸ Concrete saw	▸ 118
Structures - superstructure	▸ Construction of the bridge superstructure (deck)	▸ Crawler crane ▸ Crane ▸ Flatbed trucks	▸ 108
Rail civil works – bottom ballast	▸ Delivery and placement of the bottom ballast layer	▸ Trucks ▸ Dozer ▸ 40 t excavator ▸ Water cart ▸ Grader ▸ Smooth drum roller	▸ 116
Rail civil works – sleeper and rail installation	▸ Sleeper installation ▸ Rail installation	▸ Flatbed trucks ▸ Front end loader ▸ 20 t excavator	▸ 111
Rail civil works – ballast tamping and regulating	▸ Ballast tamping and regulating	▸ Tamper ▸ Regulator ▸ 20 t excavator ▸ Water cart	▸ 120
Road civil works – road base	▸ Construction of the road base	▸ Grader ▸ 30 t excavator ▸ Compactor ▸ Water cart ▸ Trucks (on road tandem)	▸ 115
Road civil works – pavement	▸ Pavement construction	▸ Bitumen seal sprayer/chip sealer ▸ 14 t roller	▸ 113

16.4.4.4 Construction noise modelling

Predicted noise levels from the Project construction works have been assessed by the following approach:

- SoundPLAN version 8.2 computer noise modelling software has been used to predict $L_{Aeq,adj,15min}$ construction noise levels for the key construction stages. The prediction model considers the effect from ground topography, ground absorption, buildings and the location of the noise source and receptors within the study area.
- The acoustically significant construction activities/ stages of works have been broken into a series of construction scenarios (18 in total) each defined as a set of activities involving several scheduled equipment items, each operating within a specific area of authority, during specified times.
- Noise predictions adopted a downwind setting that enhances the propagation of noise from the construction noise sources to each of the sensitive receptors. This is a conservative approach for local weather conditions.
- The construction noise levels were predicted and assessed based on the standard and non-standard hours defined in the CoP Vol 2. The standard and non-standard hours from this code are applied as a threshold for the implementation of noise (and vibration) management measures during the proposed construction works.

The assessment methodology purposely adopted conservative approaches and assumptions to establish the potential worst-case noise levels from the construction of the Project.

The factors adopted in the assessment, include:

- The study area.
- The typical loudest 15-minute period of construction activity has been conservatively assessed for noise-intensive work activities, where the loudest equipment operates at the same time and is also located at the shortest anticipated distance to the receptors.
- Worst-case weather conditions that could enhance the propagation of noise from construction works towards the sensitive land-uses and receptors have been conservatively applied to all calculations.
- The lower and upper construction noise limits were established from the CoP Vol 2 with reference to the measured background noise and the work periods.

16.4.4.5 Construction ground vibration modelling

The methodology for the prediction of ground vibration levels from the proposed Project construction sources was based on the following conservative, industry accepted sources recommended by the CoP Vol 2:

- Hydraulic breakers, jackhammers, and plate compactors—California Department of Transportation's, Transportation and Construction Vibration Guidance Manual, specifically Section 7.1.3 '*Vibration Amplitudes Produced by Hydraulic Breakers*' and Section 7.2 '*Vibration Produced by Other Construction Equipment*'
- Vibratory rollers, vibratory piling (sheet piling), percussive piling (impact piling)—British Standard BS 5228-2:2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 2 Vibration* (BS 5228.2), specifically Table E.1 '*Empirical predictors for groundborne vibration arising from mechanized construction works*'. The applicable equations in BS 5228.2 Table E.1 utilised in this study are consistent with those presented in the Hiller and Crabb (2000) '*Groundborne vibration caused by mechanised construction works*' report (Transport Research Laboratory report 429).

The vibration assessment used empirical relationships to quantify potential ground-borne vibrations from key vibration-generating equipment, including vibratory piling, impact piling, and compaction. The calculations incorporated conservative assumptions, such as accounting for stiff soils and the high energy required to break rock and compact materials.

Ground vibration prediction equations for the individual equipment/activities are summarised in Table 45 Appendix V Noise and Vibration Assessment – Construction and Road Traffic.

16.4.4.6 Blasting overpressure and ground vibration modelling

The assessment of potential for airblast overpressure and/or ground vibration impacts associated with blasting for the Project has been conservatively based on the following industry guidance:

- The attenuation formula in Australian Standard AS 2187.2 – 2006 *Explosives- Storage, Transport and Use – Part 2 Use of Explosives* (AS 2187) and ICI Explosives (now Orica) Blasting Guide 1995
- Calculation of Maximum Instantaneous Charges (MIC) masses (per delay) in kilograms (kg) to comply with the blasting criteria.

The blasting assessment determined the Maximum Instantaneous Charge (MIC) of individual blasts needed to achieve predicted compliance with airblast overpressure and blast vibration limits, based on the proximity of the closest sensitive receptors to the proposed blasting sites.

The assessment methodology and formulas for estimating airblast overpressure and ground vibration are detailed in Appendix V Noise and Vibration Assessment – Construction and Road Traffic.

16.4.4.7 Construction road traffic noise modelling

Onsite construction traffic has been included in the modelled scenarios and assessed accordingly. For offsite construction vehicle movements associated with the Project, haulage of material to/from the site as well as construction light vehicles would add to the traffic on the existing road network.

The effect of construction-related vehicle traffic on the noise emission from roadways may be assessed by calculating how the additional traffic would alter the level of noise emission from roadways using the Calculation of Road Traffic Noise (CoRTN) prediction algorithms. On a given roadway, the essential modelling inputs that the additional construction traffic will alter are the percentage of heavy vehicles and total vehicle numbers utilising that roadway. It is assumed all other parameters required for CoRTN predictions would remain the same (i.e. vehicle speed, pavement surface type, road gradients, etc).

Construction vehicle movements and existing traffic flows have been based on information derived from Appendix AA: Traffic Impact Assessment. The traffic volumes used for the basis of this assessment are the median minimum hourly existing traffic and the corresponding peak hour construction traffic flows from the Project.

16.4.5 Operational road traffic noise assessment methodology

The assessment of operational road traffic noise levels applies only to the sections of roads modified or added by the Project and does not consider the predicted cumulative road traffic noise level (i.e. of all surrounding roads) where the surrounding roads do not contribute to the total noise level exposure at individual receptors.

The Project comprises the construction of new road segments and modification works to existing road segments. Several road segments have low existing traffic volumes and are located further than 300 m from the nearest sensitive receptor. For this reason, the assessment of operational road traffic noise has been completed using the following methodology:

- Screening assessment: an initial screening assessment was carried out for all road segments to identify where the CoP Vol 1 road traffic noise criteria may potentially be exceeded. Where compliance with the applicable noise criterion is comfortably predicted (i.e. at least 3 dBA below the criterion), further assessment of road traffic noise was not required. Where the predicted future road traffic noise level exceeded or was within 2 dBA of the applicable criterion, a detailed assessment was undertaken.
- Detailed assessment: involved completing a detailed assessment of operational road traffic noise, considering:
  - the pre-construction road traffic noise measurement results
  - verification of a 3-D noise model against the measurement results
  - 3-D model predictions of future road traffic noise levels.

16.4.6 Operational railway noise and vibration assessment methodology

The operational railway noise and vibration assessment has been undertaken in accordance with the Interim Guideline, which provides criteria and assessment methodologies for noise and vibration from rolling stock operations on a railway, such as the Inland Rail.

The guideline requires reasonable and practicable measures to be implemented to prevent or minimise environmental harm and nuisance from noise and vibration associated with railway operations. To support the assessment of noise impacts, the enHealth guideline '*The Health Effects of Environmental Noise'* was referenced for guidance on sleep disturbance effects.

For railway infrastructure projects if the operational noise and vibration levels are measured or predicted to exceed the established criteria at sensitive land uses, mitigation measures are to be considered.

The aim of these mitigation measures is to reduce the noise and vibration levels to meet the criteria and to attenuate associated impacts, where reasonable and practicable.

16.4.6.1 Railway noise and vibration modelling

This section describes the key aspects of the proposed railway operations on the Project and the application of these inputs in the modelling and assessment of railway noise and vibration. Further detail on the railway operations and the noise and vibration modelling inputs is provided in Appendix W: Noise and Vibration Assessment – Railway Operations.

The assessment covers the potential railway noise levels at the Project Opening and the future long term railway operations on Inland Rail in 2040. These operations account for the projected movement of goods and material (tonnage) on the Project.

The proposed train movements are derived from the tonnage predictions and are directly linked to the expected future demand for freight services. The tonnage predictions account for the demand of inter-capital, intermodal and regional agricultural freight, the effects of climate change, the economic and industrial demands of the future road freight, coal processing volumes, and exchange rates.

The Interim Guideline requires noise and vibration to be assessed based on the 'typical worst-case (e.g., typical maximum operating conditions)'. For the Project, this is the peak daily train services, which account for the maximum forecast operations, including the seasonal agricultural services.

The noise assessment adopted the train movements in Table 16-3, which are the total train movements per 24-hour periodand are rounded to integers to assess a complete train pass by. The total movements are equally distributed to determine the northbound and southbound daily train movements, based on rail forecasts of train departure times. In addition, these total train movements were proportioned equally over the during the night period (10:00 pm–6:00 am) for the night-time sleep disturbance assessment.

While the Project will facilitate rail traffic in both directions on the same line, the noise modelling can account for the direction of travel and the train movements are divided by two to obtain the daily train movements in each direction.

TABLE 16-3 DAILY TRAIN MOVEMENTS ON THE PROJECT

Train services	Train movements [a]	
	Peak 2028 [b]	Peak 2040
MB Express (Bromelton)	1	2
MB Express (Acacia Ridge)	1	2
MB Superfreighter (Bromelton)	5	6
MB Superfreighter (Acacia Ridge)	1	1
GB Superfreighter (Bromelton)	2	3
GB Superfreighter (Acacia Ridge)	1	2
Narrabri – Port of Brisbane Grain	2	3
Yelarbon – Port of Brisbane Grain	2	3
Narrabri – Port of Brisbane Export	1	2
Yelarbon – Port of Brisbane Cotton	1	1
Total per 24-hours	**17**	**25**

Table notes
a: The railway noise assessment considers only whole trains, the train movements are rounded up to the nearest integer.
b: 2028 has been used as the operation start date for assessment purposes only. Construction schedules assumed for the purposes of EIS technical assessments have been based on information available at the time of assessment and are subject to change. The assumptions made regarding construction schedules are considered suitably conservative and appropriate for the purposes of EIS impact assessment and any changes unlikely to alter the outcomes and conclusions presented in the EIS.

To control the speed of the trains, the locomotives have a series of throttle controls, known as notches. Most locomotives have up to eight notches and follow the operational principles below. The assessment adopted the following locomotive operations for the prediction of worst-case noise levels:

- When operating on relatively flat or moderate gradients the locomotive would generally be operated at a medium notch setting (notch settings 3, 4 or 5).
- On downhill gradient track, all trains were assessed to require the use of dynamic braking where the traction motors that drive each locomotive axle are used to slow the train. Dynamic braking can be a source of additional noise as the radiator cooling fans are used to dissipate heat energy from resistor banks on the locomotive.
- For uphill gradients, all trains were assumed to operate at high notch settings (notch setting 6, 7 or 8) to maintain line speed uphill.

The noise modelling applied speed profiles for each train type based on worst-case operational train speeds. The following are assumed in assigning modelling speeds:

- All trains are modelled at no less than their maximum potential line speed for non-stopping services travelling along the mainline. This includes a consistent 115 km/h for the interstate and super-freighter services and all other services such as grain and cotton trains at the safe maximum and permitted speed granted for freight rail transport operators services, which is a consistent 80 km/hr unloaded and 60 km/hr loaded.
- No allowance is made for trains to slow due to track features such as terrain/gradient or curvature. Not allowing for reductions in speed due to train performance over terrain/gradient or curvature on the main line adds further conservatism to the modelled speed profiles and associated noise level predictions.
- Trains stopping at crossing loops (roughly one in four trains) are modelled at 45 km/h which is the posted speed at crossing loops.

The maximum potential line speed of the trains on the Project alignment, applied to the noise modelling, are detailed in Figure 16-1 and Figure 16-2.

Other key elements of the railway noise level predictions included:

- A verified noise emission database for the locomotives expected to operate on Inland Rail
- Each train was assumed to operate with the maximum number of locomotives and wagons to provide predictions based on the longest expected trains
- Consideration of the noise emissions associated with double-stacked container freight
- Noise emissions correction factors for railway and track features including bridges, viaducts, track at level crossings, and turnouts
- At each crossing loop it was assumed one in four trains would be held at each of the five crossing loops. In practice, a train would only be held on a crossing loop when necessary to facilitate a train moving in the other direction.

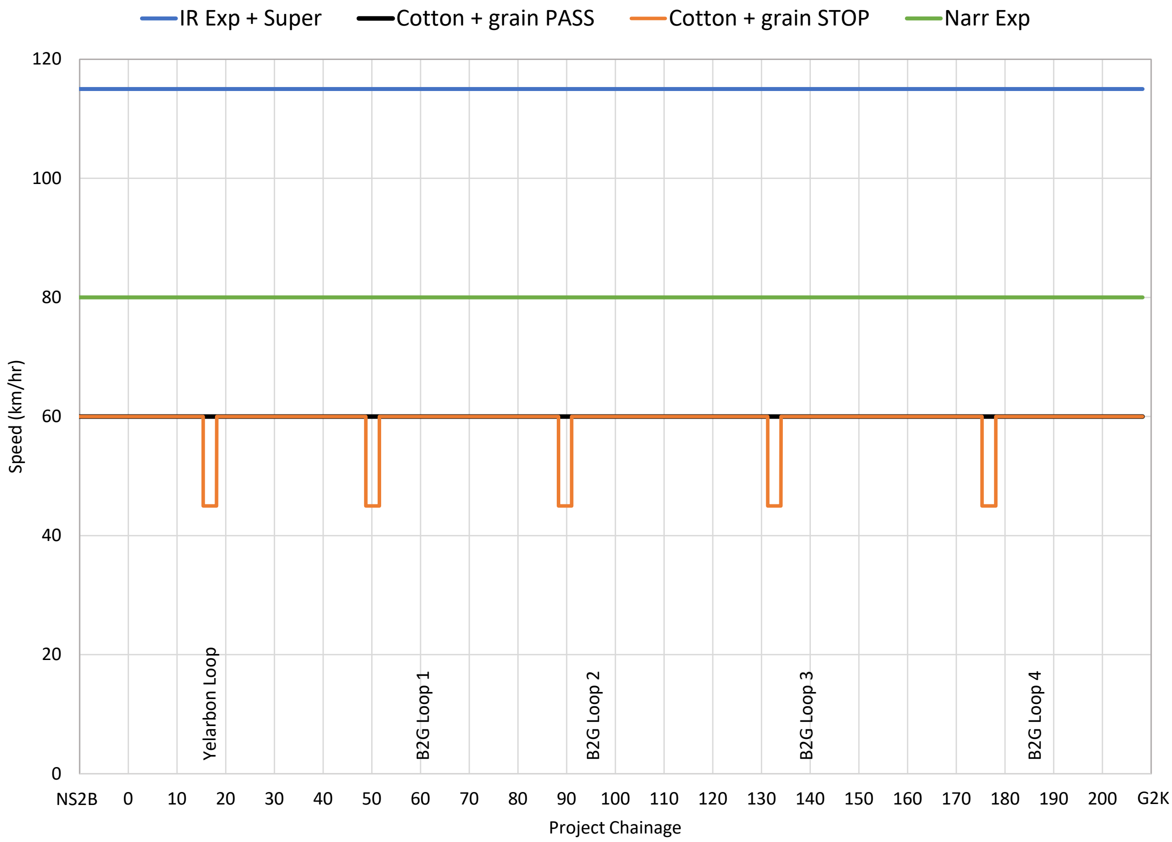


FIGURE 16-1 OPERATIONAL TRACK SPEED PROFILE, BORDER TO GOWRIE DIRECTION

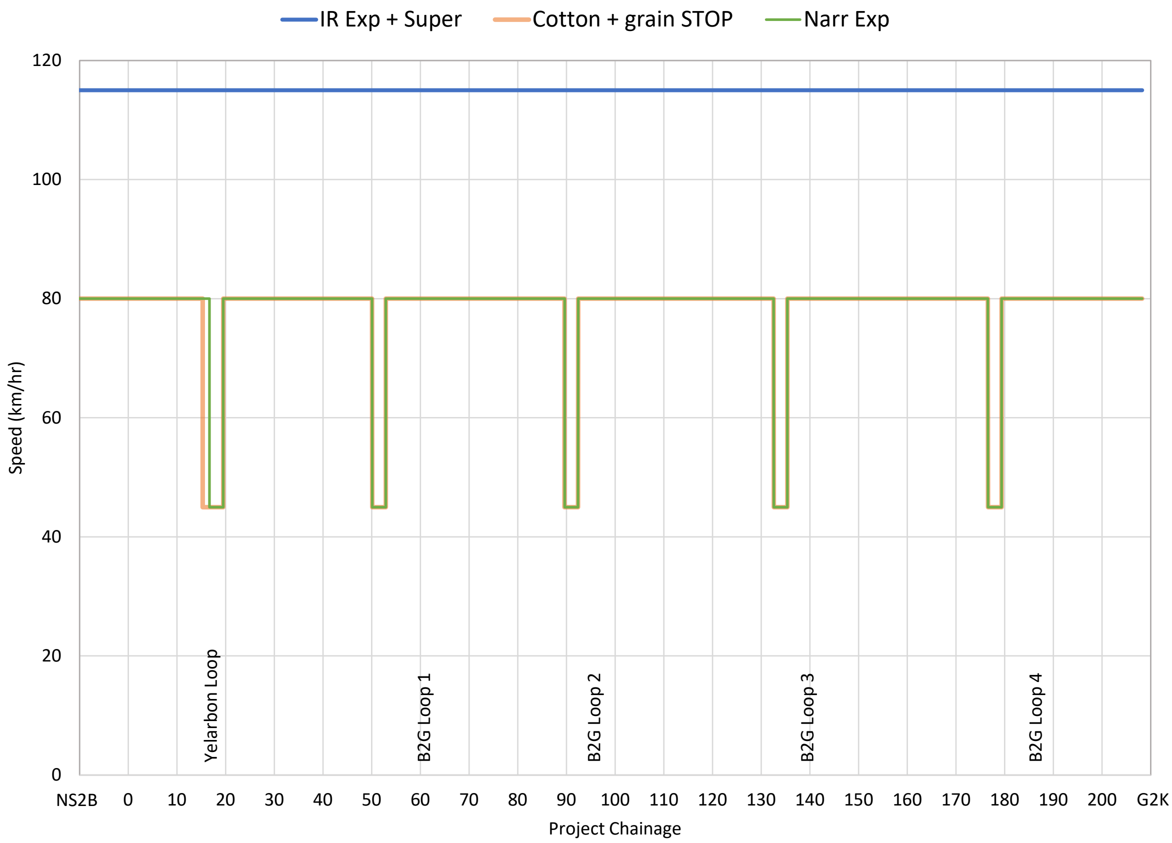


FIGURE 16-2 OPERATIONAL TRACK SPEED PROFILE, GOWRIE TO BORDER DIRECTION

16.5 Existing environment

The existing environment section of this chapter describes the land uses and receptors that are identified as being sensitive to noise and vibration. It also describes the existing noise and vibration environment in the communities along the Project.

16.5.1 Sensitive land uses and receptors

The route passes through rural towns including Yelarbon, Inglewood, Millmerran, Brookstead, and Pittsworth with individual rural residential properties and agricultural lands interspersed along the alignment.

The land use and receptor categories that are potentially sensitive to noise and vibration are defined in various regulatory guidelines for Queensland. The following categories have been adopted from CoP Vol 1 (road traffic), CoP Vol 2 (construction) and the Interim Guideline (rollingstock operations).

The category of accommodation activities includes:

- A dwelling house, townhouse, dwelling unit, community residence, dual occupancy, multiple dwelling, or home-based business
- Residential care facility, resort complex, retirement facility, rooming accommodation, relocatable home park, caravan park, reformatory institution, short-term accommodation, or tourist park
- Non-residential workforce accommodation, rural works' accommodation, and caretaker's accommodation.

A range of community uses are identified, which are not accommodation activities, including:

- Educational establishments, including colleges and primary and secondary schools
- Childcare centres, creches, early childhood centres, kindergartens, school playgrounds, and preschools
- Healthcare services, including medical centres, health clinics, hospitals, and surgeries
- Places of worship
- Courts of law, art galleries, rural fire brigade stations, community halls, libraries, and museums
- Commercial premises such as offices and retailed facilities
- Public parks or gardens for use other than for organised sport or entertainment, including war memorials and similar sites that can be sensitive to vibration
- A protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the *Nature Conservation Act 1992* (Qld)
- Non-Indigenous sites of heritage significance, as detailed in Appendix Z: Non-Indigenous Cultural Heritage Survey Report. These receptors are considered potentially sensitive to vibration, not noise.

Approved developments that once constructed become sensitive land uses have been considered in the assessment of noise and vibration impacts. A review of material change of use (MCU) and operational works applications for the Goondiwindi and Toowoomba LGAs was undertaken to identify potential sensitive land uses, such as residential subdivisions. The search was based on a six-year period up to 1 Oct 2024 to be consistent with the typical six-year currency period for a MCU and to align with the timeframes for the preparation of the revised draft EIS.

A summary of the sensitive receptors is provided in Table 16-4 and the identified individual sensitive land uses and receptors are detailed within Appendix V: Noise and Vibration Assessment—Construction and Road Traffic and Appendix W: Noise and Vibration Assessment—Railway Operations.

There are no World Heritage Areas or areas protected under the *Nature Conservation Act 1992* (Qld) or the *Marine Parks Act 2004* (Qld) located within the study area.

Sensitive Receptor locations are detailed in map series Figure 16-7 and Figure 16-8. The receptors located further than 2 km from the railway alignment are identified in Appendix A of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

TABLE 16-4 SUMMARY OF SENSITIVE LAND USE AND RECEPTORS

Sensitive land use	Number of identified receptors
Residential activities	2,458 sensitive receptors were included in the assessment of noise and vibration for construction works and road traffic. The operational railway noise and vibration has been assessed at 2,388 sensitive receptors within 2,000 metres (m) of either side of the railway alignment. The greater number of sensitive receptors for the construction and road traffic assessment reflects that some works are undertaken away from the railway alignment. The survey of approved, yet to be built, development applications identified 24 future noise sensitive developments. These have been included in the noise and vibration assessment as sensitive receptors.
Community uses	Yelarbon Soldiers Memorial Hall, Yelarbon Yelarbon Fire Station, Yelarbon Yelarbon Scouts Hall, Yelarbon Millmerran Seventh Day Adventist Church, Millmerran St John's Lutheran Church, Millmerran All Saints Anglican Church, Yandilla Pampas Memorial Hall, Pampas Pampas Rural Fire Brigade, Pampas Brookstead Community Hall, Brookstead 26 Weale Street, Pittsworth Pittsworth Uniting Church, Pittsworth Pittsworth and District Assembly of God, Pittsworth St Stephen's Catholic Church, Pittsworth Anglican Church of Australia, Pittsworth Pittsworth Masonic Centre, Pittsworth Pittsworth Library, Pittsworth Soldiers Memorial School of Arts, Pittsworth Pittsworth Fire and Rescue Station, Pittsworth Lutheran Church of Australia, Pittsworth Southbrook Hall, Southbrook St Brigid's Church, Southbrook
Educational institutions	Yelarbon State School, Yelarbon Brookstead State School, Brookstead St Stephens Catholic Primary School, Pittsworth Pittsworth State School, Pittsworth Pittsworth Kindergarten, Pittsworth Pittsworth State High School, Pittsworth Southbrook Central State School, Southbrook Flight Training School Toowoomba, Wellcamp
Medical facilities	Beauaraba Living Aged Care Facility, Pittsworth Queensland Regional Accommodation Centre Medical Facility, Wellcamp
Sporting and Recreation facilities	17 individual recreational and sporting venues and facilities
Commercial use buildings	43 offices
Sites of heritage significance	40 heritage areas of interest
Intensive animal operations	8 properties (see Section 16.9.1)

16.5.2 Baseline noise and vibration environment

Measurement surveys of baseline noise and vibration levels were undertaken in 2018, 2022 and 2023 (Sections 5.4 and 5.5 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic), to quantify and characterise the existing (pre-construction) acoustic environment at sensitive receptor locations throughout the study area.

The measured noise and vibration levels were applied to define three key aspects of the existing environment:

- The baseline ambient environment encompasses all sources of measurable noise and vibration and is typically adopted as a description of the overall levels of noise and vibration within the environment.
- Background noise levels, which represent the typical steady daily noise levels in the absence of short-lived high noise events. The background represents a baseline to set criteria and evaluate aspects such as the intrusiveness of new or additional sources of noise.
- Road traffic noise levels for use in quantifying the existing road traffic noise environment and verifying the accuracy of the road traffic noise modelling predictions.

The technical requirements of the measurement equipment and the survey methodologies were established with reference to:

- The *Noise Measurement Manual* (DES, 2020g)
- Australian Standards for the measurement of environmental noise and vibration and the electroacoustic specifications for measurement equipment
- Road traffic noise measurement requirements from CoP Vol 1
- Baseline noise and vibration measurement guidelines from the CoP Vol 2.

Comprehensive details of each survey are provided in Appendix V: Noise and Vibration—Construction and Road Traffic. An overview of the survey methodologies and measured noise and vibration levels is provided in the following sections.

There are minimal existing railway operations on the South Western Line and the Millmerran Branch Line, often with no train movements over consecutive days. As a result of the 2011 floods in Queensland, the Millmerran Line remains closed (red boarded) between Brookstead and Millmerran. On this basis, a survey of noise and vibration from occasional train passby events was not undertaken and the assessment conservatively assumed there is no existing railway noise and vibration within the study area.

16.5.2.1 Existing outdoor noise environment

Environmental noise levels were surveyed outdoors at 29 locations within the study area. Noise measurement locations were selected to represent the geographic range of the sensitive receptors along the Project alignment, particularly those most at risk of being impacted by noise from construction works. A separate survey of road traffic noise was undertaken in 2020, as detailed in Section 16.5.2.3.

The survey included long-term continuous measurement of noise levels over a minimum seven-day period using noise loggers (unattended monitoring). Additional short-term noise measurements were conducted by the acoustic consultants to identify and quantify the local sources of noise that would influence the long-term noise levels.

Measurements were carried out using Class 1 sound level meters as specified in AS/NZS IEC 61672.1:2019 *Electroacoustics: sound level meter specifications* (Standards Australia and Standards New Zealand, 2019b). The microphones were mounted at a height of 1.8 m at single storey buildings on slab (adjusted for elevated buildings). Microphones were located nominally 1.0 m from the building facade or 3.5 m away from reflecting walls, depending on the installation location. The equipment was set to measure noise levels for a range of statistical metrics over 15 minute averaging periods.

Local weather conditions were satisfactory for environmental noise monitoring during the surveys, with any periods of precipitation and wind speeds greater than 5 m/s identified and filtered from the measurement results, in line with noise measurement guidelines and standards.

For the day, evening, and night periods, noise measurements are reported using two noise-level metrics:

- The L_{Aeq} noise metric is used to quantify the ambient noise environment. It provides a measure of the continuous steady sound for all the sources of noise during the measurement period. The L_{Aeq} provides a representative measure of the average environmental noise exposure over each period.
- The Rating Background Level (RBL) is the overall background noise level derived from the L_{A90} noise levels measured over discrete 15-minute periods. The L_{A90} is the sound level that occurs for 90 per cent of the measurement period and, being less influenced by short duration high noise events than the L_{Aeq} noise metric, describes the average minimum ambient noise level.

The noise measurement locations are presented in Figure 16-3.

FIGURE 16-3 BASELINE AND ROAD TRAFFIC NOISE AND VIBRATION MEASUREMENT LOCATIONS

1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

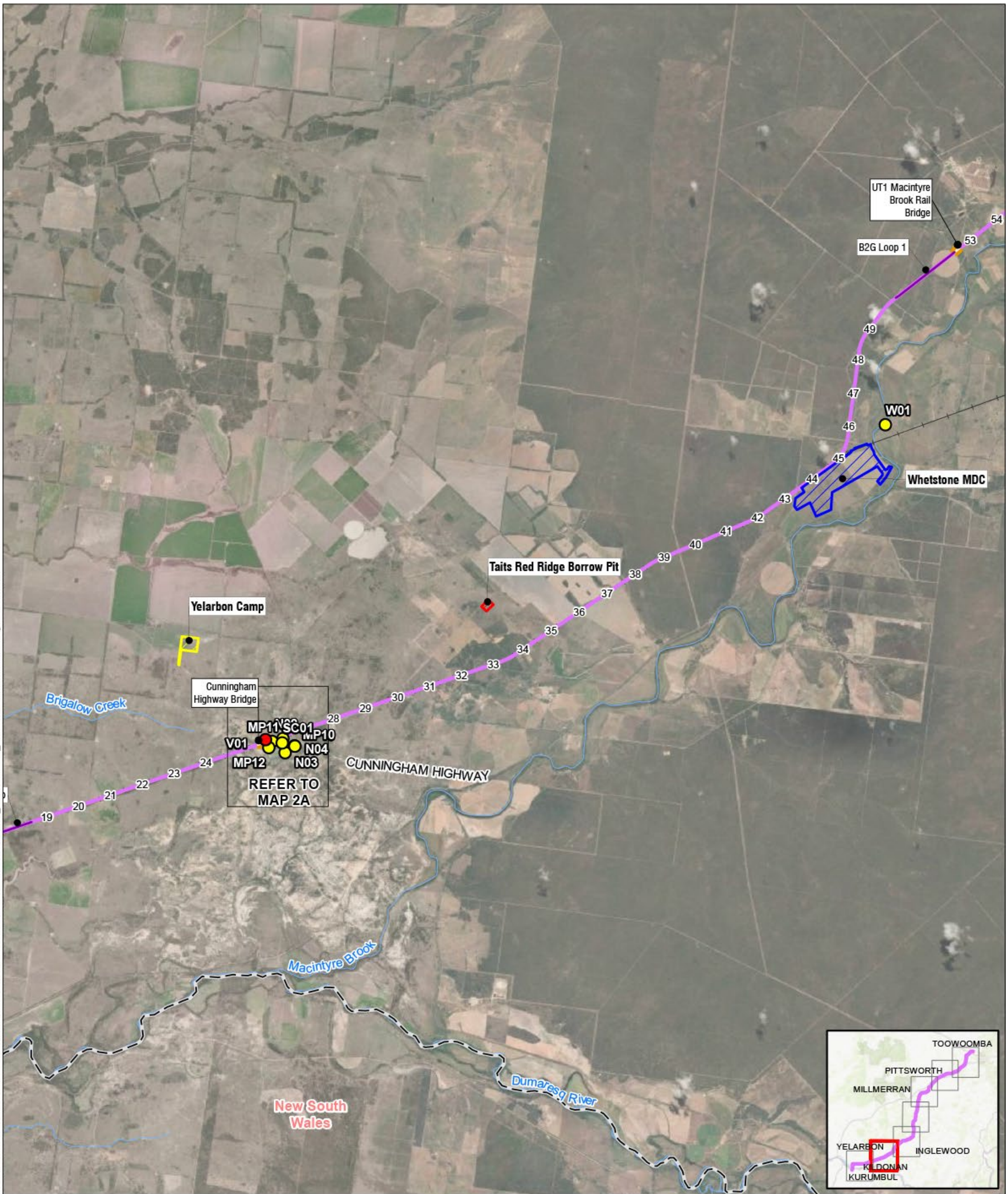
Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

FIGURE 16-3 MAP 1 OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R\06 SLR Data\01 CADGIS\GIS\Construction noise contour\620031489_NoiseContours_Noise and vibration monitoring locations.mxd



1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

FIGURE 16-3 MAP 2 OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R06 SLR Data\01 CAD\GIS\GIS\Construction noise contour\620031489_NoiseContours_Noise and vibration monitoring locations.mxd

100 m

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:15,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

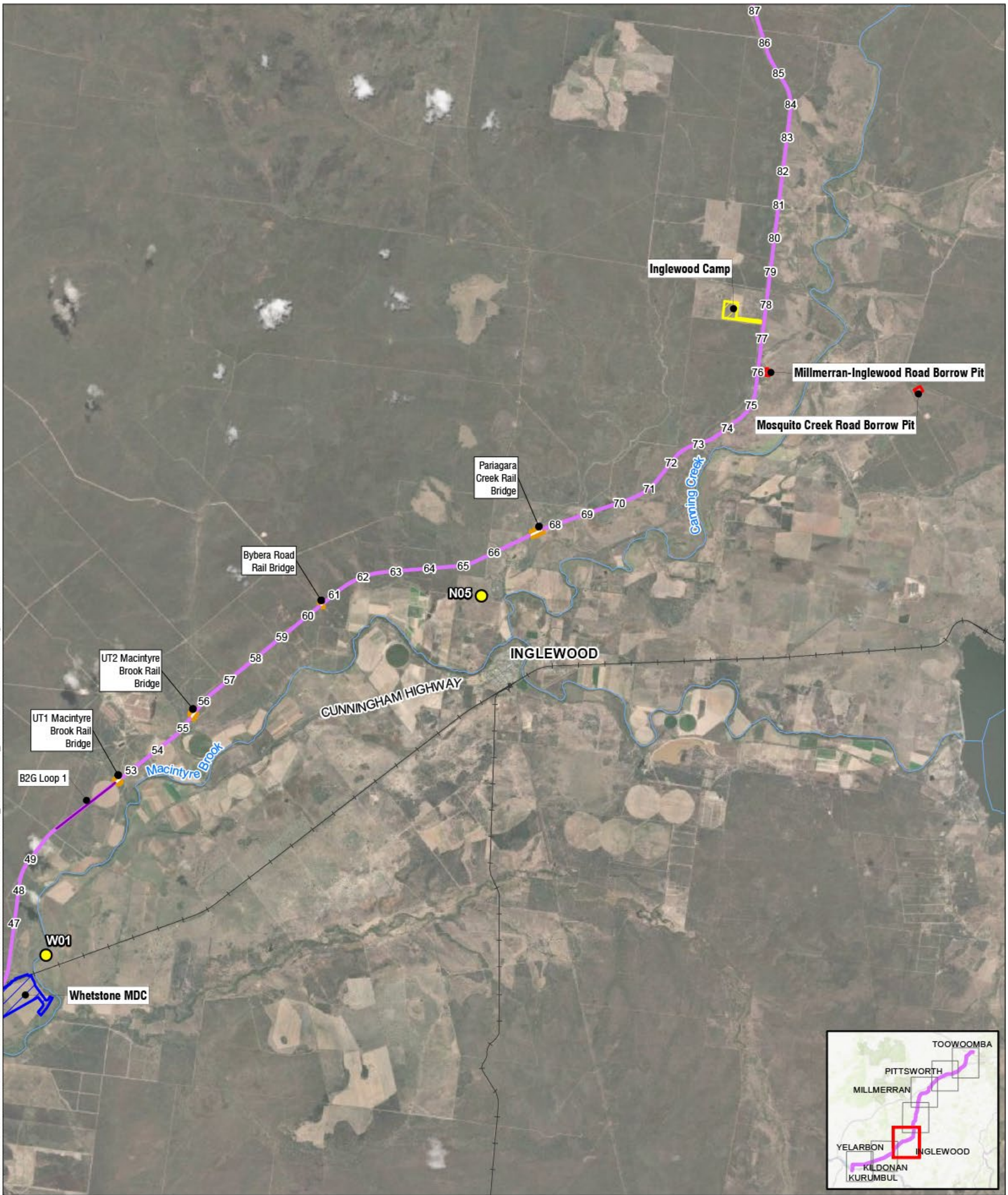
Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (March 2023)

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

FIGURE 16-3 MAP 2A OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R06 SLR Data\01 CADGIS\GIS\Road traffic noise contour\620031489_NoiseContours_Noise and vibration monitoring locations_Map2A.mxd



1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

FIGURE 16-3 MAP 3 OF 7

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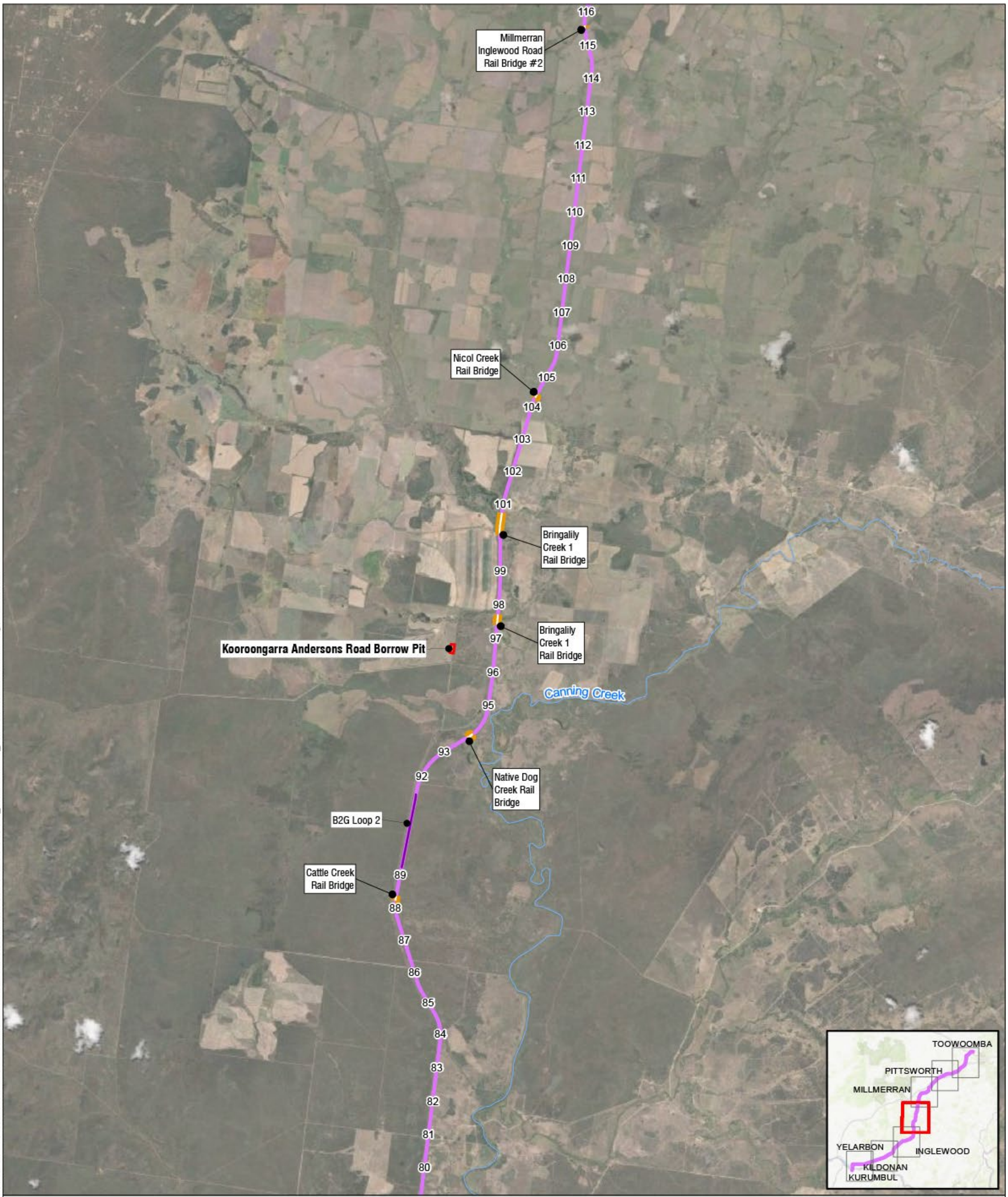


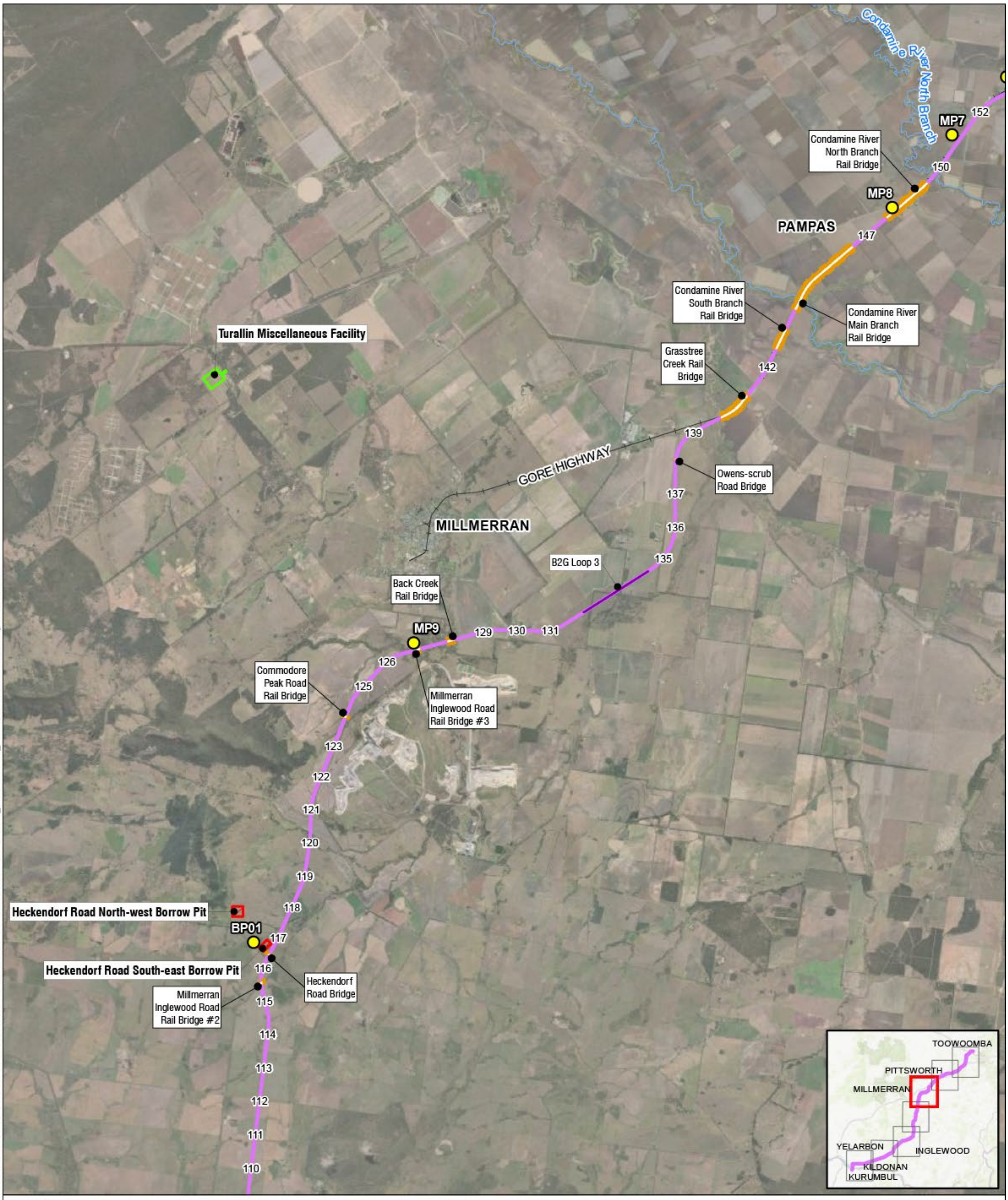
SLR

INLAND RAIL B2G
CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic
Noise & Vibration Measurement Locations

Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

FIGURE 16-3 MAP 4 OF 7



1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

FIGURE 16-3 MAP 5 OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R06 SLR Data\01 CADGIS\GIS\Construction noise contour\620031489_NoiseContours_Noise and vibration monitoring locations.mxd

1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

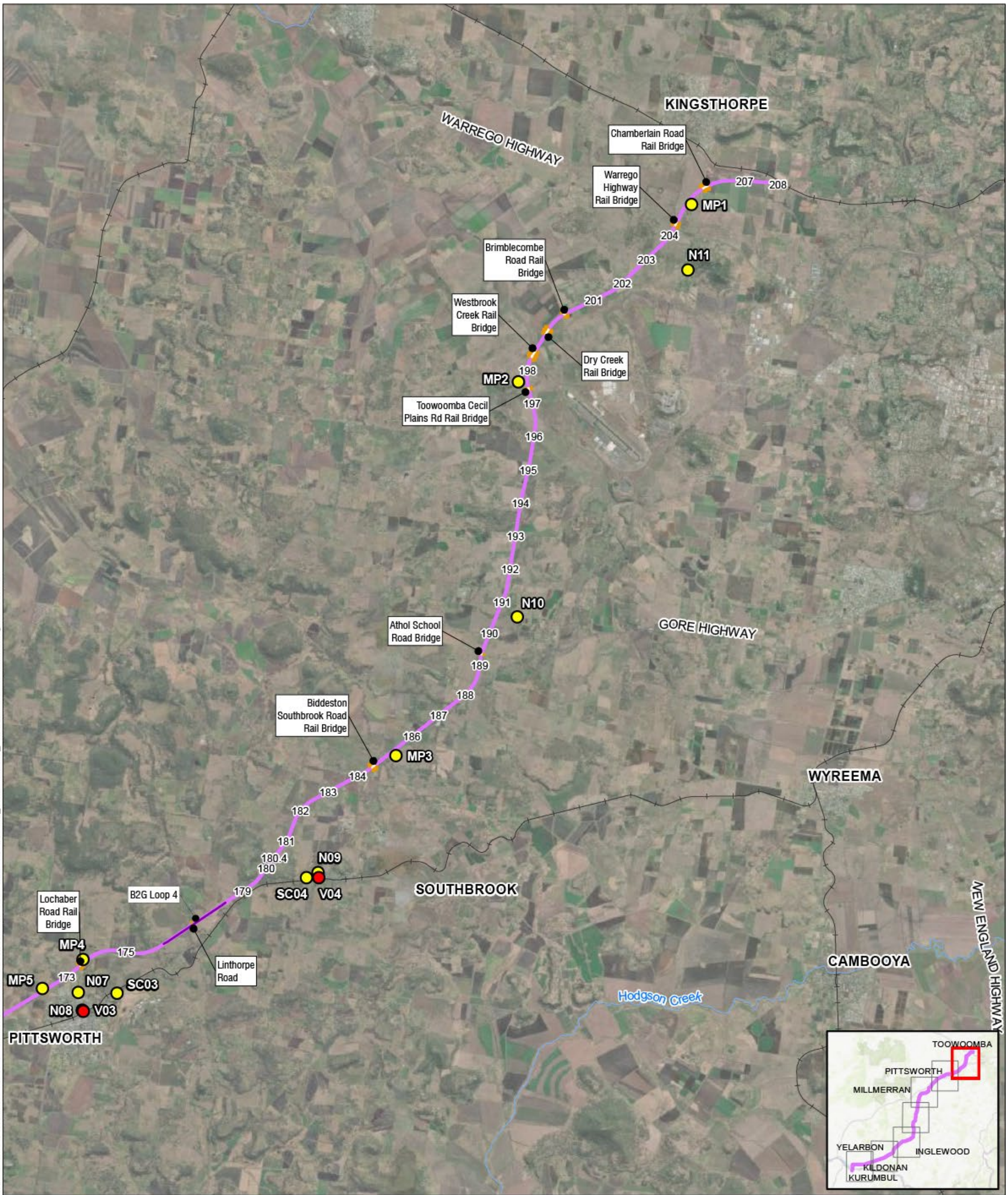
Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

FIGURE 16-3 MAP 6 OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R106 SLR Data\01 CADGIS\GIS\Construction noise contour\620031489_NoiseContours_Noise and vibration monitoring locations.mxd



1 km

Coordinate System:	GDA 1994 MGA Zone 56
Scale:	1:148,000 at A4
Project Number:	620.031489
Date:	14-Mar-2024
Drawn by:	JG

SLR

- Noise Monitoring Location
- Vibration Monitoring Location
- Watercourses
- Existing Railway
- Crossing Loops
- Rail Alignment/Centreline
- Bridges and Viaducts
- State Boundaries
- Accommodation Camps
- Borrow Pits
- Turallin Miscellaneous Facility
- Whetstone MDC

Data Sources:
QLD DoR spatial catalogue, ESRI basemap world imagery (Dec 2023)

INLAND RAIL B2G CONSTRUCTION NOISE CONTOUR ASSESSMENT

Baseline and Road Traffic Noise & Vibration Measurement Locations

FIGURE 16-3 MAP 7 OF 7

H:\Projects-SLR\620-BNE\620-BNE\620.031489.00001 Inland Rail B2G Construction R106 SLR Data\01 CADGIS\GIS\Construction noise contour\620031489_NoiseContours_Noise and vibration monitoring locations.mxd

Noise measurement locations and measured ambient (L_{Aeq}) and RBL noise levels are detailed in Table 16-5.

The noise levels follow a typical pattern, with higher noise levels experienced during the day period, due to local road traffic, residential activities, and agricultural operations, with noise levels decreasing through the evening into the night period. The long-term measured noise levels at the 11 locations are relatively low, typically less than 40 dB(A), which is representative of the rural setting of the Project and the local communities.

TABLE 16-5 EXISTING OUTDOOR NOISE LEVELS

Location	Ambient $L_{Aeq,T}$ noise levels dB(A)			Rating Background Level, dB(A)		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
N01, Kurumbul	47	50	48	30	34	28
N02, Yelarbon	52	52	48	36	35	25
N03, Yelarbon	52	49	45	41	40	24
N04, Yelarbon	50	52	48	32	34	23
N05, Inglewood	46	45	39	31	33	23
N06, Brookstead	52	53	49	39	38	29
N07, Pittsworth	48	50	44	35	40	27
N08, Pittsworth	47	45	41	37	38	25
N09, Southbrook	48	49	45	38	37	30
N10, Athol	49	45	41	36	36	29
N11, Gowrie Mountain	45	44	39	34	31	26
MP1, Kingsthorpe	54	49	54	38	33	28
MP2, Biddeston	59	47	49	34	29	20
MP3, Southbrook	55	56	54	39	33	21
MP4, Pittsworth	62	58	59	36	30	23
MP5, Scrubby Mountain	64	59	60	42	28	23
MP6, Brookstead	63	63	60	42	35	22
MP7, Brookstead	55	54	57	35	28	20
MP8, Pampas	59	61	58	40	32	26
MP9, Millmerran	68	49	49	34	28	20
MP10, Yelarbon	56	55	52	29	29	25
MP11, Yelarbon	62	61	58	37	27	19
MP12, Yelarbon	55	51	49	48	48	39
BP01, Clontarf	43	46	43	28	40	29
SC01, Yelarbon State School	50	52	48	36	37	35
SC02, Brookstead State School	54	52	57	36	38	42
SC03, Pittsworth State School	52	50	49	37	40	38
SC04, Southbrook Central State School	51	52	48	40	43	38
W01, Whetstone	50	54	49	33	26	20

Table note:
The time periods for baseline noise measurements are day 7:00 am to 6:00 pm, evening 6:00 pm to 10:00 pm and night 10:00 pm to 7:00 am.

16.5.2.2 Existing outdoor vibration environment

Baseline vibration surveys were conducted to identify the background vibration that occurs from local sources, prior to the construction and operation of the Project. Existing ground vibration levels were measured in July 2019 at the four locations shown in Figure 16-3, which are representative of the sensitive receptor communities within the study area.

The measurements were conducted using a Dytran 3192A Accelerometer and SVAN 957 vibration meter over a 15-minute period with observations made on potential sources of vibration. The measured Peak Particle Velocity (PPV) vibration levels at the four monitoring locations are summarised in Table 16-6.

The vibration levels provide a general measure of local sources of vibration, including local road traffic, nearby fauna movements and community activity. The vibration levels are relatively low, noting that PPV levels between 0.15 and 0.30 millimetres per second (mm/s) are commonly described as being just perceptible for most people.

TABLE 16-6 EXISTING OUTDOOR VIBRATION LEVELS HIGHEST MEASURED LEVELS

Location	Time	Vibration level PPV mm/s
V01, Kurumbul	11.44 am	0.13
V02, Brookstead	2.03 pm	0.29
V03, Pittsworth	2.54 pm	0.10
V04, Southbrook	3.30 pm	0.20

16.5.2.3 Existing road traffic noise environment

Existing road traffic noise levels were measured at 12 locations within the study area between 13 June and 30 June 2022. The noise measurements were conducted in areas exposed to existing road traffic and included nearby receptors that could be sensitive to potential changes in road traffic noise due to the Project.

The 12 measurement locations are detailed in Table 16-7 and presented in Figure 16-3, and are considered to be exposed to road traffic from the following State-controlled roads:

- Warrego Highway
- Gore Highway
- Gore Highway, Oakey Pittsworth Road
- Cunningham Highway
- Cunningham Highway, Wondali Street
- Toowoomba Cecil Plans Road
- Millmerran Inglewood Road.

TABLE 16-7 ROAD TRAFFIC NOISE MEASUREMENT LOCATIONS

Location	Dominant road	Nearby sensitive receptor categories
MP1 Kingsthorpe	Warrego Highway	Residential activities
MP2 Biddeston	Toowoomba Cecil Plans Road	Residential activities
MP3 Southbrook	Gore Highway	Residential activities
MP4 Pittsworth	Gore Highway	Residential activities
MP5 Scrubby Mountain	Gore Highway, Oakey Pittsworth Road	Residential activities
MP6 Brookstead	Gore Highway	Residential activities and Brookstead State School
MP7 Brookstead	Gore Highway	Residential activities
MP8 Pampas	Gore Highway	Residential activities, Pampas Memorial Hall
MP9 Millmerran	Millmerran Inglewood Road	Residential activities
MP10 Yelarbon	Cunningham Road	Residential activities, Yelarbon State School, Yelarbon Fire Station, and Yelarbon Soldier Memorial Hall
MP11 Yelarbon	Cunningham Road	Residential activities, Yelarbon State School, Yelarbon Fire Station, and Yelarbon Soldier Memorial Hall
MP12 Yelarbon	Cunningham Road, Wondali Street	Residential activities

Noise measurements were carried out using 01dB Class 1 sound level meters configured as noise loggers. The microphones were mounted at a height of 1.8 m at single storey buildings on slab (adjusted for elevated buildings). Microphones were located nominally 1.0 m from the building facade or 3.5 m away from reflecting walls, depending on the installation location. The equipment was set to measure noise levels for a range of statistical metrics over 1-hour averaging periods.

These measurements were conducted during normal traffic flow conditions, excluding periods of school holidays and public holidays. One 15-minute attended noise measurement, with a Brüel and Kjær 2250 Class 1 sound level meter, was conducted at each location during the installation and collection of the noise monitoring equipment to confirm the contribution of local road traffic noise.

The rainfall and wind speed during the period of noise measurements were recorded using a portable weather station at locations MP4 (Pittsworth), MP7 (Brookstead), MP9 (Millmerran) and MP10 (Yelarbon). The weather station was collocated with the noise monitoring equipment at a minimum of 5 m from the nearest building.

The measured weather data comprised:

- Average and maximum wind speed
- Average temperature
- Rainfall
- Humidity
- Air pressure.

Based on CoP Vol 1, wind speeds (hourly averaged) greater than 3 m/s, or rainfall greater than 0.3 millimetres per hour (mm/h) are both defined as "adverse weather" conditions. Noise data collected during periods of adverse weather was discarded and replaced with interpolated data, where the noise level during the hour before and hour after is averaged and assigned to the weather-affected hours. Further discussion on the analysis of measurement data and the local weather conditions is provided in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

The average road traffic noise levels were determined for the time periods associated with the assessment of road traffic noise at various sensitive receptor categories as follows:

- 18-hour L_{A10} noise levels for the period 6:00 am to midnight referenced in the assessment of road traffic noise at residential land uses and receptors
- One-hour L_{A10} noise levels adopted in the assessment of road traffic noise during the hours when educational institutions are open
- 12-hour L_{A10} noise levels between 6:00 am to 6:00 pm.

The average measured road traffic noise levels are shown in Table 16-8 and the daily measured noise levels are provided in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

The attended noise surveys confirmed the noise levels at all locations were dominated by local road traffic noise.

TABLE 16-8 MEASURED EXISTING ROAD TRAFFIC NOISE LEVELS

Location	Dominant road	Average measured road traffic noise level, dB(A)		
		$L_{A10(18\text{-hour})}$	$L_{A10(12\text{-hour})}$	$L_{A10(1\text{-hour peak})}$
MP1	Warrego Highway	53.3	54.7	60.1
MP2	Toowoomba Cecil Plans Road	53.1	54.3	59.6
MP3	Gore Highway	58.9	58.4	63.1
MP4	Gore Highway	59.3	58.1	66.6
MP5	Gore Highway, Oakey Pittsworth Road	65.1	66.0	68.0
MP6 Brookstead	Gore Highway	66.6	66.6	69.8
MP7	Gore Highway	55.1	53.6	61.4
MP8	Gore Highway	63.9	63.4	67.6
MP9	Millmerran Inglewood Road	52.5	53.6	58.5
MP10 Yelarbon	Cunningham Road	58.4	57.9	61.5
MP11 Yelarbon	Cunningham Road	63.0	64.3	67.2
MP12	Cunningham Road, Wondali Street	52.0	51.8	57.2

Table notes:
L_{A10}: The A-weighted sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L10.
$L_{A10(18\ hours)}$: The arithmetic average of the $L_{A10(1\ hour)}$ from 6:00 am to 12:00 am
$L_{A10(12\ hours)}$: The arithmetic average of the $L_{A10(1\ hour)}$ for each of the 12 one hour periods between 6:00 am and 6:00 pm
$L_{A10(1hour)}$: The A-weighted sound pressure level which is exceeded for 10% of the measurement period (for the peak 1 hour)

16.6 Potential impacts—Construction noise and vibration

The assessment of noise and vibration associated with the construction phase activities adopted relevant guidance from the CoP Vol 2. The following sections summarise the potential noise and vibration impacts during the Project's construction. Detailed assessment results can be found in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

16.6.1 Application of the construction hours

While ARTC is proposing to conduct construction works as summarised in Section 16.4.4.2 the CoP Vol 2 requires the assessment and management of noise and vibration to be aligned with the work periods detailed in Table 16-9.

The work periods from the CoP Vol 2 recognise the sensitivity of different times of day to potential noise and vibration exposure. The construction noise management and mitigation measures are defined based on these work periods and must be applied during the times ARTC intends to conduct construction activities.

TABLE 16-9 COP VOL 2 DEFINED WORK HOURS

Work period		General construction	Blasting
Standard hours - daytime	Mon–Fri	7:00 am to 6:00 pm	Mon–Fri 9:00 am to 3:00 pm
	Sat	8:00 am to 1:00 pm	Sat 9:00 am to 1:00 pm
Non-Standard hours – day/evening	Mon–Fri	6:00 pm to 10:00 pm	Generally, blasting is not to be conducted outside Standard hours.
	Sat	7:00 am to 8:00 am	
	Sat	1:00 pm to 10:00 pm	
	Sun	7:00 am to 10:00 pm	
Non-Standard hours – night-time	Mon–Sun	10:00 pm to 7:00 am	

Note: Public holiday periods are taken to be the same periods as defined for Sunday.

16.6.2 Construction noise and vibration assessment

16.6.2.1 Airborne noise assessment criteria

The CoP Vol 2 provides noise criteria that are aimed at dealing with nuisance from construction activities. Noise criteria are defined for the categories of construction noise emissions as follows:

- Airborne noise from general construction and construction road traffic
- Ground-borne (regenerated) noise
- Air-blast from blasting events.

For residential dwellings, including hotels and motels, the noise from general construction activities is assessed using the criteria in Table 16-10. The criteria are outdoor construction noise levels which apply at the facade of the dwelling at a height of 1.5 m above floor level.

With reference to the CoP Vol 2 construction hours detailed in Table 16-9, the criteria are applied to manage construction noise as follows:

- Standard hours—work within standard hours should be encouraged wherever possible. All reasonable and practicable measures should be implemented to achieve the lower limit. Triggering of the upper limit requires immediate action and community consultation to determine further mitigation measures.
- Non-standard hours—all reasonable and practicable measures should be implemented to achieve the lower limit. If exceeded, community consultation should be conducted for further mitigation measures.

TABLE 16-10 COP VOL 2 CONSTRUCTION NOISE CRITERIA

Receptor period		External noise level $L_{Aeq, adj, 15min}$[4,5] dB(A)	
		Lower limit	**Upper limit**
Standard hours		RBL + 10[1,2,3]. Minimum lower limit 50	75 where: RBL > 55
			70 where: 40 < RBL ≤ 55
			65 where: RBL ≤ 40
Non-standard hours	Evening	RBL + 5[3]. Minimum lower limit 45	RBL + 5[3]
	Night-time		

Table notes:
dB(A) is the level of noise in A-weighted decibels.
RBL is the Rating Background Level

1. RBL + 5 dB(A) should be considered where a facility, equipment and long-term earthworks are required in an area for greater than six months
2. Where the lower limit value exceeds the upper limit value, the lower limit value is taken to equal the upper limit value
3. Minimum lower limit is 50 dB(A) for Standard hours and 45 dB(A) for Non-Standard hours. A maximum lower limit of 75 dB(A) applies for Non-Standard hours
4. Noise contribution from construction activity determined as the component level
5. The noise level from construction includes adjustment factors defined in CoP Volume 2. For example, low frequency noise, impulsivity, tonality, intermittency, and modulation.

To establish objectives that are representative of the receiving environment, the RBLs in the study area were referenced to set Project specific construction noise criteria.

The RBLs are relatively low and in all locations where construction works will occur, consequently the minimum noise criteria for Standard and Non-Standard hours apply at all residential activities, as detailed in Table 16-11.

The more stringent (lower) assessment criteria are adopted to assist in the management of impacts, including sleep disturbance.

TABLE 16-11 PROJECT EXTERNAL CONSTRUCTION NOISE LIMITS

Receptor type	Work period	External noise level $L_{Aeq,adj,15\ min}$ dB(A)	
		Lower limit	Upper limit
Residential receptors	Standard hours (for work areas ≥ 6 months)	45	65
	Standard hours	50	65
	Non-Standard hours – day/evening	45	45
	Non-Standard hours – night-time	45	45
Non-residential and non-critical receptors [1]	Standard hours	65	
	Non-Standard hours – day/evening	45	
	Non-Standard hours – night-time	45	

Table notes:
1. Applies to commercial buildings (including retail and offices), active recreation areas and passive recreation areas.

In addition to the dwellings, the CoP Vol 2 provides construction noise criteria for non-residential critical sensitive receptors, including medical, educational and community buildings, which are to be met where reasonable and practicable. The noise criteria in Table 16-12 are internal noise levels that apply during the operational hours of each facility.

TABLE 16-12 INTERNAL CONSTRUCTION NOISE CRITERIA FOR CRITICAL FACILITIES

Type of occupancy/activity	Internal noise level $L_{Aeq,adj,15min}$ dB(A)
Medical/health buildings (wards, surgeries, operating theatres, consulting rooms)	40
Educational/research facilities (rooms designated for teaching/research purposes)	45
Community buildings (libraries, places of worship)	45

To assess against the internal noise limits for critical facilities, the external predicted noise levels Table 16-12 were adjusted by a facade correction which accounts for the reduction of noise achieved by the building (with windows open).

For the educational establishments and community buildings potentially impacted by the Project, a conservative 7 dB facade noise reduction has been applied based on the guidance provided in DES *Noise and Vibration EIS Information Guideline* recommended for typical Queensland buildings. Accordingly, noise levels within the educational and community receptor buildings would be expected to achieve the internal noise limit (in Table 16-12) where the external noise level is not more than 52 dB(A) $L_{Aeq,adj,15min}$.

Further to the above, sound insulation testing of representative facades of the educational buildings at Yelarbon State School, Brookstead State School, Pittsworth State High School and Southbrook Central State High were provided by ARTC. Based on the results of these tests, the external construction noise limits for the local schools were:

- Yelarbon State School: 71 dBA $L_{Aeq,adj,15min}$
- Brookstead State School: 73 dBA $L_{Aeq,adj,15min}$
- Pittsworth State High School: 81 dBA $L_{Aeq,adj,15min}$
- Southbrook Central State School: 77 dBA $L_{Aeq,adj,15min}$

For potentially impacted hospital and healthcare service buildings, it will be necessary to consult with the hospital or service provider prior to the commencement of construction to ascertain the nature of the exposed facades (e.g. windows and doors remain closed, type of building materials, etc) with measurement of the actual facade noise reduction likely to be completed.

16.6.2.2 Construction noise levels

The construction noise modelling predicted noise levels at over 2,000 individual existing sensitive receptors surrounding the construction work sites. The worst-case (highest) predicted noise levels were used to assess against the lower and upper noise limits from the CoP Volume 2 and to recommend reasonable and practicable noise management and mitigation measures.

The findings of the assessment are summarised in the following sections, including identification of the highest predicted noise levels and the extent to which noise mitigation has been triggered.

Laydown areas

Assessment of the 78 laydown areas (Section 6.1.1.1 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) required to support the Project has identified the following:

- Noise levels of up to 75 dBA $L_{Aeq,adj,15min}$ are predicted with the dump trucks being the dominant noise source at sensitive receptor locations (refer to Section 6.2 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic for heavy vehicle mitigation measures).
- 46 of the assessed laydowns areas are predicted to exceed the Standard hours lower limit of 50 dBA $L_{Aeq,adj,15min}$ at the closest sensitive receptor, thereby triggering the requirement for all reasonable and practicable mitigation measures in accordance with the CoP Vol 2.
- 13 laydown areas are predicted to exceed the upper limit of 65 dBA $L_{Aeq,adj,15min}$ at sensitive receptors during standard hours.
- Given the nature of works and the limited duration of the laydown area establishment works (i.e. up to 30 days), it is anticipated that noise impacts during standard hours would be avoided with the application of reasonable and practicable noise mitigation measures provided in Appendix V: Noise and Vibration Assessment - Construction and Road Traffic.
- It is expected that the establishment of laydown areas for the project would be completed during standard hours where practicable; however, the modelling and assessment of worst-case non-standard hours works indicates that noise levels would likely comply with the 45 dBA $L_{Aeq,adj,15min}$ noise limit at the nearest receiver during non-standard hours construction at 19 laydown areas. Applying reasonable and practicable noise mitigation to these works, including limiting the number of dump trucks and graders operating and using the quietest available equipment, would potentially increase the non-standard hours noise limit compliant laydown areas to 34 (i.e. based on a 10 dBA noise reduction).
- Given the large number of predicted non-standard hours limit exceedances at Yelarbon, Pampas, Brookstead and Pittsworth, it is recommended that the site laydown establishment works be designed, where reasonable and practicable, to be undertaken during standard hours in these areas.
- In relation to the non-residential sensitive receptors, exceedance of the 52 dBA $L_{Aeq,adj,15min}$ noise limit is predicted for:
  - Yelarbon Soldiers Memorial Hall (254564) by up to 10 dBA $L_{Aeq,adj,15min}$ due to the proximity of a proposed laydown (LDN025).
  - Pampas Memorial Hall (260123) by up to 13 dBA $L_{Aeq,adj,15min}$ due to a proposed laydown (LDN147.1).
  - Brookstead Hall (262035) by a marginal 1 dBA (i.e. 53 dBA $L_{Aeq,adj,15min}$) due to a proposed laydown (LDN152.0).
  - Harvest New Life Church (322790) by up to 13 dBA $L_{Aeq,adj,15min}$ due to a proposed laydown (LDN172.0).

Accommodation camp construction and operation

Assessment of potential noise levels associated with the construction phase and long-term operation of the Project accommodation camps near Yelarbon and Inglewood (Sections 6.1.1.2 and 6.1.1.3 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified compliance with the CoP Vol 2 noise limit of 45 dBA at all sensitive receptors with the highest predicted noise level of 31 dBA $L_{Aeq,adj,15min}$.

Temporary concrete batch plant

Assessment of potential noise levels associated with the operation of the two Project concrete batch plants at laydown areas LDN138.5 and LDN150.5 (Sections 6.1.1.4 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified the following:

- No exceedance of the CoP Vol 2 noise criteria (Standard or Non-Standard hours) predicted for the batch plant at laydown area LDN138.5
- Exceedance of the 45 dBA $L_{Aeq,adj,15min}$ noise limit is predicted for the three closest residential receptors to the LDN150.5 concrete batch plant. The concrete batch plant, with an assumed overall SWL of 115 dBA, is predicted to be the dominant noise source from the site.
- Two of the exceedances are marginal (i.e. up to 2 dBA) and the highest exceedance of 6 dBA is predicted for sensitive receptor 261227. Further assessment during the detailed design stage of the concrete batch plant is required to confirm the exceedance and allow for reasonable and practicable mitigation measures to be incorporated into the design. Reasonable and practicable mitigation measures may include selection of quieter plant, careful design/layout of the site to direct noise away from sensitive receptors, acoustic screening of elevated components, shielding provided by other site structures (e.g. offices, crib rooms, toilet blocks etc).

Whetstone MDC

Assessment of predicted Whetstone MDC site establishment and mitigated operational noise levels (Sections 6.1.1.5 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified the following:

- Exceedances of up to 17 dBA above the 45 dBA $L_{Aeq,adj,15min}$ noise limit have been predicted during the site establishment stage of the work based on the modelled worst-case scenario. It is recommended that the site establishment works are completed during standard hours to minimise the potential impact. Further to this, the highest predicted noise level of 60 dBA $L_{Aeq,adj,15min}$ at sensitive receptors 254681, 254682 and 254689 is compliant with the standard hours upper limit of 65 dBA $L_{Aeq,adj,15min}$ applied across the Project. Reasonable and practicable noise mitigation measures would be required during the standard hours site establishment work.
- No exceedances have been predicted during activities involving rail stockpiling, sleeper stockpiling, ballast stockpiling and workshop activities, when these activities occur in isolation.
- For all activities occurring simultaneously (excluding laydown area activities), compliance with the 45 dBA $L_{Aeq,adj,15min}$ noise limit is predicted for all sensitive receptors except for 254705 where a marginal 1 dBA exceedance is predicted.
- For all activities occurring simultaneously including laydown area activities, marginal 1 dBA exceedances are predicted for sensitive receptors 254689 and 254705. The predicted marginal 1 dBA exceedances are primarily attributed to sand blasting associated with Scenario 5b.

Considering the above, it is recommended that sand blasting be undertaken during standard hours where reasonable and practicable and conducted within an acoustically rated partial enclosure. This would result in compliance with the 45 dBA $L_{Aeq,adj,15min}$ lower limit at all sensitive receptors. Further, it is recommended that site establishment works are conducted during standard hours.

The final noise mitigation requirements would be confirmed during the detailed design stage of the Project.

Borrow pits

Assessment of predicted worst-case operational noise levels associated with the borrow pits located in six locations (Sections 6.1.1.6 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified the following:

- Compliance with the stringent 45 dBA $L_{Aeq,adj,15min}$ noise limit is predicted for the following borrow pit locations:
  - Mooroobie Lane, with the highest noise level of 42 dBA $L_{Aeq,adj,15min}$ predicted at sensitive receptor 2008455 when all proposed borrow pit activities are taking place at the site (i.e. combined operations)
  - Mosquito Creek Road, with the highest noise level of 29 dBA $L_{Aeq,adj,15min}$ predicted at sensitive receptor 2008467
  - Millmerran-Inglewood Road, with the highest noise level of 39 dBA $L_{Aeq,adj,15min}$ predicted at sensitive receptor 2008465
  - Kooroongarra Andersons Road, with the highest noise level of 45 dBA $L_{Aeq,adj,15min}$ predicted at sensitive receptor 255333
  - Heckendorf Road (north-west pit), with the highest noise level of 41 dBA $L_{Aeq,adj,15min}$ predicted at sensitive receptors 255691, 2008485 and 2008486 (i.e. when the rifle range is in use)
- Exceedance of the 45 dBA $L_{Aeq,adj,15min}$ noise limit is predicted at the following two borrow pit locations:
  - Taits Red Ridge, with exceedances predicted at two sensitive receptors (i.e. 254656 and 254666) of up to 5 dBA with the exceedances attributed to the operation of the rock hammer and crushing and screening equipment. Borrow pit material loading is predicted to comply at all sensitive receptors surrounding this site.
  - Heckendorf Road (south-east pit), with exceedances of up to 11 dBA predicted at sensitive receptor 255691. No cumulative noise impacts associated with the simultaneous operation of the south-east and north-west borrow pits have been predicted.

Considering the above, it is recommended that the operation of the D10 dozer during site establishment, rock hammering and/or crushing and screening activities required at the Taits Red Ridge and Heckendorf Road (south-east) borrow pits be undertaken during standard hours to minimise the potential impact. The potential for reducing equipment noise emission levels through selection of quieter plant, locating equipment within the partially excavated pits and use of temporary bunding would be investigated during the detail design stage of the Project.

Earthworks

Assessment of predicted construction noise levels associated with the Project earthworks involving clearing and grubbing, cut and fill and blasting preparation (Sections 6.1.1.7, 6.1.1.8 and 6.1.1.9, respectively, of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic), has identified the following:

- Construction noise levels are predicted to exceed the standard hours upper noise limit of 65 dBA $L_{Aeq,adj,15min}$ at up to 132 sensitive receptors in proximity to the Project. These exceedances generally relate to sensitive receptors within approximately 150 m of the earthworks. Exceedances ranging up to 26 dBA have been predicted which, by nature of the activity (i.e. relatively mobile equipment such as scrapers and haul trucks) and the degree of exceedance, are very difficult to mitigate to the extent that compliance with the upper noise limit would be achieved. Consequently, it will be necessary to consult directly with all sensitive receptors (i.e. predicted to be exposed to construction noise levels exceeding 65 dBA $L_{Aeq,adj,15min}$), to further develop mutually agreeable mitigation and management measures.
- Earthworks noise levels have been predicted for the following educational receptors:
  - Yelarbon State School: up to 62 dBA $L_{Aeq,adj,15min}$, which complies with external noise limit of 71 dBA $L_{Aeq,adj,15min}$.
  - Brookstead State School up to 71 dBA $L_{Aeq,adj,15min}$, which complies with external noise limit of 73 dBA $L_{Aeq,adj,15min}$.
- Exceedance of the 52 dBA $L_{Aeq,adj,15min}$ noise limit has been predicted for:
  - Yelarbon Soldiers Memorial Hall (up to 78 dBA), Pampas Memorial Hall (up to 78 dBA), Pampas Rural Fire Shed (up to 79 dBA), Brookstead Hall (up to 61 dBA) and the Harvest New Life Church (up to 68 dBA). The predicted exceedances are dominated by the operation of the D11 and D10 dozers which should be avoided from operating in proximity to these sensitive receptors while in use.
- Construction noise levels associated with the proposed cut-and-fill earthworks are predicted to significantly exceed the 45 dBA $L_{Aeq,adj,15min}$ non-standard hours noise limit for numerous sensitive receptors. On this basis, areas of the Project would not be suitable for non-standard hours cut-and-fill earthworks without additional mitigation in measures in place. Based on this worst-case assessment, even with all reasonable and practicable mitigation measures in place, residual cut-and-fill noise levels may still exceed the noise limit at most sensitive receptors in proximity to the works. Further analysis of this work scenario will be conducted during detailed design to identify opportunities to avoid and minimise impact.
- In addition to the stakeholder consultation discussed above, the following measures would likely be required:
  - Provision of respite periods or preferred noise-intensive periods, which is particularly important noting the extended durations of the cut and fill activities
  - For highly affected sensitive receptors, consideration of the following where the application of all reasonable and practicable mitigation measures (including respite periods) are deemed to be ineffective:
    - property treatments where longer-term impacts (i.e. >6 months) associated with the Project are identified
    - temporary (short-term) alternative accommodation for the duration of impact.

Drainage

Assessment of predicted drainage installation noise levels (Section 6.1.1.10 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified the following:

- Construction noise levels are predicted to exceed the standard hours upper noise limit at 49 sensitive receptors who surround the work areas. The majority of the upper limit exceedances occur within the townships of Yelarbon, Brookstead and Pittsworth, with exceedances ranging up to 19 dBA thereby requiring all reasonable and practicable noise mitigation measures to be applied to minimise the predicted impact.
- Drainage installation noise levels have been predicted for the following educational receptors:
  - Yelarbon State School: up to 55 dBA $L_{Aeq,adj,15min}$, which complies with external noise limit of 71 dBA $L_{Aeq,adj,15min}$.
  - Brookstead State School up to 64 dBA $L_{Aeq,adj,15min}$, which complies with external noise limit of 73 dBA $L_{Aeq,adj,15min}$.
- Exceedance of the 52 dBA LAeq noise limit has been predicted for Yelarbon Soldiers Memorial Hall (up to 71 dBA), Pampas Memorial Hall (up to 70 dBA), Brookstead Hall (up to 54 dBA) and the Harvest New Life Church (up to 61 dBA). The predicted exceedances are dominated by concrete trucks and pumps, which should be avoided from operating in proximity to these sensitive receptors while in use.
- Construction noise levels associated with the proposed drainage works are predicted to exceed the 45 dBA $L_{Aeq,adj,15min}$ non-standard hours noise limit at 485 sensitive receptors. On this basis, further investigation of potential non-standard hours drainage works noise levels would be required during the detailed design stage with all reasonable and practicable mitigation measures applied.

In the context of the broader construction program, drainage installation works would likely be short-term and therefore noise impacts limited in duration at any individual sensitive receptor. The duration and magnitude of potential noise impacts would be clearly communicated during the consultation process.

Structures

Assessment of predicted construction noise levels associated with the Project structures involving foundations, piers and superstructure construction (Section 6.1.1.11 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic), has identified the following:

- Up to three sensitive receptors are predicted to experience construction noise levels that exceed the 65 dBA $L_{Aeq,adj,15min}$ upper noise limit (i.e. by up to 6 dBA).
- Up to 238 sensitive receptors are predicted to experience construction noise levels that exceed the lower limit but comply with the upper noise limit. Exceedance of the lower noise limit requires all reasonable and practicable mitigation measures to be applied.
- During worst-case bridge substructure construction, exceedance of the 52 dBA $L_{Aeq,adj,15min}$ noise limit has been predicted for:
    - Yelarbon Soldiers Memorial Hall (up to 54 dBA), Brookstead Hall (up to 53 dBA) and the Harvest New Life Church (up to 55 dBA). The predicted exceedances are dominated by the operation of the piling rig. Subject to the detailed design requirements, the piling rig should be selected (i.e. based on its SWL) to achieve compliance with the noise limit at these sensitive receptors.
- During non-standard hours, bridge construction noise levels are predicted to exceed the non-standard hours noise limit at a significant number of sensitive receptors (i.e. up to 537 during driven piling). The majority of the upper limit exceedances occur within the townships of Yelarbon and Pittsworth, with exceedances ranging up to 26 dBA, thereby requiring all reasonable and practicable noise mitigation measures to be applied to minimise the predicted impact.
- Six out of the 34 bridge construction sites are predicted to comply with the non-standard hours noise limit of 45 dBA $L_{Aeq,adj,15min}$ and therefore substructure construction works involving bored piling could proceed without the need for further noise mitigation measures. This number reduces to four (out of the 34 sites) if driven piling is required for the foundation work.

Rail civil

Assessment of predicted construction noise levels associated with the Project rail civil works involving bottom ballast laying, sleeper and rail laying, and ballast tamping and regulating (Sections 6.1.1.12 to 6.1.1.14 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic), has identified the following:

- Exceedance of the noise limits during both standard and non-standard hours with the majority of the upper limit exceedances occurring within the townships of Yelarbon, Brookstead and Pittsworth. As noted above for the capping and ballast placement scenario, rail civil works should be carried out during standard hours insofar as possible. Further investigation of noise mitigation measures would be required where non-standard hours rail civil works are required.
- Exceedance of the 52 dBA $L_{Aeq,adj,15min}$ noise limit has been predicted for the Yelarbon Soldiers Memorial Hall (up to 74 dBA), Pampas Memorial Hall (up to 72 dBA), Brookstead Hall (up to 60 dBA) and the Harvest New Life Church (up to 64 dBA). The highest predicted construction noise levels are dominated by the ballast tamper and regulator; therefore, consultation with these sensitive receptors is required during the detailed design stage to coordinate construction hours that would have the least or no impact on the use of these venues.

It is important to note that rail civil works can be inherently noisy and irrespective of the predicted noise levels the approach will be to ensure all reasonable and practicable steps are in place to minimise the potential impact.

Road civil

Assessment of predicted construction noise levels associated with the Project road civil works involving the installation of the road base and asphalt layers (Section 6.1.1.15 to 6.1.1.16 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic) has identified the following:

- The majority of the noise limit exceedances are predicted to occur within the townships of Yelarbon, Brookstead and Pittsworth, with exceedances ranging up to 35 dBA thereby requiring all reasonable and practicable noise mitigation measures to be applied.
- 248 sensitive receptors are predicted to experience construction noise levels that exceed the lower limit but comply with the upper noise limit. In accordance with the CoP Vol 2, reasonable and practicable noise mitigation shall be adopted where the lower limit is not met. Works that trigger the upper limit will require additional mitigation measures to provide reasonable and practicable respite, temporary relocation, and at-property treatment.
- During road base construction works, exceedance of the 52 dBA $L_{Aeq,adj,15min}$ noise limit has been predicted for:
    - Yelarbon Soldiers Memorial Hall (up to 86 dBA) and the Pampas Memorial Hall (up to 94 dBA) due to the proximity of these receptors to the road civil works. Predicted construction noise levels are dominated by the grader and compactor. Consultation with these sensitive receptors is required during the detailed design stage to coordinate construction hours that would have the least or no impact on the use of these venues.

16.6.2.3 Summary of the construction noise assessment

In summary the assessment of construction noise determined:

- Based on the predicted noise levels at the most affected sensitive receptors, it is expected that ARTC will need to implement reasonable and practicable measures for many of the construction activities. The mitigation would include industry standard approaches discussed later in Section 16.10.2.1 of this chapter. In this regard, the work is expected to adopt noise management practices consistent with large scale transport projects of this nature.
- When the works are predicted to exceed the upper limit from CoP Vol 2, ARTC will need to implement additional mitigations. These will include any reasonable and practicable measures such as respite, temporary relocation, and at-property treatment for affected sensitive receptors.
- Cut-and-fill earthworks is predicted to be the worst-case activity in relation to the potential for noise impacts associated with the construction of the Project. The predicted exceedances are dominated by the operation of mulchers, dozers, scrapers and trucks. Importantly, the extent of earthworks required in any area of the Project will vary and work areas requiring the most intensive work (e.g. deep cut and fill areas) would be completed during standard hours where practicable.
- Noise mitigation during construction will be required at non-residential sensitive receptors, including Yelarbon Soldiers Memorial Hall, Yelarbon Fire Station, Pampas Memorial Hall, Pampas Rural Fire Shed and Brookstead Hall.
- Construction noise levels comparable to the earthworks stages have been predicted during rail civil and road civil works when these works occur in proximity to sensitive receptors; however, these stages of construction are expected to be significantly shorter in duration, particularly the sleeper and rail installation, and tamping and regulating stages which steadily progress along the rail alignment.
- Due to the remote nature of a large proportion of the Project, there are substantial regions of the proposed construction works that are a sufficient distance from sensitive land uses and receptors to minimise the potential for noise impacts in these areas. Further detail of these areas is provided in Appendix V : Noise and Vibration Assessment—Construction and Road Traffic.

16.6.2.4 Sleep disturbance assessment

The CoP Vol 2 recognises that sleep disturbance can potentially result from exposure (of sensitive receptors) to excessive levels of noise and vibration. The CoP Vol 2 does not provide construction noise criteria that specifically aims to preserve sleep but rather the noise criteria are primarily aimed at dealing with nuisance, including the evening and night-time non-standard work periods.

To manage sleep impacts during construction, ARTC will investigate and implement additional reasonable and practicable noise mitigation measures if the upper limits from CoP Vol 2 are exceeded during nighttime work. These measures will be in addition to those required when the lower limit is not achieved. Such measures may include the offer of respite periods, alternative accommodation and architectural treatments, which are discussed in further detail in Section 16.12.1.

16.6.2.5 Ground-borne vibration assessment criteria

Vibration during construction works will be assessed and managed to control impacts relating to human comfort and structural/building damage. The CoP Vol 2 details suitable vibration criteria to be achieved, where reasonable and practicable, to manage these potential impacts.

The ground-borne vibration criteria are established with reference to relevant Australian and international standards for vibration and its effects, as follows:

- Human comfort—disturbance to building occupants, arising from vibration which inconveniences or possibly disturbs occupants or users of a building. The vibration criteria are based on the requirements of BS 5228.2.
- Building damage—vibration which may result in cosmetic damage or possibly compromise the integrity of the building structure itself. The vibration criteria are based on the recommendations of British Standard 7385: *Part 2-1993 Evaluation and measurement for vibration in buildings Part 2* (BS 7385) (British Standards, 1993).

Human comfort

The Project has adopted the vibration levels set out in Table 16-13 to minimise the potential for annoyance and disturbance impacts that could be associated with the construction works. The lower limits are generally considered to be a threshold for perceptible vibration and the upper limits to be where significant annoyance could occur if exceeded.

The Project will apply all reasonable and practicable measures to achieve the lower limits, and that exceedance of the upper limit will require the Project to consider further mitigation measures and taking immediate action, such as further community consultation to develop appropriate mitigation measures.

The vibration levels are expressed as a PPV metric. The PPV provides a measure of the maximum instantaneous movement of the particles in the ground due to vibrations created from sources such as construction plant and construction traffic.

TABLE 16-13 HUMAN COMFORT VIBRATION ASSESSMENT CRITERIA

Building	Work period	Resultant PPV (mm/s)	
		Lower limit	Upper limit
Dwellings including hotels and motels	Standard hours	1.0	2.0
	Non-standard hours – evening	0.3	1.0
	Non-standard hours – night	0.3	1.0
Medical/ health buildings (wards, surgeries, operating theatres, consulting rooms)	All	0.3	1.0
Educational facilities (rooms designated for teaching purposes)	While in use		
Court of Law (Court rooms)			
Court of Law (Court reporting and transcript areas, Judges' chambers)			
Community buildings (libraries, places of worship)	While in use	1.0	2.0
Commercial (offices) and retail areas			

Building/structural damage

With respect to relevant vibration damage criteria, the CoP Vol 2 recommends the consideration of the building damage criteria contained in BS 7385. BS 7385 is a standard against which the likelihood of building damage from ground vibration can be assessed. Sources of vibration which are considered in BS 7385 include blasting, demolition, piling, ground treatments (i.e. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The guide values from BS 7385 for transient vibration judged to result in a minimal risk of cosmetic damage to residential buildings and industrial buildings are presented in Table 16-14.

TABLE 16-14 BUILDING VIBRATION CRITERIA FOR TRANSIENT CONSTRUCTION VIBRATION SOURCES

Line	Type of building	Peak Component Particle Velocity in frequency range of predominant pulse (mm/s)	
		4 to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Non-reinforced 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

Table note:
Values referred to are at the base of the building.

Consideration for material fatigue is also addressed in BS 7385 whereby it is concluded that unless calculation indicates a significant (in respect of the fatigue life of building materials) magnitude and number of load reversals, the guide values in Table 16-14 should not be reduced for fatigue considerations.

Nevertheless, BS 7385 states that the guide values in Table 16-14 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 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 16-14 may need to be reduced by up to 50 per cent.

Accordingly, the BS 7385 guide values to be applied to the assessment of continuous construction vibration sources is summarised in Table 16-15.

TABLE 16-15 BUILDING VIBRATION CRITERIA FOR CONTINUOUS CONSTRUCTION VIBRATION SOURCES

Line	Type of building	Peak Component Particle Velocity in frequency range of predominant pulse (mm/s)	
		4 to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy-commercial buildings	25 mm/s at 4 Hz and above	
2	Non-reinforced or light framed structures residential or light-commercial type buildings	7.5 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Table note:
Values referred to are at the base of the building.

16.6.2.6 Predicted ground-borne vibration levels

Some construction activities, such as the use of piling rigs and compaction with vibratory rollers, may generate ground-borne vibration beyond the bounds of construction sites. Potential ground-borne vibration levels have been predicted to identify the minimum safe working distance needed between the plant and sensitive receptors to achieve the human comfort and structural damage criteria for vibration.

Any sensitive land uses and receptors identified within the safe working distances trigger the need for recommendation of reasonable and practicable measures to reduce and control ground-borne vibration emissions during construction.

The minimum safe working distances for the various vibration criteria that apply to the management of vibration impacts are detailed in Table 16-16. The criteria for human comfort are more stringent than for structural damage and result in the largest safe working distances required. In most cases, where impacts to human comfort are managed, potential impacts to building damage are also avoided.

TABLE 16-16 PREDICTED SAFE WORKING DISTANCES FOR VIBRATION

Plant item	Human comfort			Heritage structures	Building damage
	Night PPV 0.3 mm/s	Day (lower) PPV 1 mm/s	Day (upper) PPV 2 mm/s	PPV 2.5 mm/s	PPV 7.5 mm/s
20 t vibratory roller Start-up/run down	299	117	68	57	23
12 t vibratory roller Start-up/ run down on low vibrate setting	130	50	29	24	9
Vibratory piling	286	105	59	50	20
Percussive piling	445	176	102	86	34
Hydraulic hammer	175	59	31	25	9

The safe working distances for vibration in Table 16-16 are recommended, for the avoidance of human comfort impacts, and cosmetic damage to sensitive and commercial buildings. Based on the calculated safe working distances and the contours presented in Appendix E of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic, the following key points are provided:

- Human comfort safe working distances in the order of 300 m have been calculated for the largest vibratory rollers during start-up/run down on the high amplitude setting. The majority of sensitive receptors located within the contours trigger only the human comfort vibration limits, indicating that building damage impacts from the Project would likely be avoided.
- Regarding the safe working distances calculated for the rock breaker, exact rock-breaking work areas are not yet known. Where rock breaking is required, the safe working distances should be maintained unless direct measurement of rock breaking vibration levels confirm that the vibration limits are being always complied with. Like the vibratory rollers, smaller sized rock breakers would be expected to generate lower levels of vibration.
- If required for the Project, both driven (percussive) piling and sheet piling human comfort safe working distances are significant (i.e. out to 445 m during non-standard hours) albeit likely to be overly conservative due to the prediction equations used for the assessment. All sensitive receptors within the contours trigger only the human comfort vibration limits. It should be noted that the requirement for driven (percussive) piling is not yet confirmed for the Project (i.e. will be reviewed during the detailed design stage). Human comfort vibration impacts are not anticipated from bridge substructure construction utilising the bored piling technique.

- The following heritage structures/sites, which include train stations and sidings, homestead and shearing complexes, memorial halls and gardens, Yelarbon Mill and bridges, were identified to lie within the 2.5 mm/s vibration safe working distance contour:
  - B2G-19-H01 to H11
  - B2G-19-H15 to H16
  - B2G-19-H20 to H34

  Vibration mitigation measures such as preconstruction conditions surveys, use of smaller construction equipment, alternative construction methodology and vibration monitoring, will likely be required for all Project vibration-intensive works occurring within the safe working distance to these heritage structures/sites. Pre- and post-condition surveys and vibration monitoring will be completed for all heritage structures where vibration-intensive works are required to take place within the safe working distances. Details regarding the condition surveys and vibration monitoring will be detailed within the NVMP.

16.6.2.7 Assessment of ground-borne noise

If structural vibration levels within a room are sufficiently high, ground-borne (regenerated) noise can be produced which, due to its low frequency components, can be noticeable (perceptible) to occupants. Where ground-borne noise is observed, the internal noise criteria in Table 16-17 are applied to determine whether additional reasonable and practicable mitigation options should be investigated.

TABLE 16-17 GROUND-BORNE NOISE INVESTIGATION LIMITS

Building	Ground-borne noise limit	
	Work period	L_{ASmax}, dB(A)
Accommodation activity (including hotels or other premises which provides accommodation for the public	Standard hours	40
	Non-standard hours – evening	35
	Non-standard hours – night time	35
Hospital & health care services (wards, surgeries, operating theatres, consulting rooms)	All	35
Educational establishments (rooms designated for teaching/research purposes) & childcare centre	While in use	35
Court of law (court rooms)	While in use	30
Court of law (court reporting and transcript areas, Judges' chambers)	While in use	35
Community use & place of worship	While in use	40
Commercial (offices)	While in use	40
Retail facility	While in use	45

Table note:
L_{ASMax}: The A-weighted maximum sound pressure level with slow response

Based on the following aspects of the Project works, ground-borne noise impacts are not expected, and further assessment of ground-borne noise is not required:

- Typically, ground-borne noise impacts are restricted to underground construction works, such as tunnel-boring machines and road headers, which are not required on the Project.
- Controlling ground-borne vibration levels to meet the vibration criteria in Table 16-13 will assist in minimising ground-borne noise impacts during construction.
- Given sensitive receptors surrounding the Project are not significantly shielded from the construction works, airborne noise levels from construction works are expected to be much higher than ground-borne noise levels and dominate the noise environment at all sensitive receptors.

16.6.3 Construction blasting assessment

Blasting can be associated with airblast (vibrations through the air and noise) and ground vibration. The effects of airblast and vibration can include impacts to human comfort (annoyance) and structural damage to buildings and structures. Examples of these effects include when a sudden or loud noise startles individuals or when air-blast and/or ground vibration causes windows and lightweight items to rattle.

Blasting is expected to only occur during the following standard hours, which include a reduced timeframe to avoid the earlier and later times of the day:

- Monday to Friday 9:00 am to 5:00 pm
- Saturday 9:00 am to 1:00 pm.

The air-blast and vibration management criteria summarised in Table 16-18 have been developed in line with recommendations from the CoP Vol 2.

TABLE 16-18 COP VOLUME 2 RECOMMENDED BLASTING NOISE AND VIBRATION CRITERIA

Category	Location	Blasting limits
Airblast – human comfort	Sensitive receptors	Not more than 115 dB(Linear) for 9 out of any 10 consecutive blasts, and not more than 120 dB(Linear) for any blast
	Occupied non-sensitive sites, such as factories and commercial premises	125 dB(Linear) maximum unless agreement is reached with the occupier that a higher limit may apply
Airblast – damage control	Structures that include masonry, plaster and plasterboard in their construction and unoccupied structures of reinforced concrete or steel construction	133 dB(Linear) maximum unless agreement is reached with the occupier that a higher limit may apply
Ground vibration – human comfort	Sensitive receptors	Not more than 5 mm/s PPV for 9 out of any 10 consecutive blasts and not more than 10 mm/s for any blast
	Occupied non-sensitive sites, such as factories and commercial premises	25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Ground vibration – damage control	Buildings of special value or significance (may include historical buildings, monuments)	2.5 mm/s 1
	Sensitive structures (e.g., residential dwellings, schools, community buildings etc)	15 mm/s at 4 Hz, increasing to 20 mm/s at 15 Hz, increasing to 50 mm/s at 40 Hz and above 2
	Occupied non-sensitive structures of reinforced concrete or steel construction (e.g. factories and commercial premises)	50 mm/s maximum
	Unoccupied structures of reinforced concrete or steel construction	100 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply

Table notes:

1 Based on the heritage criterion from German Standard DIN 4150 – Part 3 – *Structural Vibration in Buildings – Effects on Structures 2016* (DIN 4150).

2 As per the vibration criteria recommended in British Standard 7385: *Part 2-1993 Evaluation and measurement for vibration in buildings Part 2* (BS 7385).

In practice, each blast will be carefully planned by a specialist blasting contractor to control the air-blast and vibration levels. The blasting assessment includes calculations to determine the blast parameters that are expected to control the emissions to meet the air-blast and blast vibration criteria.

Guidance was referenced from Australian Standard (2006) AS 2187.2 (*Explosives – Storage and use Part 2: Use of explosives*) to calculate potential air-blast and ground vibration levels from blast events. The standard includes formulae to calculate blast emissions based on the charge mass of the explosives, a range of constants for the blast parameters, and the distance between the blast and receptors. Further details on the blasting formulae and calculation process are provided in Section 4.3.3 Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

The blasting criteria were calculated to be met at all sensitive receptors. If, however, blasting is required within 200 m of sensitive receptors, it is expected that specific blast parameters would need to be established or alternative construction techniques adopted to control air-blast levels.

The details of the blasting assessment for the control of airblast is provided in Table 16-19 and Table 16-20 for ground vibration.

TABLE 16-19 BLASTING REQUIREMENTS TO CONTROL AIRBLAST IMPACTS—SENSITIVE RECEPTORS

Potential blasting region	Distance between receptor and potential blasting zone (m)	MIC to comply with (kg)			
		115 dBL	120 dBL	125 dBL	133 dBL
Ch 48.9 to 51.3 km	725	36	28	119	1,221
Ch 114.5 to 114.7 km	760	42	32	138	1,409
Ch 165.3 to 168.8 km	150	<10	<10	<10	10
Ch 176.1 to 176.6 km	215	<10	<10	<10	31
Ch 178.8 to 180.5 km	110	<10	<10	<10	<10
Ch 186.5 to 186.9 km	100	<10	<10	<10	<10
Ch 190.2 to 191.6 km	230	<10	<10	<10	38
Ch 193.5 to 194.6 km	385	<10	<10	18	179

TABLE 16-20 BLASTING REQUIREMENTS TO CONTROL VIBRATION IMPACTS—SENSITIVE RECEPTORS

Potential blasting region	Distance between receptor and potential blasting zone (m)	MIC to comply with (kg)					
		5 mm/s PPV	10 mm/s PPV	15 mm/s PPV	25 mm/s PPV	50 mm/s PPV	100 mm/s PPV
Ch 48.9 to 51.3 km	725	596	611	1,014	1,921	4,568	10,859
Ch 114.5 to 114.7 km	760	655	671	1,115	2,111	5,020	11,933
Ch 165.3 to 168.8 km	150	26	26	43	82	196	465
Ch 176.1 to 176.6 km	215	52	54	89	169	402	955
Ch 178.8 to 180.5 km	110	14	14	23	44	105	250
Ch 186.5 to 186.9 km	100	11	12	19	37	87	207
Ch 190.2 to 191.6 km	230	60	61	102	193	460	1,093
Ch 193.5 to 194.6 km	385	168	172	286	542	1,288	3,062

Further assessment of blasting parameters was undertaken to determine the maximum permissible charge weight to minimise potential risk for damage impacts to receptors identified as being areas of interest for heritage significance. The maximum permissible mass charges are detailed in Table 16-21. The assessment of potential blasting impacts to heritage structures/sites indicates that only the region between Ch 165.3 to 168.8 km would require further analysis and detailed blast design to mitigate against potential impacts to the homestead complex (B2G-19-H33).

TABLE 16-21 BLASTING REQUIREMENTS TO CONTROL IMPACTS—HERITAGE BUILDINGS

Potential blasting region	Closest heritage structure	Distance between receptor and potential blasting zone (m)	MIC to comply with (kg)
			2.5 mm/s PPV criterion
Ch 48.9 to 51.3 km	B2G-19-H14 (homestead)	3,260	2,184
Ch 114.5 to 114.7 km	None within 5 km	--	--
Ch 165.3 to 168.8 km	B2G-19-H33 (homestead)	500	51
Ch 176.1 to 176.6 km	None within 5 km	--	--
Ch 178.8 to 180.5 km	None within 5 km	--	--
Ch 186.5 to 186.9 km	None within 5 km	--	--
Ch 190.2 to 191.6 km	None within 5 km	--	--
Ch 193.5 to 194.6 km	None within 5 km	--	--

16.6.4 Construction road traffic noise assessment

Construction haulage and transportation on public roads has the potential to create traffic noise issues for existing communities. To manage the effects of construction traffic, road traffic noise from construction should not increase pre-construction $L_{A10,1hour}$ road traffic noise levels by more than 3 dB(A) during the hours within each work period.

The assessment methodology calculates the potential change in road traffic noise based on:

- The 1-hour basic noise level algorithm from the Calculation of Road Traffic Noise (CoRTN) methodology (Department of Transport, Welsh Office (UK), 1988).
- The minimum median existing $L_{A10,1hr}$ road traffic noise levels for the standard and non-standard construction work periods.
- For the roads that will be utilised as construction traffic routes:
  - existing road traffic volumes and traffic composition (heavy and light vehicles)
  - traffic speeds, road pavement surface, and road gradients
  - proposed hourly construction road traffic volumes and traffic composition.

The purpose of the assessment is to identify where reasonable and practicable measures would be required to control the temporary effects of increasing traffic on the local road networks during the construction period.

Due to the relatively low existing road traffic volumes, the assessment determined that road traffic noise levels are likely to increase by more than 3 dB(A) L_{Aeq} on many of the roads used for construction access. However, the absolute maximum noise levels associated with vehicle pass-bys on these roads would likely be unaltered by the Project construction vehicles (i.e. being a similar noise event to existing heavy vehicle movements on these roads). Only the frequency of such events would marginally increase.

Once construction is completed, or has moved further along the alignment, the influence of construction traffic would reduce, and road traffic noise levels are expected to return to existing levels.

16.7 Potential impacts—Operational road traffic noise

16.7.1 Road traffic noise criteria

16.7.1.1 Criteria for new roads

The road traffic noise assessment criteria for new roads were established from the CoP Vol 1. Further details expanding on the application of the road traffic noise criteria are provided in Section 3.3.3 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic. Maps showing the location of the assessed roads are provided in Appendix J of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

The new road criteria apply at existing residences, at educational, community, and health buildings, and at outdoor educational and passive recreational areas. For existing residences, the criteria are established with reference to the level of any existing road traffic noise experienced at the properties.

The criteria apply over timeframes that are specific to the type of sensitive receptor, as follows:

- 18-hour period of 6:00 am to midnight for existing residences
- 1-hour periods during the operational hours of educational, community, and health buildings. This typically corresponds to the 1-hour peak road traffic volumes/ noise levels
- 12-hour period from 6:00 am to 6:00 pm for outdoor educational and passive recreational areas.

The road traffic noise assessment criteria for the 36 new road sections delivered under the Project are provided in Table 16-22. Due to the low existing traffic noise in the locality of the new roads, the existing road traffic noise is $L_{A10(18hour)} \leq 55$ dB(A) so the most stringent $L_{A10(18hour)}$ 60 dB(A) road traffic noise criterion applies at residences.

TABLE 16-22 ROAD TRAFFIC NOISE CRITERIA FOR NEW ROADS

Categories	Road traffic noise criteria		
	Existing residences (façade corrected)	Educational, community and health buildings (façade corrected	Outdoor educational and passive recreational areas (including parks) (free field)
New road—Access controlled	$L_{A10(18hour)}$ 63 dB(A) existing level $L_{A10(18hour)}$ >55 dB(A)	$L_{A10(1hour)}$ 58 dB(A)	$L_{A10(12hour)}$ 63 dB(A)
	$L_{A10(18hour)}$ 60 dB(A) existing level $L_{A10(18hour)}$ ≤55 dB(A)		

Table notes:
The road traffic noise criteria are applied at 1 m from the building facade for existing residences and for educational, community, and health buildings unless free-field environments.
The assessment location is 1.5 m above the finished floor level or mid-window height, whichever is higher for each storey or building. Otherwise, the receptor heights are 1.8 m and 4.6 m above the building platform level for the ground and first floors, respectively. For free field environments, the receptor height is 1.5 m above the ground floor.

16.7.1.2 Criteria for upgrading existing roads

For the upgrade of 46 sections of existing road network, the criteria in Table 16-23 have been applied to assess and manage road traffic noise from the upgraded roads at the identified sensitive receptors. The criteria are applied consistent with the timeframes and receptor locations described above for the assessment of noise from new roads.

TABLE 16-23 ROAD TRAFFIC NOISE CRITERIA FOR UPGRADING EXISTING ROADS

Categories	Road traffic criteria		
	Existing residences (façade corrected)	Educational, community and health buildings (façade corrected	Outdoor educational and passive recreational areas (including parks) (free field)
Upgrading existing road	$L_{A10(18hour)}$ 68 dB(A)	$L_{A10(1hour)}$ 65 dB(A)	$L_{A10(12hour)}$ 63 dB(A)

Table note:
The road traffic noise criteria in the table only include the road categories from the DTMR Code of Practice Volume 1 that are applicable to the Project.

16.7.2 Assessment of road traffic noise

The findings of the initial desktop screening assessment and the subsequent detailed assessment for the roads where the noise criteria may not be achieved are described in following sections. The predicted road traffic noise levels at individual sensitive receptors are reported in Section 7 of Appendix V: Noise and Vibration Assessment - Construction and Road Traffic.

16.7.2.1 Screening assessment

The road traffic noise levels at the nearest sensitive receptors are expected to meet the road traffic noise criterion at all the new road sections, except the two new road sections at:

- Cunningham Highway, at Chainage (Ch) 25.4 km, west of Eena Street
- Wondalli Street at Ch 25.4 km. South of Kera Street.

In addition to the above, Lochaber Road at Ch 173.7 km at the intersection with the Gore Highway was conservatively included in the detailed assessment due to being within 2 dB of the criterion.

For the existing roads to be upgraded as part of the Project, the assessment identified the road traffic noise criteria are predicted to be achieved at most of the upgraded road sections. The following upgraded road sections required further detailed assessment of road traffic noise:

- Cunningham Highway, west of Wyemo Street
- Millmerran Inglewood Road, north of Kooroongarra Road
- Gore Highway at five locations—east of Pampas Road, south of Elsden Road, west of Saal Road, north of Lochaber Road, and north of Biddeston Southbrook Road
- Oakley-Pittsworth Road—west of Gore Highway
- Toowoomba Cecil Plains Road—west of Toowoomba Bypass
- Warrego Highway—west of Jannuschs Road.

16.7.2.2 Detailed road traffic noise assessment

Based on the findings of the initial desktop assessment, three new road sections and 10 upgraded road sections, totalling 12 road sections in all, were subject to further detailed assessment utilising a detailed road traffic noise prediction model.

The noise modelling incorporates extensive technical parameters for the existing and proposed road alignments, and traffic conditions, in accordance with the CoRTN method for road traffic noise predictions in Queensland. The comprehensive details of the noise modelling are provided in Section 7.2 of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

In line with the requirements of the CoP Vol 1, the road traffic noise levels were calculated for two periods, being the opening of the Project and at 10 years following opening of the Project.

The road traffic noise levels predicted at the individual receptors and contour maps of the future road traffic noise levels are provided in Appendix J of Appendix V: Noise and Vibration Assessment—Construction and Road Traffic. For most sensitive receptors, the future road traffic noise levels are within the assessment criteria for both predicted periods, including outdoor educational areas and recreational areas.

A summary of the receptors where unmitigated road traffic noise levels are predicted to be above the assessment criteria is provided in Table 16-24.

TABLE 16-24 SUMMARY OF THE ROAD TRAFFIC NOISE CRITERIA TRIGGERS

Receptors	Road traffic year 2028		Road traffic year 2038	
	No. of exceedances	Highest exceedance	No. of exceedances	Highest exceedance
Residential receptors	9	4 dB(A)	10	5 dB(A)
Educational and community buildings	3	9 dB(A)	3	10 dB(A)

Road traffic noise levels are predicted to exceed the nominated noise criterion from:

- Warrego Highway at one residential receptor between the B2G alignment and Jannuschs Road
- Gore Highway at two receptors near Lord Street, Brookstead, three receptors near Pampas Road, and the Pampas Memorial Hall
- Cunningham Highway at three residential receptors on Taloom Street and two community receptors (i.e. Yelarbon Soldiers Memorial Hall and Fire Station).

Future road traffic noise levels are predicted to exceed the noise criteria at locations in non-accessed controlled road situations, where the properties have direct access to the relevant roads. They do not qualify for noise treatment under the framework of the CoP Vol 1 but would be reviewed on a case-by-case basis as part of the Project noise mitigation strategy in conjunction with the rail noise mitigation requirements (Section 16.10.2).

16.8 Potential impacts—Operational railway noise and vibration

16.8.1 Assessment of railway noise

A detailed assessment of noise and vibration from the future railway operations on the Project has been undertaken in Appendix W: Noise and Vibration Assessment—Railway Operations. The key findings of the assessment are provided in this section of the chapter.

16.8.1.1 Assessment criteria

The airborne noise criteria for sensitive land-uses and receptors utilise two noise descriptors, being the Single Event Maximum (SEM) and the time average noise level (L_{Aeq}) for the 24-hour and 12-hour periods. The SEM is a measure of the highest individual noise events associated with rolling stock operations, and the L_{Aeq} is a measure of the total railway noise exposure over the specified time periods.

The SEM and L_{Aeq} noise descriptors are defined as:

- Single Event Maximum is the arithmetic average of the maximum (L_{AFmax}) levels from the highest 15 single events (rolling stock passby) during a 24-hour period
- L_{AFMax} or Fast, is the average maximum sound level over 0.125 of a second
- $L_{Aeq,24hour}$ is the time average A-weighted sound level having the same total energy as the time varying sound measured for the 24-hours between midnight and midnight on a given day
- $L_{Aeq,12hour}$ is the time average A-weighted sound level having the same total energy as the time varying sound measured for the 12-hours between 6:00 am to 6:00 pm.

The Project will involve rollingstock operations on sections of new railway and on sections where the railway is being upgraded to collocate the Inland Rail tracks within existing rail corridors.

ARTC has elected to assess and manage railway noise on the entire Project alignment by applying the noise criteria applicable to new railways.

The key factors that were considered to determine the application of the noise criteria for new railways throughout the Project included:

- This approach means adopting the most stringent (lowest) noise criteria from the Interim Guideline to assess and manage railway noise at sensitive land uses and receptors.
- All sensitive land uses and receptors will be assessed against the same set of criteria, irrespective of whether an individual land use or receptor would currently experience noise and vibration from existing rail operations.
- As a result of the 2009 and 2011 floods in Queensland, the Millmerran Line remains closed (red boarded) between Brookstead and Millmerran. There are currently no railway operations on this section, so nearby sensitive land uses and receptors would not be experiencing railway noise and vibration emissions.
- The existing railway operations on the existing South Western Line and Millmerran Branch Line have a relatively small number of weekly train movements associated with seasonal agriculture. The operations equate to approximately one train per day and there would be periods throughout the year with no train movements over consecutive days.
- Any requirements for noise and vibration mitigation will be determined by the future railway operations with the Project, rather than the existing railway operations.

The Interim Guideline railway noise criteria adopted on the Project are detailed in Table 16-25.

TABLE 16-25 INTERIM GUIDELINE AIRBORNE ROLLINGSTOCK NOISE CRITERIA

Type	Sensitive land use	Location	External Operational Railway Noise Criteria, dB(A)1		
			SEM	$L_{Aeq,24hr}$	$L_{Aeq,12hr}$
New railway	Accommodation activities	All facades	≤82 (façade corrected)	≤60 (façade corrected)	None
	Educational establishments				
Applied route-wide on B2G Project	Childcare centres				
	Health care services				
	Hospitals	Outdoor spaces for passive recreation	≤79 (free field)	None	≤57 (free field)
	Community uses	Outdoor education area			
	Places of worship	Outdoor play area[2]			
	Offices				

Table notes:

1. The façade corrected noise measurement/calculation/prediction height shall be 1.5 m above finished floor level or mid window height, whichever is higher, for each storey of the building (1.0 m in front of the most exposed façade). Otherwise, the receptor heights shall be assumed at 1.8 m and 4.6 m above the building platform level for the ground and first floors respectively. A height of 0.5 m below the eaves' height is also acceptable. For free field criteria, the noise measurement/calculation/prediction height shall be 1.5 m above the ground level.
2. For outdoor educational, outdoor play and passive recreational areas greater than 2,000 m^2, the criterion level is to be achieved for a minimum 2,000 m^2. For areas less than 2,000 m^2, the criterion level shall be achieved for the whole area. All available relevant information about the provision and future use of the outdoor educational or passive recreational areas should be considered.

16.8.1.2 Predicted airborne noise levels

The railway noise levels predicted at each of the 2,388 sensitive receptors within the study area are detailed in Appendix W: Noise and Vibration Assessment—Railway Operations for the railway operations at Project opening and the year 2040.

For railway operations at the Project opening and the design year 2040, the unmitigated predicted noise levels were above the Interim Guideline criteria, at 82 residential receptors. There were 15 non-residential sensitive receptors where railway noise levels trigger the Interim Guideline requirements for review and implementation of noise mitigation. The residential and non-residential noise-mitigation triggers are discussed further in Table 16-28.

The predicted L_{Aeq} and SEM railway noise levels for year 2028 (Project opening) and 2040 operations are provided in Figure 16-4 to Figure 16-6. The maximum noise levels, represented by the SEM and detailed in Figure 16-6, are determined by the highest train pass by events and are the same for the Project opening year and the 2040 operations.

In each graph, the relevant rolling stock noise limit from the Interim Guideline is included. If the predicted noise levels at sensitive receptors, indicated by individual markers in the graphs, are below the criterion line, the Project is forecasted to meet the noise limits. Noise contours for façade corrected noise levels are presented in Figure 16-7 for 24hour L_{Aeq} and Figure 16-8 for SEM noise levels. Free field noise contours for locations with outdoor spaces are presented in Figure 16-9 for 12hour L_{Aeq} and Figure 16-10 for SEM noise levels.

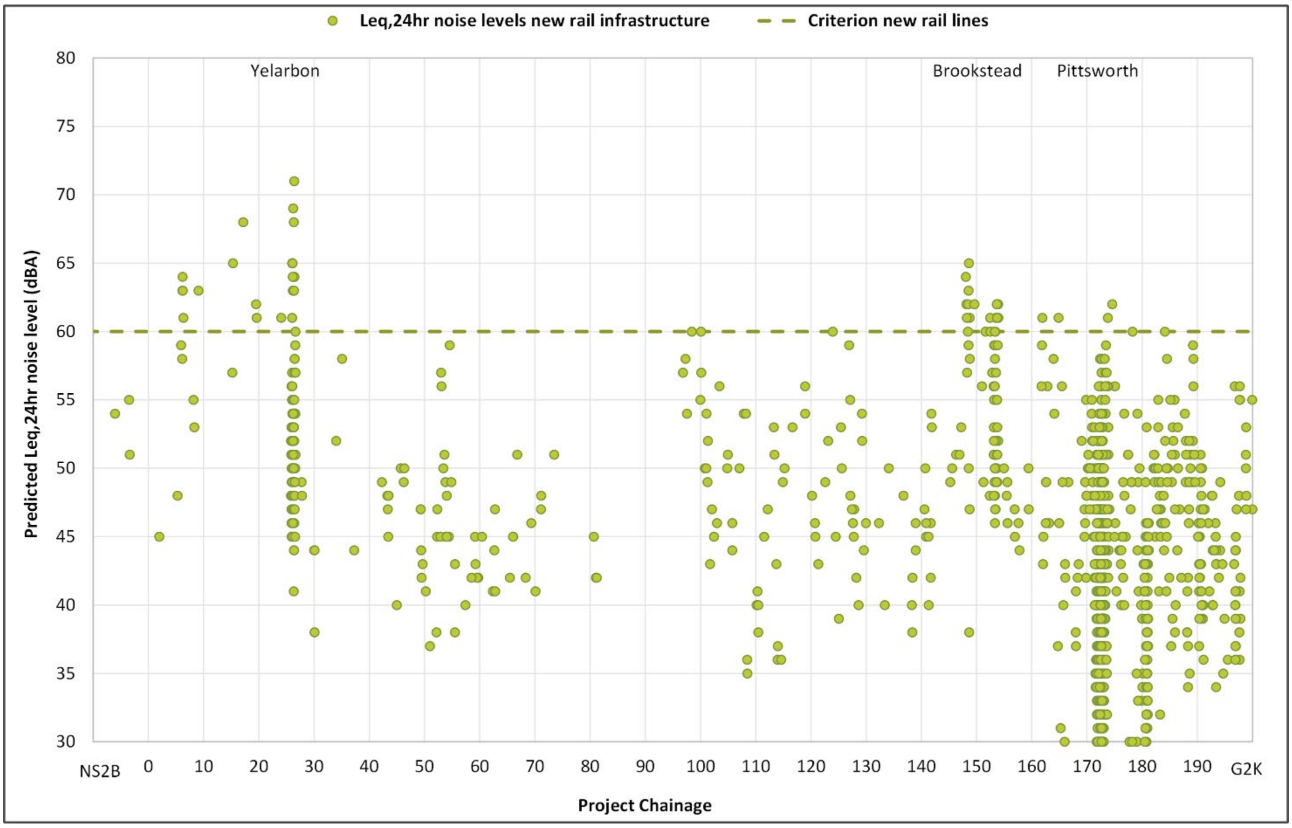


FIGURE 16-4 INTERIM GUIDELINE PREDICTED L_{Aeq} RAILWAY NOISE LEVELS—YEAR 2028

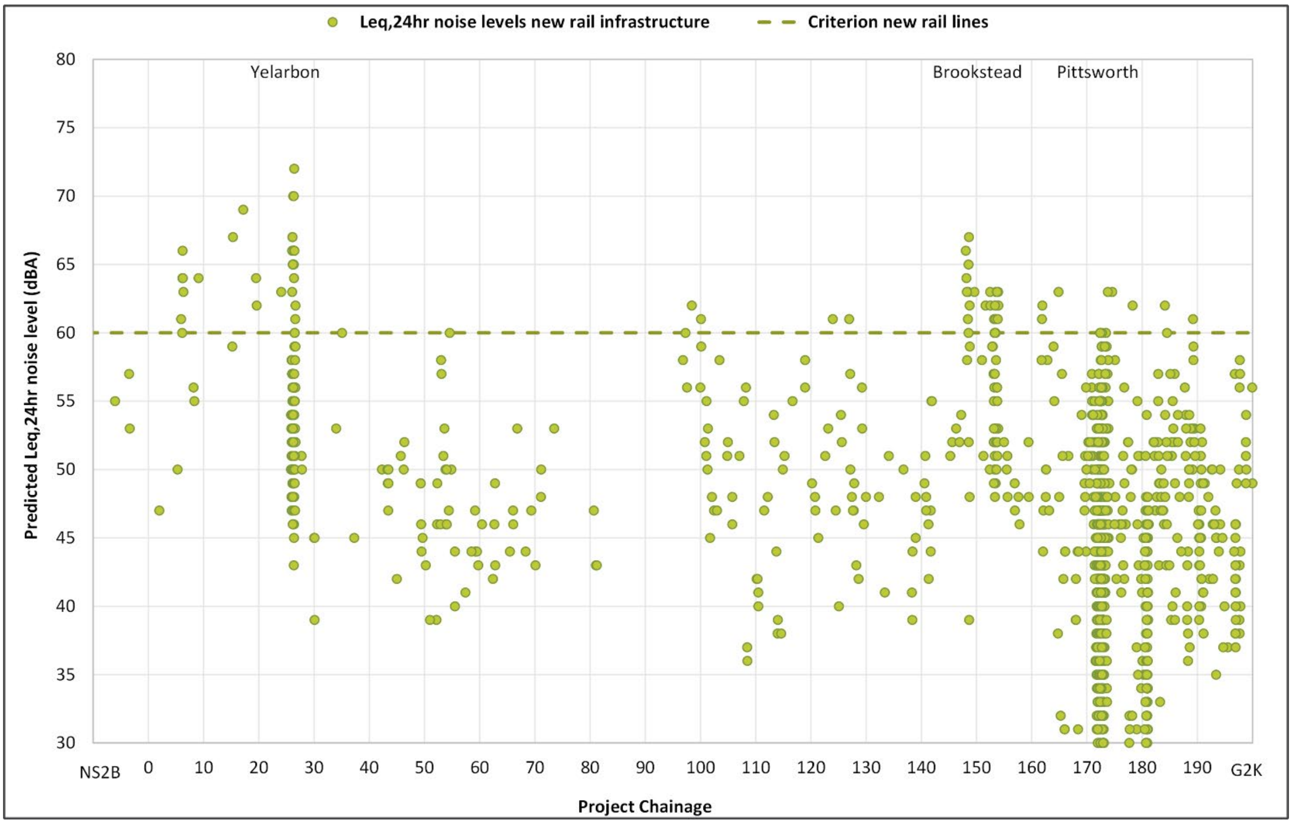


FIGURE 16-5 INTERIM GUIDELINE PREDICTED L_{Aeq} RAILWAY NOISE LEVELS—YEAR 2040

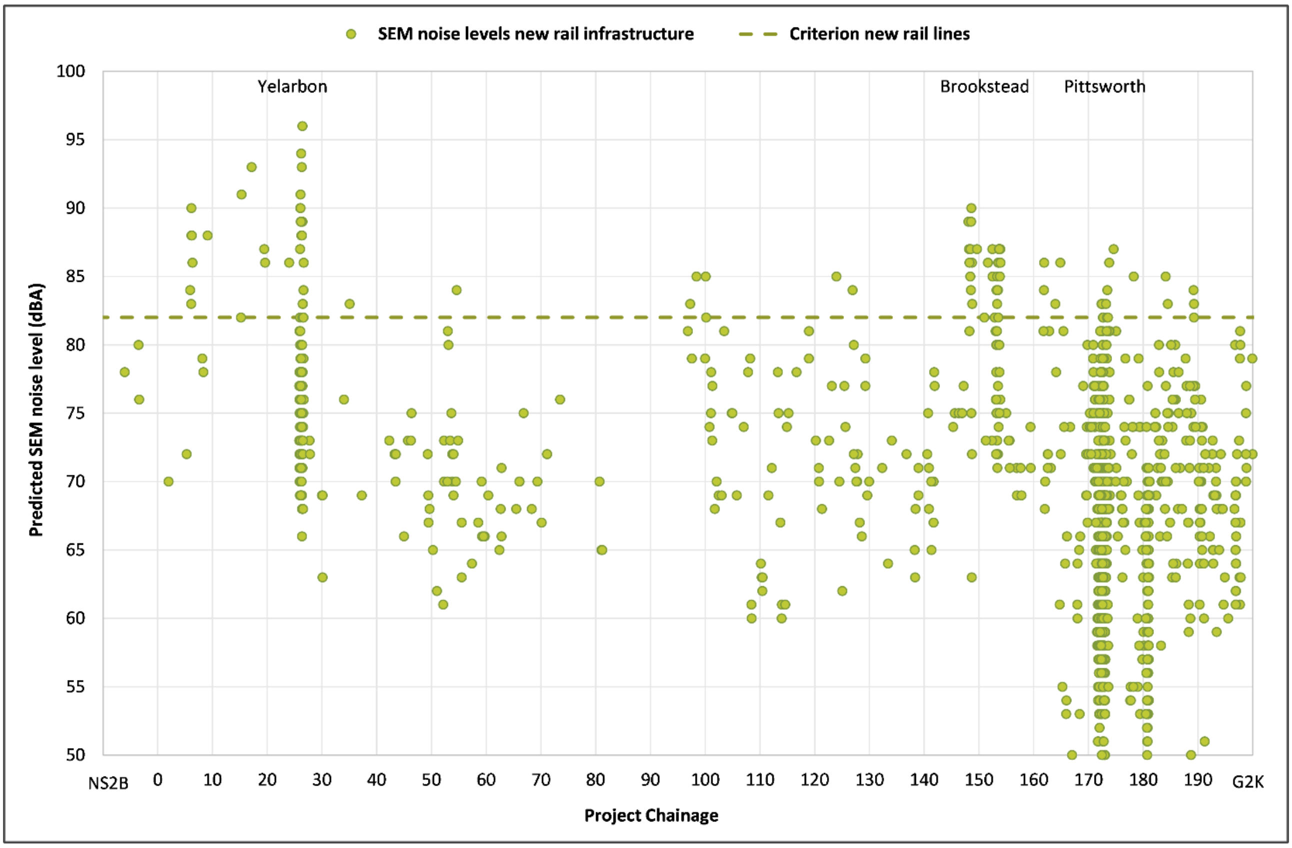
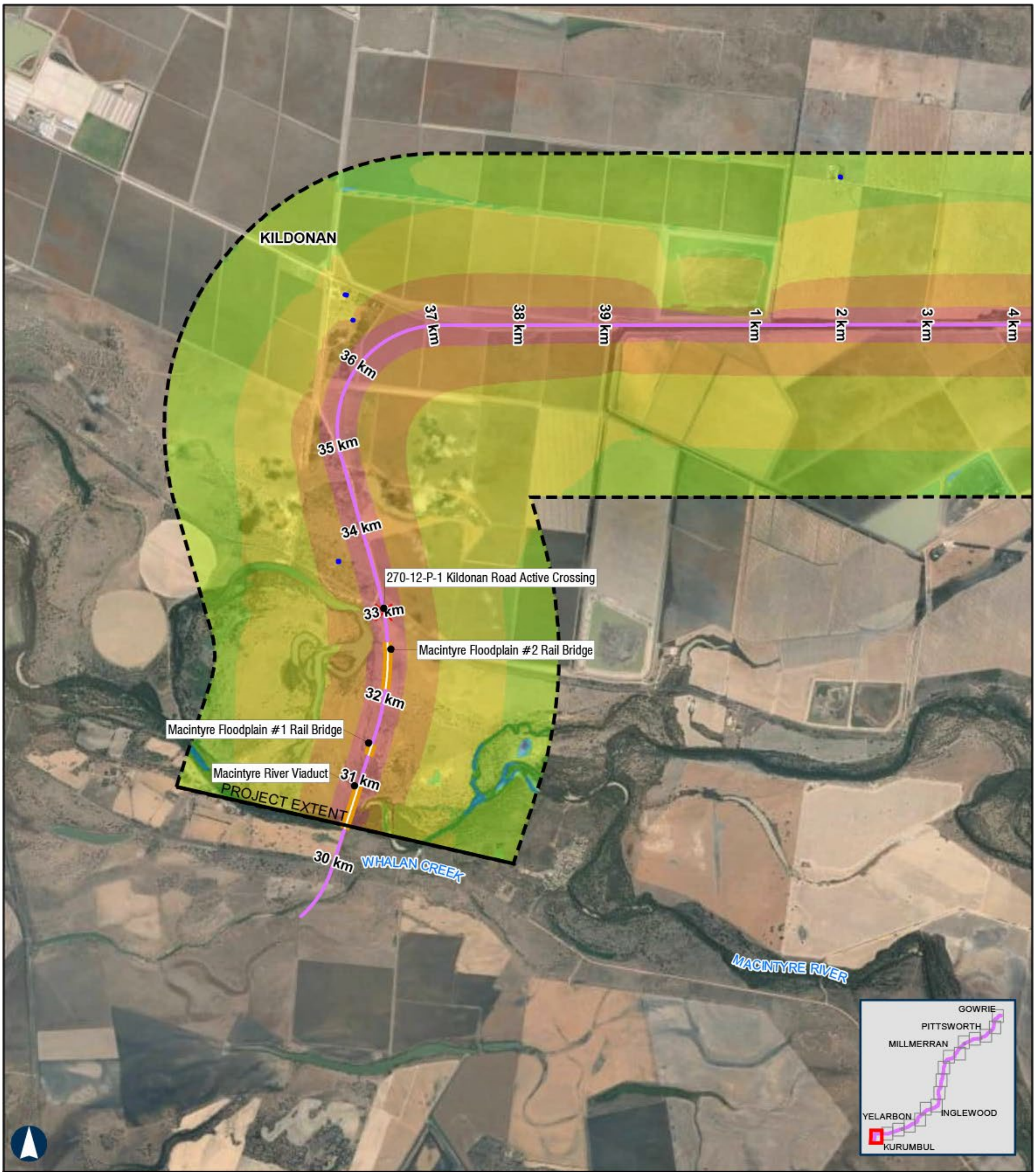


FIGURE 16-6 PREDICTED SEM RAILWAY NOISE LEVELS—OPENING/2040



BORDER TO GOWRIE | **Railway Noise Level Contours – Leq,24hour Year 2040** | Figure 16-7 Map 1 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Date: 23-Oct-2024
Author: JG

- Level Crossings
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- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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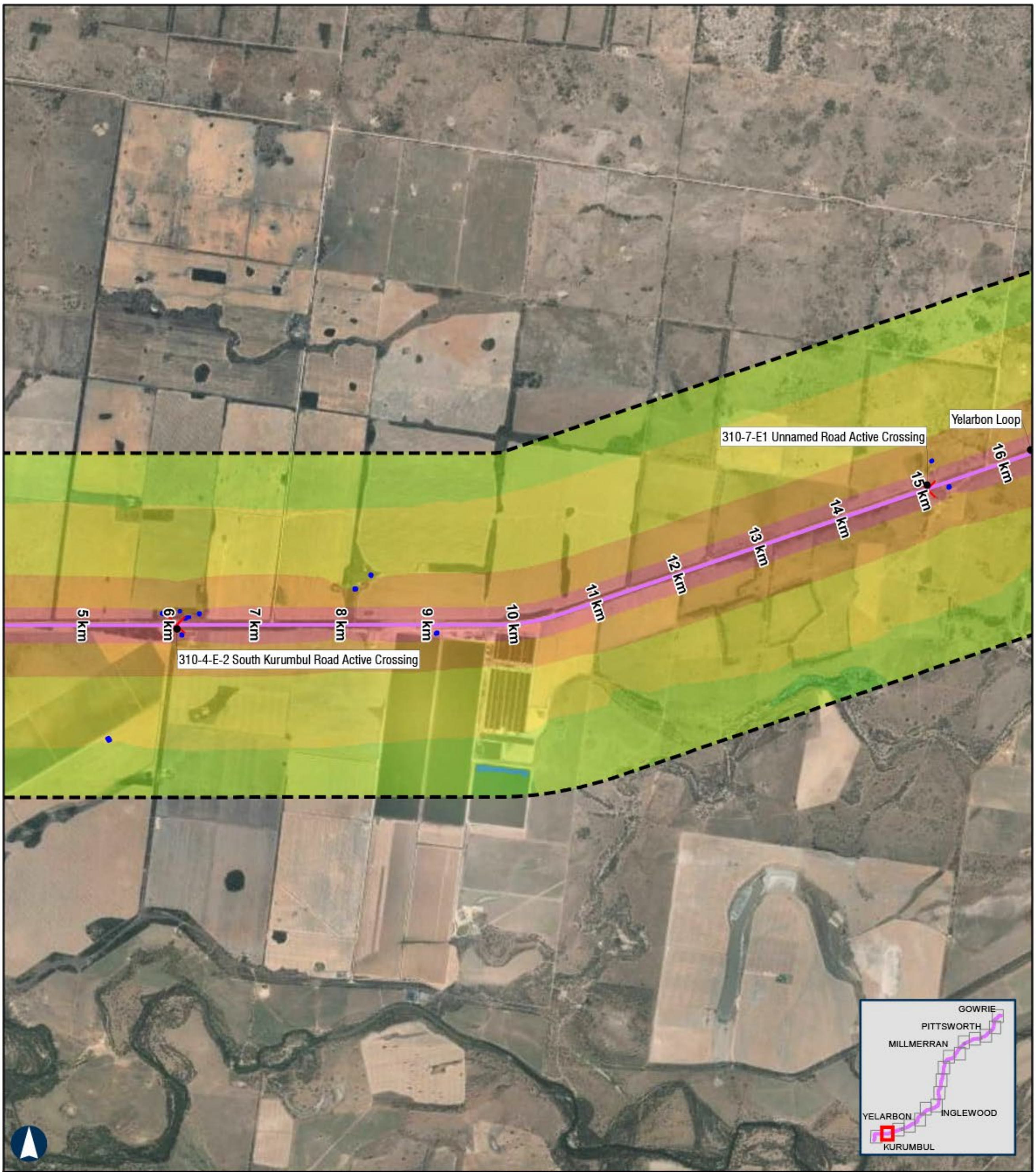

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 2 of 20

1000 m

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Noise Levels

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- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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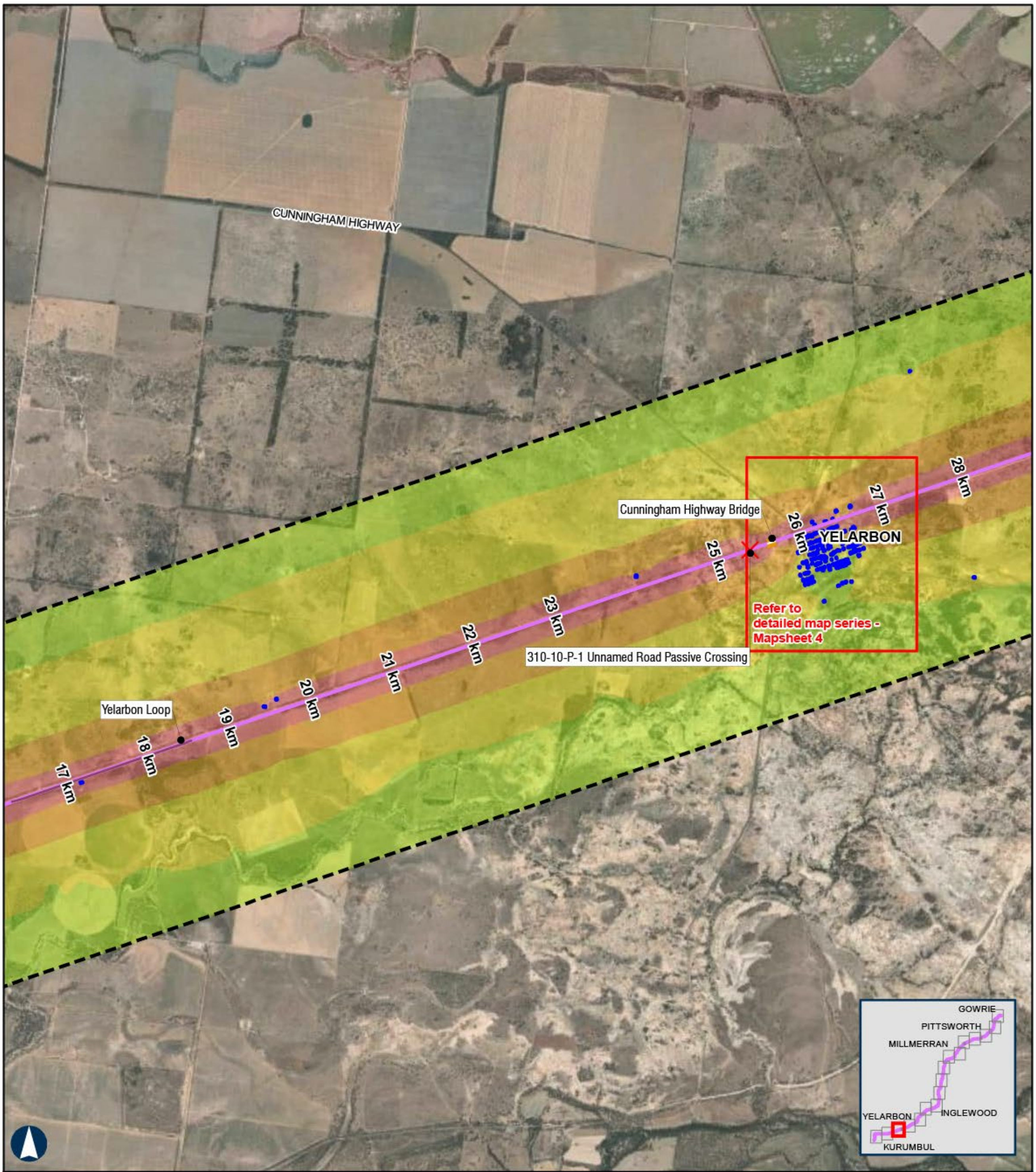

BORDER TO GOWRIE | **Railway Noise Level Contours – Leq,24hour Year 2040** | Figure 16-7 Map 3 of 20

1000 m

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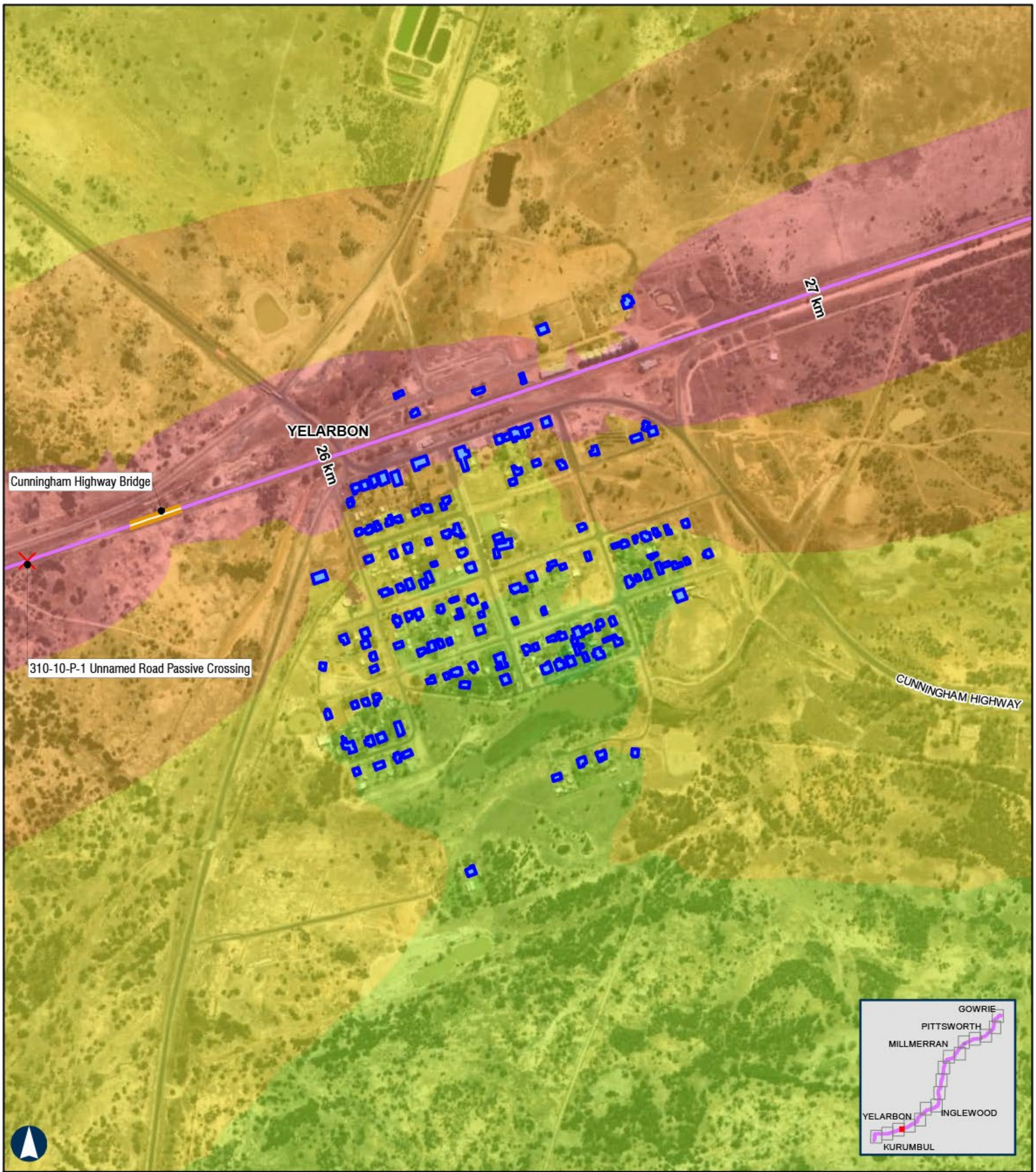

BORDER TO GOWRIE

Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 4 of 20

175 m

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Noise Levels

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- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
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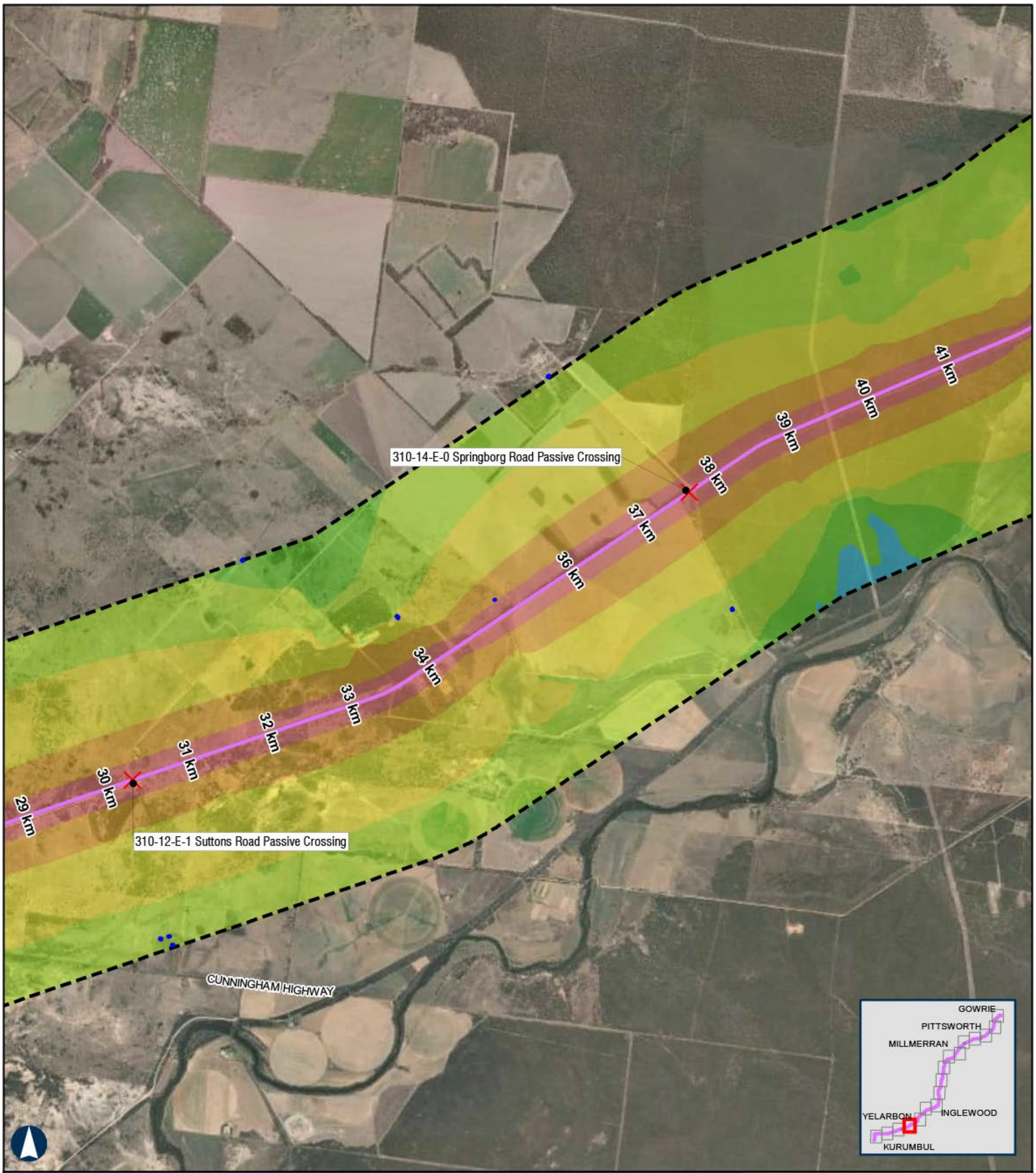

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 5 of 20

1000 m

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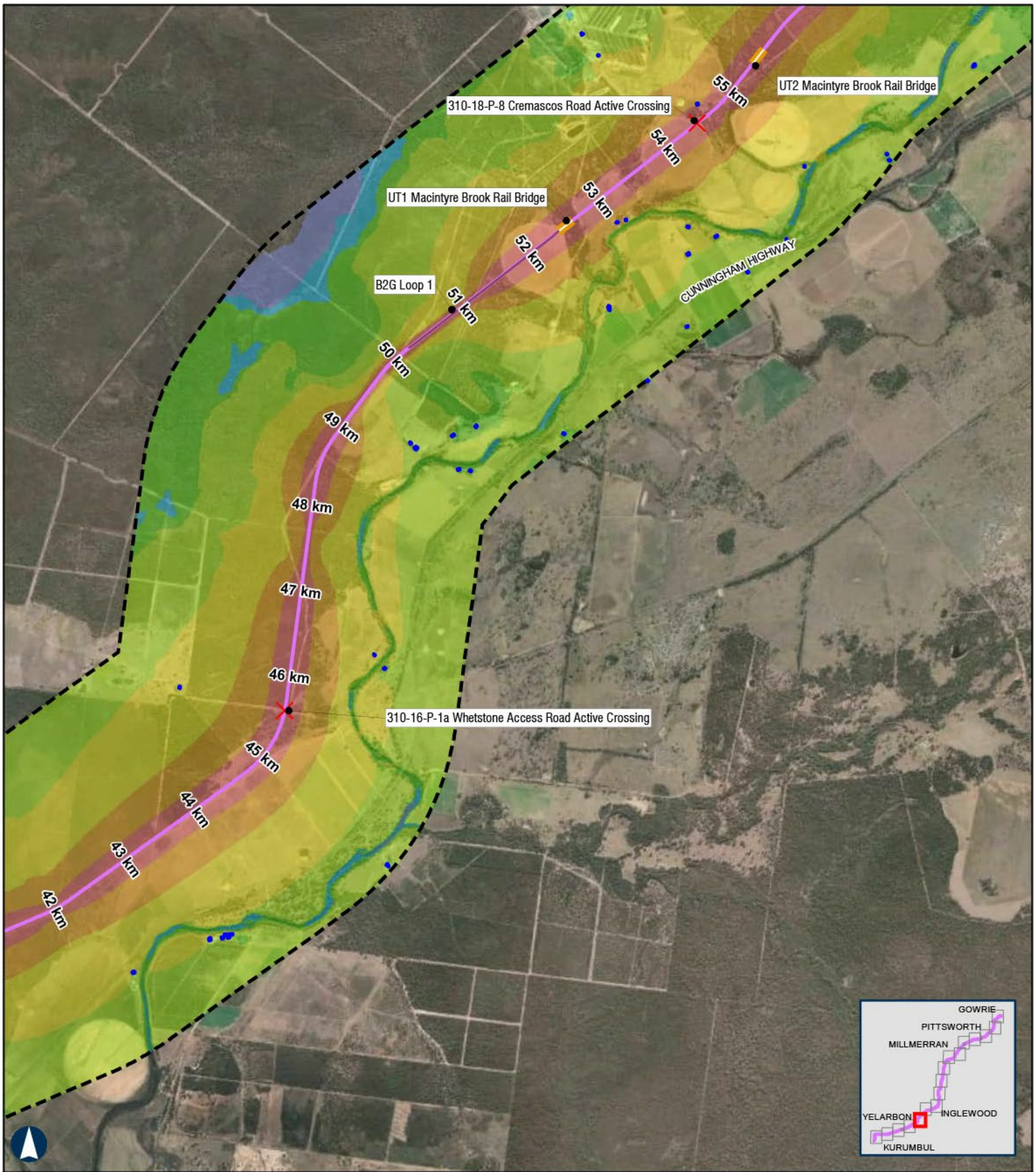

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 6 of 20

1000 m

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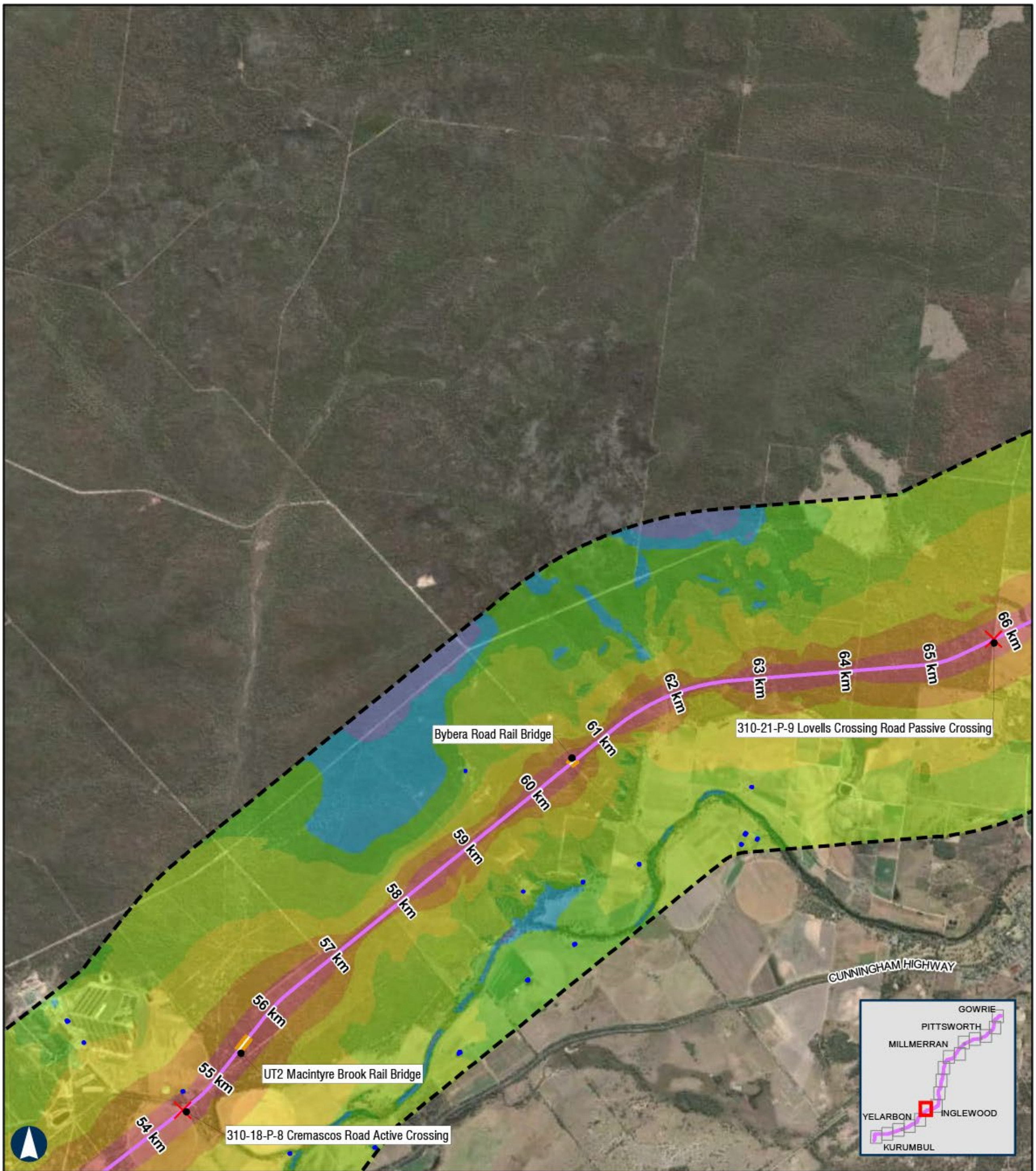

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1000 m

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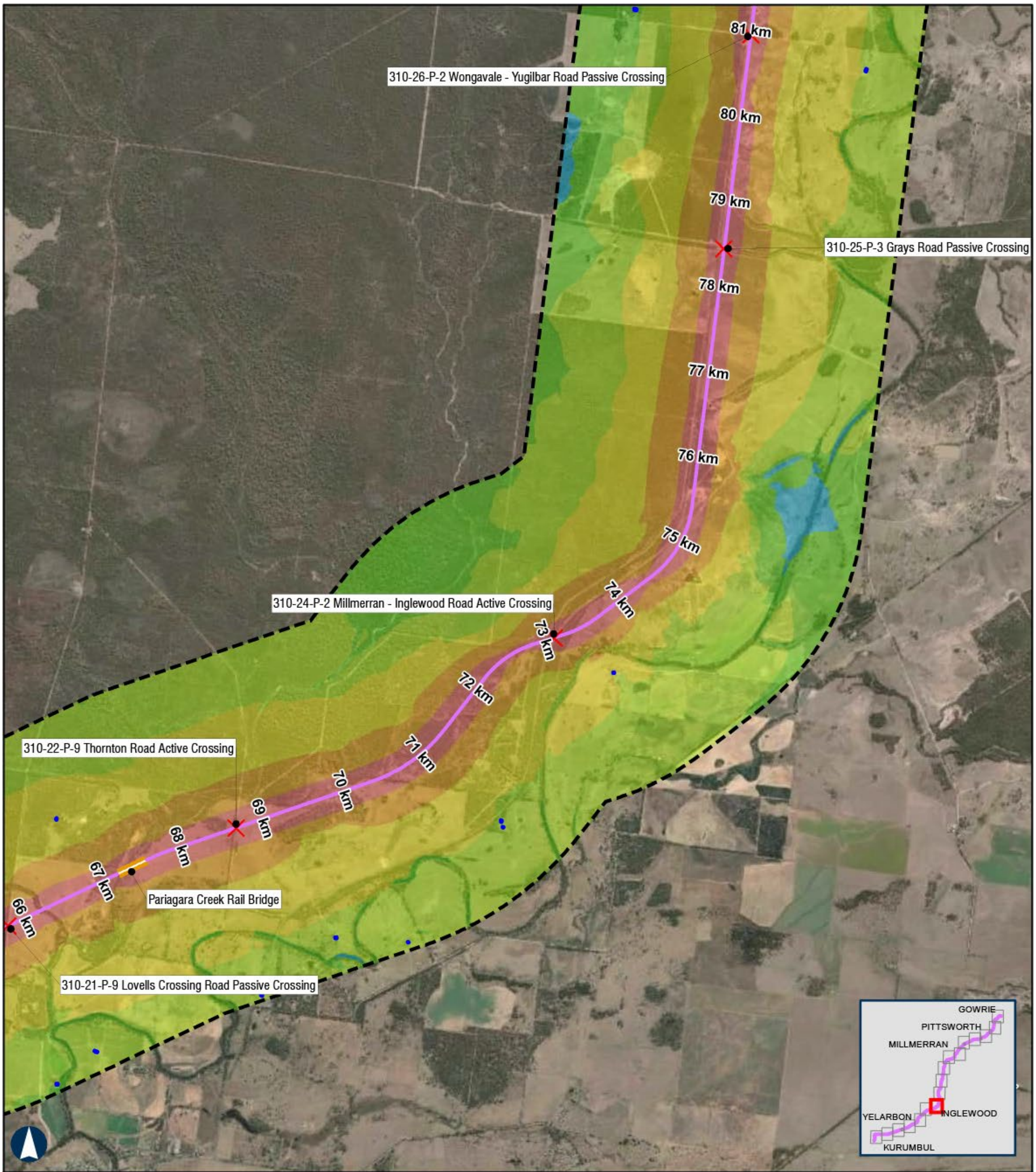

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1000 m

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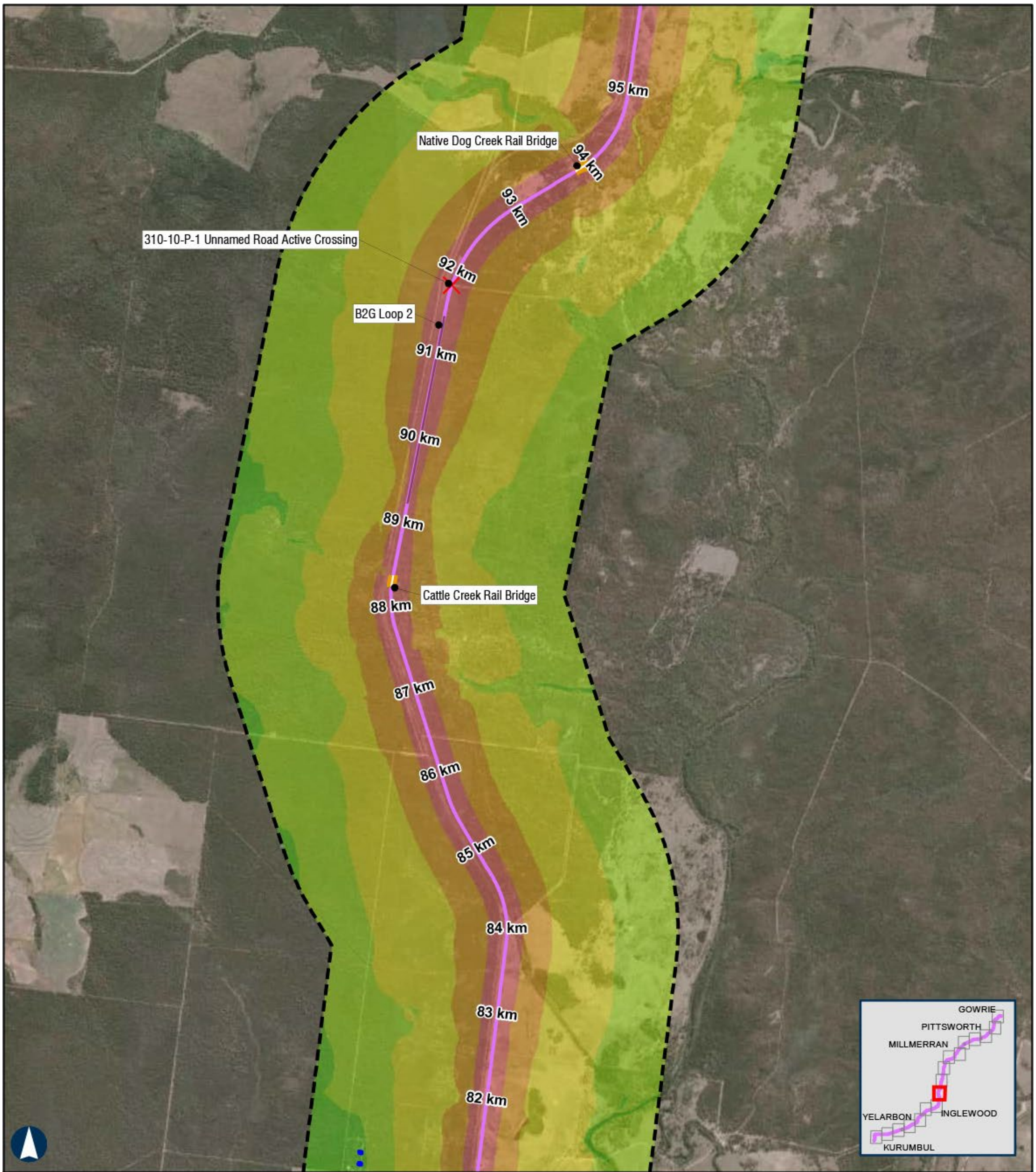

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 9 of 20

1000 m

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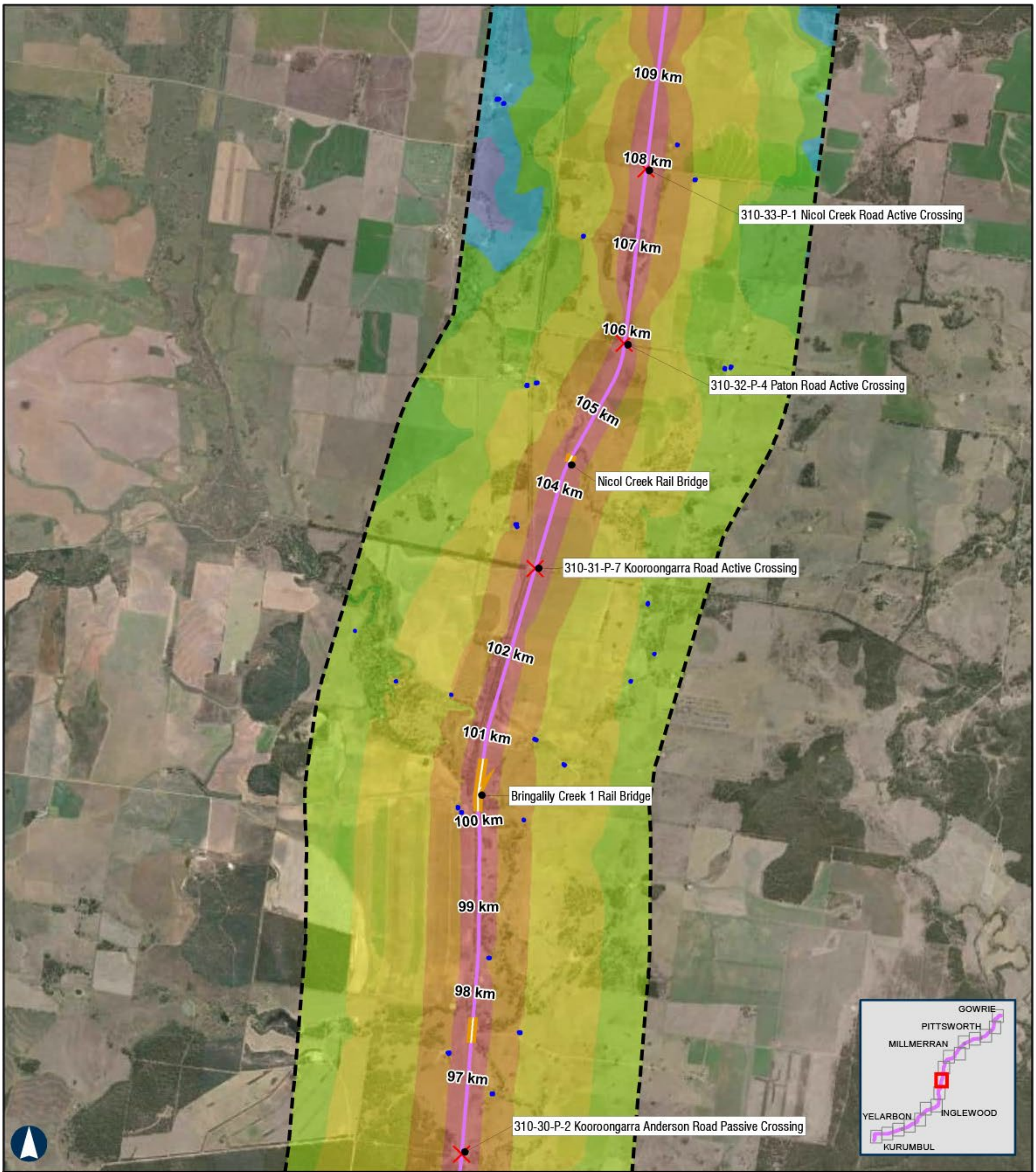

BORDER TO GOWRIE | Railway Noise Level Contours – Leq,24hour Year 2040 | Figure 16-7 Map 10 of 20

1000 m

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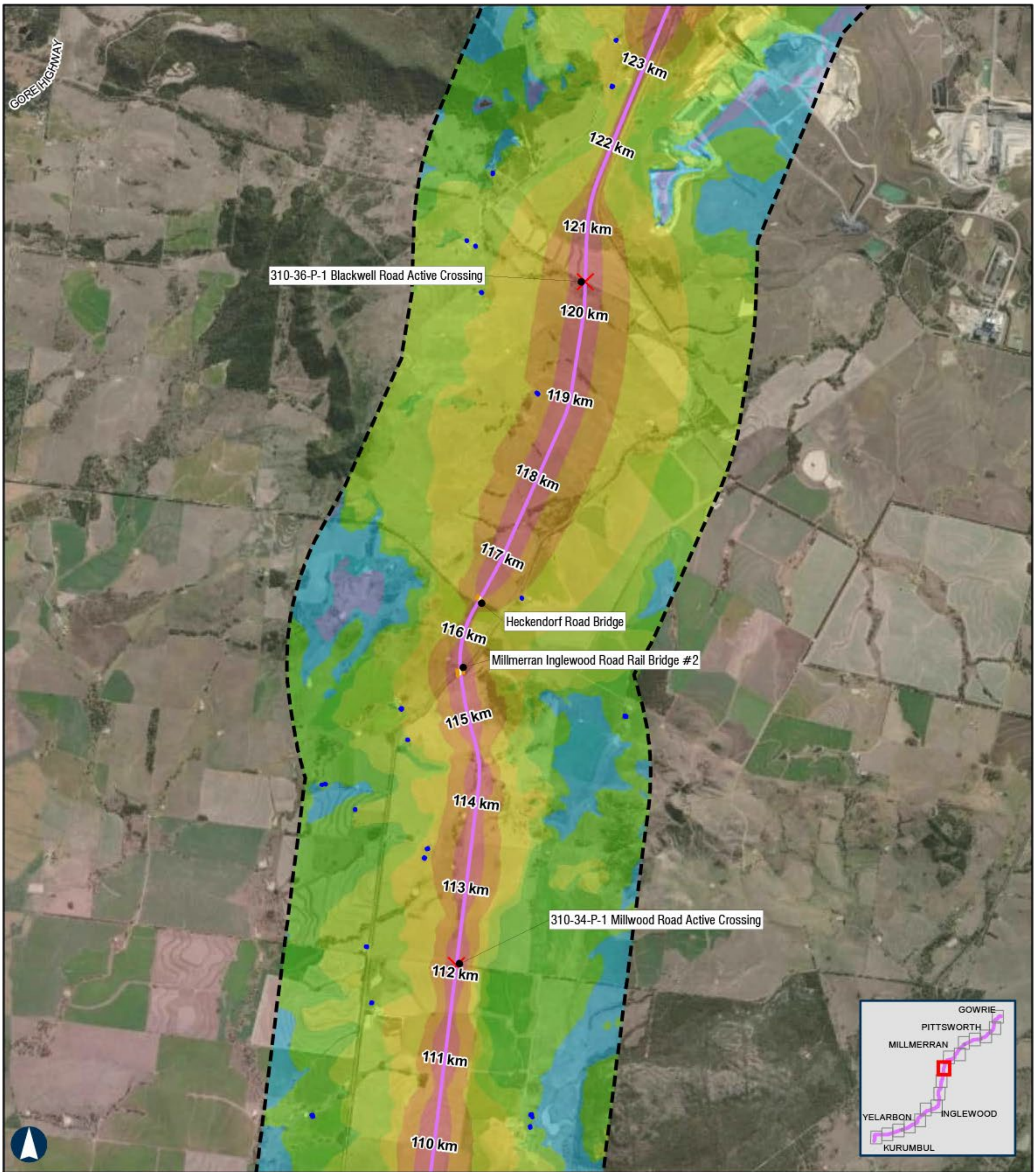

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 11 of 20

1000 m

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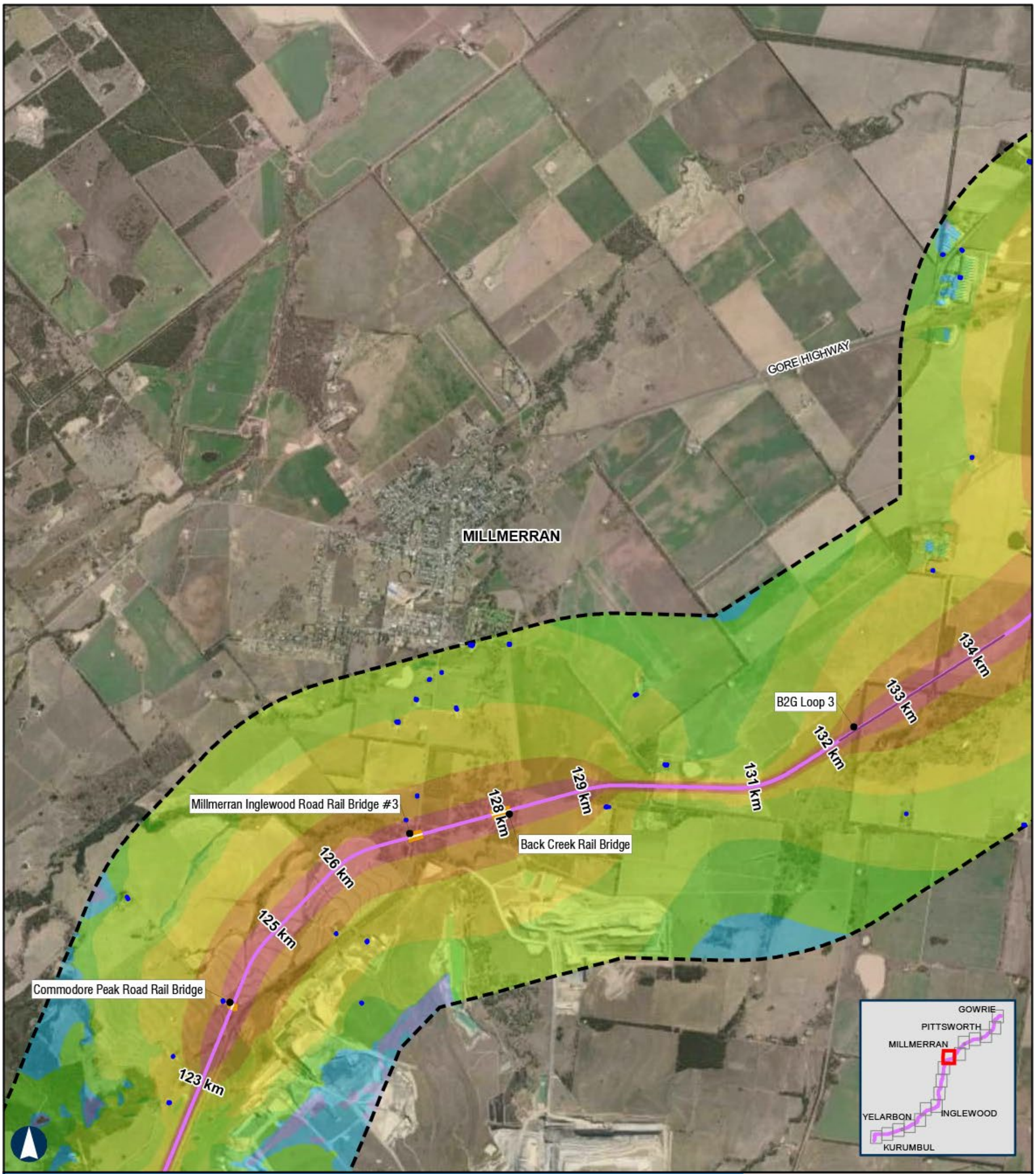

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 12 of 20

1000 m

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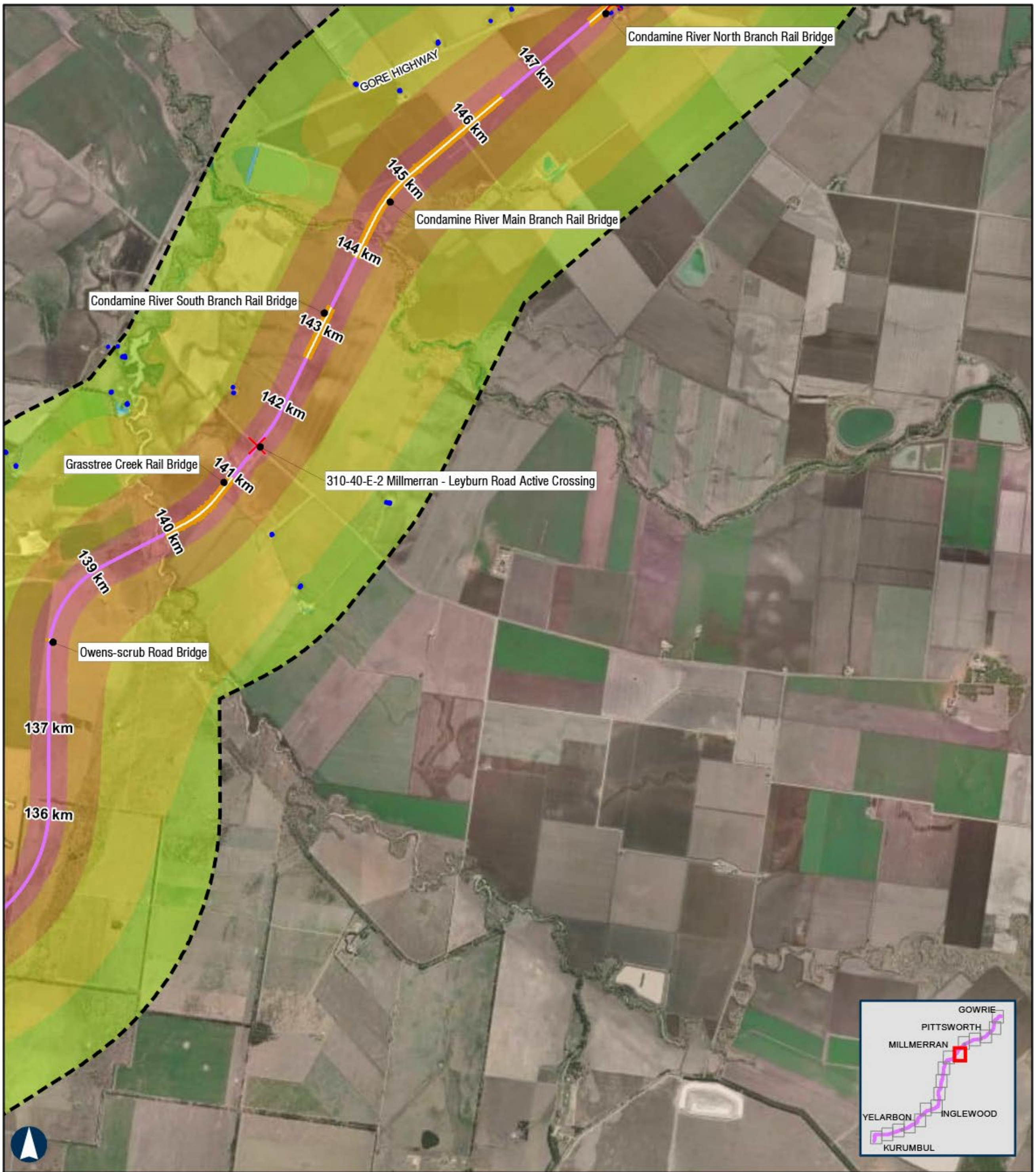

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1000 m

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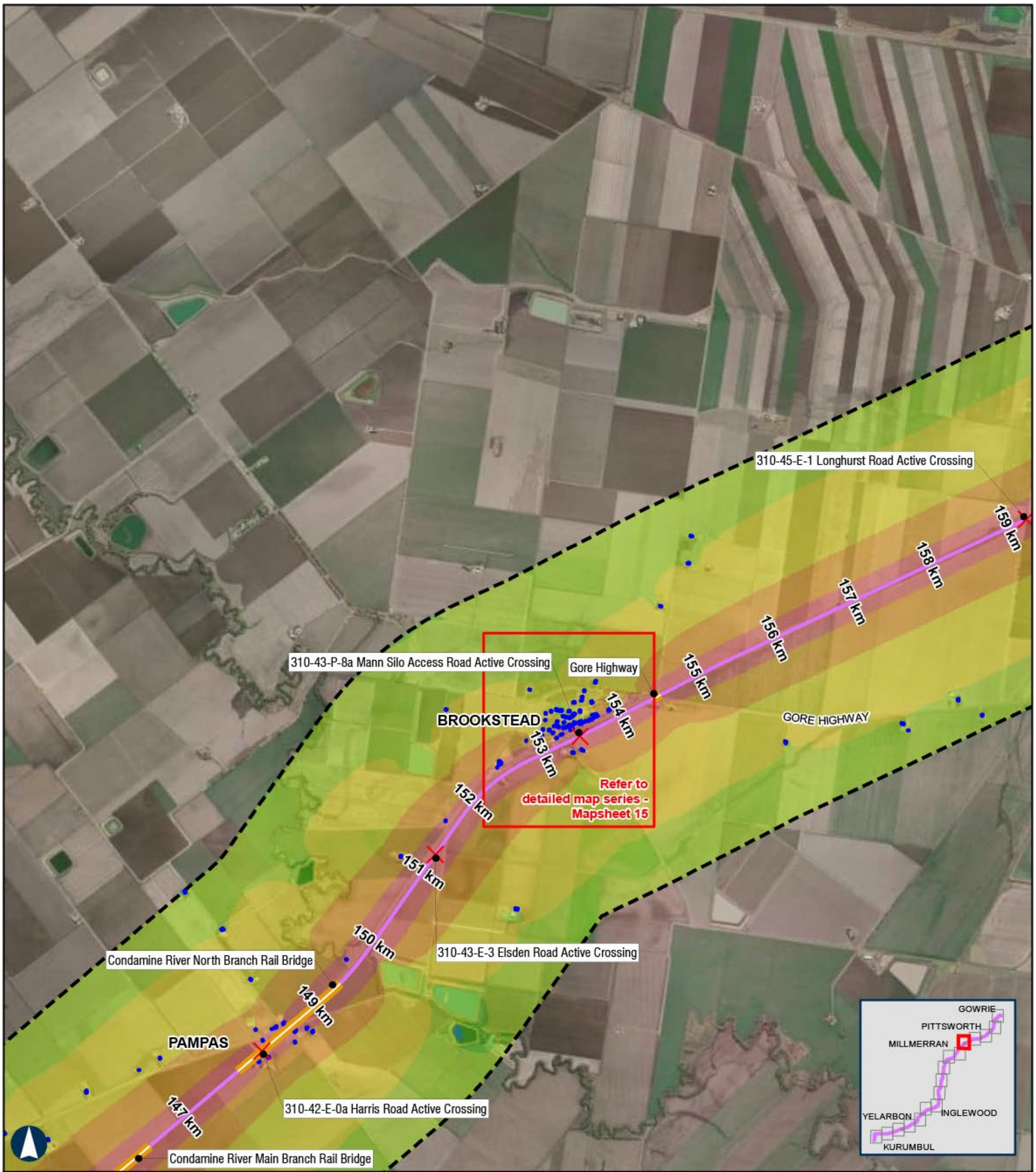

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 14 of 20

1000 m

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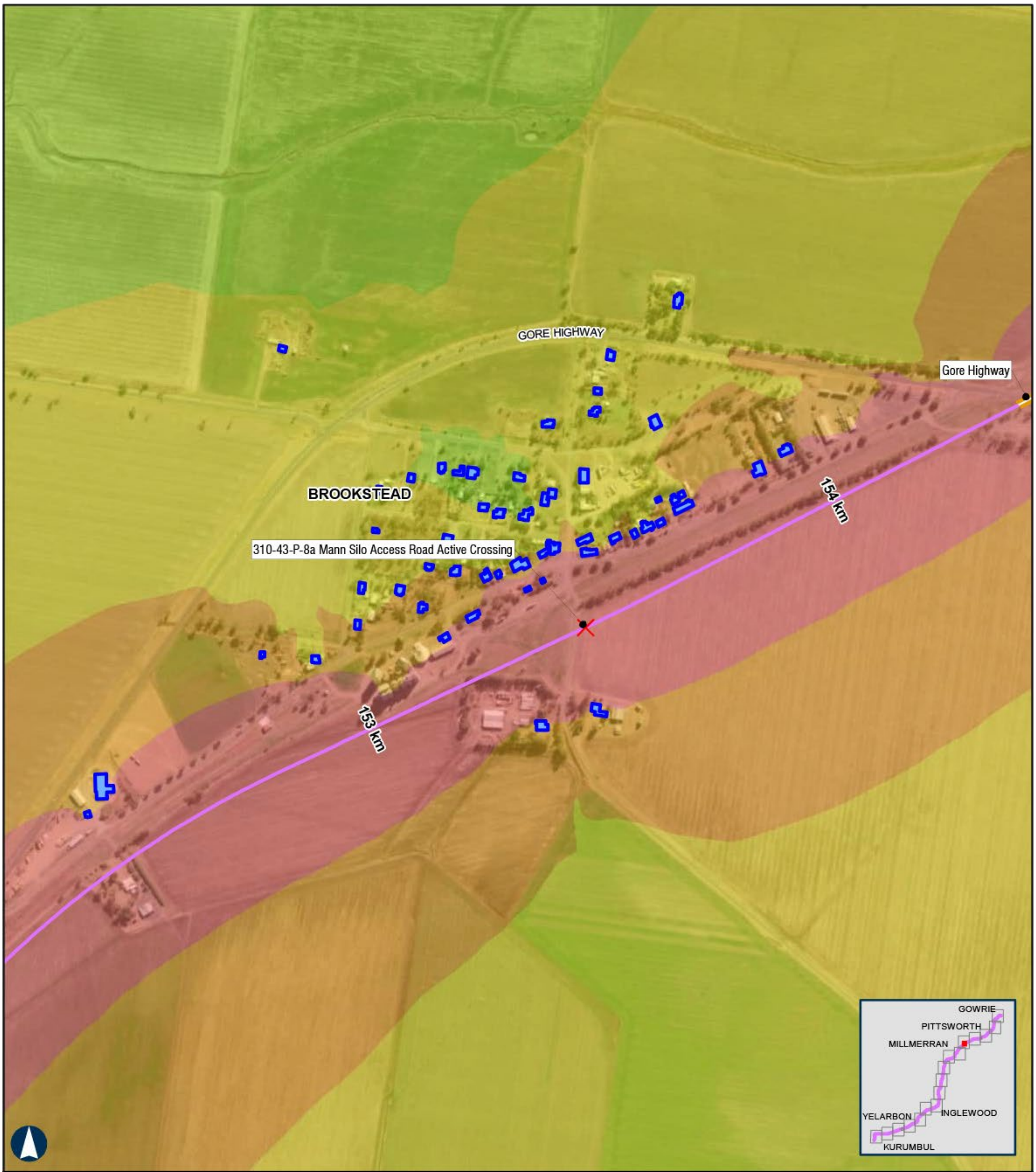

BORDER TO GOWRIE

Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 15 of 20

175 m

Coordinate System: GDA 1994 MGA Zone 56

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Paper: A4 Scale: 1:10,000
Date: 23-Oct-2024
Author: JG

- Level Crossings
- Project Extent
- Crossing Loops
- Bridges and Viaducts
- Rail Alignment/Centreline
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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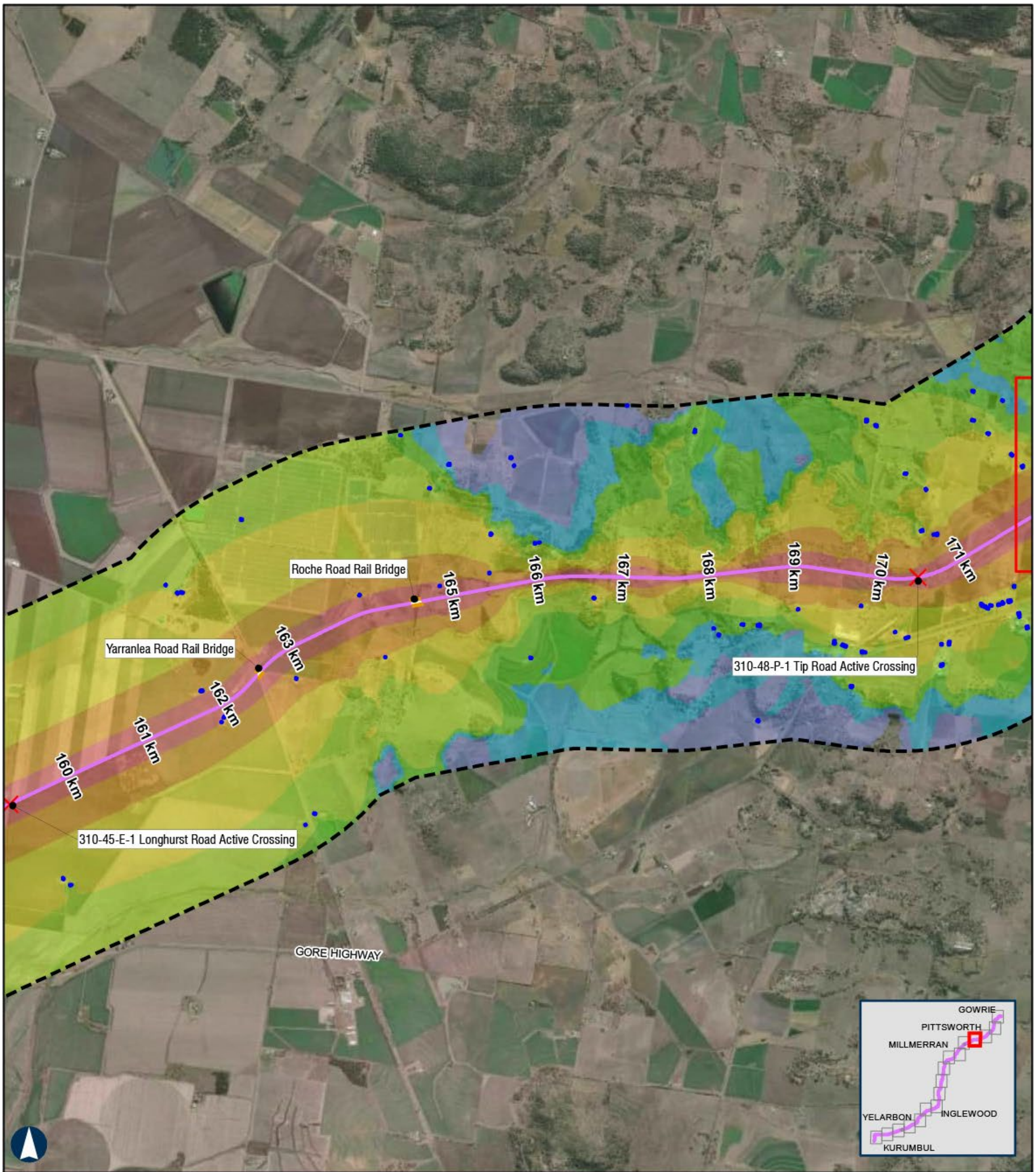

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 16 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

Paper: A4 Scale: 1:60,000
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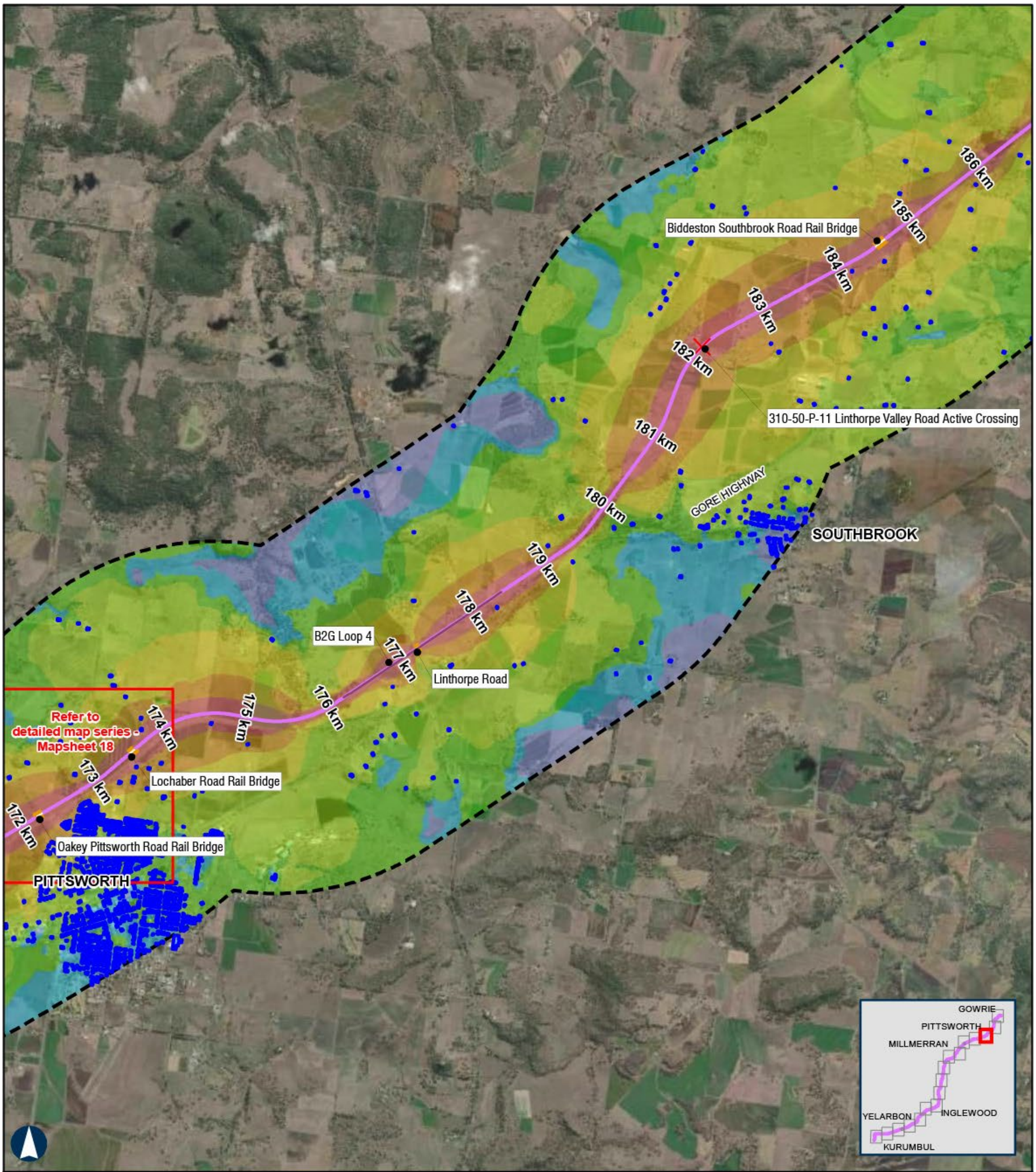

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 17 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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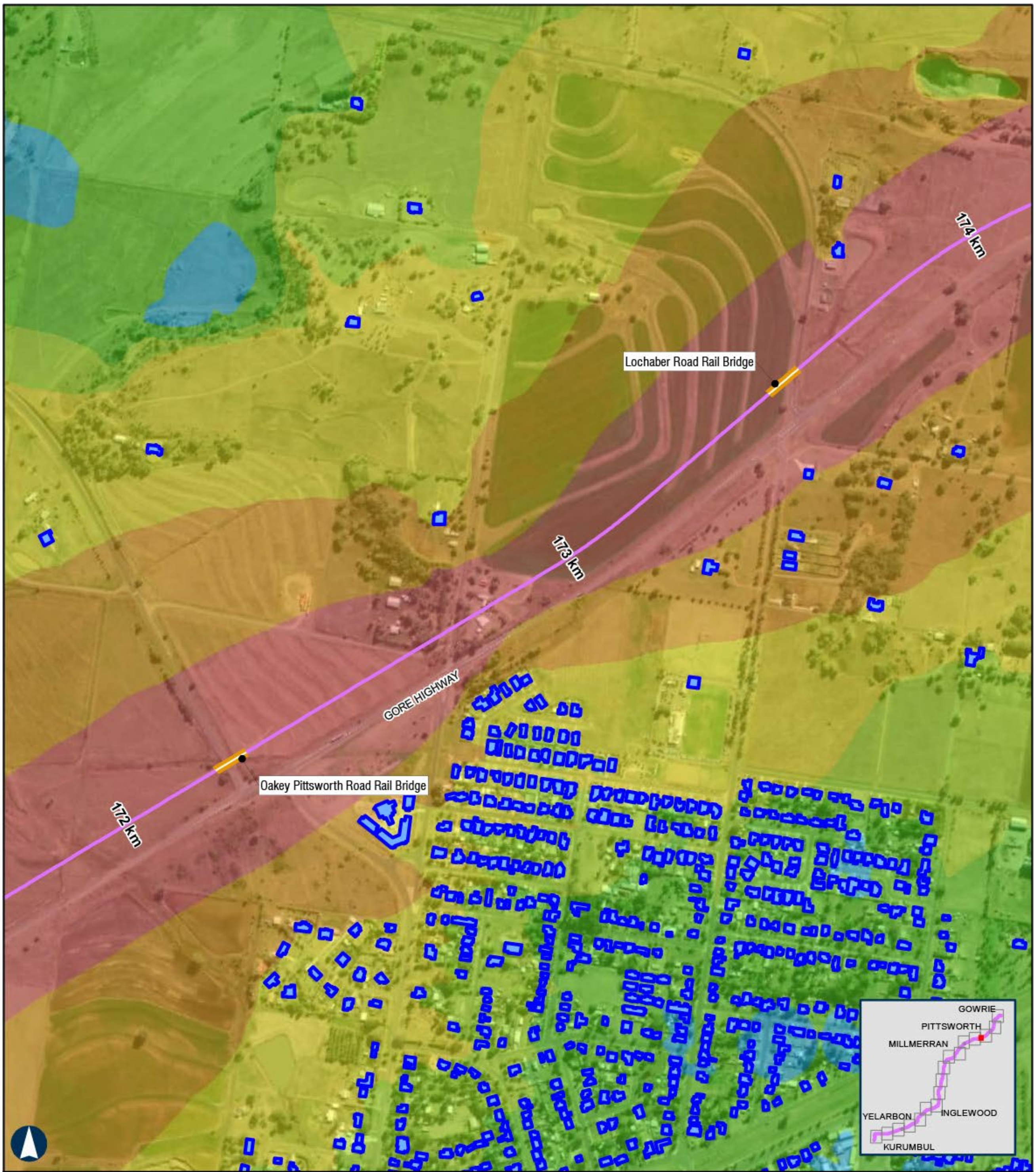

BORDER TO GOWRIE

Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 18 of 20

175 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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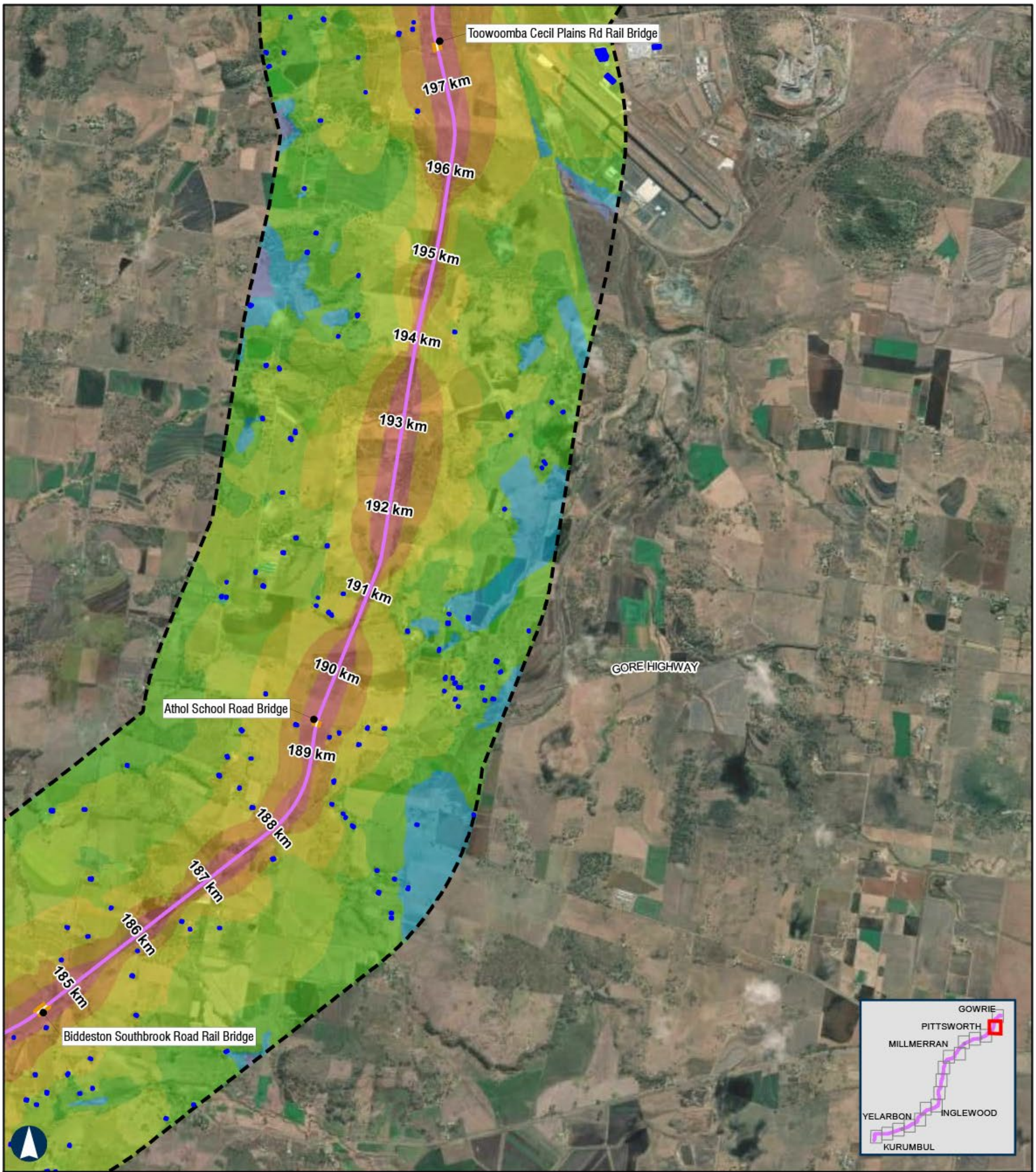

BORDER TO GOWRIE **Railway Noise Level Contours – Leq,24hour Year 2040** Figure 16-7 Map 19 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Bridges and Viaducts
Rail Alignment/Centreline
Study Area
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Noise Levels
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35 - 40 dBA
40 - 45 dBA
45 - 50 dBA
50 - 55 dBA
55 - 60 dBA
> 60 dBA

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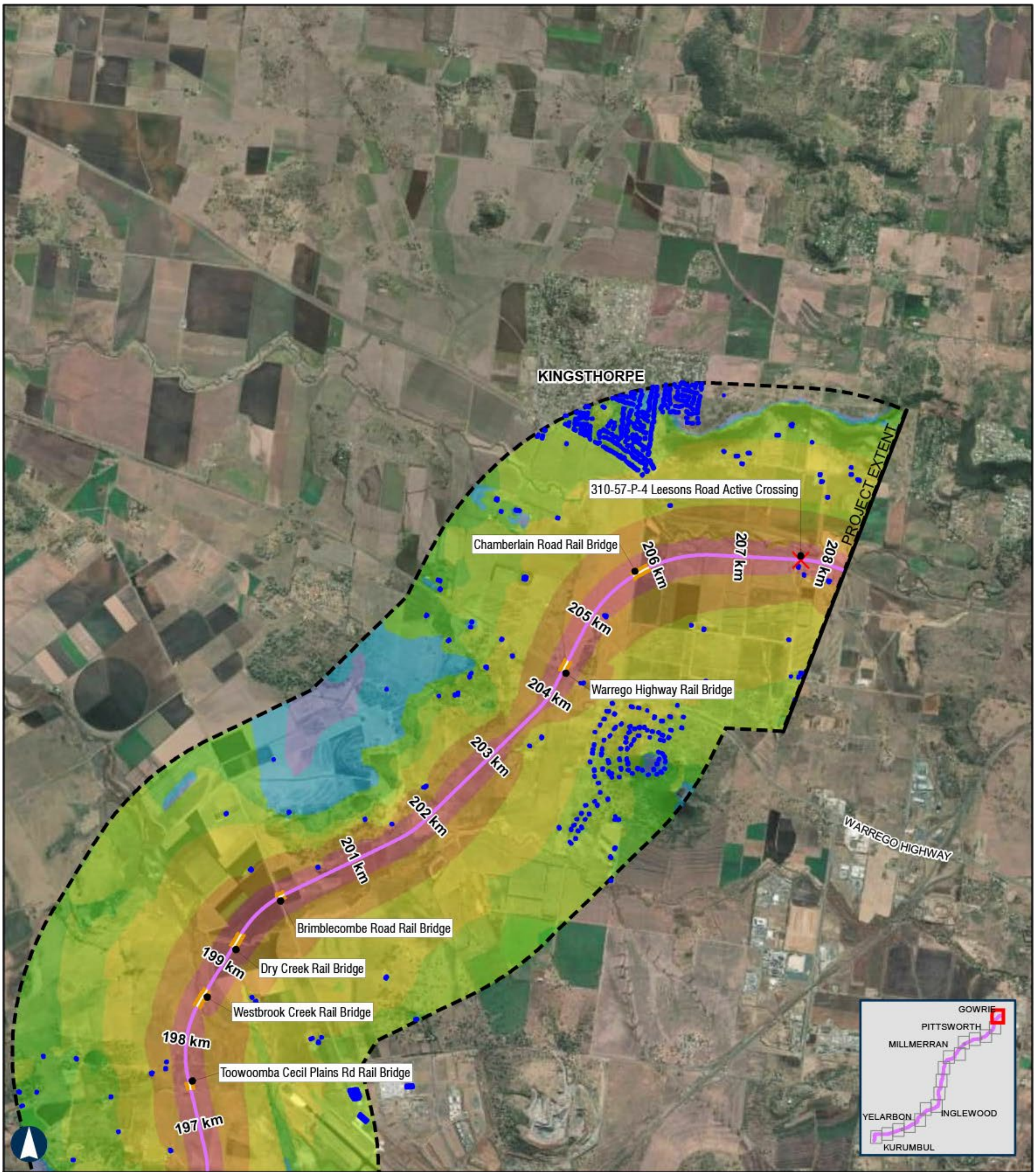

BORDER TO GOWRIE Railway Noise Level Contours – Leq,24hour Year 2040

Figure 16-7 Map 20 of 20

1000 m

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

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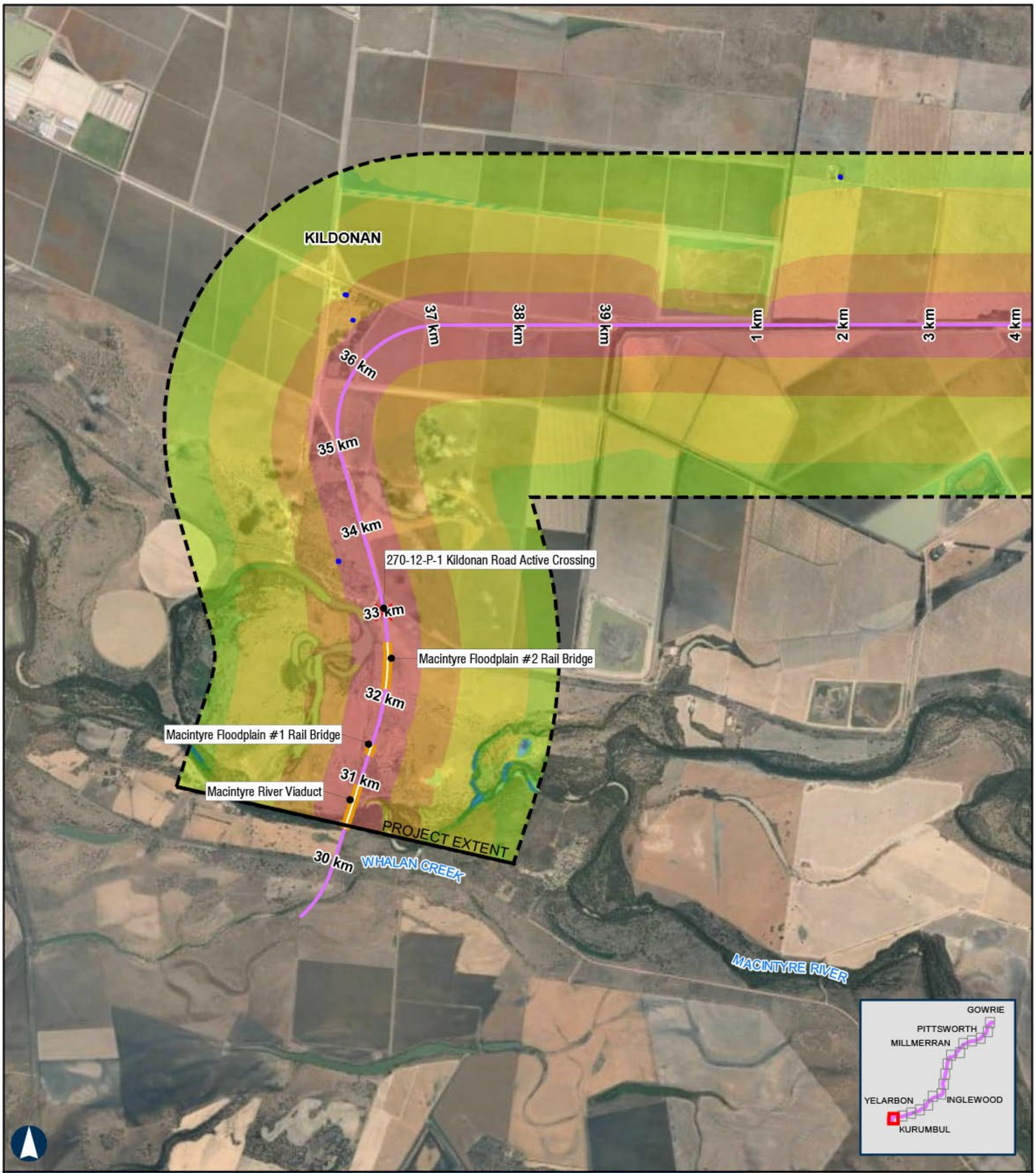

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 1 of 20

1000 m

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- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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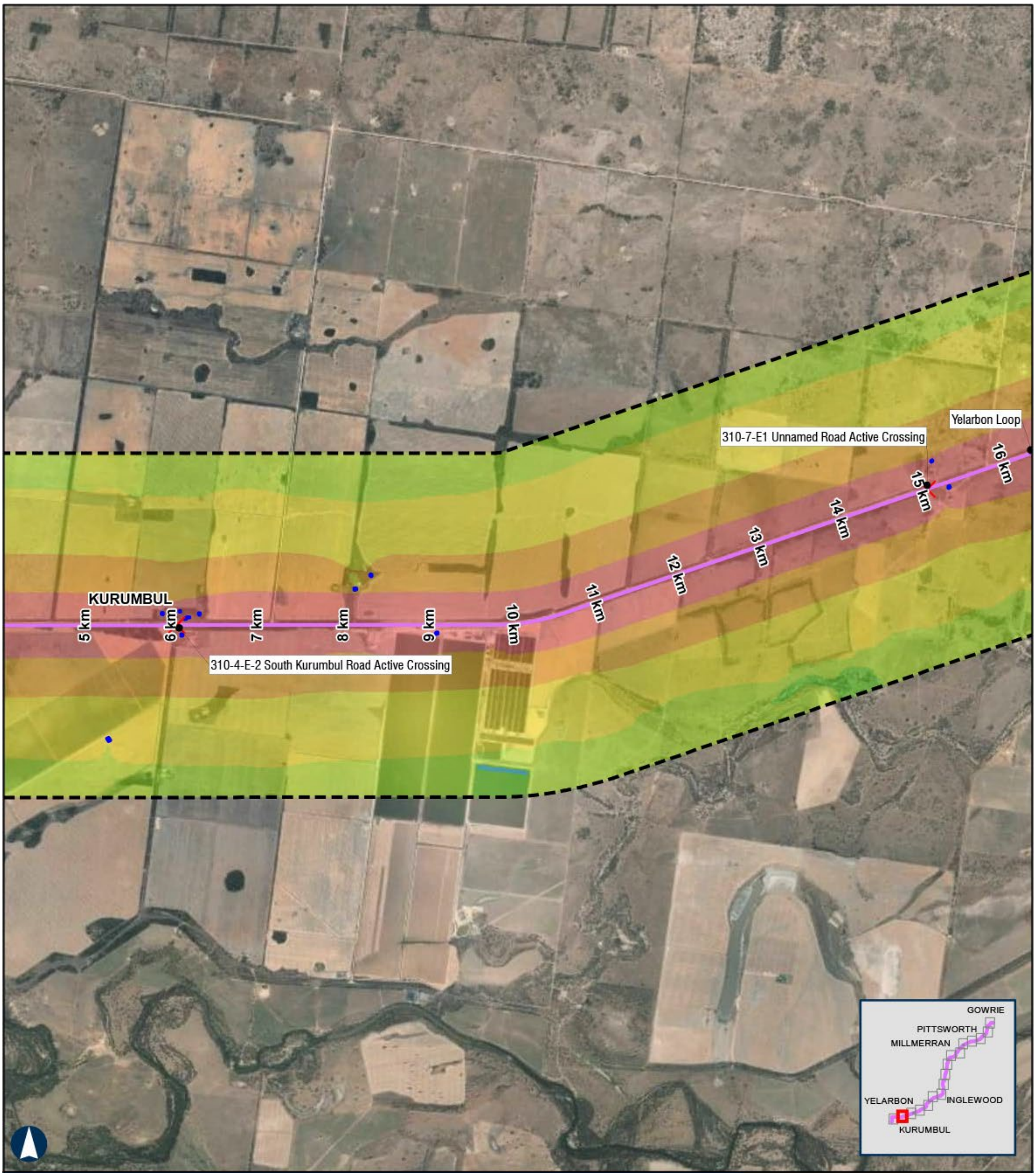

BORDER TO GOWRIE

Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 2 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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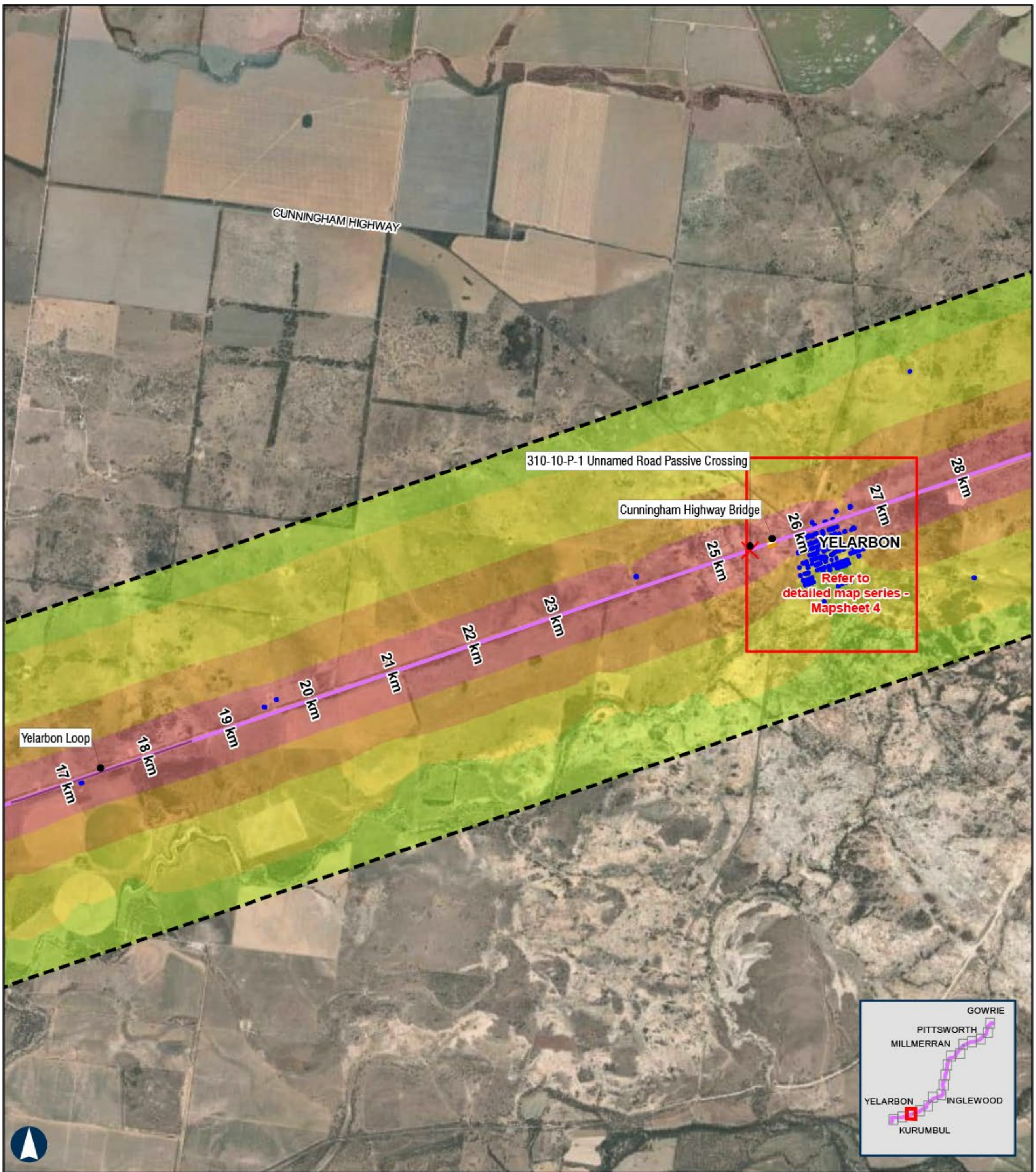

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 3 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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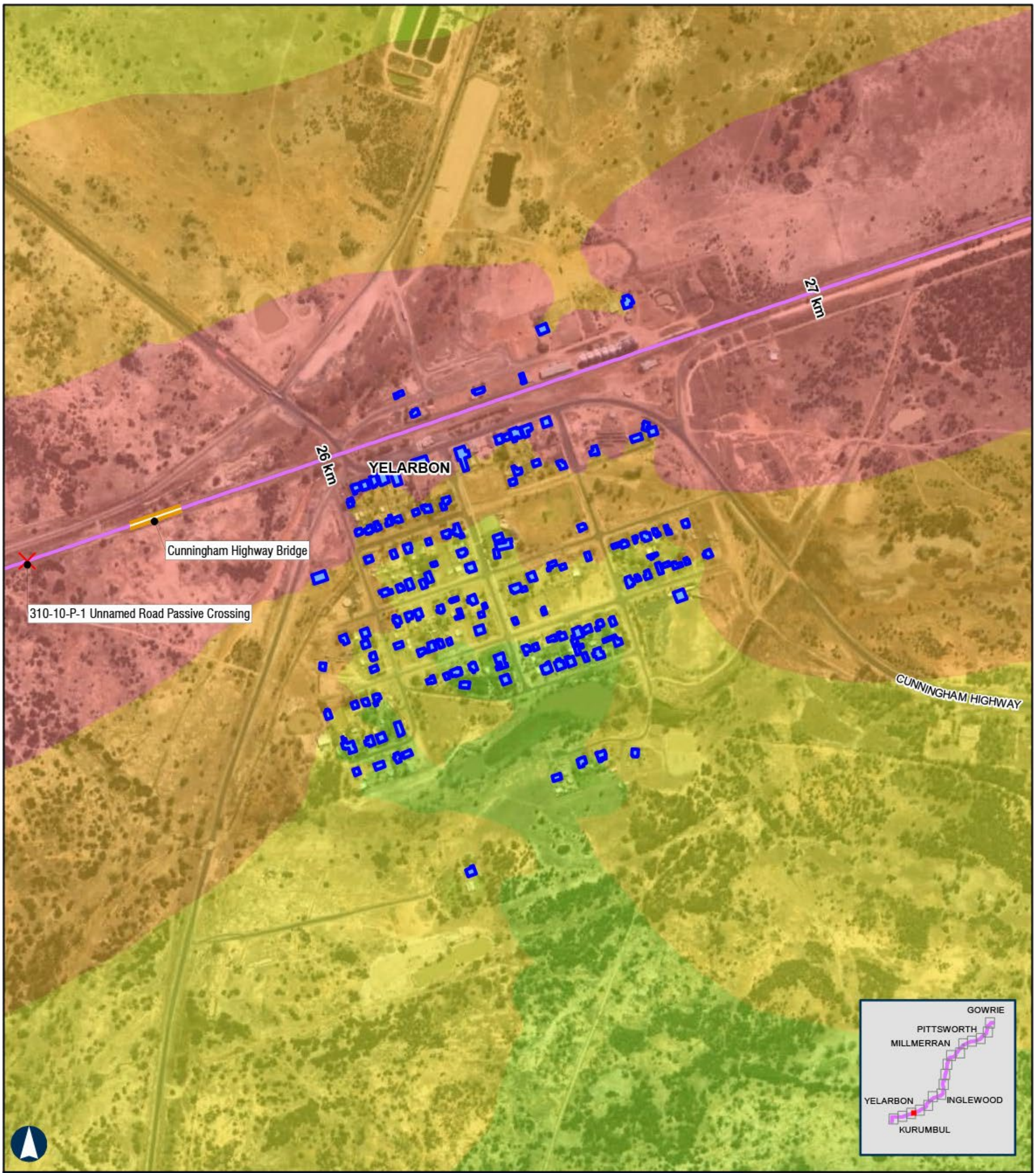

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 4 of 20

175 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise Levels

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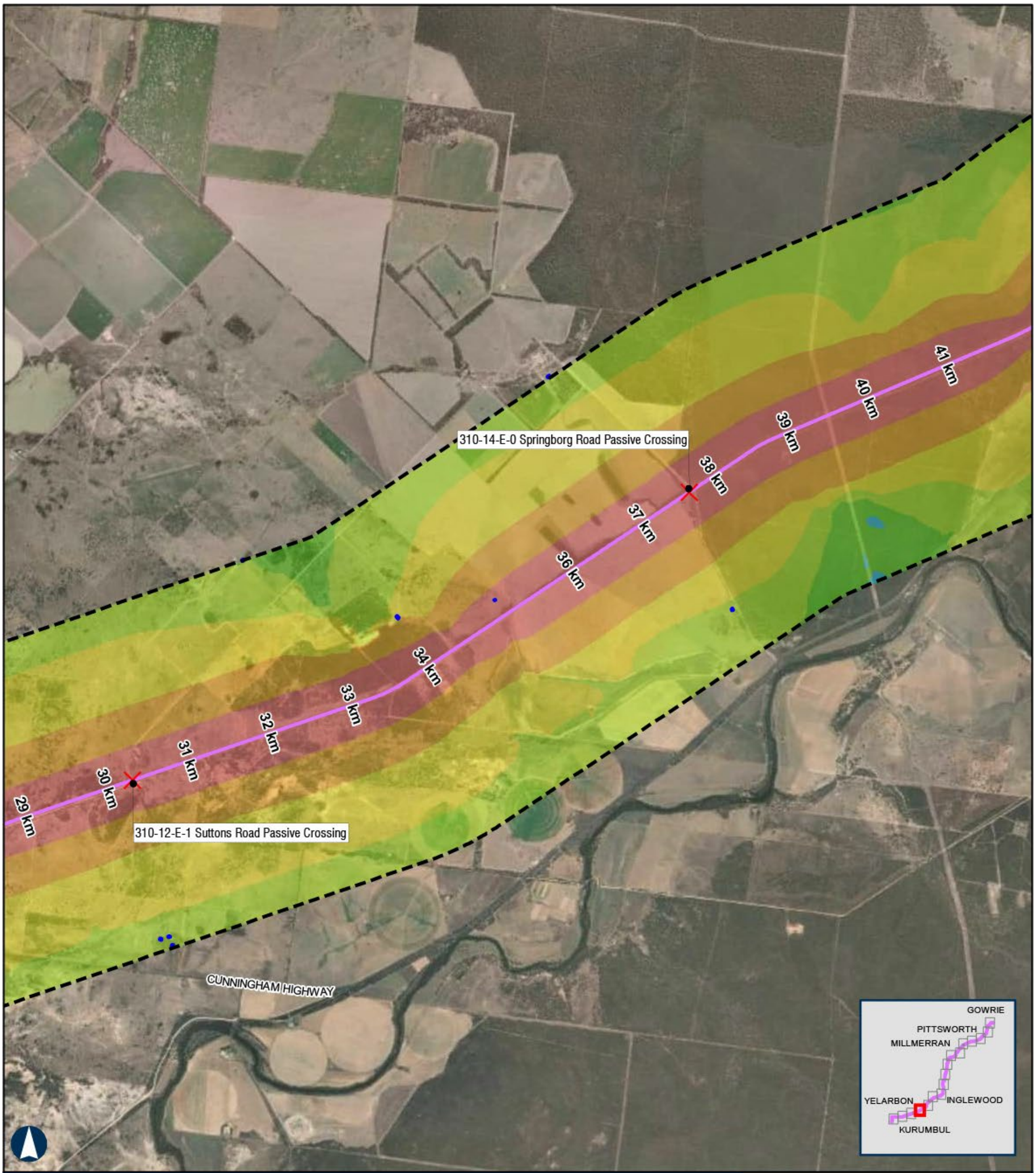

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 5 of 20

1000 m

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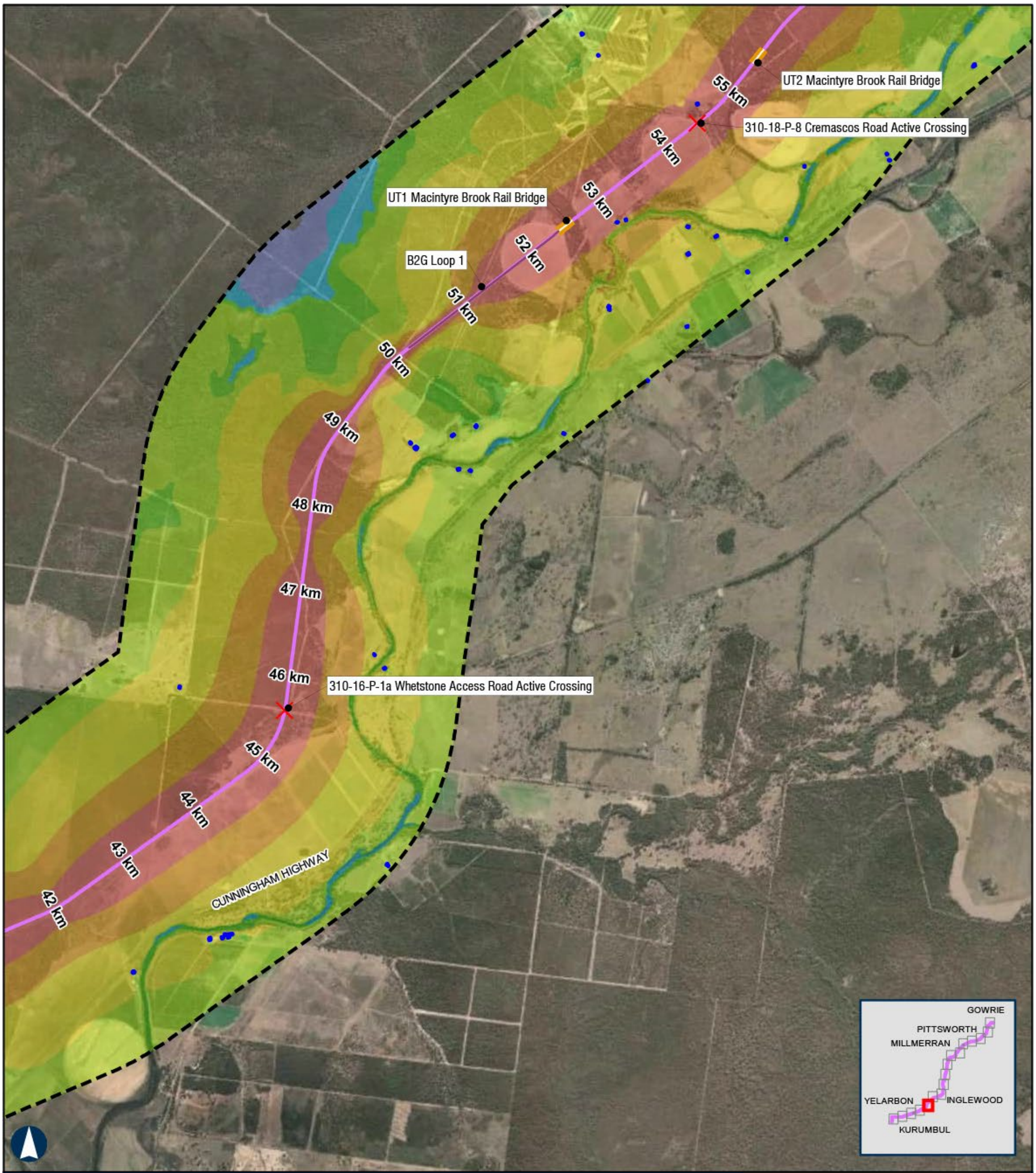

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 6 of 20

1000 m

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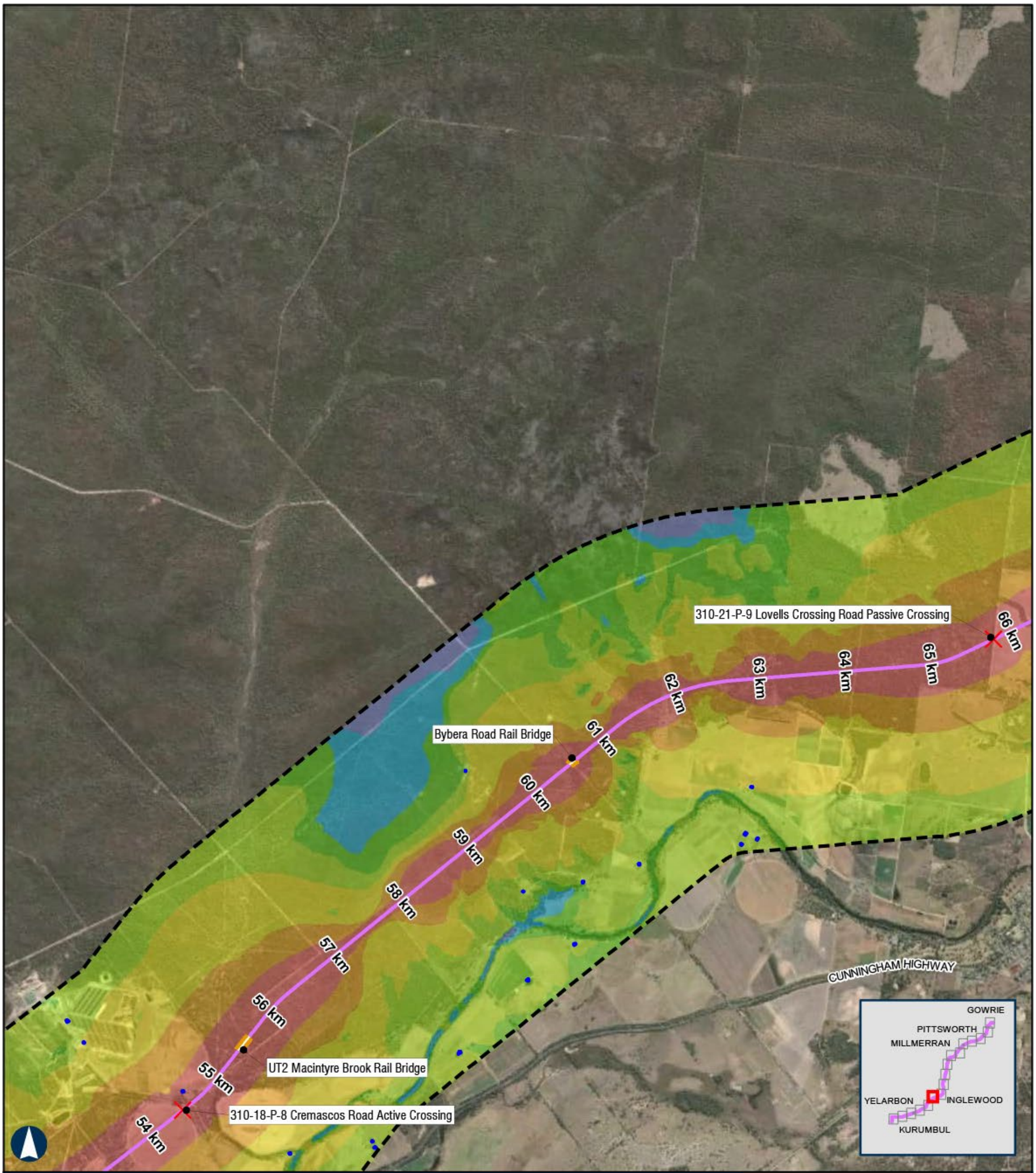

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 7 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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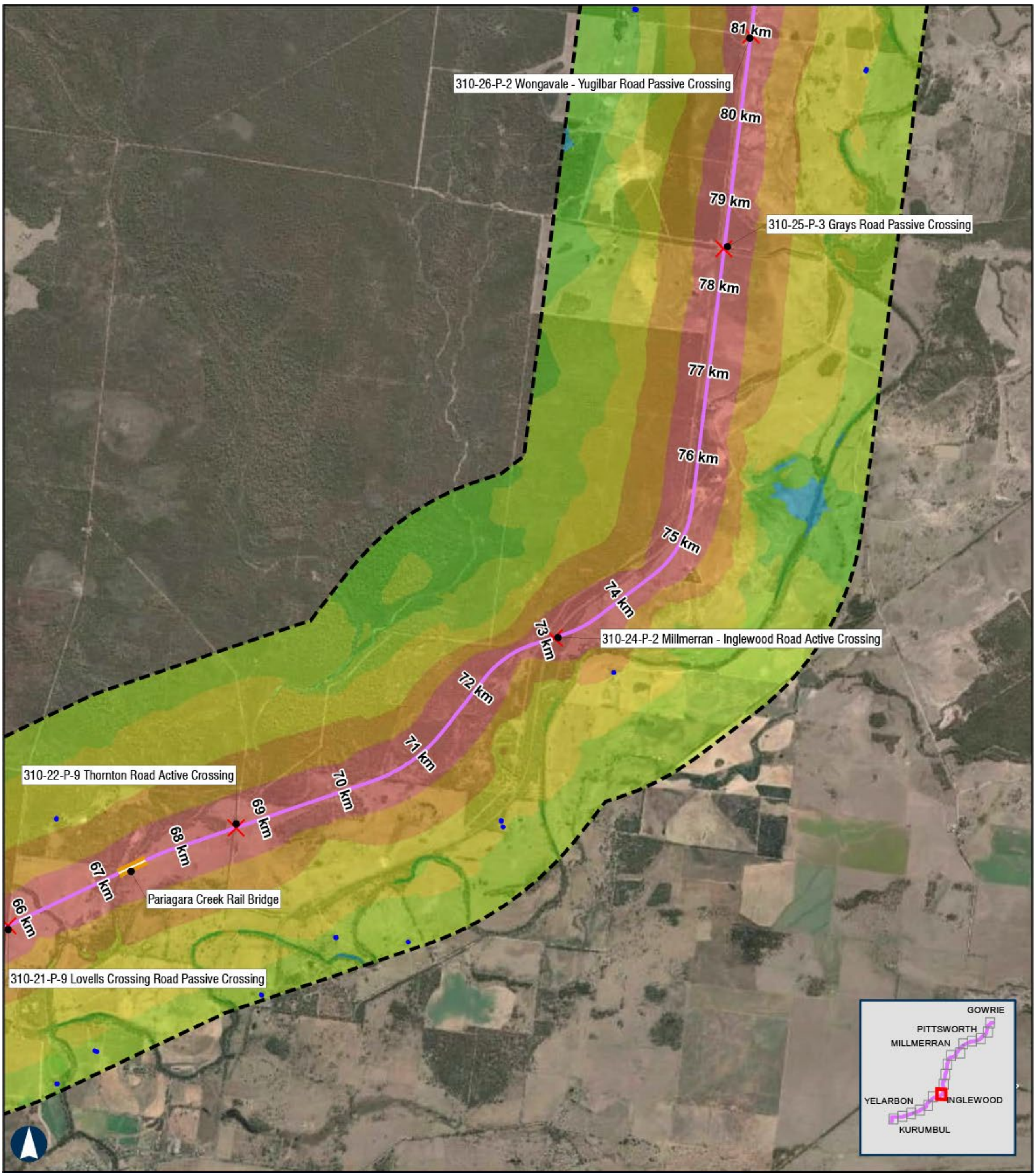

BORDER TO GOWRIE **Railway Noise Level Contours – Single Event Maximum** Figure 16-8 Map 8 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise Levels
- 50 - 55 dBA
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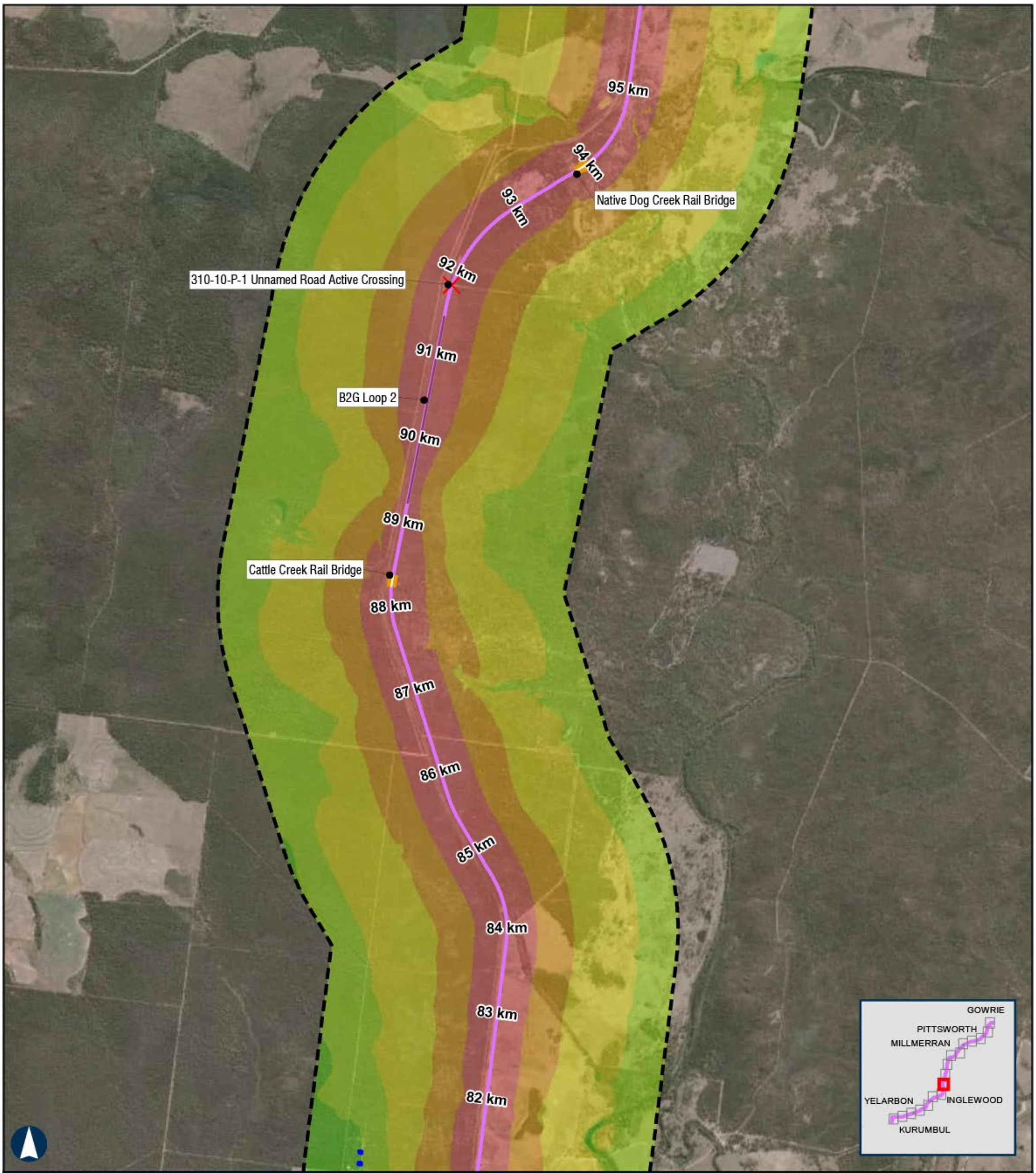

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 9 of 20

1000 m

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Author: JG

- Level Crossings
- Project Extent
- Bridges and Viaducts
- Rail Alignment/Centreline
- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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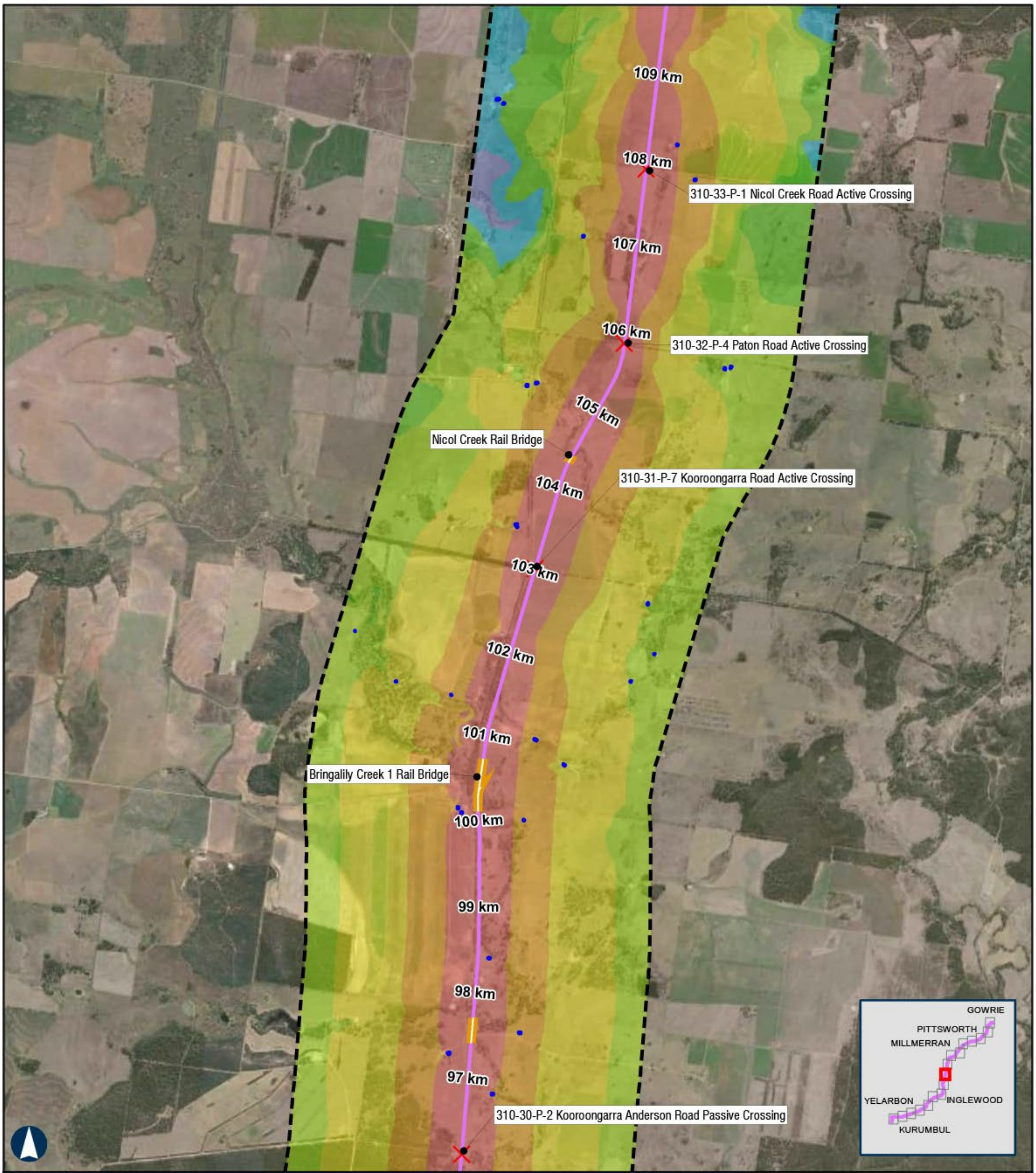

BORDER TO GOWRIE | **Railway Noise Level Contours – Single Event Maximum** | Figure 16-8 Map 10 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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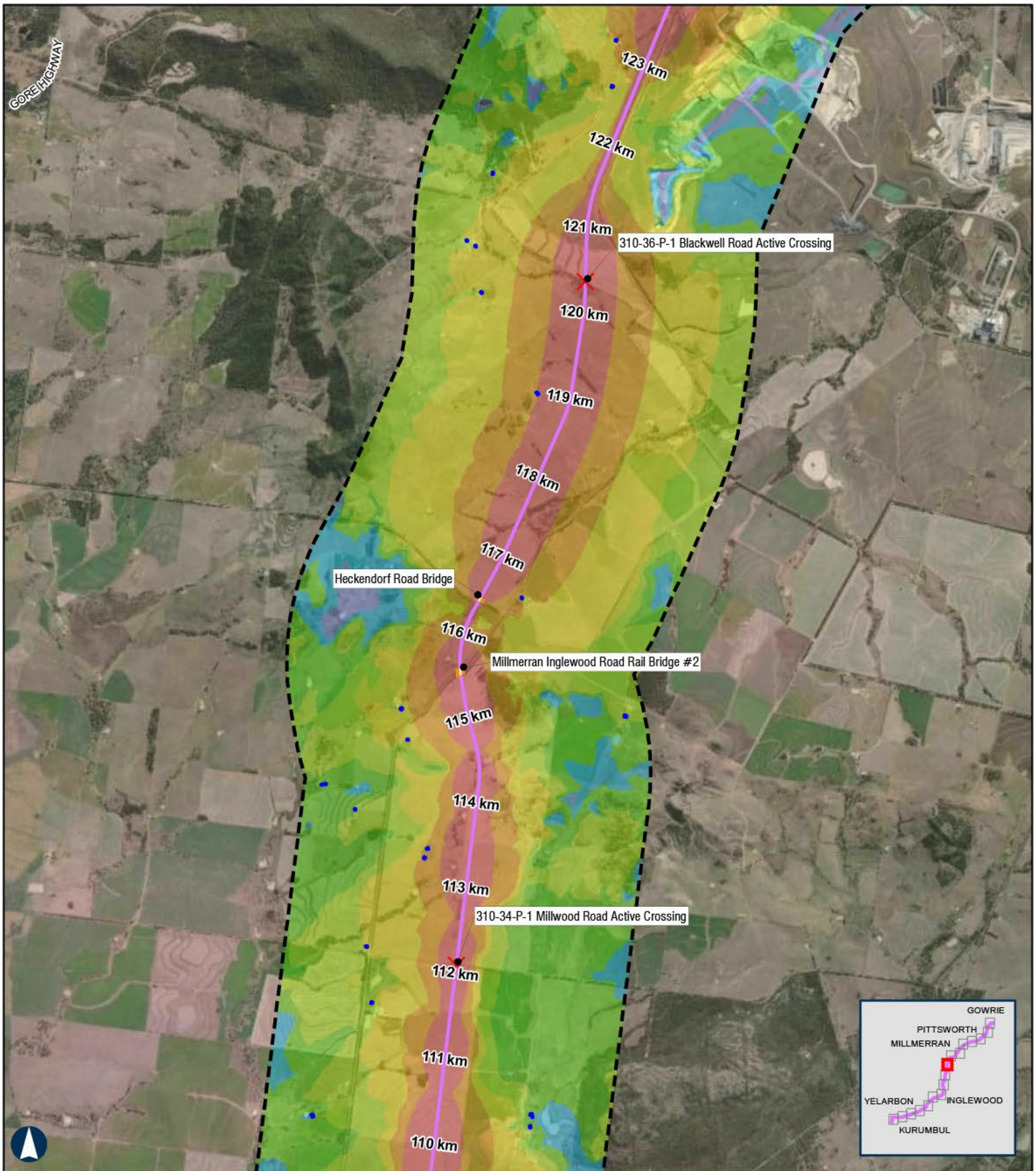

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 11 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels
- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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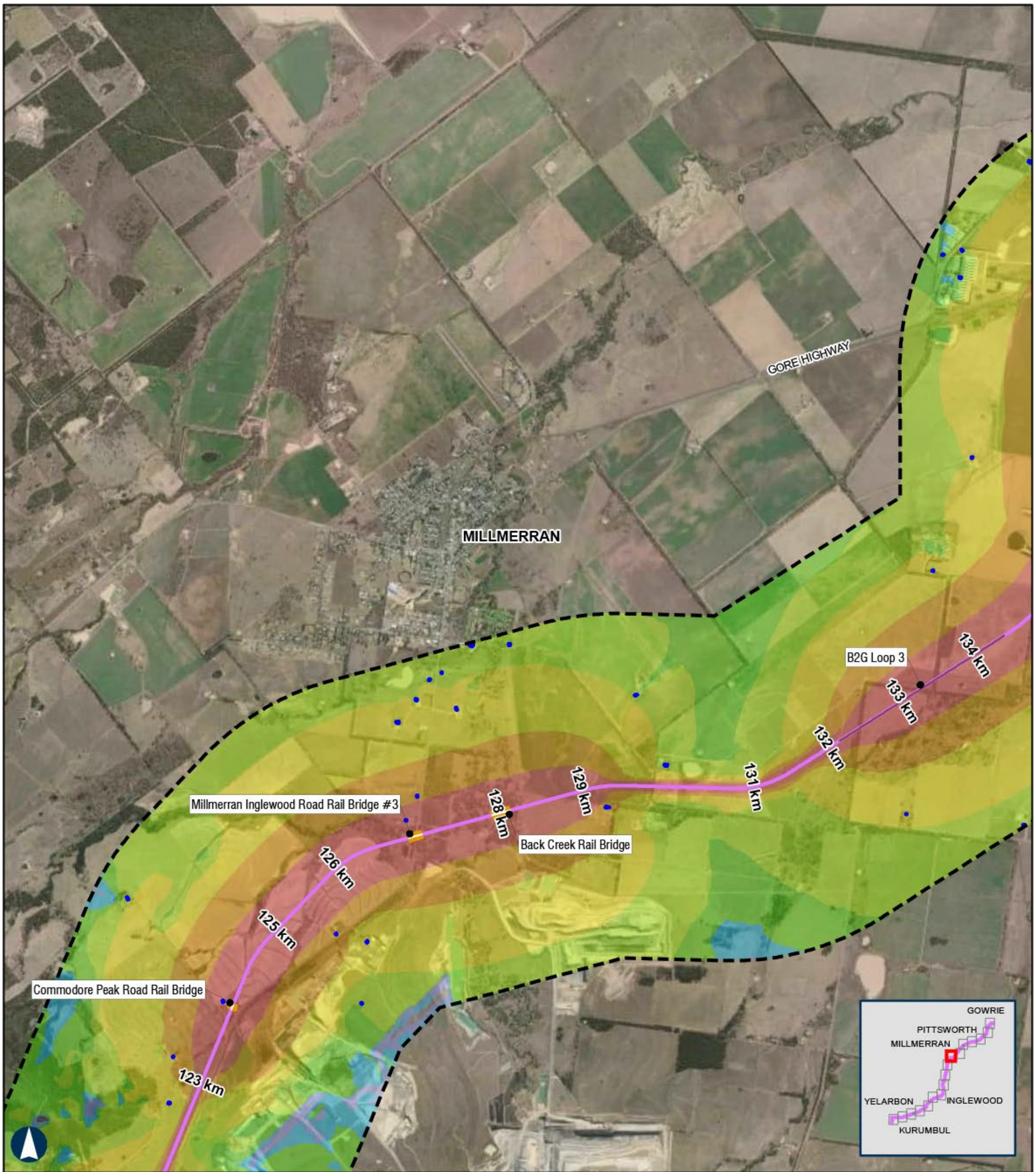

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 12 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- Rail Alignment/Centreline
- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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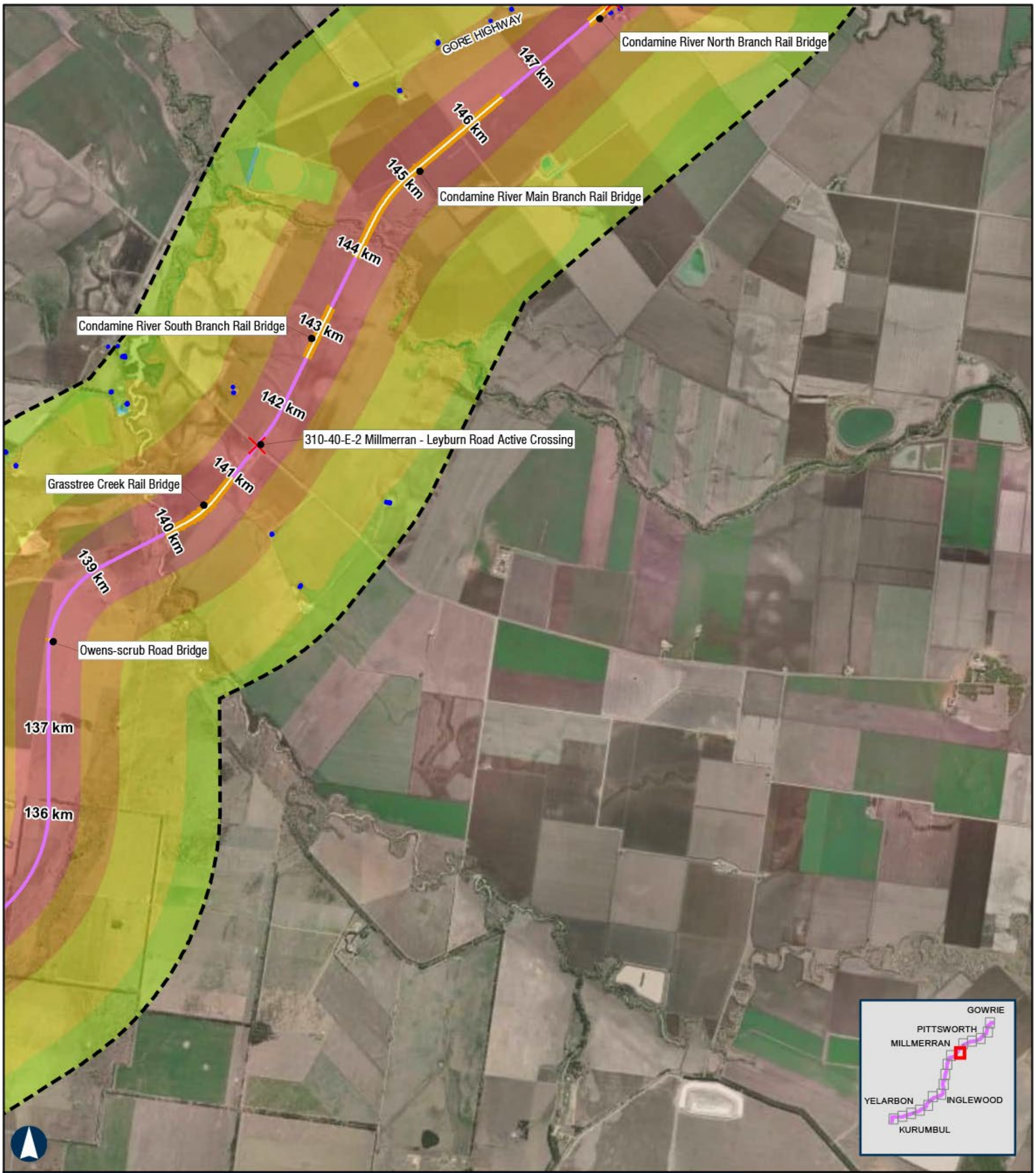

BORDER TO GOWRIE | **Railway Noise Level Contours – Single Event Maximum** | Figure 16-8 Map 13 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- Rail Alignment/Centreline
- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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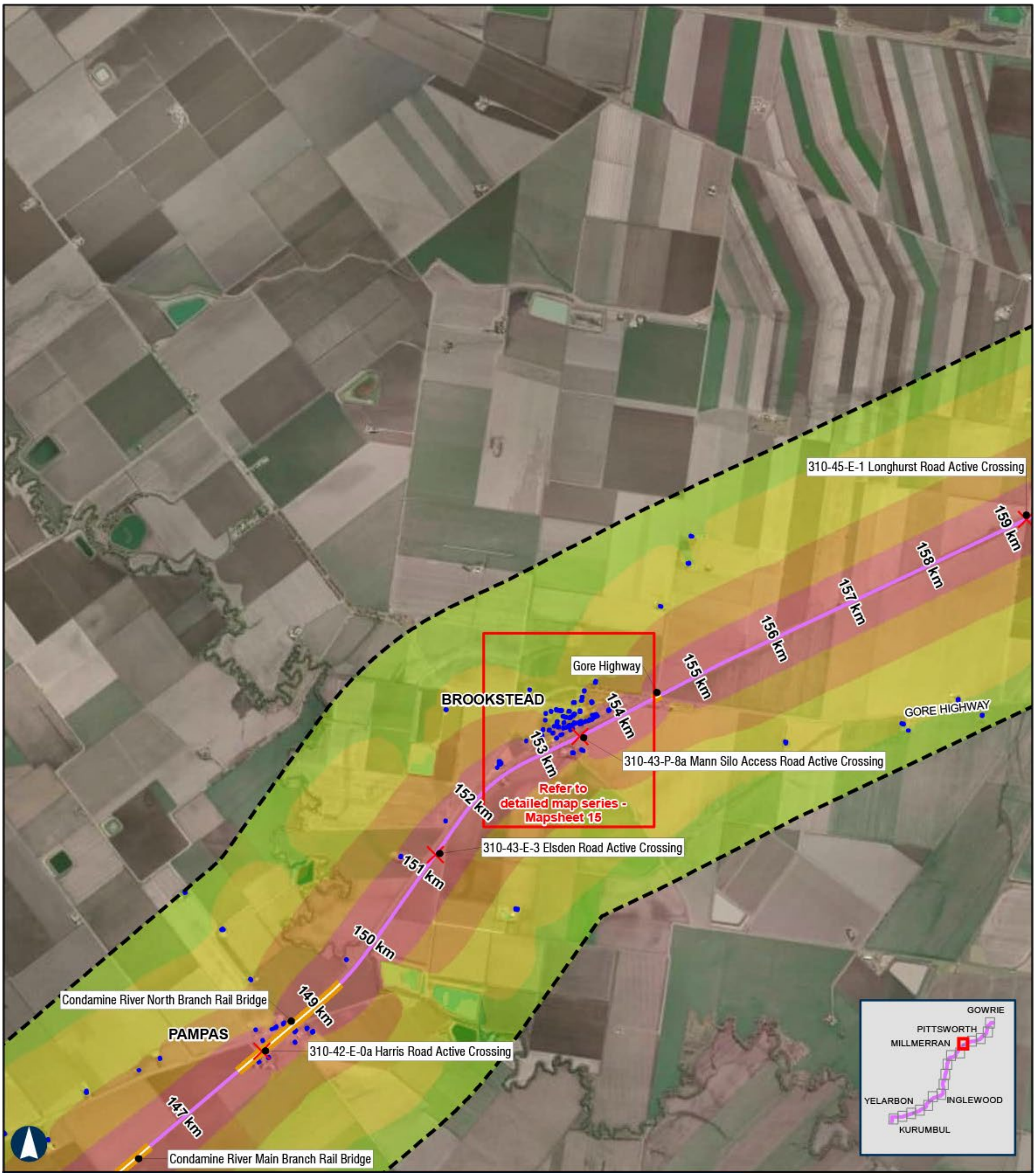

BORDER TO GOWRIE | **Railway Noise Level Contours – Single Event Maximum** | Figure 16-8 Map 14 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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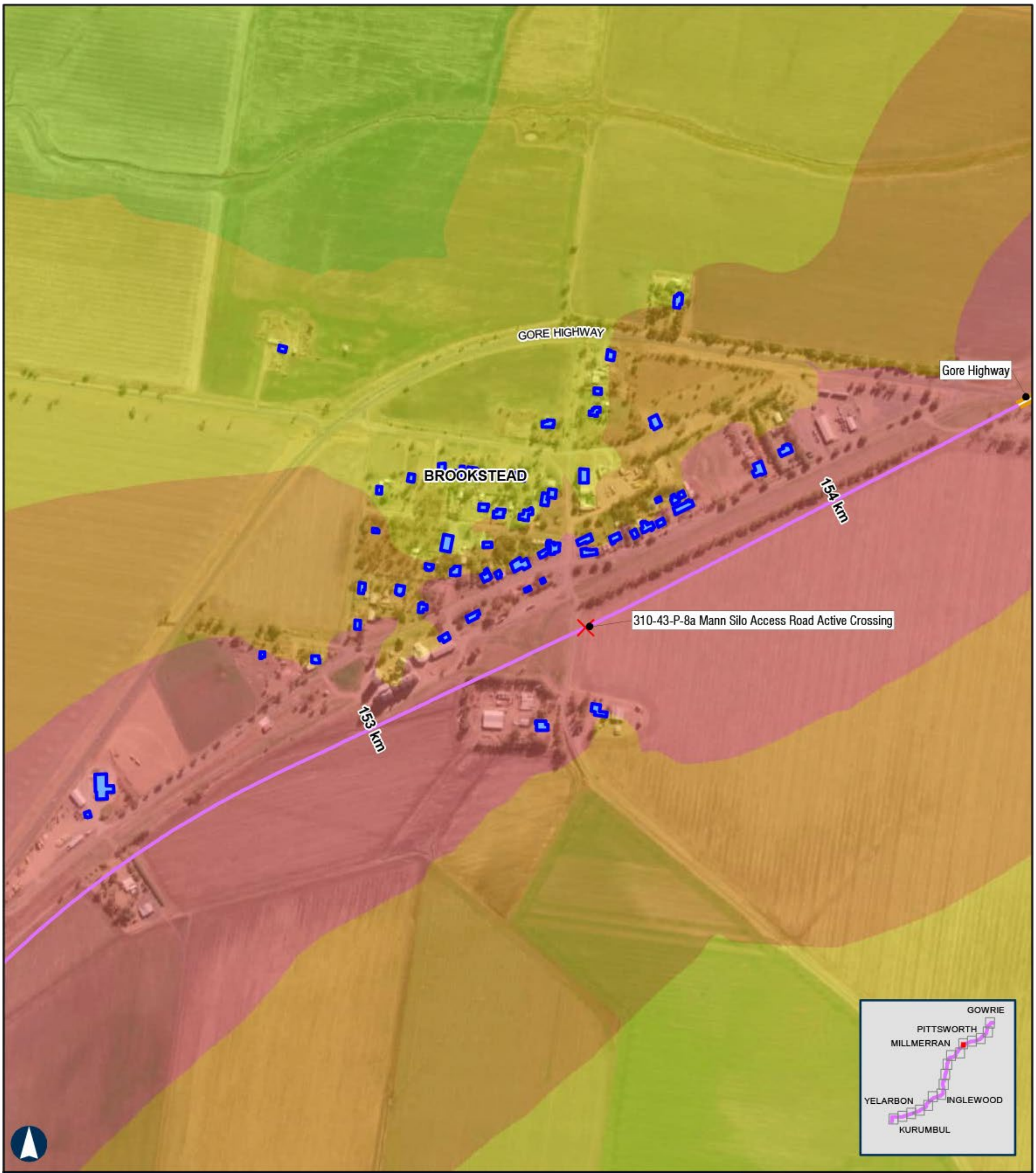

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 15 of 20

175 m

Coordinate System: GDA 1994 MGA Zone 56

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- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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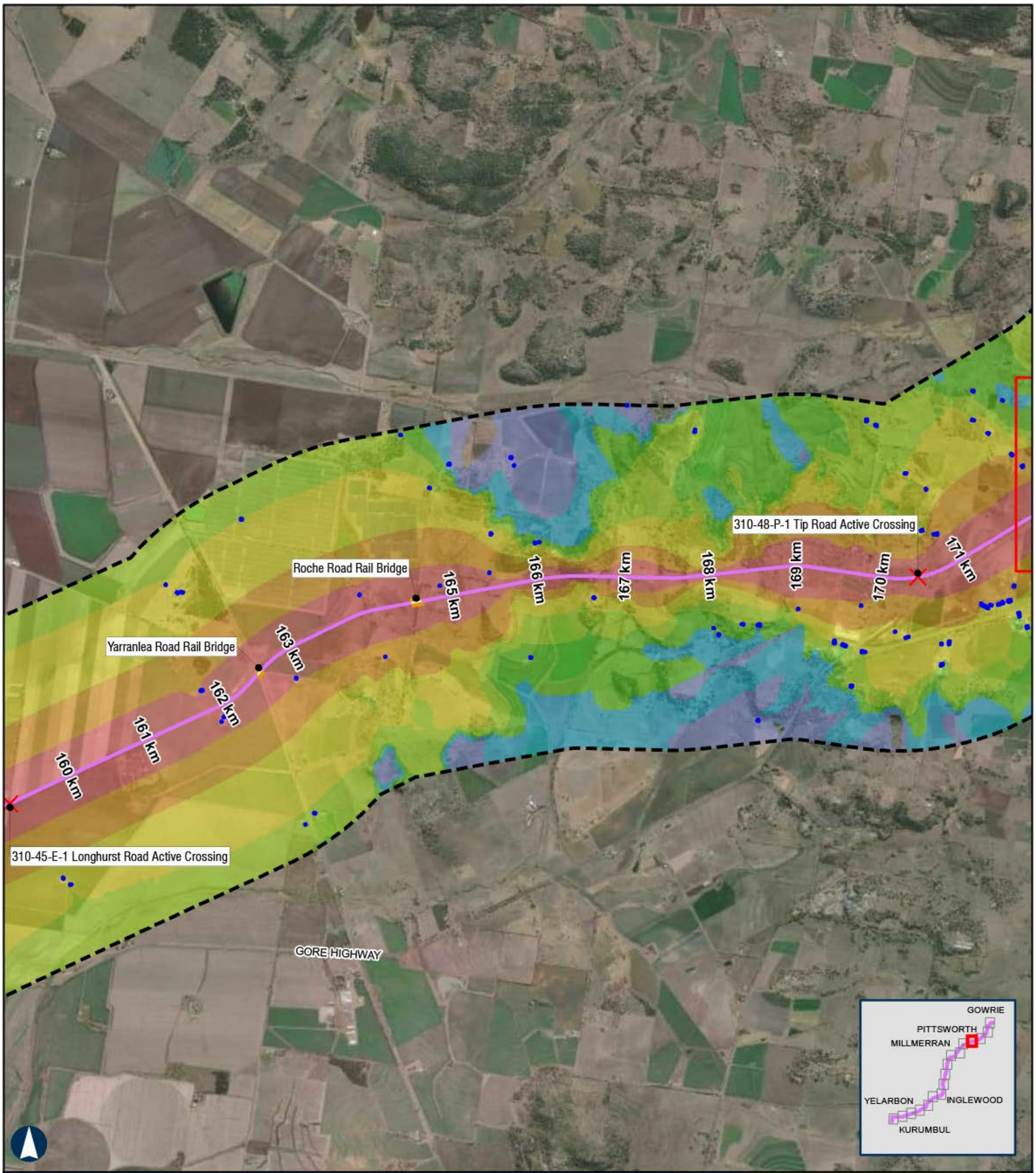

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 16 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- Crossing Loops
- Study Area
- Sensitive Receptors

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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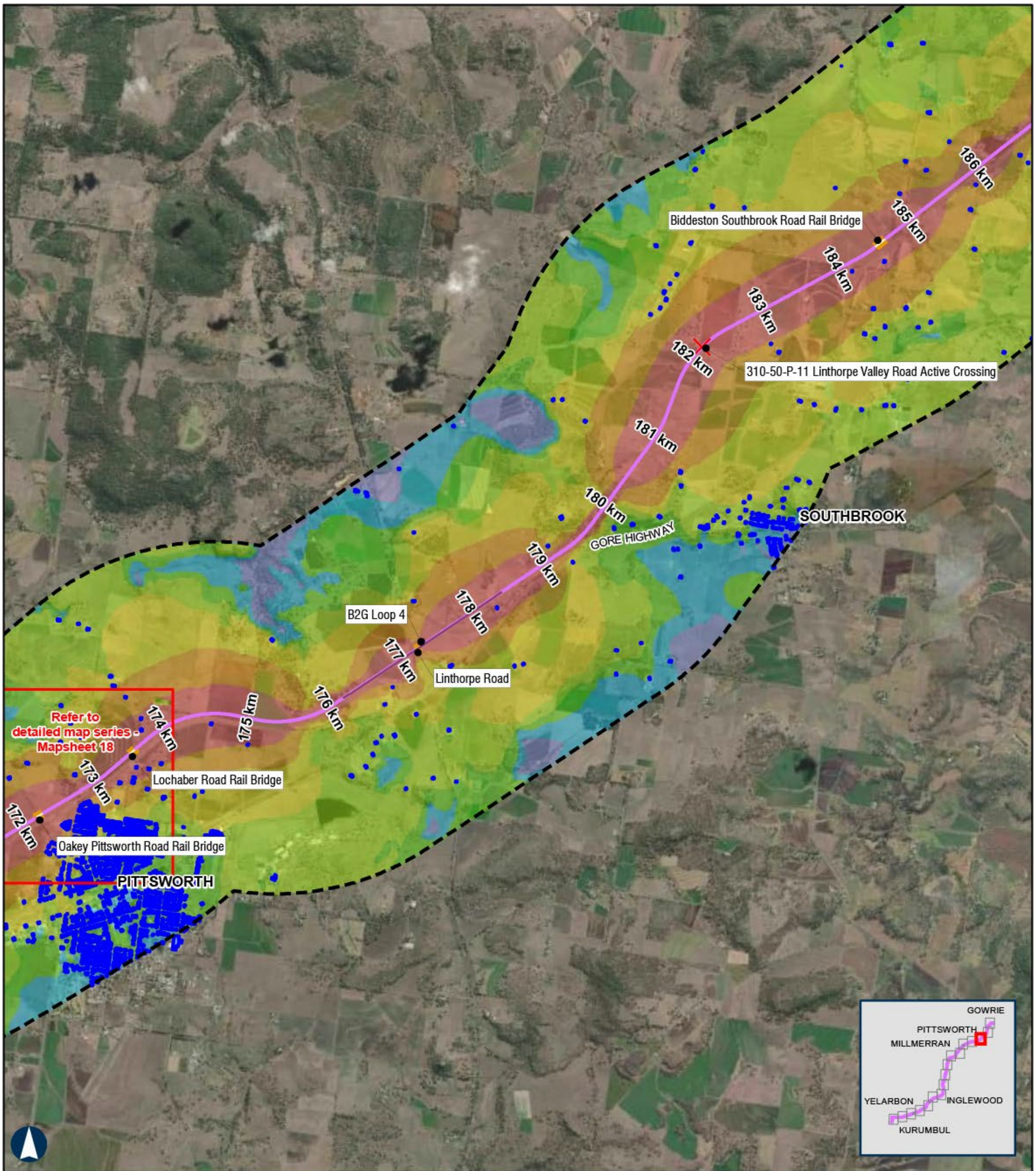

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 17 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels
- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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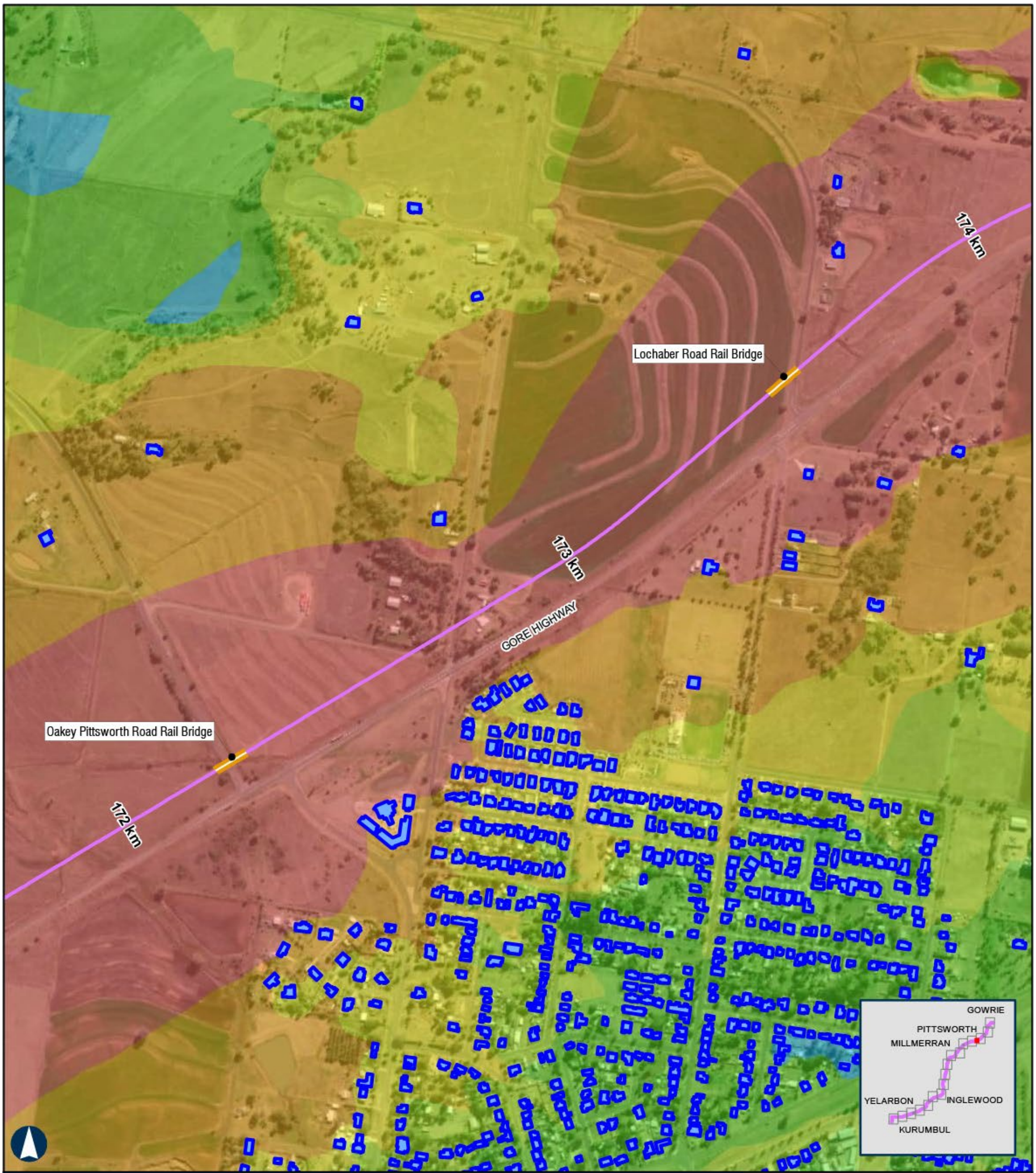

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 18 of 20

175 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

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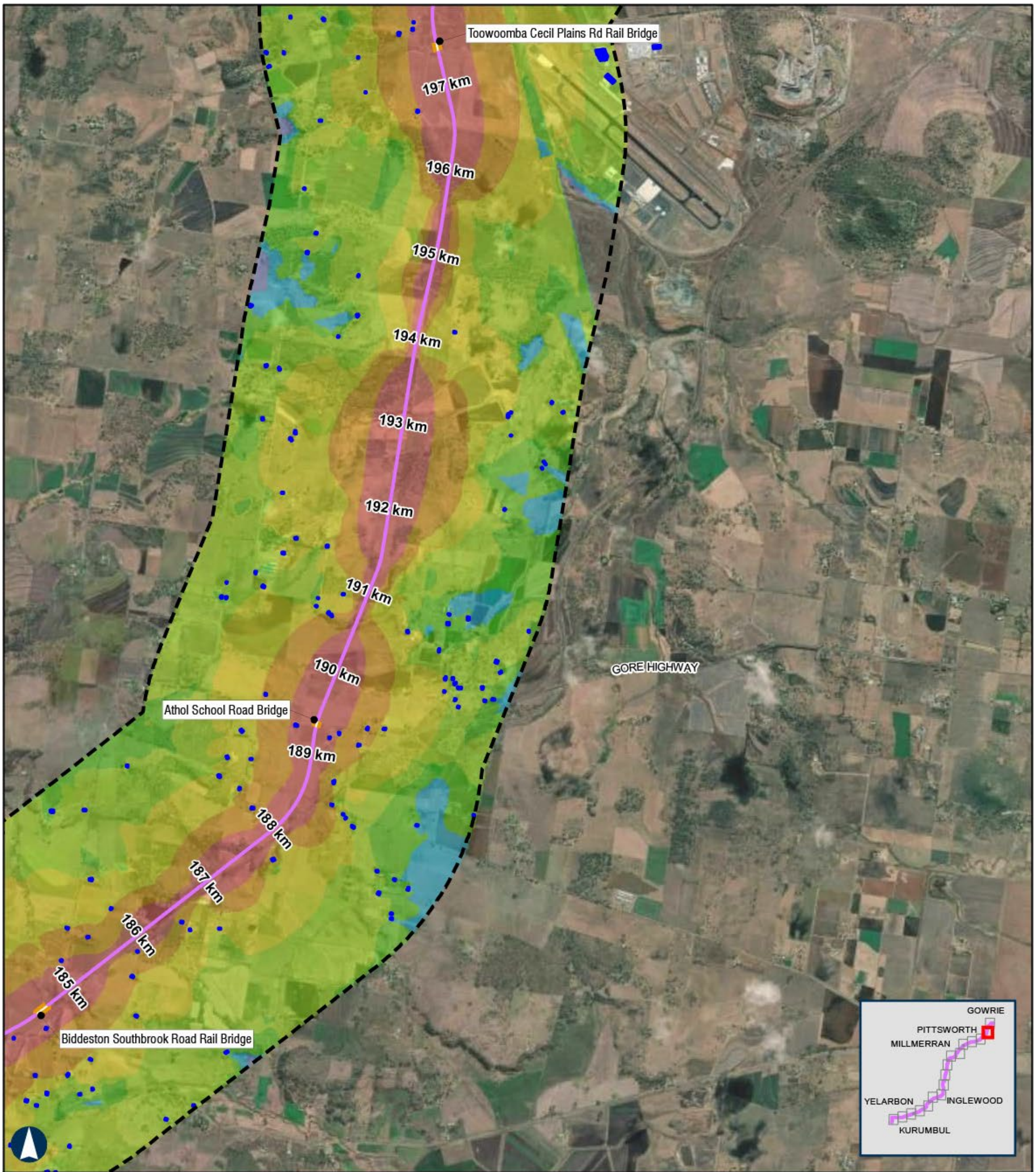

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 19 of 20

1000 m

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Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
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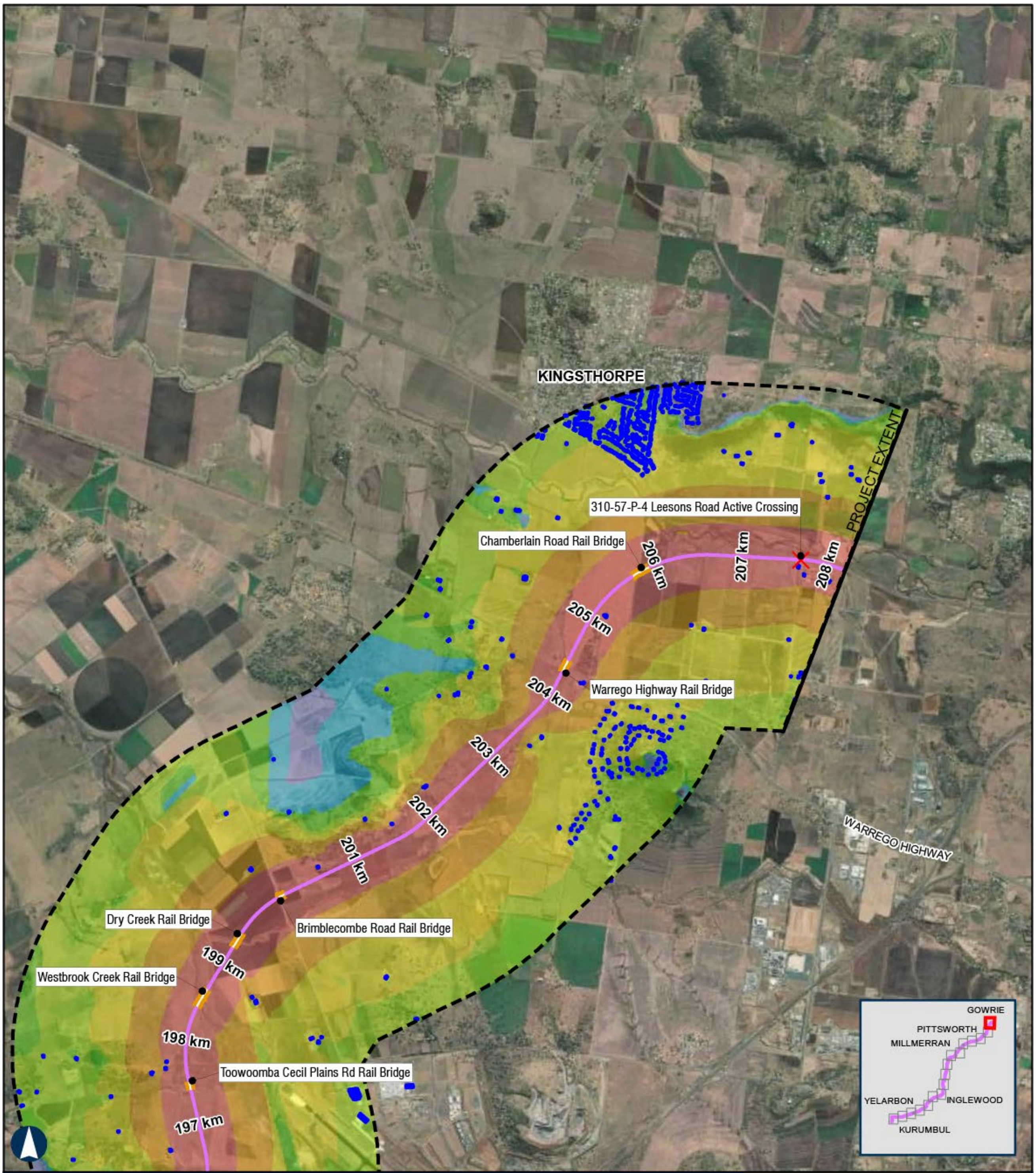

BORDER TO GOWRIE Railway Noise Level Contours – Single Event Maximum

Figure 16-8 Map 20 of 20

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Noise Levels

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- 55 - 60 dBA
- 60 - 65 dBA
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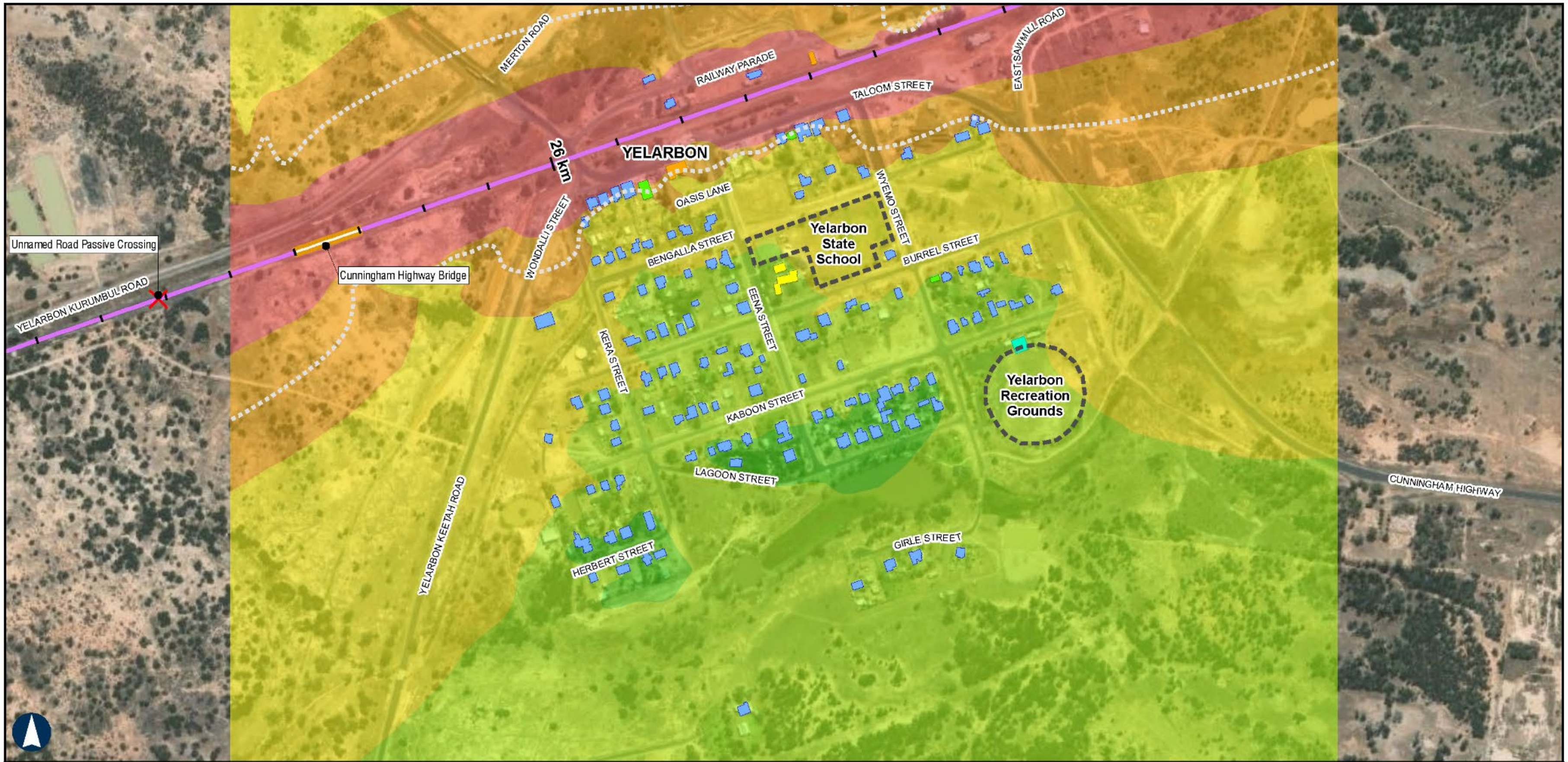

BORDER TO GOWRIE Unmitigated Noise Levels – 2040 Leq,12h

Figure 16-9 Yelarbon - Map 1 of 4

100 m

Coordinate System: GDA 1994 MGA Zone 56

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Author: JG

- Level Crossings
- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
- Outdoor Receptors

Sensitive Receptor Type
- Residential
- Community
- Educational
- Commercial
- Parkland

Criterion (57 dBA)

Noise Levels
- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

Noise contours are free-field and at a height of 1.5m above ground level

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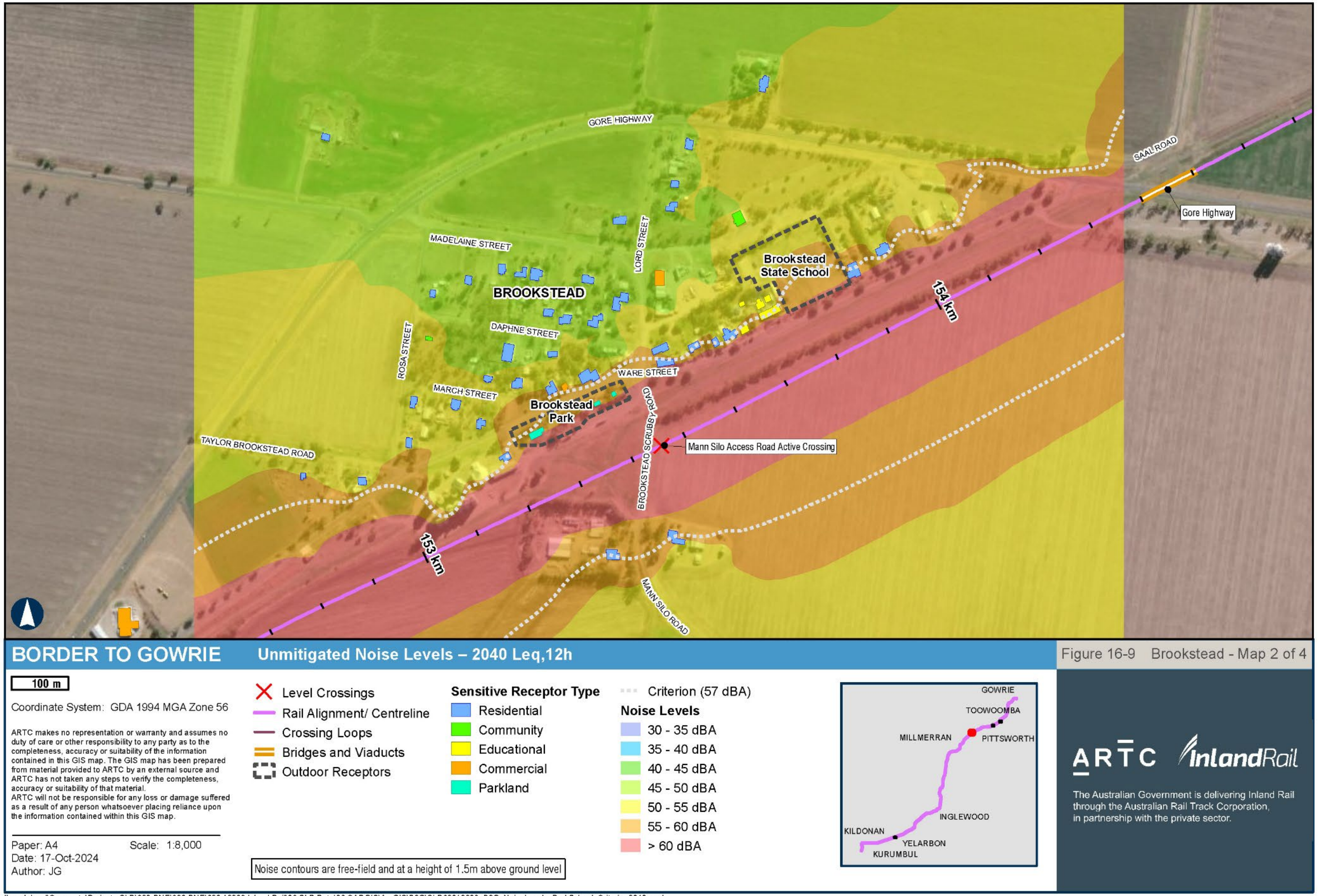

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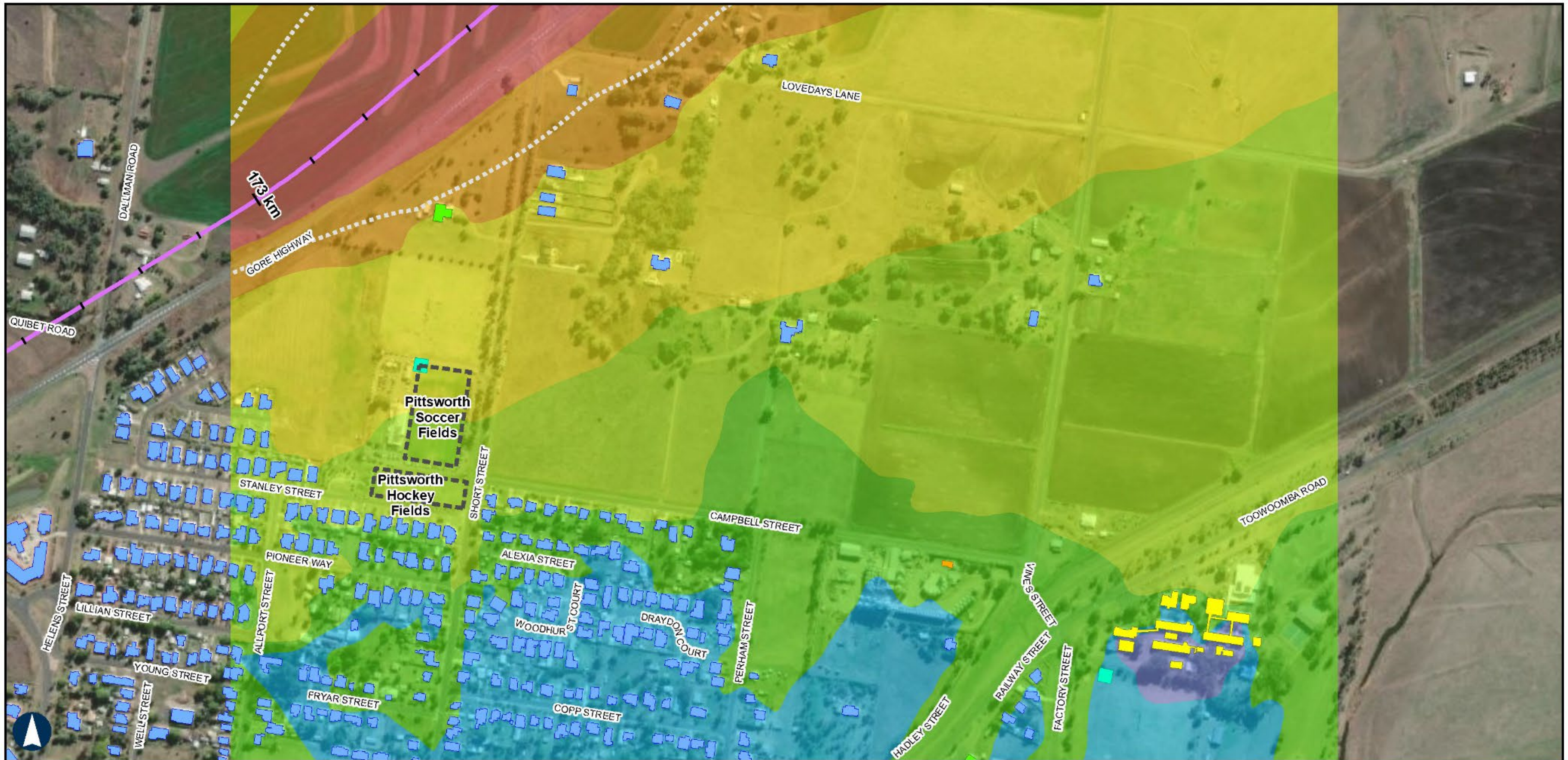

BORDER TO GOWRIE **Unmitigated Noise Levels – 2040 Leq,12h**

Figure 16-9 Pittsworth - Map 3 of 4

100 m

Coordinate System: GDA 1994 MGA Zone 56

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- Crossing Loops
- Bridges and Viaducts
- Outdoor Receptors

Sensitive Receptor Type

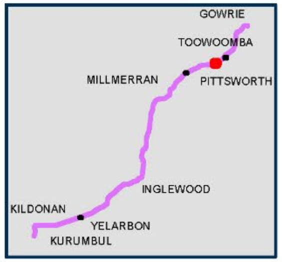
- Residential
- Community
- Educational
- Commercial
- Parkland

Criterion (57 dBA)

Noise Levels

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

Noise contours are free-field and at a height of 1.5m above ground level



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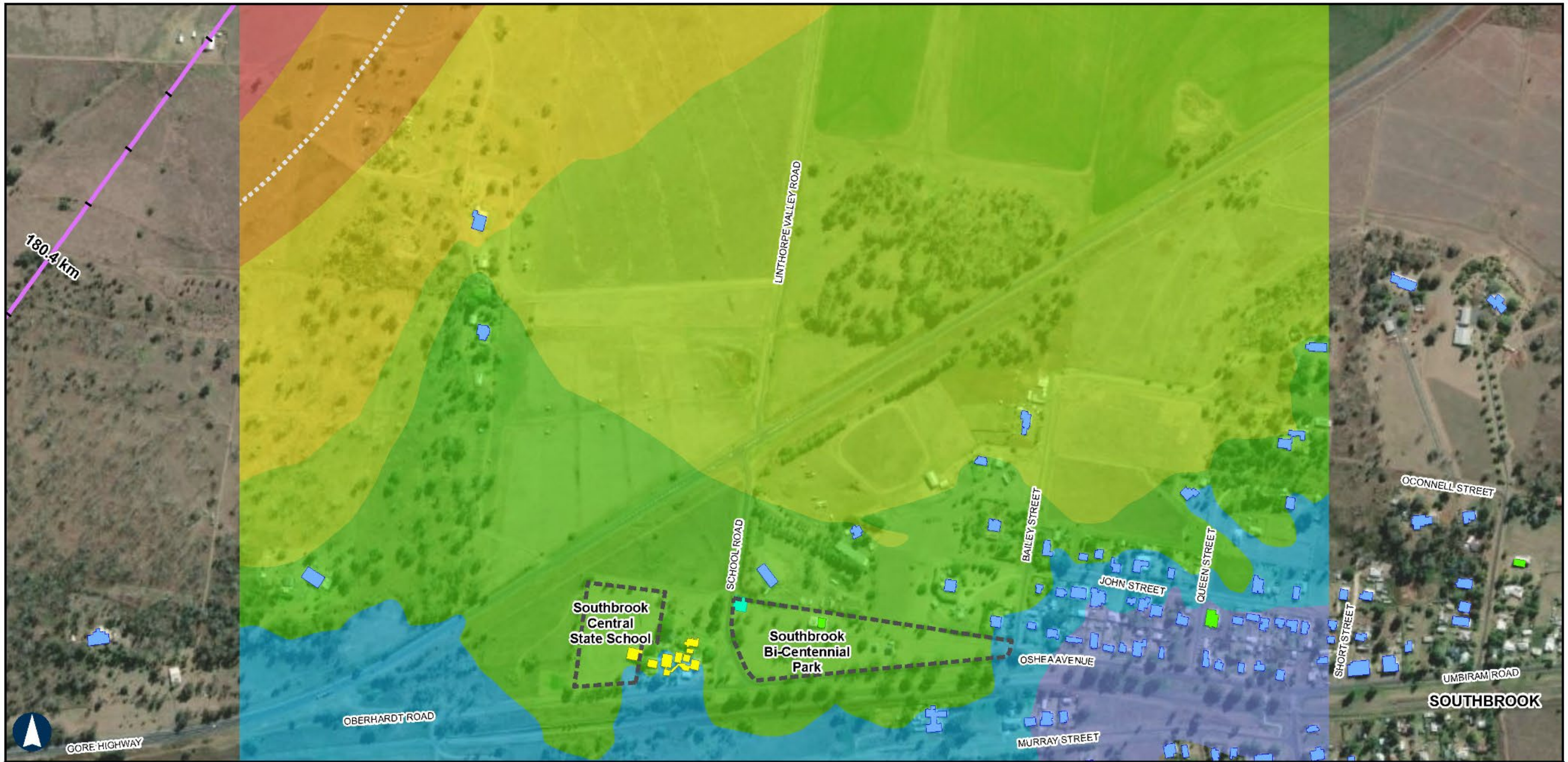

BORDER TO GOWRIE **Unmitigated Noise Levels – 2040 Leq,12h**

Figure 16-9 Southbrook - Map 4 of 4

100 m

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- Level Crossings
- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
- Outdoor Receptors

Sensitive Receptor Type
- Residential
- Community
- Educational
- Commercial
- Parkland

- Criterion (57 dBA)

Noise Levels
- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

Noise contours are free-field and at a height of 1.5m above ground level

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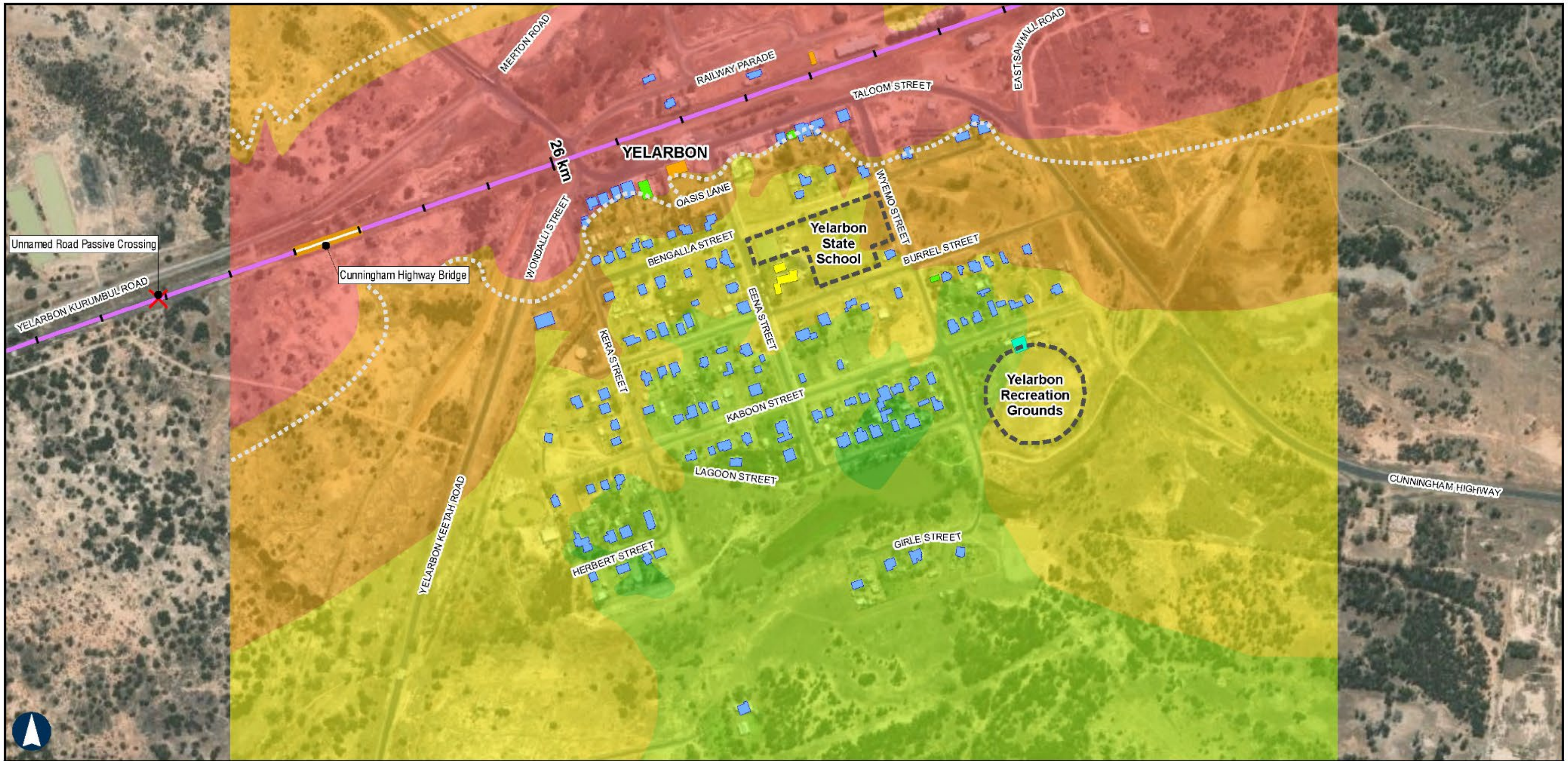

BORDER TO GOWRIE

Unmitigated Noise Levels – 2028/2040 SEM

Figure 16-10 Yelarbon - Map 1 of 4

100 m

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- Outdoor Receptors

Sensitive Receptor Type
- Residential
- Community
- Educational
- Commercial
- Parkland

Criterion (79 dBA)

Noise Levels
- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

Noise contours are free-field and at a height of 1.5m above ground level

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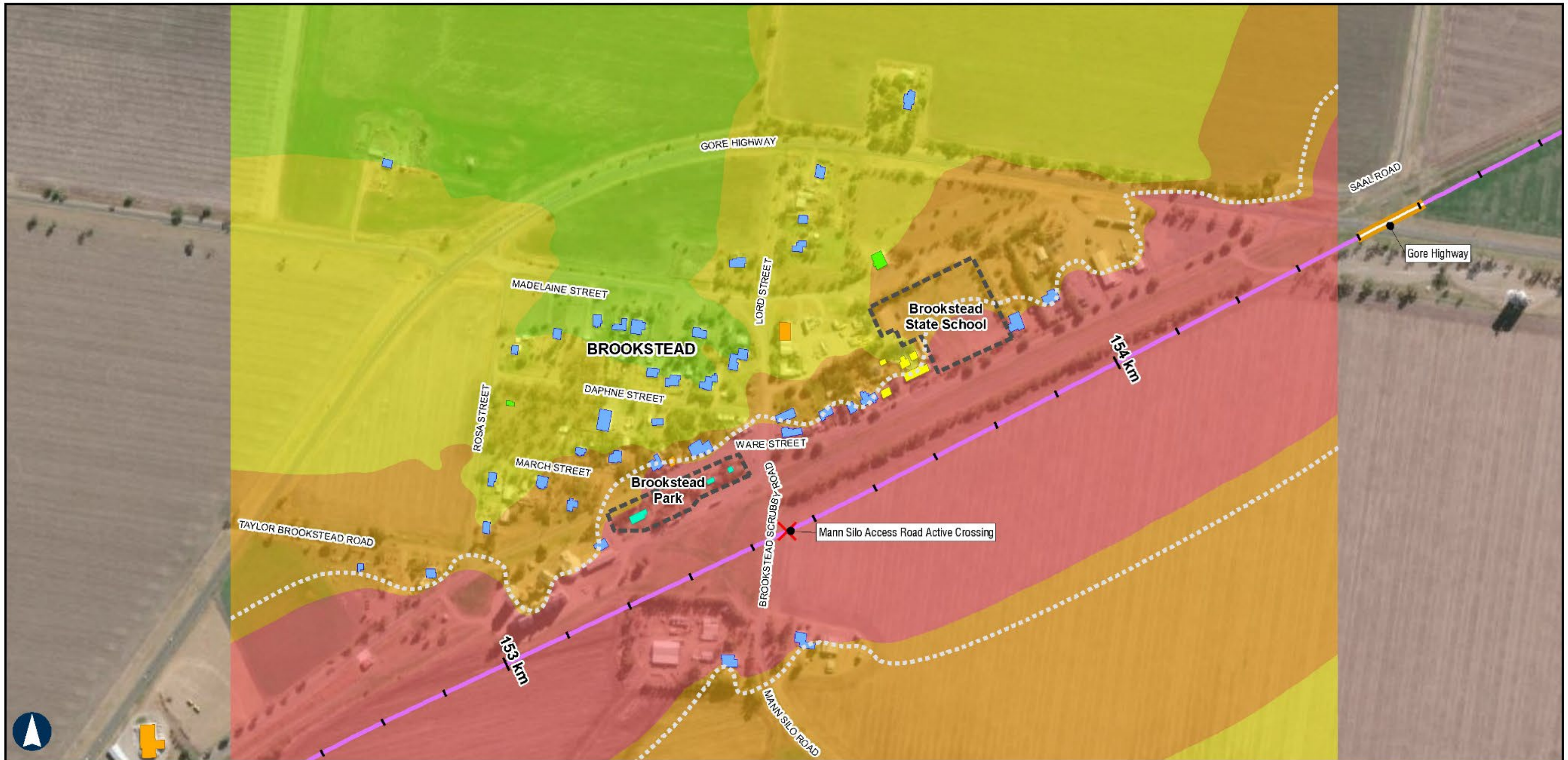

BORDER TO GOWRIE Unmitigated Noise Levels – 2028/2040 SEM

Figure 16-10 Brookstead - Map 2 of 4

100 m

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Sensitive Receptor Type

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- Community
- Educational
- Commercial
- Parkland

Criterion (79 dBA)

Noise Levels

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

Noise contours are free-field and at a height of 1.5m above ground level

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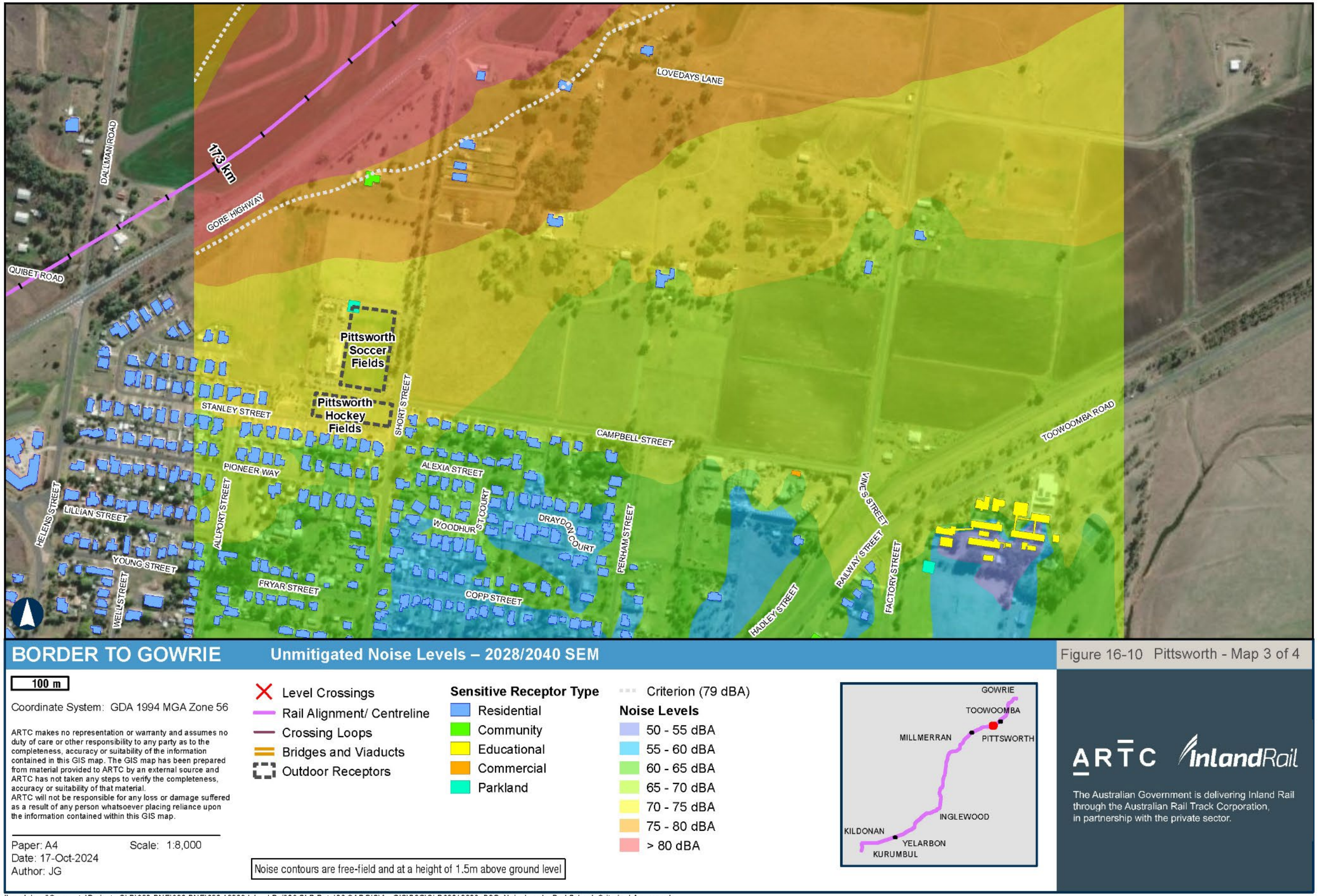

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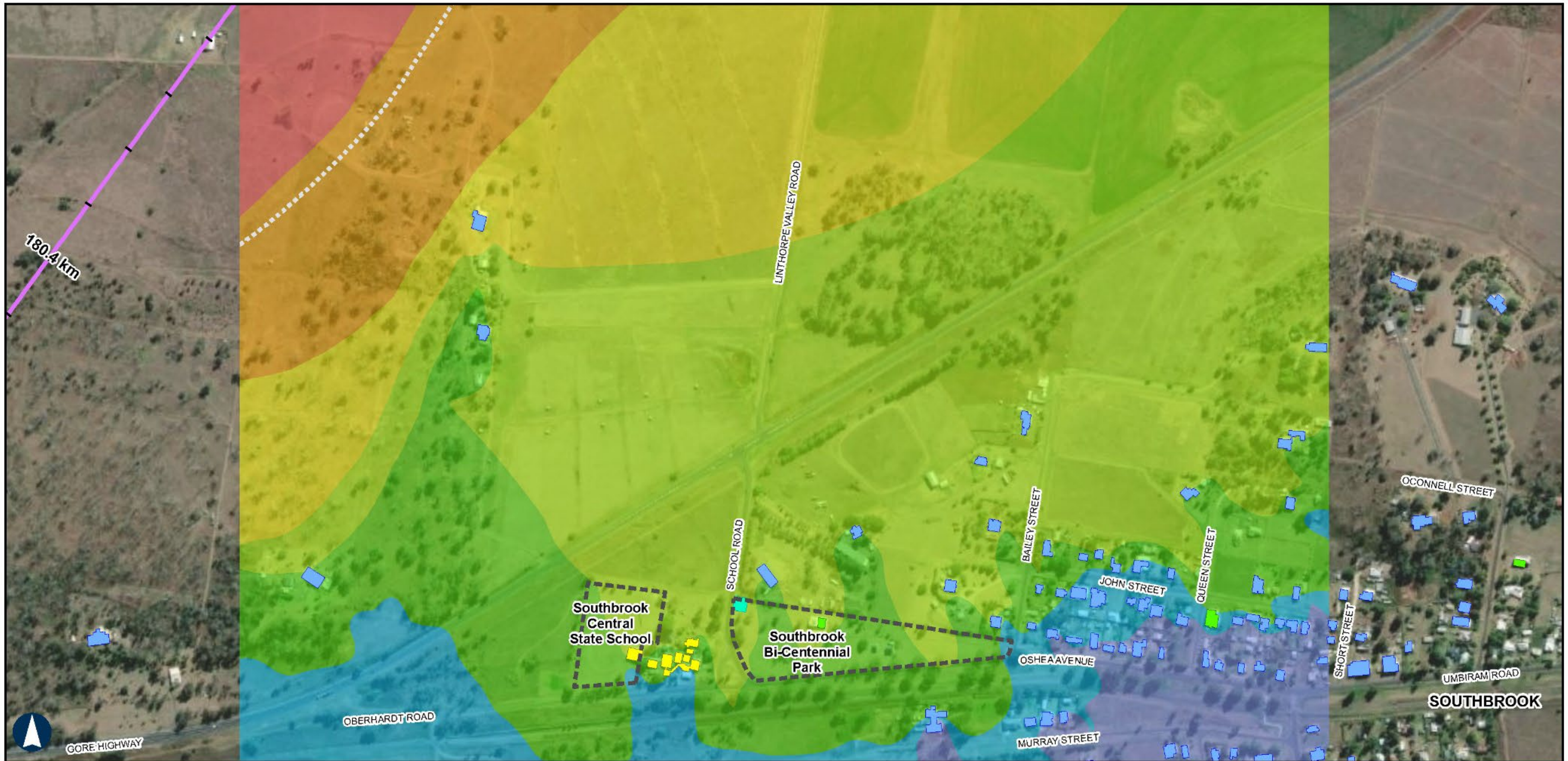

BORDER TO GOWRIE Unmitigated Noise Levels – 2028/2040 SEM

Figure 16-10 Southbrook - Map 4 of 4

100 m

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- Community
- Educational
- Commercial
- Parkland

- Criterion (79 dBA)

Noise Levels
- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- > 80 dBA

Noise contours are free-field and at a height of 1.5m above ground level

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16.8.1.3 Sleep disturbance assessment

Potential sleep disturbance impacts have been assessed using a criteria of 55 dBA $L_{eq,night}$ (10 pm–6 am), which is based on the Queensland *Noise and Vibration EIS Information Guide* (DES, 2024), which references the Australian Government's Department of Health publication, *The Health Effects of Environmental Noise*, 2018 (enHealth, 2018).

The enHEALTH 2018 publication includes review of international evidence on the influence of environmental noise on sleep, cardiovascular disease and cognitive outcomes. It is based on over 200 research papers, publications and policies from January 1994 to March 2014. The findings of the enHEALTH publication include the following:

- During the night-time, an evidence-based limit of 55 dB(A) at the facade using the $L_{eq,night}$, or similar metric and eight-hour night-time period is suggested.

The enHEALTH guideline thresholds are external limits at the façade of the building and are an annual average.

Compliance with the enHEALTH thresholds does not preclude the potential for sleep disturbance in some individuals. Inland Rail recognise that lower thresholds for sleep disturbance have been proposed in Europe (44dBA $L_{eq,night}$) (World Health Organization, 2018). The 44 dBA night-time level as an evidence-based threshold is not strongly supported in the enHEALTH guideline as it only accounts for about 3% probability of being highly sleep disturbed based on the research literature reviewed. Comparatively, the 55 dBA threshold has about 10% probability of being highly sleep disturbed. The enHEALTH publication has considered these aspects in developing the 55 dB threshold for Australian conditions.

The assessment of sleep disturbance has been made based on the following assumptions for the Project:

- There would be at least one train movement in every hour of the night-time period, with no allowance made for hours without train operations
- The night-time train movements allow for one train per hour for eight consecutive hours
- In this scenario, approximately 32% of daily train movements would occur during the night-time
- The train types are proportionally distributed to operate at night due to the lack of more detailed scheduling information at this EIS Stage. The considered train volumes for the 2040 scenario are presented in Section 6.2 of Appendix W and are derived from the peak weekly volumes.

Based on the worst-case year 2040 scenario, the results of the sleep disturbance assessment are that 169 dwellings are predicted to trigger the threshold value, of which 82 dwellings are also predicted to exceed the Interim Guideline criteria. Maps of the receivers triggering the sleep 55dB threshold are included in Section 11 of Appendix W. A general overview of the extent of 55dB L_{Aeq} noise levels during the night time can also be seen on the L_{Aeq} 24hr noise contour shown in Figure 16-7 which is comparable.

The extent of these triggers in the context of the annual average enHEALTH guideline threshold are expected to be conservative as the noise modelling of operations required for the Interim Guideline assumes peak train volumes with all trains travelling at the maximum speed and maximum train length.

Inland Rail is committed to assessing the sleep disturbance effects carefully based on future realistic night-time operations as the Project progresses into detailed design, with consideration of the following aspects:

- Detailed train timetables as they are developed
- Actual operating conditions of trains (speeds, notches, loads, etc. at various sections)
- Knowledge of the construction of the individual buildings and use of windows (note that sleep disturbance is an internal noise effect, and the probability of semi-open windows, closed windows, etc. should be accounted for to assess impacts case-by-case)
- Updated noise prediction modelling conducted during detailed design
- Any design changes as they occur during further project development
- Any further onsite validation and measurements as required.

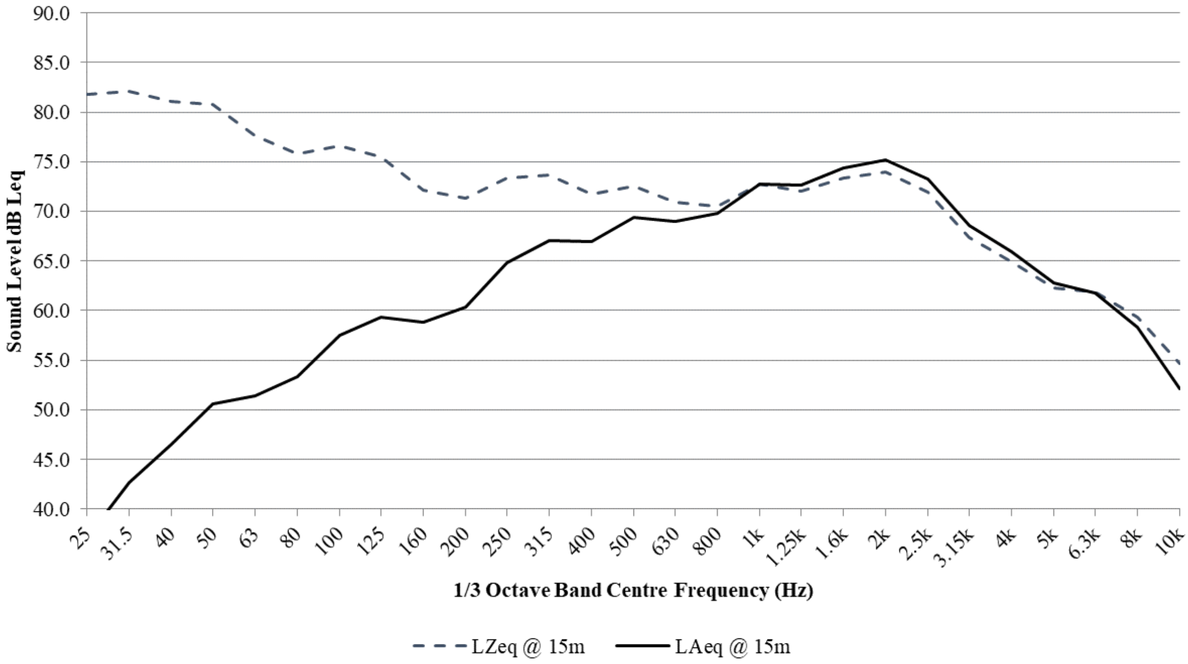
Section 11 of Appendix W: Noise and Vibration Assessment—Railway Operations provides further discussion on the assessment of sleep disturbance.

16.8.1.4 Railway noise characteristics

The potential impacts of noise from railway operations are influenced by the characteristics of rollingstock noise. An overview of the potential noise characteristics from freight rail operations is provided below, with more detailed discussion provided in Section 12.4 Appendix W: Noise and Vibration Assessment—Railway Operations.

- Bunching or stretching can occur when the couplings on a train are subject to sudden changes in force during acceleration and deceleration, which can cause transient 'squeaks' and 'bangs'. Noise events from bunching or stretching have been assessed at the Project crossing loops.
- Curving noise, such as wheel-squeal, can result in prominent tonal noise emissions. The revised reference design does not include tight-radius curves (radius ≤ 500 m) and the noise modelling did not apply noise emission correction factors for potential curving noise emission.
- The track for Inland Rail will be continuously welded rail, which reduces rolling noise and vibration compared with jointed track.

Noise spectrum including energy at lower frequencies (below 200 Hz) occurring intermittently at short intervals during the locomotive passbys, as shown in Figure 16-11.



Note Noise spectra based on the measured leq noise levels during train passby at 15 m from the rail centreline.

FIGURE 16-11 RAILWAY PASSBY NOISE SPECTRUM

16.8.1.5 Overview of railway noise impacts under the Interim Guideline

While the Project is applying the most stringent noise limits from the Interim Guideline and will be adopting noise mitigation, there remains potential for railway noise levels to be clearly perceptible at nearby sensitive land uses and receptors.

Noise from railway operations will be infrequent and only occur when trains are passing in the immediate local area. Once a train has passed through, there will be no further railway noise until the next train is scheduled. Based on the peak train movements for the Project, this could equate to approximately one train an hour.

Although only lasting the duration of a train passby, rollingstock operations can result in clearly audible noise close to the railway corridor, even where noise levels from regulatory guidelines have been achieved and measures have been implemented to reduce noise emissions.

Based on the predicted noise levels for the year of Project opening and the future design year of 2040, a summary of the number of residential receptors triggering a review of noise mitigation is provided in Table 16-26.

TABLE 16-26 SUMMARY OF RESIDENTIAL RAILWAY NOISE TRIGGERS

Assessment criteria margin	Number of residences triggering mitigation
Project opening / 2040	
1 dB(A) to 3 dB(A)	38
>3 dB(A) to 5 dB(A)	23
>5 dB(A) to 10 dB(A)	18
>10 dB(A)	3
Total residences triggering mitigation Project opening	**82**

Source Railway noise predictions from Appendix W: Noise and Vibration Assessment—Railway Operations.

The noise levels that are predicted at the 82 sensitive residential receptors triggering a review of noise mitigation are detailed in Table 16-27 for rail operations at year 2040. The individual criteria triggers are highlighted in **bold** in the table. The location of each residential receptor that triggers a review of noise mitigation is presented in Figure 16-12. Approximately half of properties were isolated properties dispersed along both sides of the Project alignment. The other triggers occurred in the townships of Yelarbon, Brookstead and Pittsworth.

TABLE 16-27 PREDICTED RAILWAY NOISE LEVELS AT RESIDENTIAL NOISE MITIGATION TRIGGERS

Sensitive receptor ID	Rail noise levels—year 2040		Sensitive receptor ID	Rail noise levels—year 2040	
	$L_{Aeq\ (24\text{-}hour)}$	SEM		$L_{Aeq\ (24\text{-}hour)}$	SEM
254161	**64**	**88**	260213	**65**	**89**
254164	**64**	**88**	260528	**63**	**87**
254168	**66**	**90**	261084	**62**	**86**
254170	**64**	**88**	261368	60	**84**
254179	**63**	**86**	261386	**61**	**85**
254181	**61**	**84**	261493	**61**	**84**
254250	**67**	**91**	261638	60	**83**
254271	**69**	**93**	261665	60	**84**
254276	**62**	**86**	261686	**63**	**86**
254347	**63**	**86**	261687	60	**84**
254551	**63**	**87**	261703	**61**	**84**
254558	**66**	**90**	261720	**62**	**86**
254559	**66**	**90**	261729	**63**	**87**
254562	**67**	**91**	261739	**63**	**87**
254565	**67**	**90**	261908	**63**	**87**
254576	**65**	**88**	261969	**62**	**86**
254578	60	**83**	315138	60	**84**
254589	**65**	**89**	315139	**63**	**87**
254595	**66**	**89**	315262	**61**	**84**
254598	**66**	**89**	315319	**61**	**85**
254601	**61**	**84**	315421	**65**	**88**
254603	**66**	**89**	319045	60	**83**
254609	**70**	**94**	319101	**61**	**84**
254612	**65**	**89**	319103	59	**83**
254614	**70**	**93**	319121	**63**	**87**
254628	60	**83**	319150	**62**	**85**
254635	**62**	**86**	319166	**59**	**83**
254661	60	**83**	319191	**62**	**86**
254828	60	**84**	319193	**61**	**84**

Sensitive receptor ID	Rail noise levels—year 2040		Sensitive receptor ID	Rail noise levels—year 2040	
	$L_{Aeq\ (24\text{-hour})}$	SEM		$L_{Aeq\ (24\text{-hour})}$	SEM
255333	60	**83**	319485	**63**	**86**
255346	**62**	**85**	319848	**62**	**85**
255350	**61**	**85**	320557	59	**83**
256019	**61**	**85**	320889	60	**83**
256166	**61**	**84**	321184	60	**84**
260058	**66**	**89**	321458	60	**83**
260067	**64**	**87**	321618	60	**83**
260119	60	**84**	322552	**63**	**87**
260150	59	**83**	323854	**63**	**86**
260169	**61**	**85**	324270	**64**	**87**
260170	**62**	**86**	324333	60	**83**
260189	**63**	**87**	2008224	60	**83**

Source *Railway noise predictions from Appendix W: Noise and Vibration Assessment—Railway Operations.*

The railway noise levels at these receptors are up to 12 dB(A) above the SEM noise criterion and up to 10 dB(A) above the $L_{Aeq\ (24hr)}$ noise criterion.

The predicted railway noise levels at the 15 non-residential sensitive receptor buildings for year 2040 are presented in Table 16-28. The location of each non-residential receptor that triggers a review of noise mitigation is presented in Figure 16-12.

TABLE 16-28 PREDICTED RAILWAY NOISE LEVELS AT NON- RESIDENTIAL NOISE MITIGATION TRIGGERS

Sensitive receptor ID	Description	Rail noise levels—year 2040	
		$L_{Aeq\ (24\text{-hour})}$	SEM
254564	Yelarbon Scouts Hall	**65**	**89**
254574	Yelarbon Post Office	**65**	**89**
254592	Yelarbon Fire Station	**64**	**88**
254619	office (Yelarbon)	**72**	**96**
260123	Pampas Memorial Hall	**63**	**86**
260154	Pampas Rural Fire Shed	**67**	**90**
261287	office (Brookstead)	**63**	**87**
261321	office (Brookstead)	**62**	**85**
261544	Brookstead Park	60	**84**
261639	Brookstead Post Office	60	**84**
261749	Brookstead State School	**63**	**87**
261795	Brookstead State School	**63**	**87**
322790	Pittsworth and District Assembly of God	59	**83**
2008446	Brookstead Park	**62**	**85**
2008488	Brookstead State School—sports fields	**61**	**85**

Source *Railway noise predictions from Appendix W: Noise and Vibration Assessment—Railway Operations.*

BORDER TO GOWRIE

Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 1 of 32

100 m

Coordinate System: GDA 1994 MGA Zone 56

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- Sensitive receptors triggering a review of mitigation (Residential)
- Sensitive receptors triggering a review of mitigation (Non-residential)

GOWRIE
PITTSWORTH
MILLMERRAN
YELARBON
INGLEWOOD
KURUMBUL

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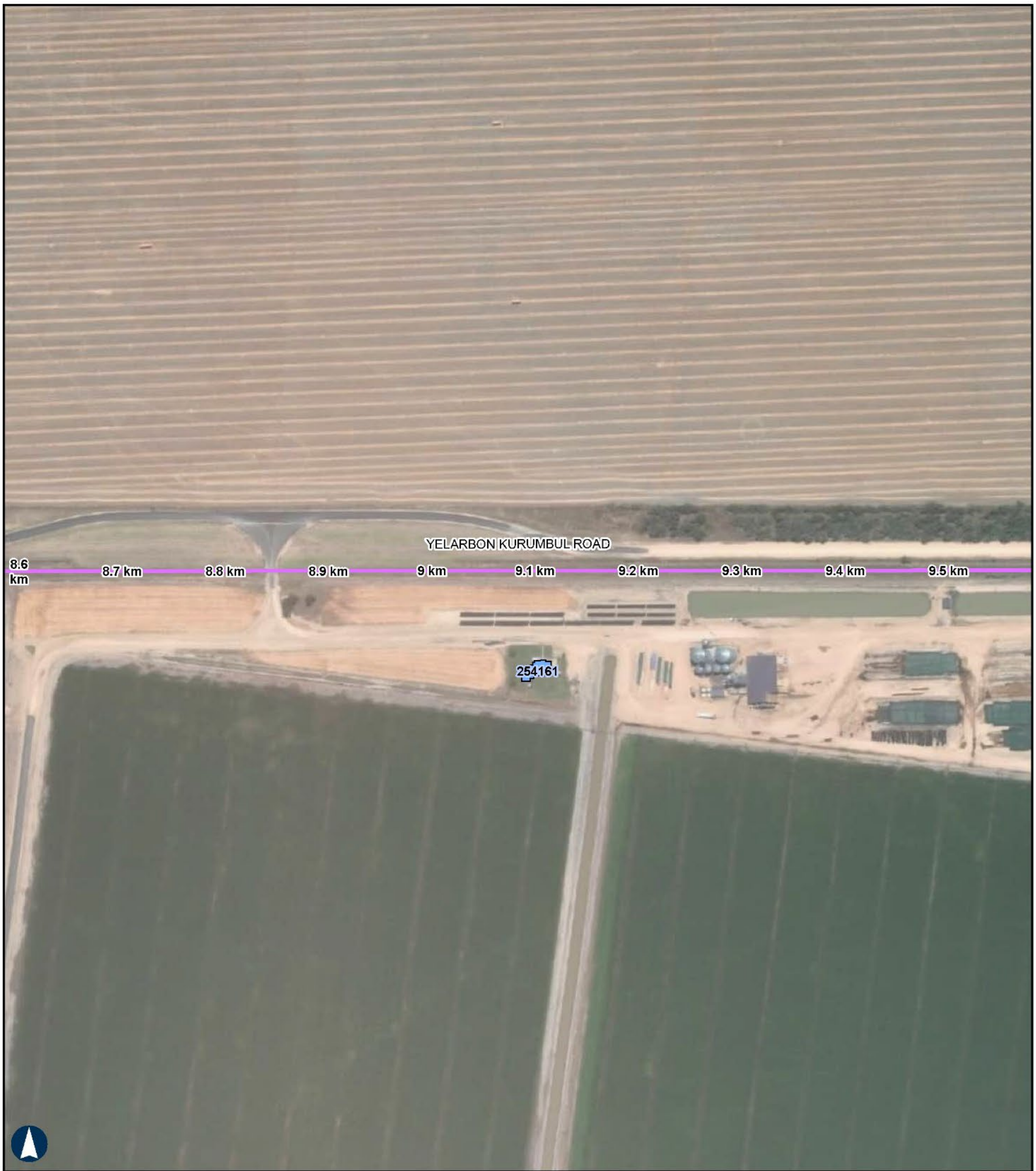

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 2 of 32

100 m

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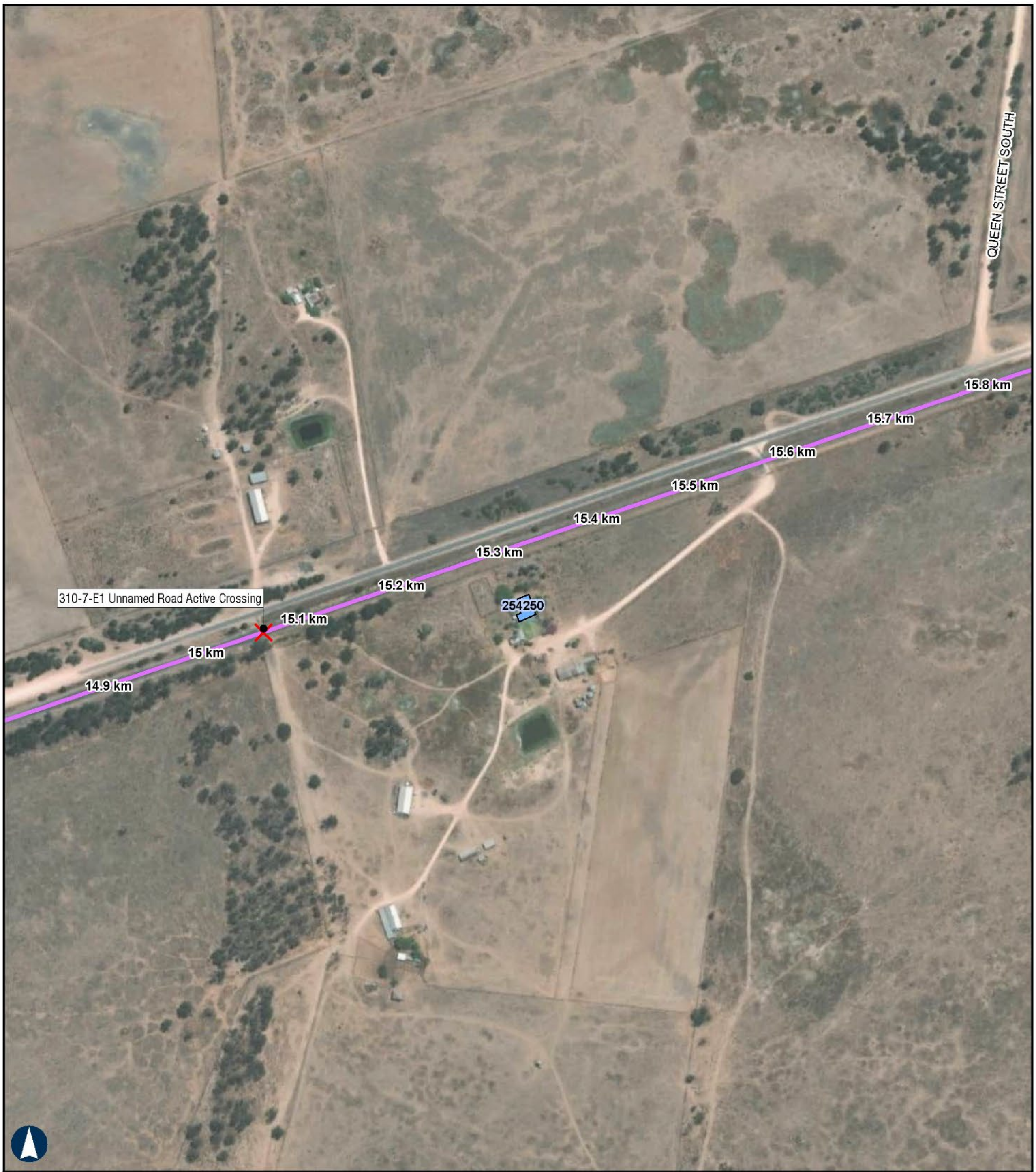

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 3 of 32

100 m

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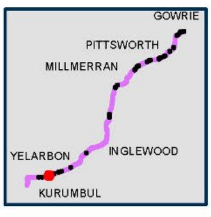

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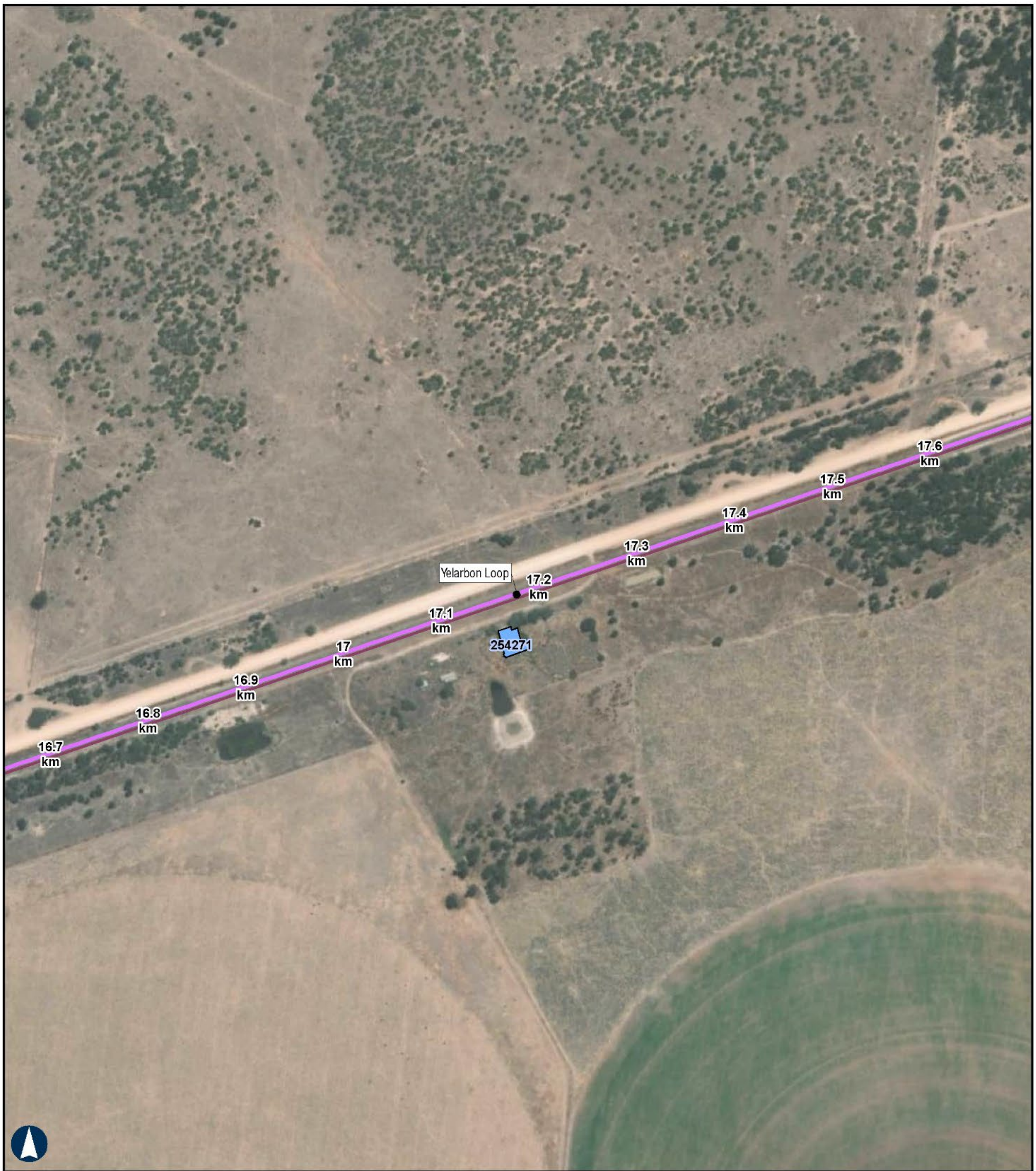

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 4 of 32

100 m

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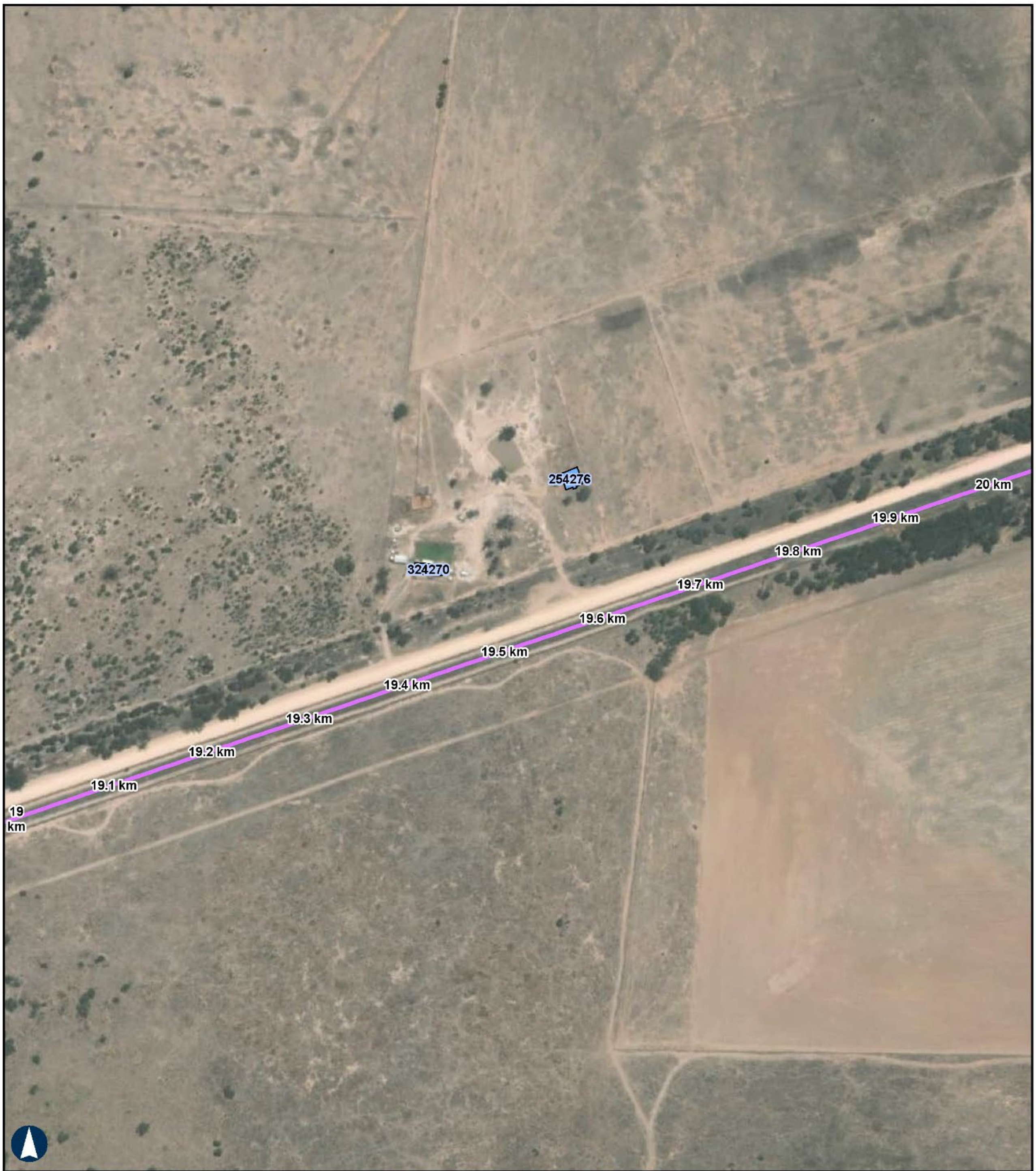

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 5 of 32

100 m

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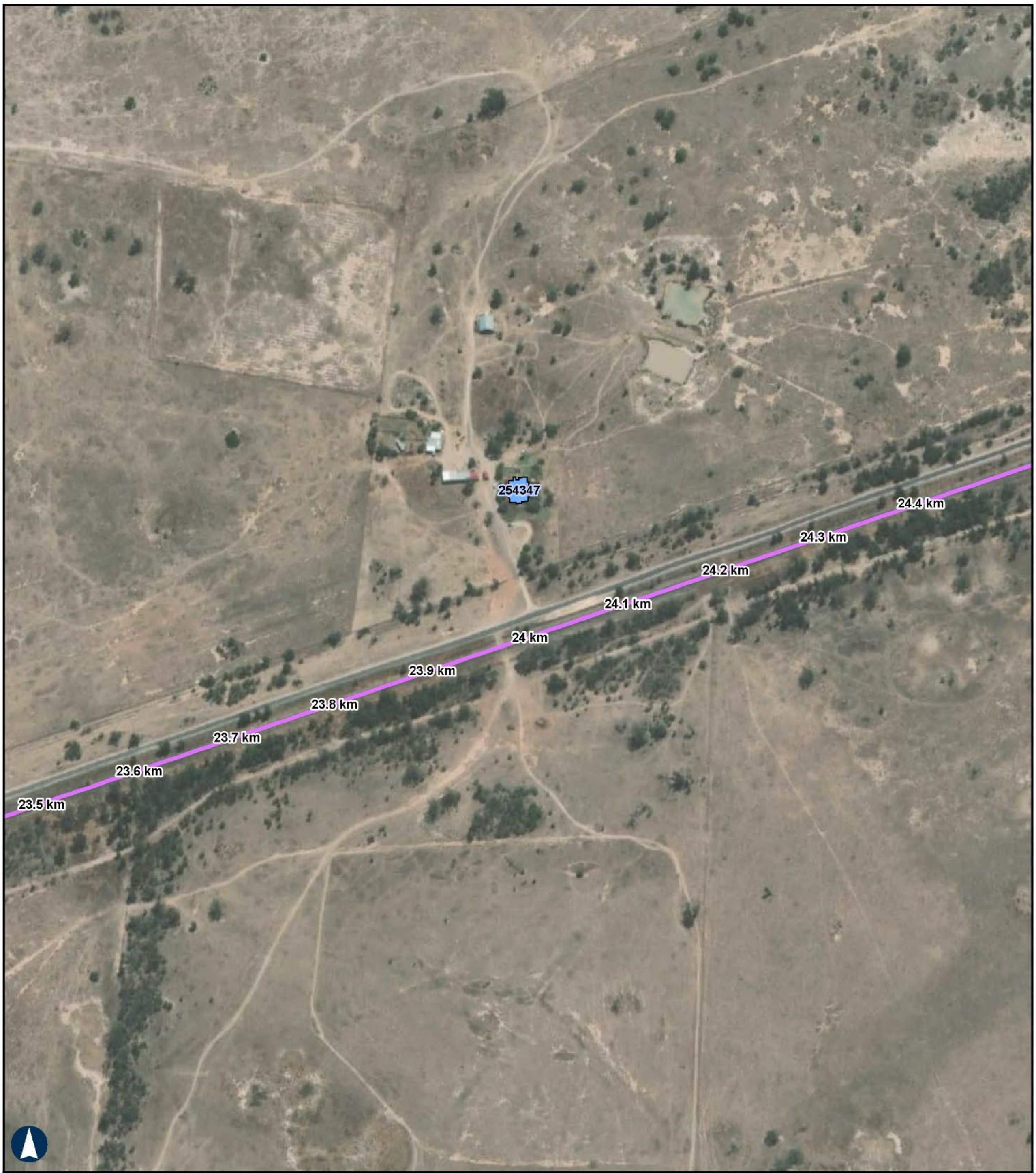

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 6 of 32

100 m

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Paper: A4 Scale: 1:5,000
Date: 17-Oct-2024
Author: JG

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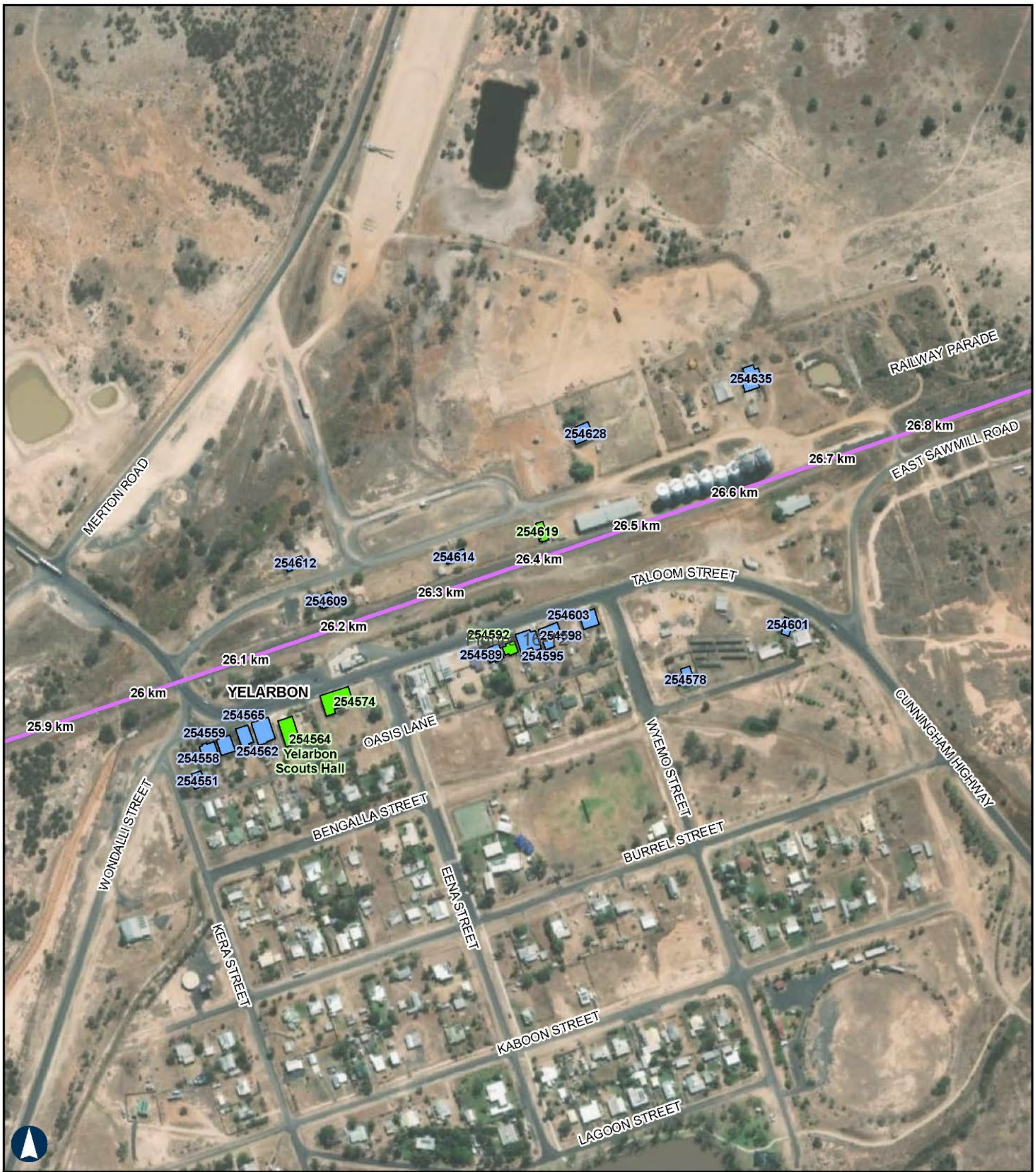

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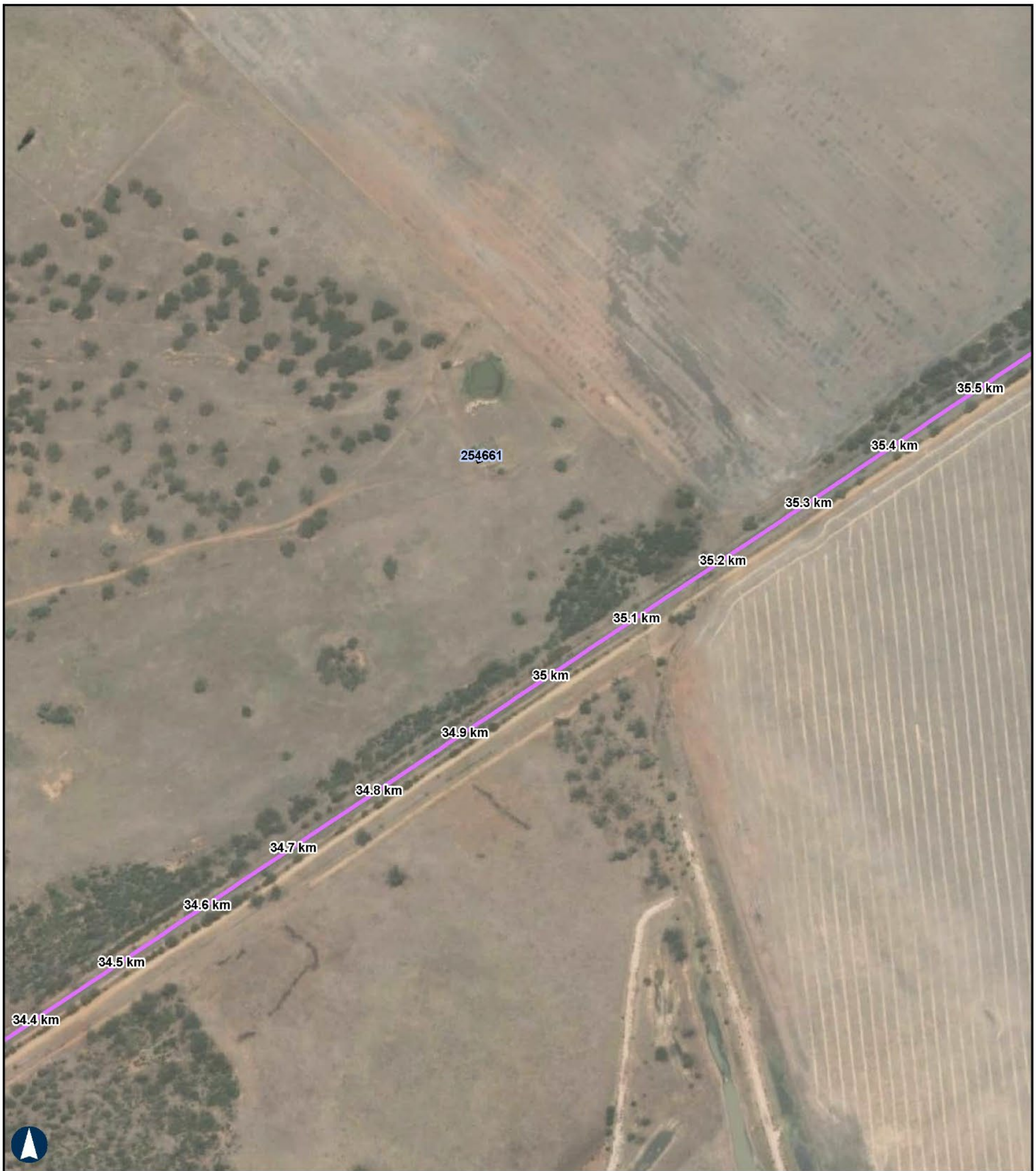

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Figure 16-12 Mapsheet 9 of 32

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 10 of 32

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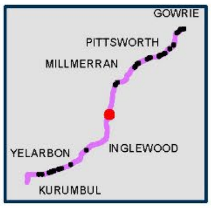

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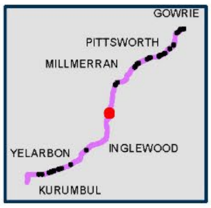

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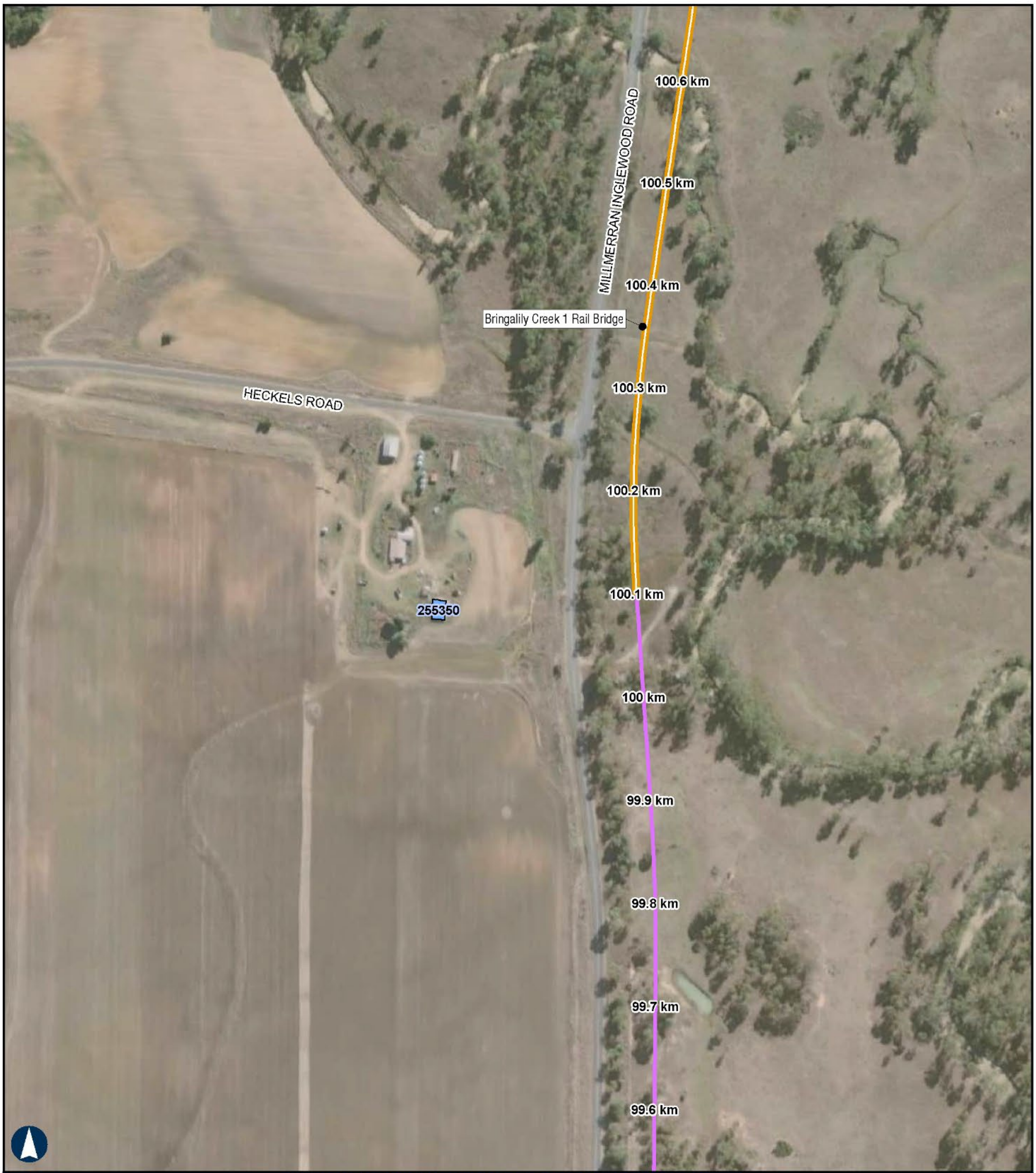

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 12 of 32

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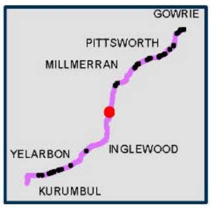

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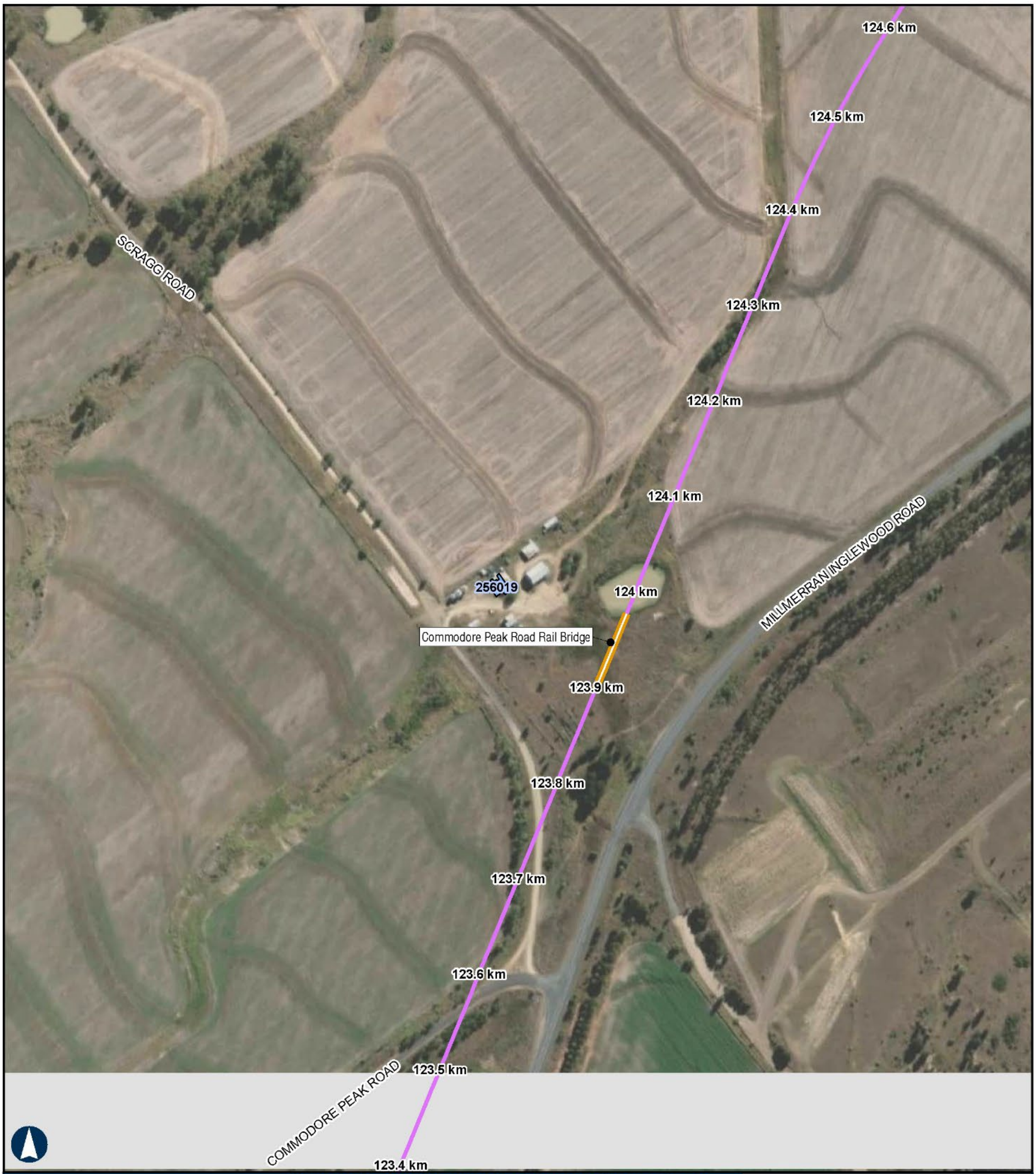

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PITTSWORTH
MILLMERRAN

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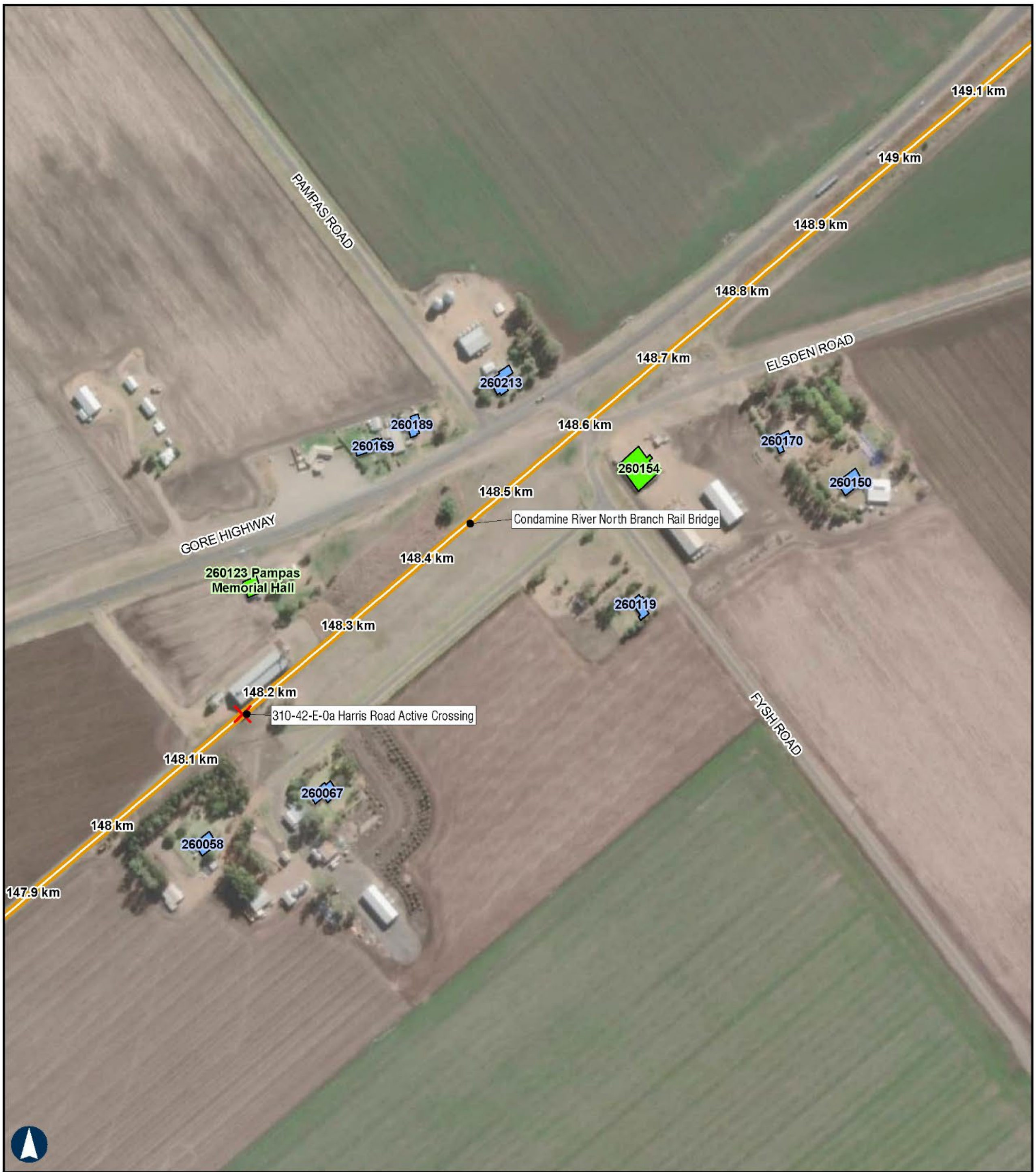

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Figure 16-12 Mapsheet 15 of 32

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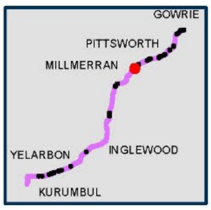

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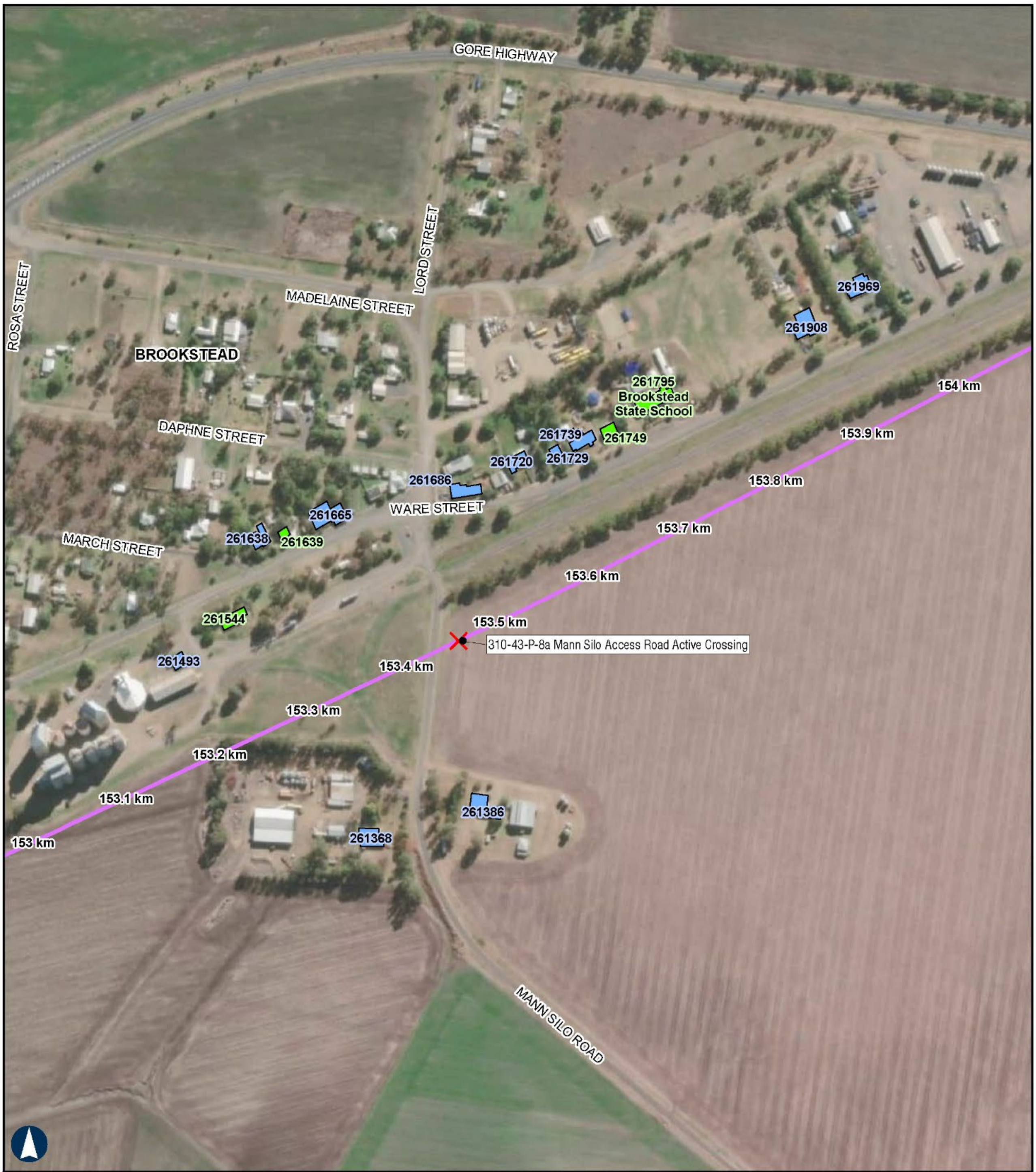

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Figure 16-12 Mapsheet 24 of 32

100 m

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Author: JG

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- Crossing Loops
- Bridges and Viaducts
- Rail Alignment/ Centreline
- Sensitive receptors triggering a review of mitigation (Residential)
- Sensitive receptors triggering a review of mitigation (Non-residential)

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 25 of 32

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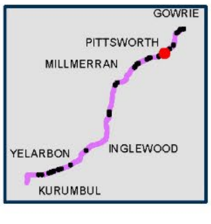

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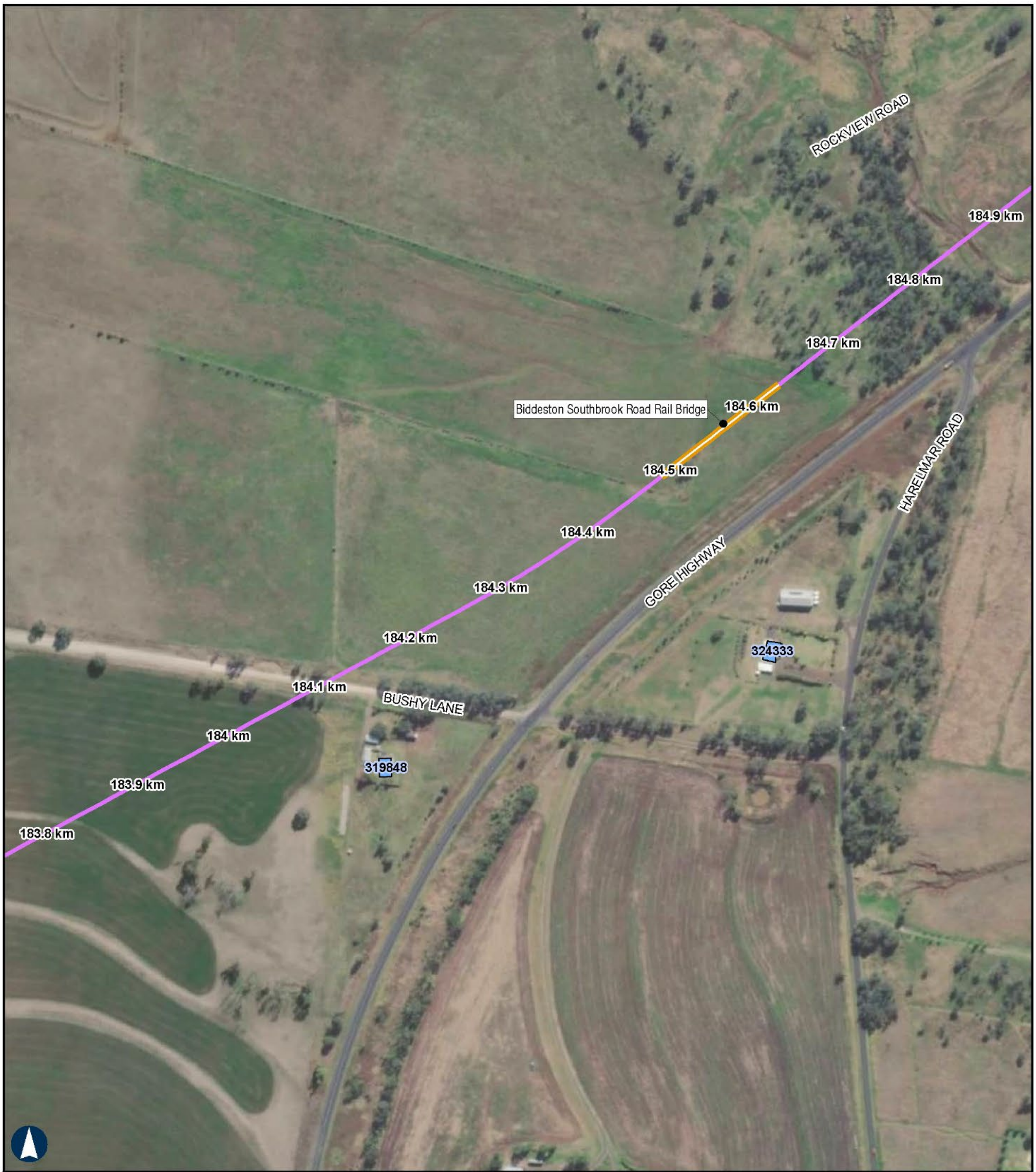

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 27 of 32

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

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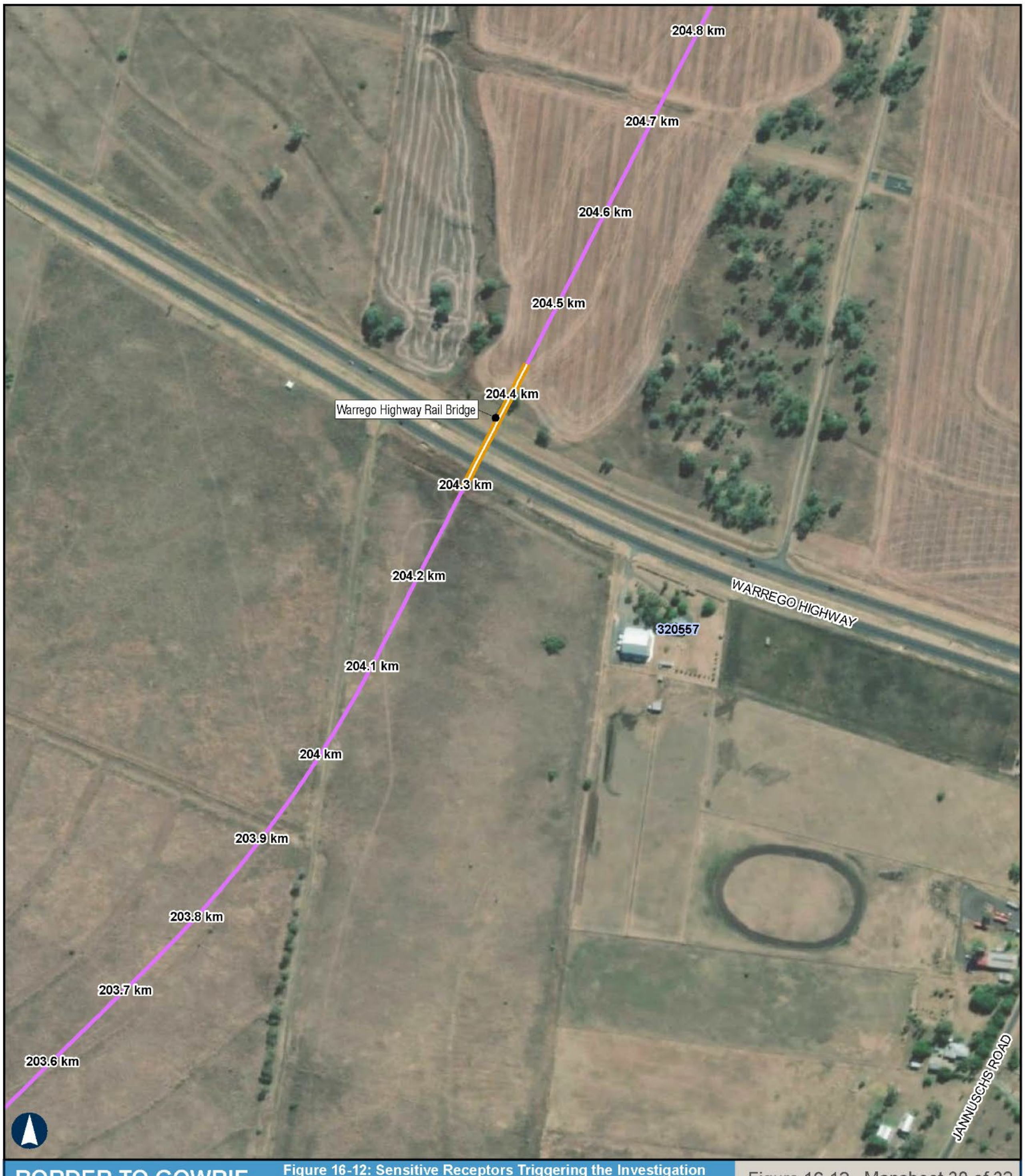

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

Figure 16-12 Mapsheet 30 of 32

100 m

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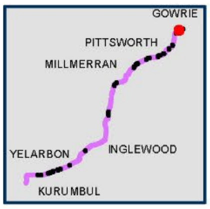

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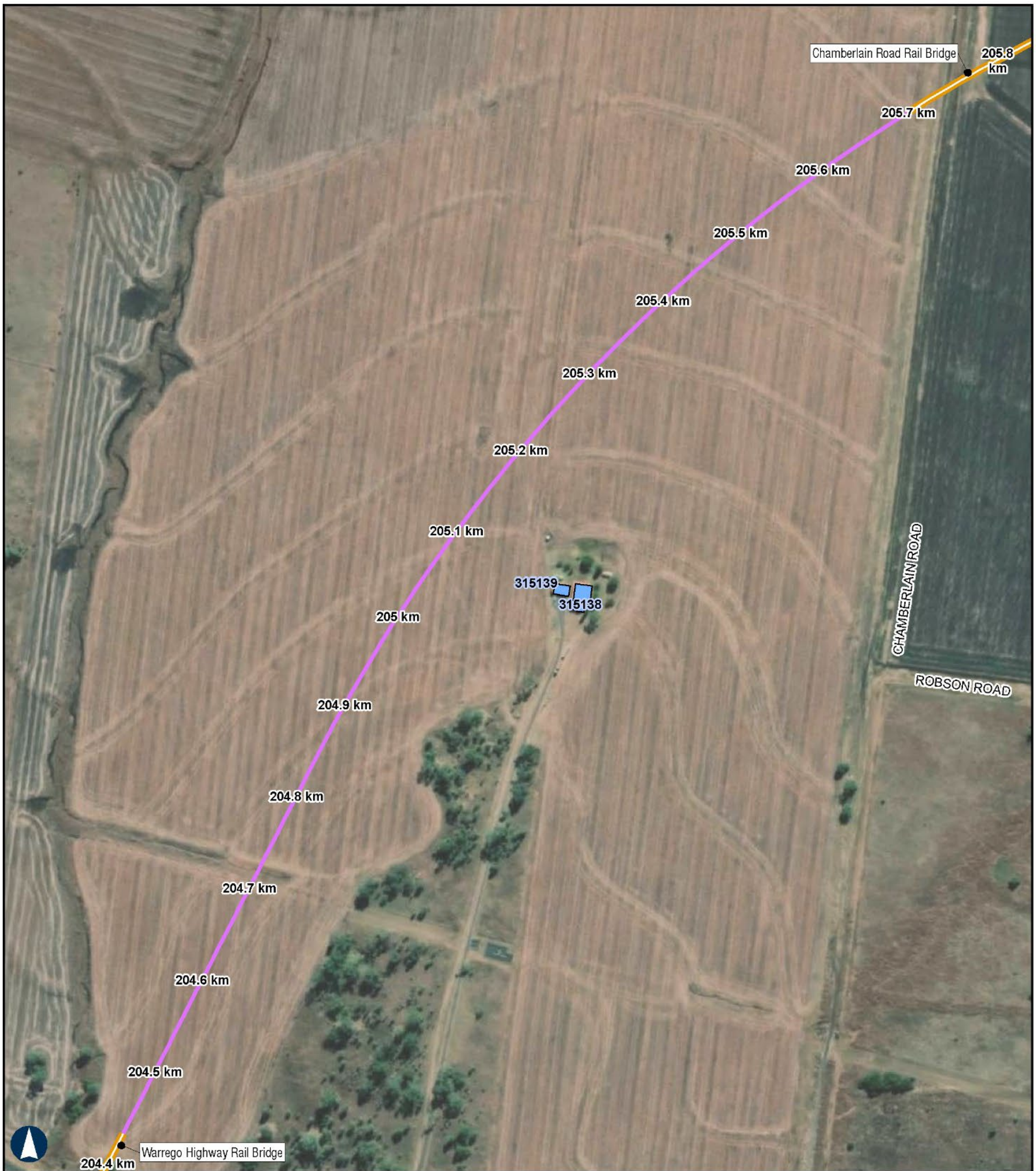

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Figure 16-12: Sensitive Receptors Triggering the Investigation of Noise Mitigation

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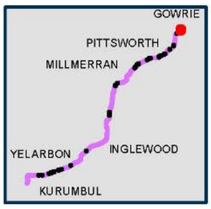

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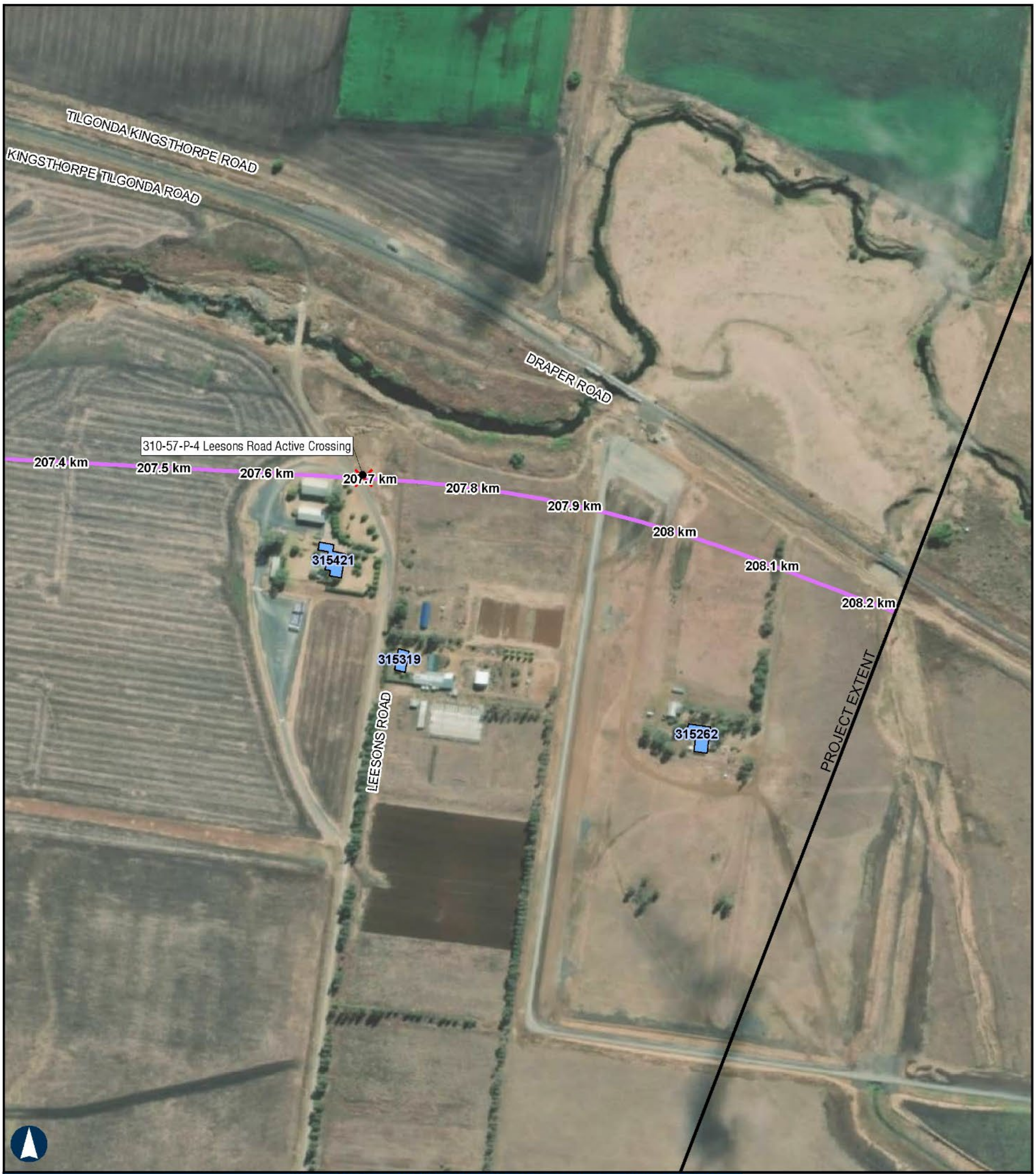

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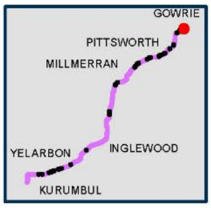

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16.8.2 Assessment of vibration

16.8.2.1 Assessment criteria

Railway vibration is generated by dynamic forces at the interface of the rail and train wheels. The resultant vibration from ground-level track can be transmitted into adjacent buildings via the intervening ground. If the levels of vibration are high enough, it can be perceived as tactile vibration by the occupants of nearby buildings.

People can perceive floor vibration at levels well below those likely to cause damage to buildings or their contents. Accordingly, it is generally not necessary to set separate criteria for vibration effects on typical building contents and structures since the criteria for human comfort are suitable to also control impacts to buildings and structures.

For intermittent events such as train passby events, the vibration dose value is applied to assess potential impacts to human comfort. The vibration dose value provides a cumulative measure of the vibration levels associated with all railway operations in the day, evening, or night periods.

The ground-borne vibration criteria for new railways from the Interim Guideline are detailed in Table 16-29. If the vibration criteria are measured or predicted to not be achieved, measures will be implemented to reduce vibration levels to achieve the criteria, where reasonable and practicable.

TABLE 16-29 GROUND-BORNE VIBRATION CRITERIA

Type	Sensitive land use	Internal ground-borne vibration criteria	
		Use period[1]	Vibration dose value m/s$^{1.75}$
New railway	Accommodation activities	Daytime	≤0.20
		Evening	
		Night-time	≤0.13
	Childcare centres	While in use	≤0.40 (all areas)
	Healthcare services		≤0.10 (critical areas)
	Hospitals		
	Places of worship		
	Offices		

Table notes:
1. Daytime is 6.00 am to 6.00 pm, evening 6.00 pm to 10.00 pm and night-time 10.00 pm to 6.00 am.

Buildings with architectural, aesthetic, historic, or cultural values may have certain sensitivities to vibration regarding their long-term preservation. In lieu of ground-borne vibration criteria for heritage sites in the Interim Guideline, a PPV vibration criterion of 3 mm/second was adopted from German Standard DIN 4150.3 (*Structural Vibration Part 3 – Effects of Vibration on Structures*), to provide a conservative criterion to manage potential railway vibration impacts to heritage sites.

16.8.2.2 Predicted vibration levels

Rail vibration levels were predicted to determine the minimum offset distance from the outer rail where the ground-borne vibration criteria would be expected to be achieved. The assessment determined that the vibration criteria would be achieved where receptors are greater than 12 m from the closest rail.

Acknowledging that some properties are within the Project disturbance footprint, and expected to not be occupied, there were no sensitive receptors triggering the ground-borne vibration criteria from railway operations.

The assessment also reviewed the potential for ground-borne vibration impacts to cultural areas of interest, as identified in Chapter 19: Cultural Heritage. The predicted vibration levels were within the assessment criteria for all heritage sites, so vibration induced impacts are not anticipated.

16.8.3 Assessment of ground-borne noise

16.8.3.1 Assessment criteria

Ground-borne vibration from train passbys can be sufficient to cause floors or walls of the structure to vibrate, which can result in an audible low frequency rumble inside buildings. This is termed as ground-borne noise or regenerated noise. The Interim Guideline contains ground-borne noise criteria for rolling stock operations that have been adopted in the assessment as detailed in Table 16-30.

The criteria are internal levels within buildings and are relevant at sensitive land-uses where the level of ground-borne noise is likely to be greater than the airborne noise.

TABLE 16-30 GROUND-BORNE NOISE CRITERIA

Type	Sensitive land use	Internal ground-borne vibration criteria	
		Use period[1]	SEMs dB(A)
New railway or Upgrading existing railway[2]	Accommodation activities	Day	≤40
		Evening/Night	≤35
	Educational establishments Childcare centres Healthcare services Hospital	While in use	≤35
	Community uses (excluding a court of law) Places of worship Offices		≤40
	Court of Law (court rooms)		≤30
	Court of Law (court reporting and transcript areas, Judges' chambers)		≤35

Table notes:
1. Daytime is 7.00 am to 6.00 pm, evening 6.00 pm to 10.00 pm and night-time 10.00 pm to 7.00 am.
2. Mitigation if ground-borne noise as part of upgrading existing railway applies only to new/refurbished infrastructure.

16.8.3.2 Predicted ground-borne noise levels

The most stringent ground-borne noise criterion of L_{ASmax} 35 dB(A) is calculated to be achieved at receptors located greater than 50 m from the rail line. At the 50 m off-set distance, the outdoor noise environment would be dominated by the airborne noise, which would likely mask the potential ground-borne noise content at the nearest habitable rooms facing the rail corridor.

Within other habitable rooms, where the airborne noise component can be lower, there is potential for the airborne noise to not fully mask potential ground-borne noise and perceptible ground-borne noise impacts may be experienced; however, considering the airborne SEM predicted the external airborne noise levels are expected to be significantly higher at over 90 dBA on closest façade and greater than 70 dBA on most shielded façade, such that airborne noise would dominate at any habitable areas with windows or glazing within the 50 m offset distance. The airborne SEMs are predicted to be dominant compared to ground-borne SEM even if the airborne noise levels are shielded by barriers; therefore, no exceedances are predicted for ground-borne noise thresholds in accordance with the Interim Guideline.

While ground-borne noise levels at all sensitive receptors were calculated to be within the assessment criteria, there can still be a risk of ground-borne noise impacts at sensitive receptors located within 50 m of the railway. Consequently, the assessment outcomes are proposed to be reviewed during the detailed design phase to verify any future requirements to mitigate ground-borne noise.

16.9 Potential noise and vibration impacts to intensive animal operations and fauna

16.9.1 Potential noise impacts

The construction and operation of the Project will generate noise and vibration that could potentially impact intensive animal operations. From the literature review findings and recommendations (detailed in Appendix W: Noise and Vibration Assessment—Railway Operations), a 90 dBA L_{max} level, which is similar to the SEM noise level predicted for rail operations, has been used to assess noise impacts on intensive animal operations adjacent to Project.

To illustrate impacts of construction and operational noise to the various intensive livestock operations identified, L_{Amax} noise levels were predicted and detailed noise contours are provided in Figure 16-13 and Figure 16-14 below.

Several construction scenarios have been modelled as part of the construction noise assessment (Appendix V: Noise and Vibration—Construction and Road Traffic), and for the purposes of assessing construction impacts to intensive animal operations, earthworks scenario: cut and fill has been selected as the most noise-intensive scenario occurring throughout the Project alignment, noting that construction activities are temporary. The predicted noise levels for earthworks indicate that the 90 dBA L_{max} noise level is largely confined to the construction area. The modelled noise levels further indicate that noise levels during construction at intensive livestock facilities such as farm buildings, sheds or feedlots visible from aerial imagery, are less than 90 dB L_{max}. Based on this, construction activities are not expected to significantly impact intensive animal operations.

The predicted noise levels (L_{max}) for the railway operations at the design year 2040 indicate that the 90 dBA L_{max} noise levels occur very close to the rail alignment. Noise levels at all farm buildings, sheds and feedlots within intensive livestock properties are less than 90 dBA L_{max}. The predicted operational noise levels indicate that there are no significant impacts to livestock that are expected to occur for the receptors identified.

16.9.2 Potential vibration impacts

An assessment of the Project's vibration impacts during the railway operations has been done as part of Appendix W: Noise and Vibration—Railway Operations primarily to assess impacts on the identified sensitive receptors. This is summarised in Section 16.8.2 of this chapter. Rail vibration levels were predicted to determine the minimum offset distance from the outer rail where ground borne vibration criteria (based on vibration dose values detailed in Table 16-29) would be expected to be achieved. The assessment determined that the vibration criteria would be achieved where receptors are greater than 12 m from the closest rail (based on the most stringent limit for the night-time period). The assessment found that there were no sensitive receptors triggering the ground-borne vibration criteria from railway operations.

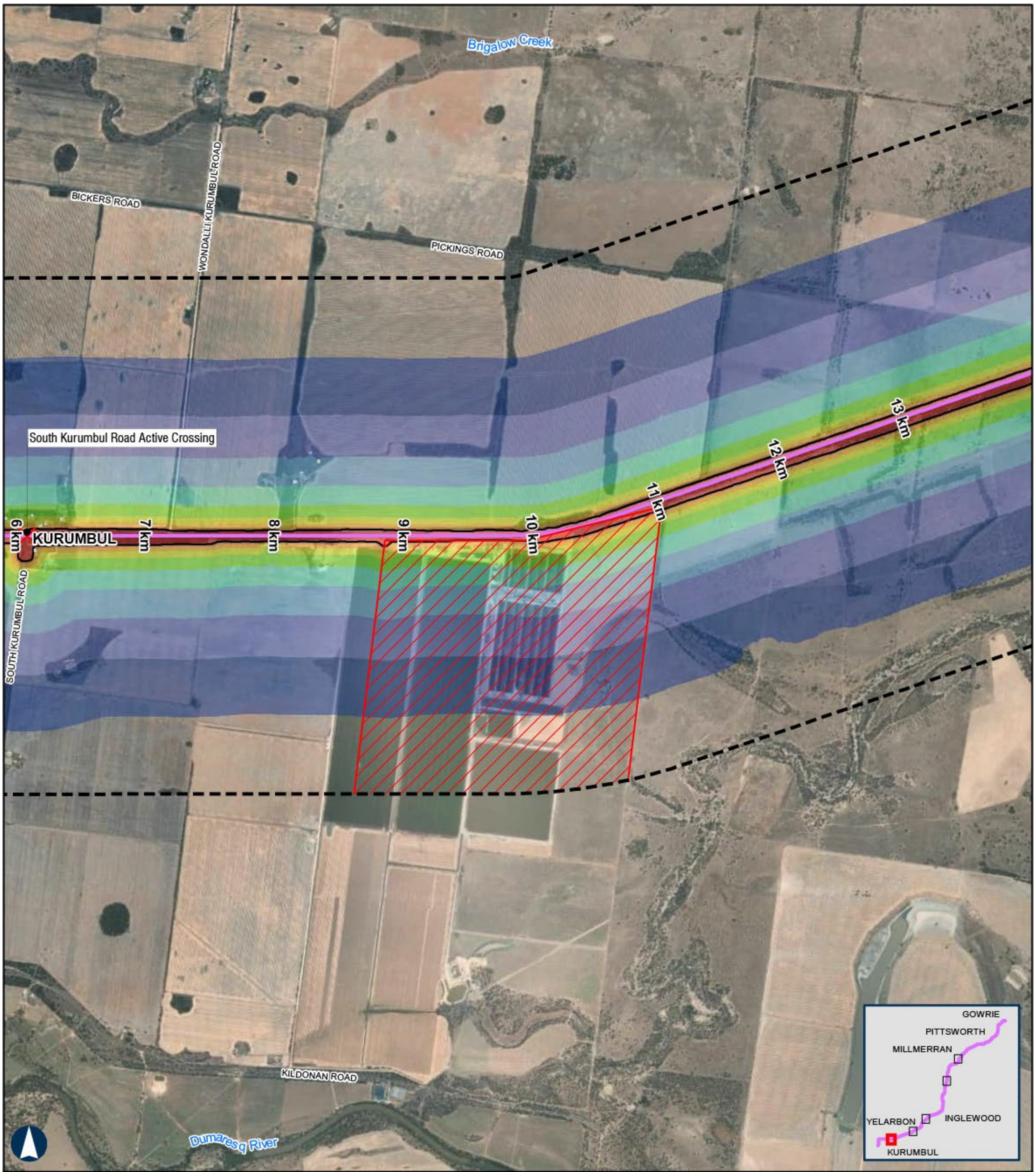
For intensive animal operations, considering that structures such as farm buildings, sheds or feedlots visible from aerial imagery, are located at distances significantly farther away than the estimated off-set distance of 12 m, it is anticipated that ground-borne vibration impacts to livestock are not likely to be expected in these locations.

Ground vibration impacts for the construction phase were assessed as part of Section 6.1.2 of Appendix V: Noise and Vibration—Construction and Road Traffic Impact and are summarised in Section 16.6.2.6 of this chapter. For construction, it is standard practice to maintain adequate separation distance or 'safe' working distance where possible and/or monitor vibration levels at sensitive receptor locations during vibration-intensive construction works.

The safe working distances provide a simple and conservative guide to site personnel to manage the likelihood of vibration impacts to sensitive receptors. Human comfort safe working distances in the order of 300 m have been calculated for the largest vibratory rollers during start-up/run down on the high amplitude setting. Vibration-safe working distance contour maps for all relevant sources of construction vibration are provided in Appendix E of Appendix V: Noise and Vibration—Construction and Road Traffic Impact.

The assessment of human comfort safe working distances indicate that potential impacts could occur at three intensive animal operations sites. It is recommended that all vibration-sensitive receptors, including any intensive animal operations that could be impacted, located within the conservative human comfort safe working distances (provided as contour maps in Appendix E) are notified in advance of the potential for vibration levels to be perceptible during the Project construction works.

To mitigate potential vibration impacts, measures such as preconstruction conditions surveys, use of smaller construction equipment, alternative construction methodology and vibration monitoring, will likely be required for all Project vibration-intensive works occurring within the safe working distance.



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Intensive Animal Operations – Construction Noise (Earthworks: cut and fill)

Figure 16-13 Map 1 of 5

1000 m

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- Study Area
- Livestock Area
- Sensitive Receptor

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels (Lmax)

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- 80 - 85 dBA
- 85 - 90 dBA
- >90 dBA

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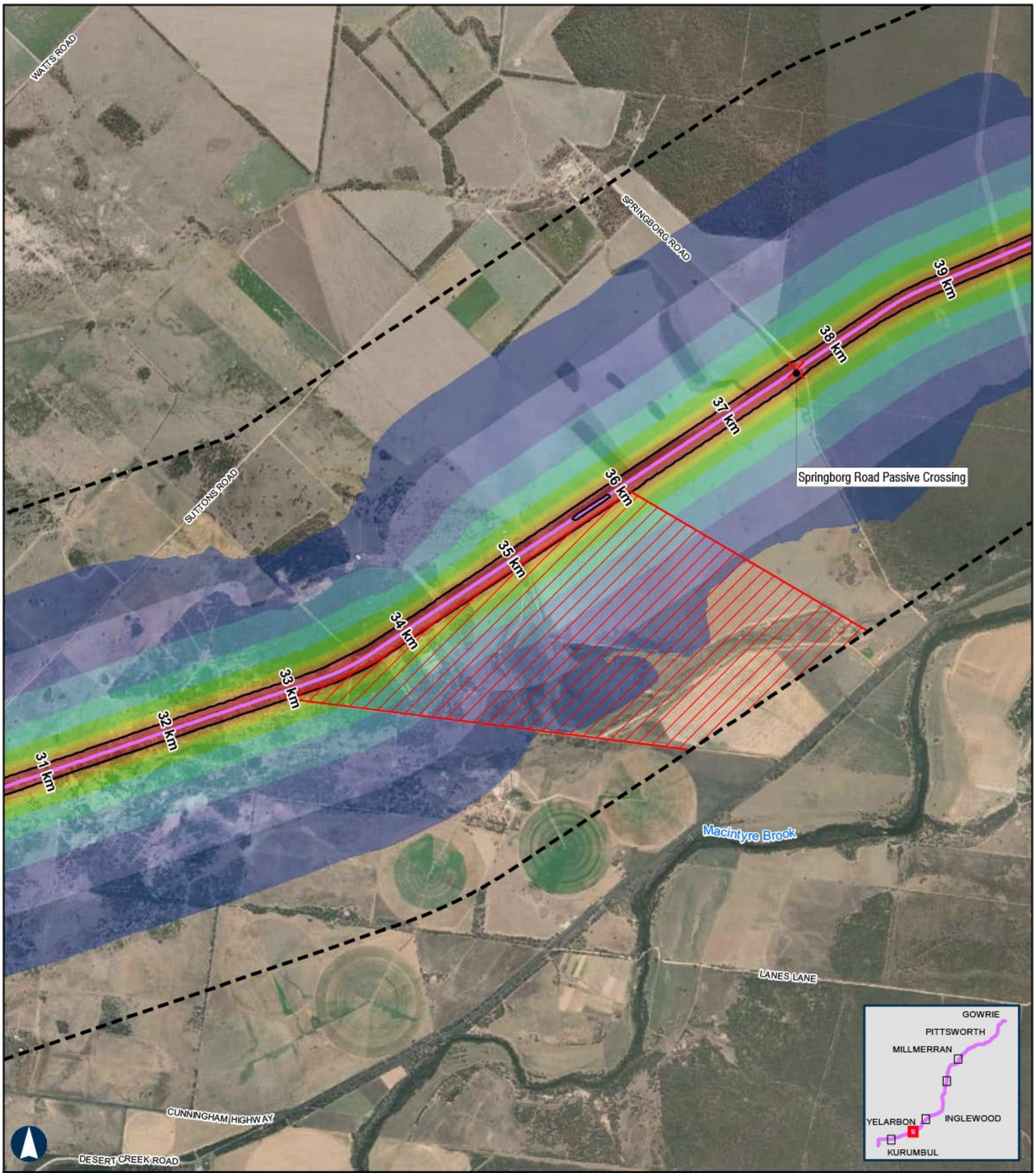

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Intensive Animal Operations – Construction Noise (Earthworks: cut and fill)

Figure 16-13 Map 2 of 5

1000 m

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Noise Levels (Lmax)

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- 80 - 85 dBA
- 85 - 90 dBA
- >90 dBA

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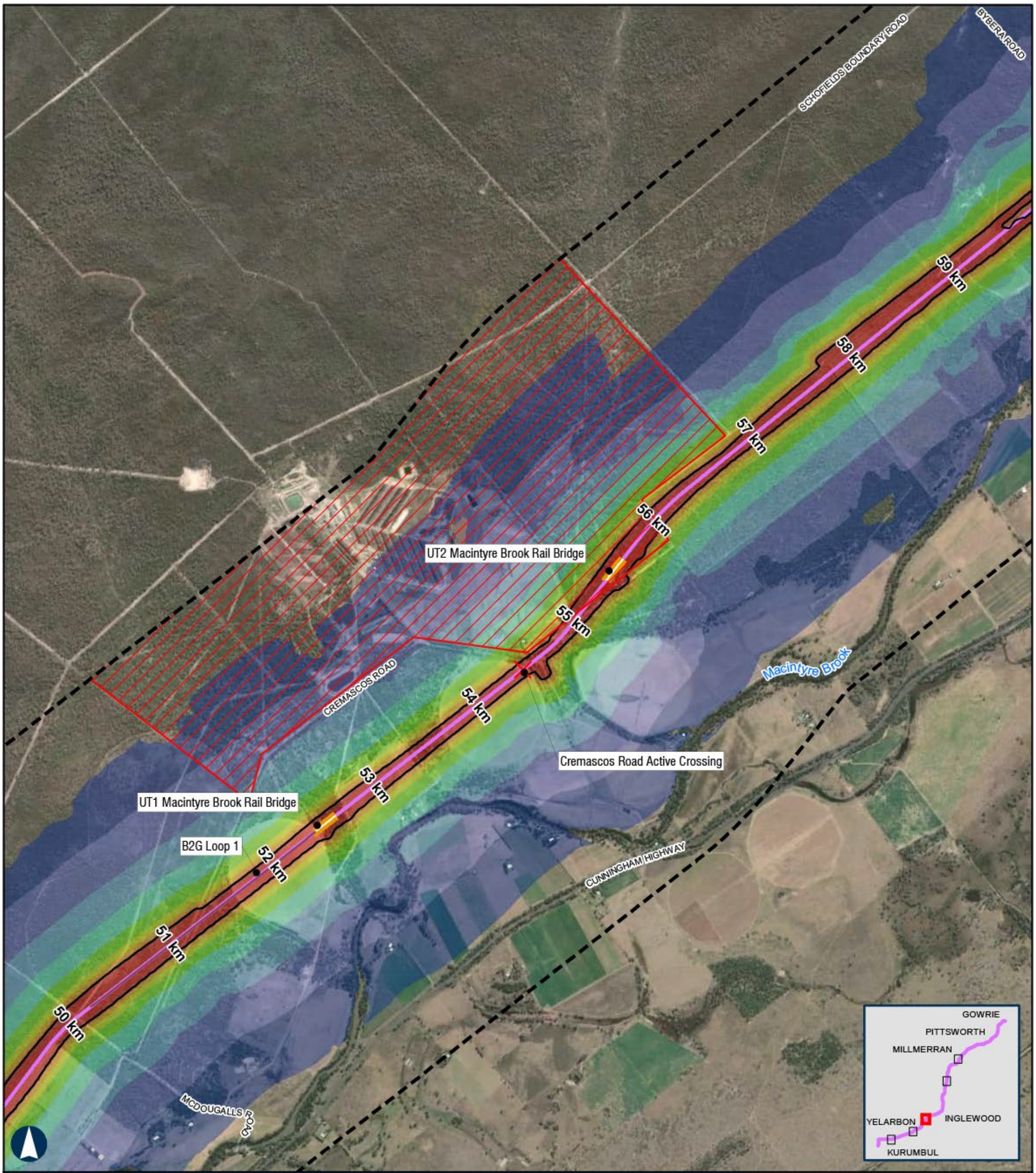

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Intensive Animal Operations – Construction Noise (Earthworks: cut and fill)

Figure 16-13 Map 3 of 5

1000 m

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Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels (Lmax)

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- 80 - 85 dBA
- 85 - 90 dBA
- >90 dBA

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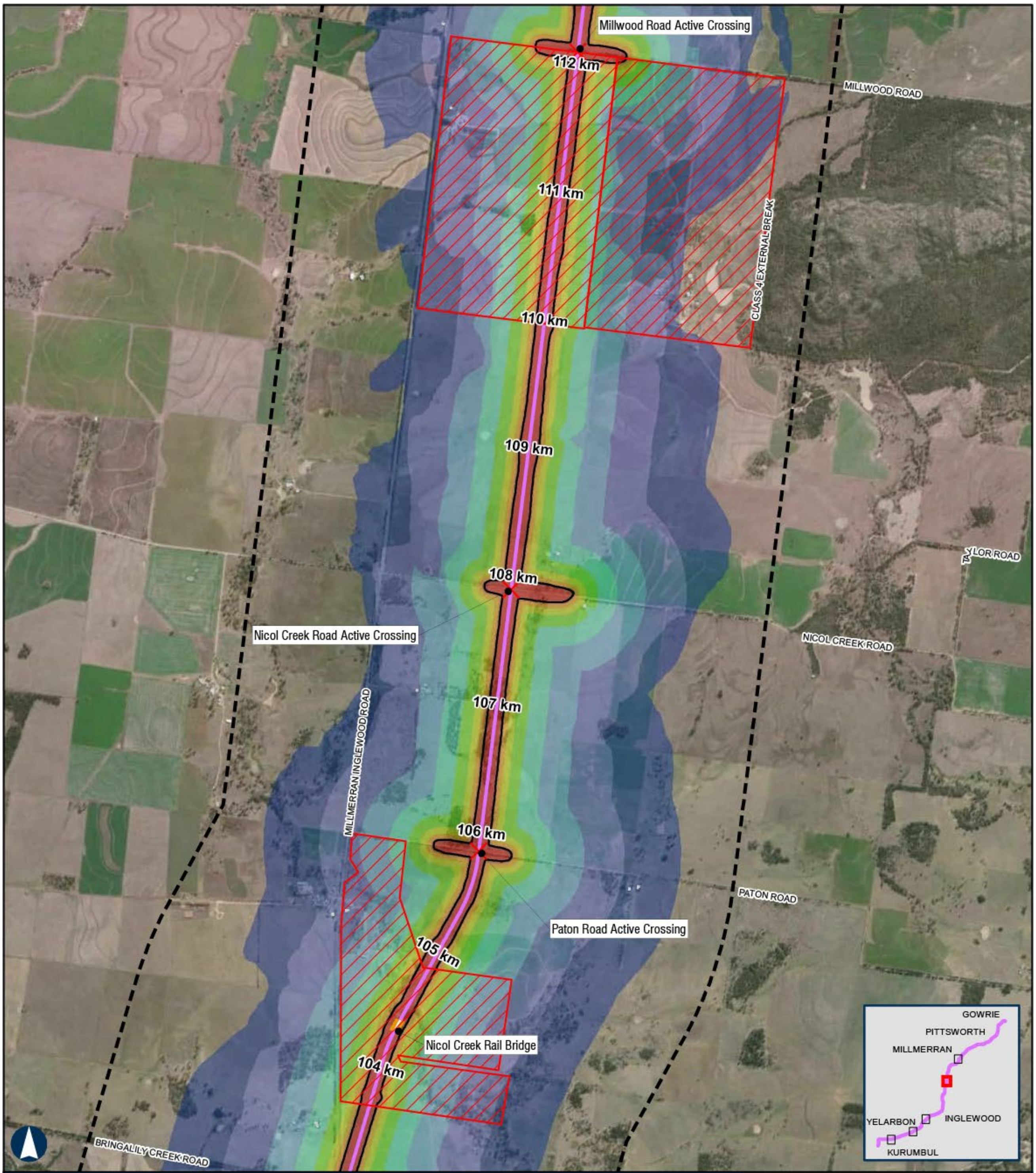

BORDER TO GOWRIE

Intensive Animal Operations – Construction Noise (Earthworks: cut and fill)

Figure 16-13 Map 4 of 5

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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Author: JG

- Level Crossings
- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
- Study Area
- Livestock Area
- Sensitive Receptor

Noise contours are façade-corrected and at a height of 1.8m above ground level

Noise Levels (Lmax)

- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- 70 - 75 dBA
- 75 - 80 dBA
- 80 - 85 dBA
- 85 - 90 dBA
- >90 dBA

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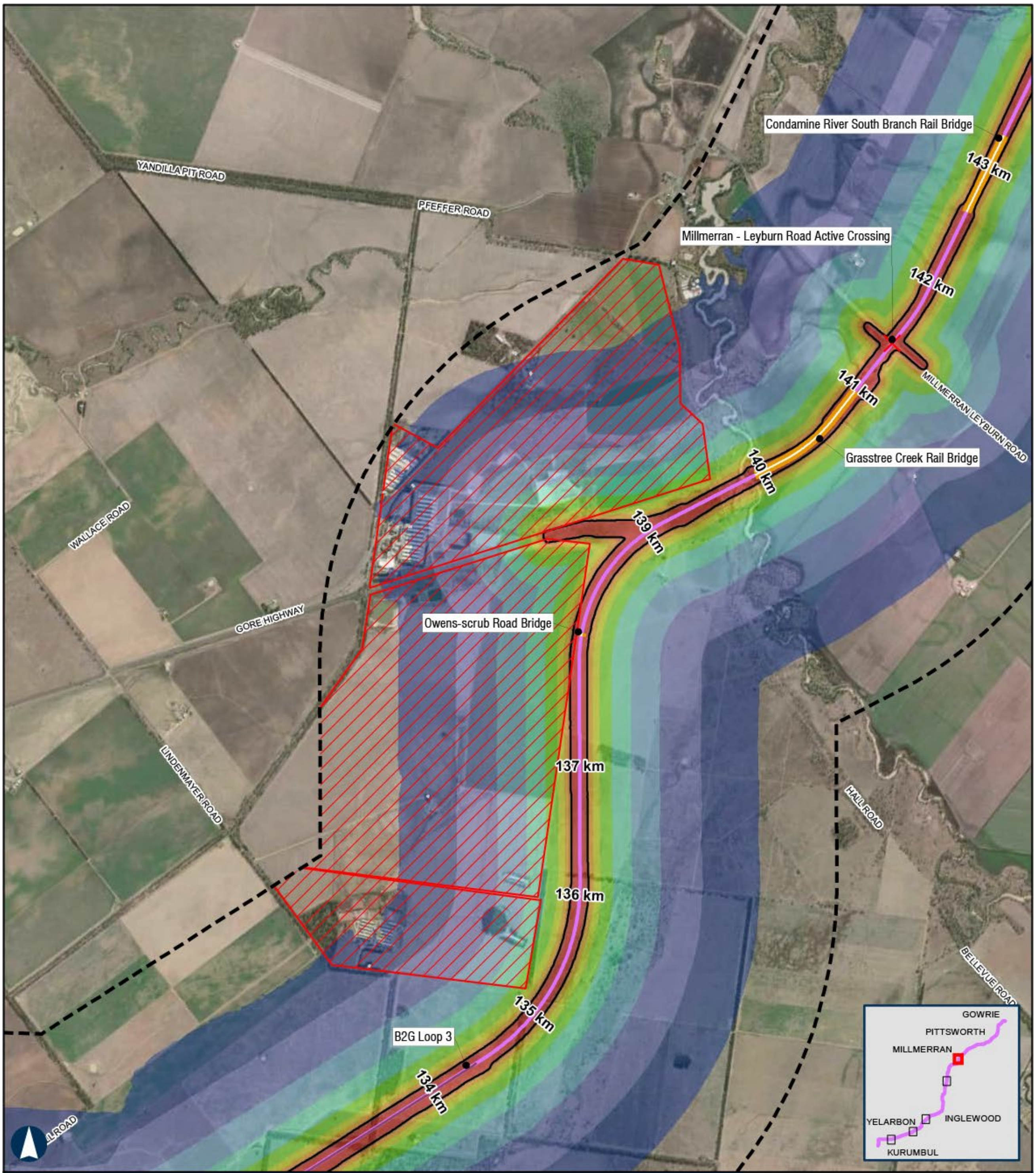

BORDER TO GOWRIE

Intensive Animal Operations – Construction Noise (Earthworks: cut and fill)

Figure 16-13 Map 5 of 5

1000 m

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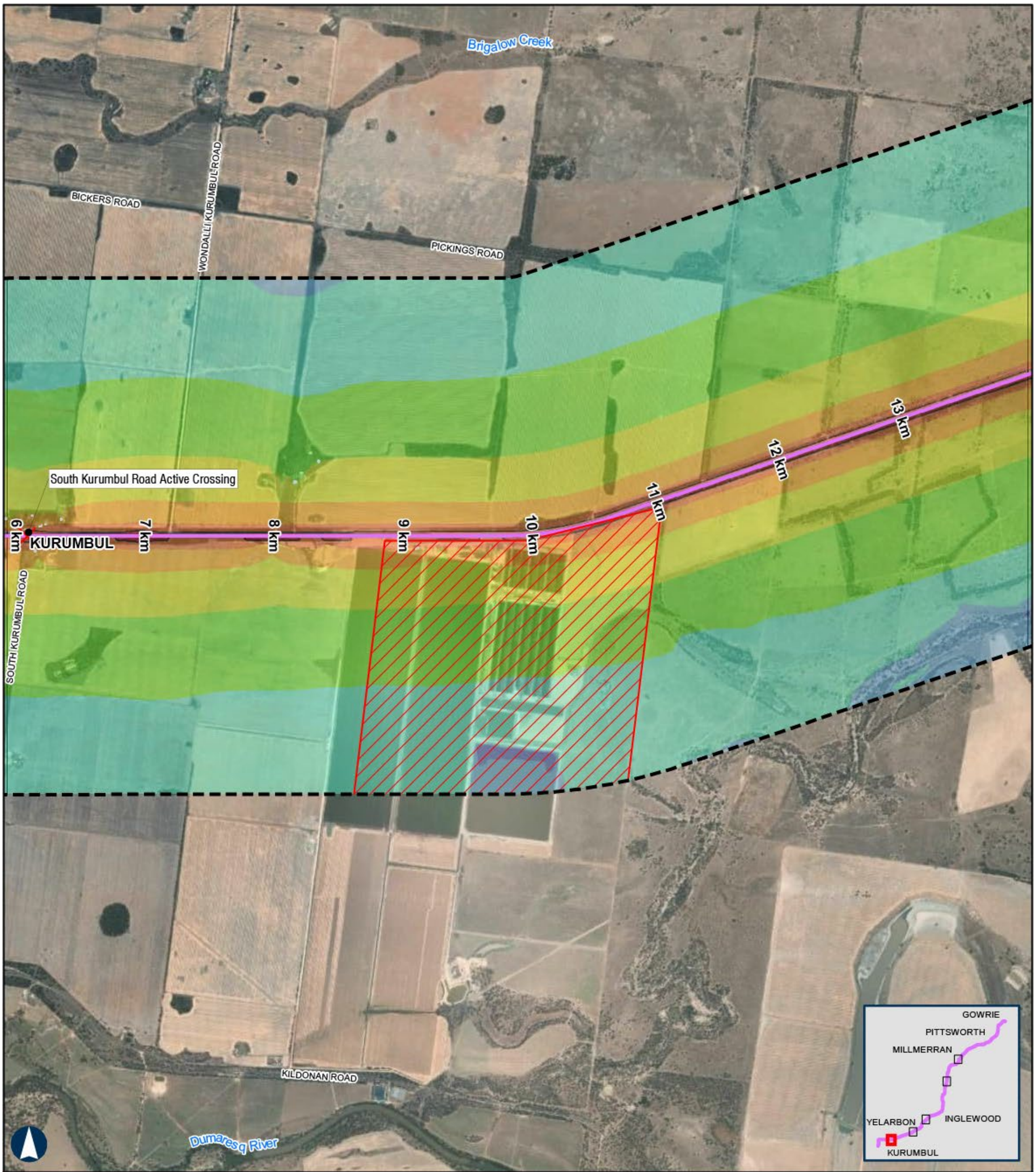

BORDER TO GOWRIE Intensive Animal Operations – Railway Noise

Figure 16-14 Map 1 of 5

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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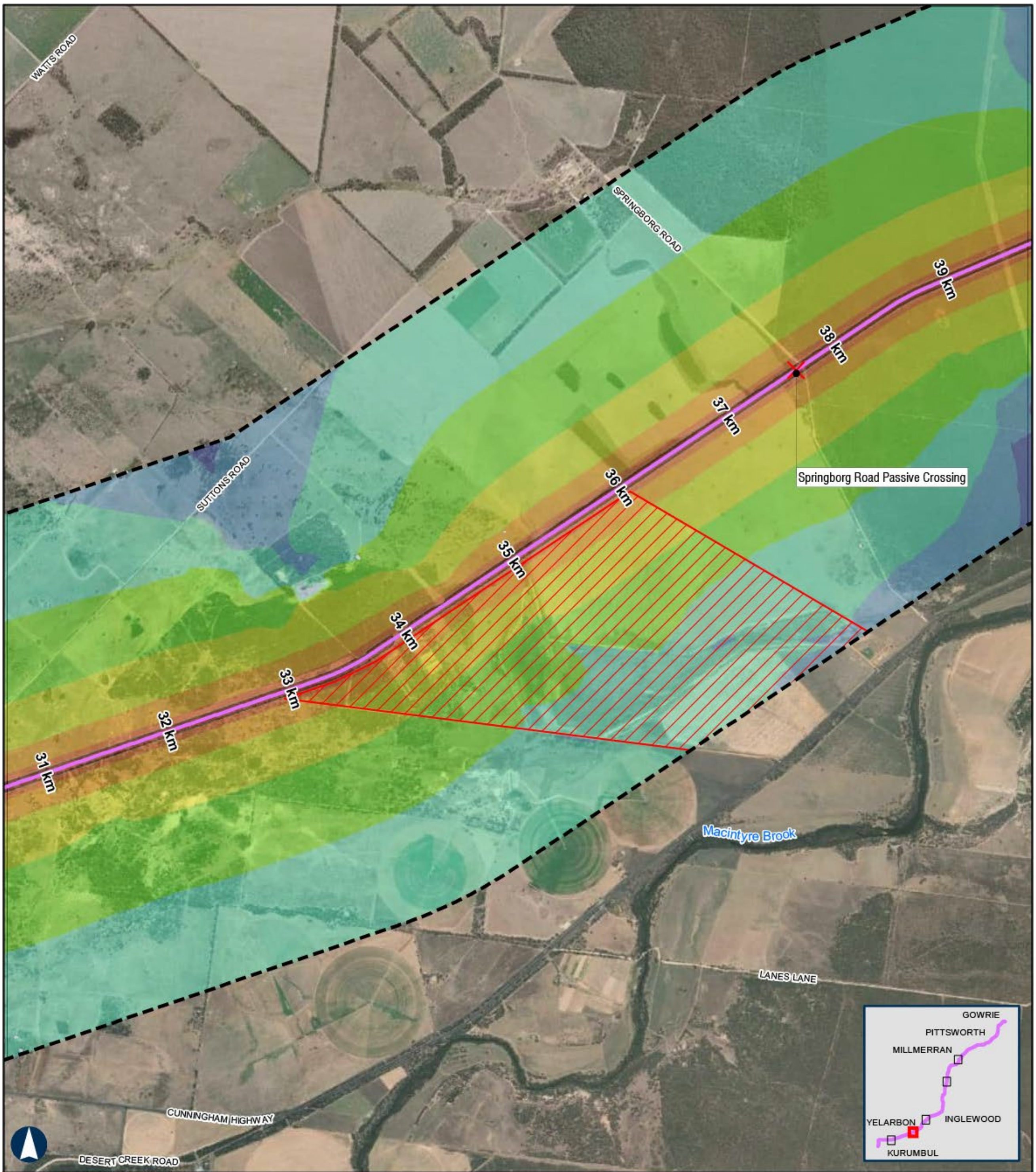

BORDER TO GOWRIE Intensive Animal Operations – Railway Noise

Figure 16-14 Map 2 of 5

1000 m

Coordinate System: GDA 1994 MGA Zone 56

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- 55 - 60 dBA
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- 75 - 80 dBA
- 80 - 85 dBA
- 85 - 90 dBA
- >90 dBA

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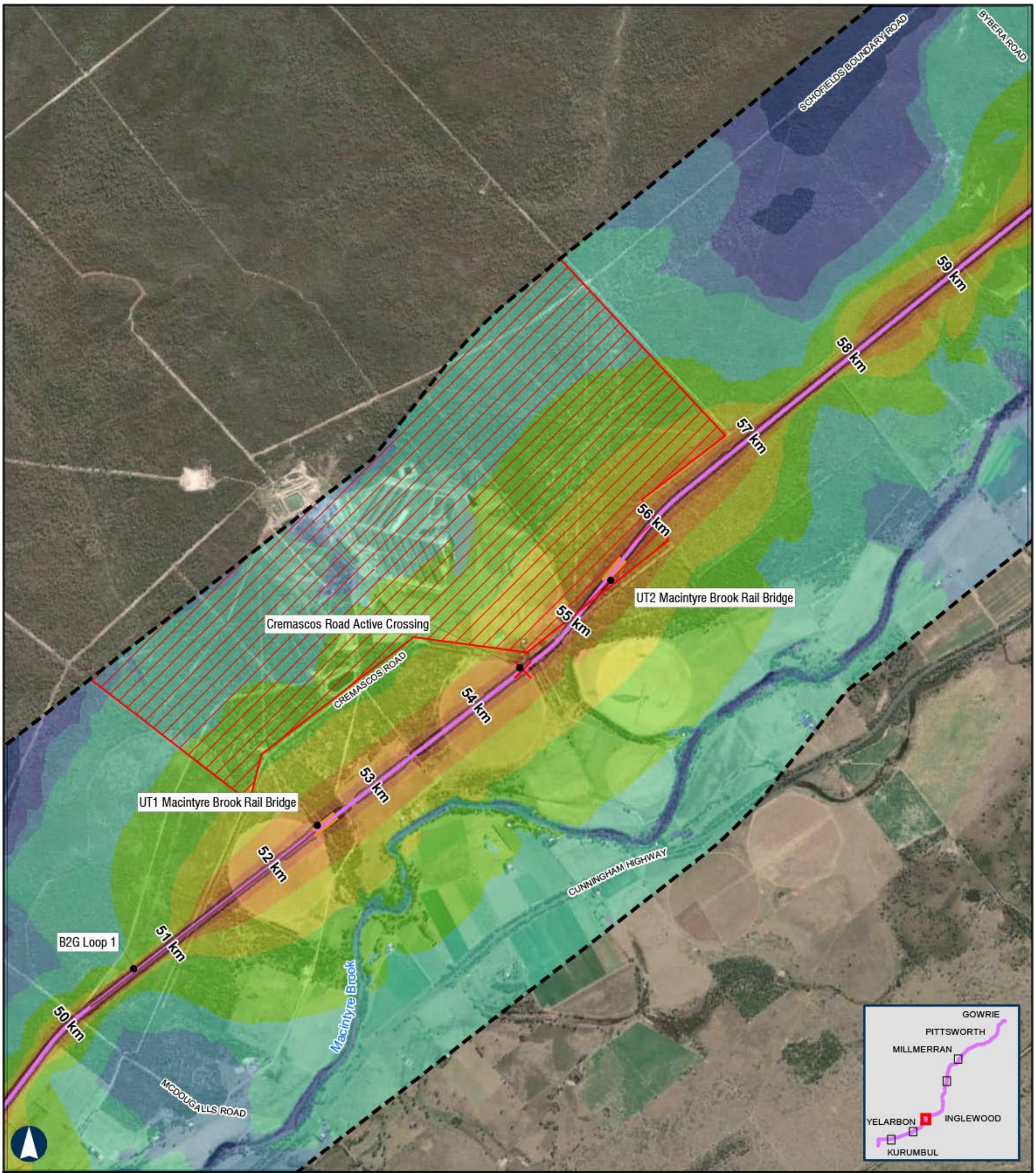

BORDER TO GOWRIE Intensive Animal Operations – Railway Noise

Figure 16-14 Map 3 of 5

1000 m

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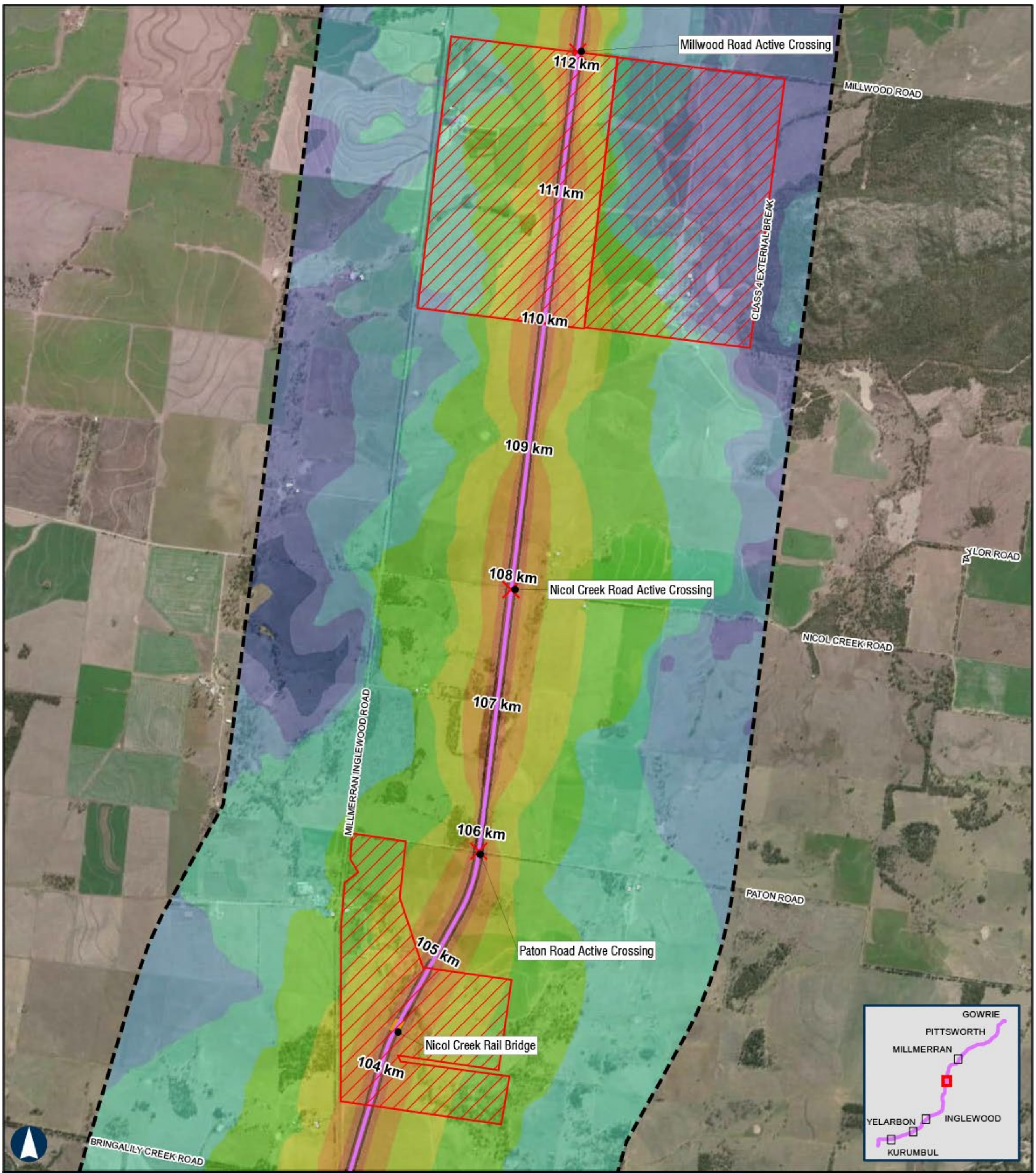

BORDER TO GOWRIE Intensive Animal Operations – Railway Noise

Figure 16-14 Map 4 of 5

1000 m

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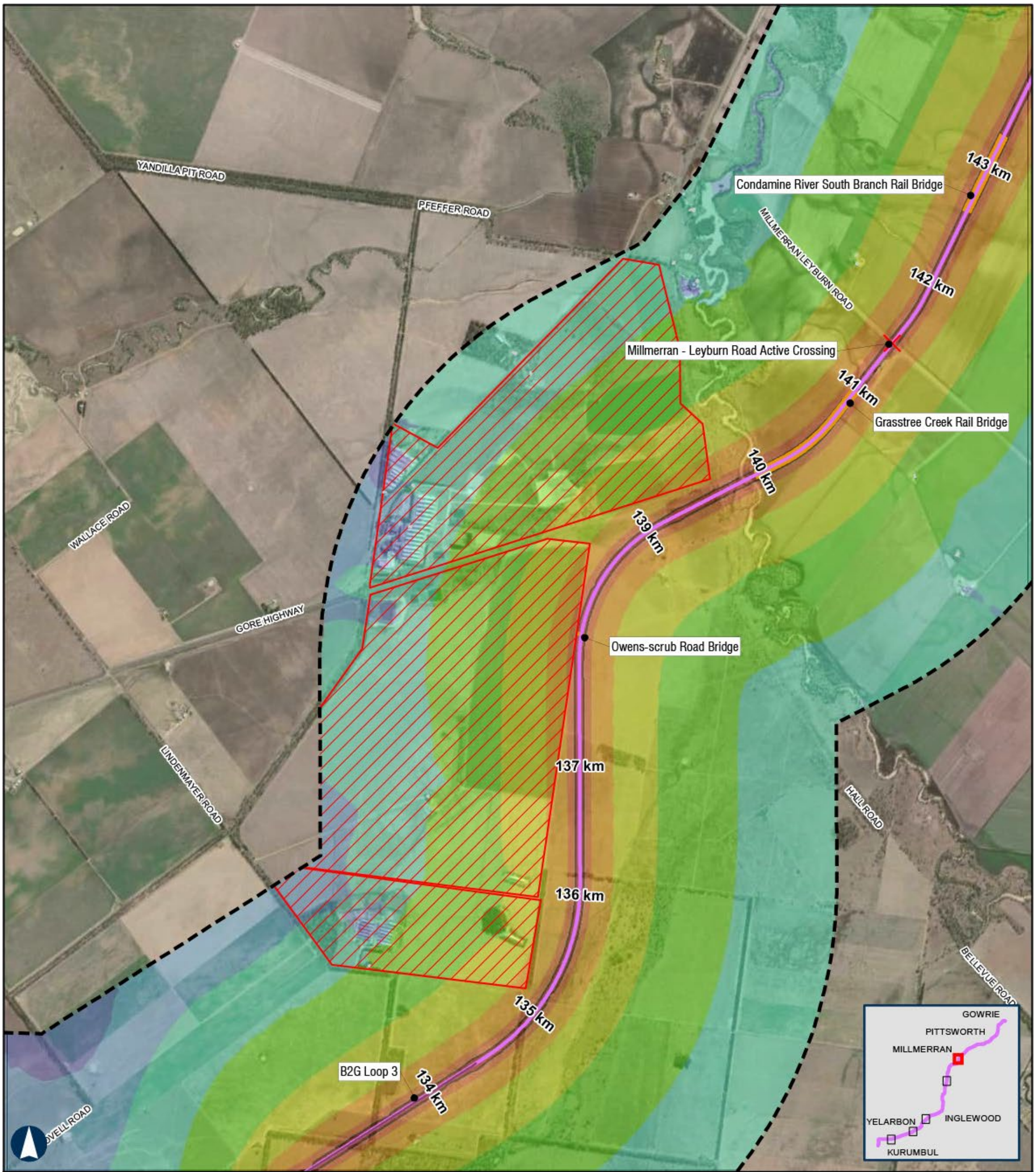

BORDER TO GOWRIE

Intensive Animal Operations – Railway Noise

Figure 16-14 Map 5 of 5

1000 m

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16.10 Mitigation measures

This section provides details on the noise and vibration mitigation measures that have been identified based on the findings of the noise and vibration assessment.

The measures consider the level of noise and vibration emissions that may be experienced at sensitive land uses and sensitive receptors, the requirements of the Code of Practice and relevant standards and guidelines, and the reasonable and practicable measures that could be adopted for the Project.

The following measures are proposed as part of demonstrating the Project can feasibly meet the requirements of the revised draft EIS. Measures relating to potential vibration impacts at intensive animal operations facilities during the construction phase are described in Section 16.9.2 above. The mitigation measures are to be further assessed and developed as part of the detailed design and construction phases of the Project.

16.10.1 Mitigation through the revised reference design phase

Development of the revised reference design for the Project has progressed in parallel with the impact assessment process. As a result, design solutions for avoiding, minimising, or mitigating impacts have been incorporated into the revised reference design as appropriate and where possible.

The mitigation measures and controls factored into the revised reference design, or otherwise implemented during the detailed design of the Project, are summarised in Table 16-31.

TABLE 16-31 INITIAL MITIGATION MEASURES FOR NOISE AND VIBRATION

Aspect	Initial mitigation measures
Emissions from construction vehicles	▸ The horizontal and vertical alignment has been established to optimise the earthworks required and achieve as close to a net balance as is possible. By minimising the material deficit for construction of the Project, the volume of material required to be imported has been reduced. Less imported material equates to fewer construction truck movements and less construction traffic noise emissions. ▸ Construction haulage routes that provide the shortest journey time between origin and destination have been identified. Reducing the potential journey times can assist in reducing the noise emissions from construction traffic.
Project designs	▸ An understanding of the potential noise and vibration emissions informed the environmental design requirements considered in the corridor selection process for the Project. ▸ The Project disturbance footprint has been established to provide the minimum clearing extents required to construct and operate the Project safely and efficiently, thus minimising the area where noise- and vibration-generating activities may be required. ▸ Laydown areas and other construction-phase facilities have been located to avoid impacts to environmental and social receptors, where practicable. ▸ Embankments, where the track is within a cutting, can assist in screening noise emissions during train passbys.
Emissions from operational trains	▸ The Project has been co-located with existing transport corridors as much as possible, including being positioned within the existing South Western Line and Millmerran Branch Line rail corridors, to avoid introducing a new linear infrastructure corridor in proximity to receptors potentially sensitive to noise and vibration. ▸ The Project has been designed to avoid, where possible, steep topography and topographical constraints to provide for a more efficient operational track geometry and grade. This reduces the incidence of high noise-generating events during train passbys, such as the use of maximum power (high notch) locomotive operations and dynamic braking downhill. ▸ The design of the Project has avoided tight-radius curves (radius < 500 m), which minimise the possible noise from wheel squeal and flanging as the trains negotiate the curves.
Emissions from idling locomotives	▸ Crossing loops at Yelarbon, Inglewood, Kooroongarra, Yandilla, and Broxburn have been positioned to avoid, where possible, the exposure of sensitive receptors to noise emissions from idling trains.
Road–rail interfaces	▸ The Project has been aligned, where possible, to minimise the number of road–rail interfaces. This reduces the potential noise and vibration emissions that can be associated with new and upgraded roads, and from railway level crossings.

16.10.2 Approach to managing impacts

The Project is committed to applying best practices and innovative solutions to address the noise and vibration impacts that may occur during its construction and operation. The management and mitigation measures proposed in this Chapter are consistent with the current Codes of Practice, Policies, and Guidelines applicable to the Project. The development of these measures will continue to reference these Codes of Practice, Policies, and Guidelines and will adopt all applicable conditions of approval, including what is reasonably practicable in pursuing best practices and supporting innovation.

16.10.2.1 Construction impact management

The management of noise and vibration during construction will be administered as part of the Project's Construction Environmental Management Plan (CEMP), discussed further in Chapter 24: Draft Outline Environmental Management Plan (OEMP). The CEMP would include a Noise and Vibration Management Plan (NVMP) to define the processes, responsibilities, and all reasonable and practicable management measures that would be implemented during construction.

The NVMP as a component of the CEMP will provide a structured approach to the management of environmental issues during the delivery of the Project with the objective of supporting delivery of the Project in a manner that maintains human health and wellbeing, including ensuring a suitable acoustic environment, so the characteristic activities of land use are not unduly disturbed, and the health and biodiversity of ecosystems are protected.

The CEMP will be developed by the Proponent (ARTC) and endorsed by the Environmental Monitor consistent with the Draft OEMP, Conditions of Approval, and all relevant laws, prior to the commencement of any relevant Project works.

The NVMP provides an opportunity to update the assessment of noise and vibration based on the construction work programs and verify the findings of this assessment. The NVMP will address the predicted noise and vibration emissions based on the finalised construction work programs and the location-specific works planned along the Project. The NVMP will demonstrate the management of noise and vibration from construction work activities consistent with the requirements of the CoP Vol 2, and other applicable legislative and Project requirements, including details of monitoring during construction works to inform the management of potential impacts, and confirming the application of reasonable and practicable noise and vibration management measures.

All Project construction activities, including pre-construction and early works will be managed in accordance with the NVMP, which will include:

- Construction noise and vibration goals and limits
- Construction activities including plant and equipment
- Time periods of construction activity
- Locations of construction activity
- Reasonable and practicable mitigation and management measures inside and outside standard hours based on confirmed construction programs
- Community liaison requirements and complaint procedures.

The NVMP will include the community notification process to advise of significant works with potential for noise nuisance or vibration at sensitive receptors and surrounding residences/premises. Details will be provided on the locations and procedures for pre and post-condition surveys, and noise and vibration measurements, in response to validated complaints. Sensitive receptors will be consulted regarding predicted noise and vibration construction impacts including advance notification with details including expected dates and durations of construction activities that may result on noise and vibration being experienced within local communities.

Mitigation measures required for construction to achieve the environmental outcomes, will be implemented in consultation with affected stakeholders and in place ahead of and during the Project works. The performance of the Project works will be monitored and actively managed, in accordance with the noise and vibration management sub-plan, with periodic reporting available.

Works that have a minimal risk of noise and vibration impacts provide an opportunity to work outside the standard hours and benefit local communities and landowners by completing the works in a reduced timeframe.

The Project will implement physical mitigation such as railway noise barriers for the opening year of railway operations and start at-property treatments as soon as possible once the assessment of the final design is complete. This includes, where feasible, providing eligible at-property treatments for operational railway noise at the time of construction works, so the attenuation provided by the treatments also assists in reducing potential impacts from construction noise. The application of noise treatments including noise barriers will be done in consultation with affected local communities and landowners.

16.10.2.2 Operation impact management

The management of noise and vibration during operational Project works will be governed by a Noise and Vibration Management Plan (NVMP), which will form a component of the Operations Environmental Management Plan (EMP). This plan will outline the processes, roles, and responsibilities for noise and vibration management, and confirm the mitigation measures to be implemented throughout the operation phase of the Project.

The NVMP will adopt a structured approach to managing noise and vibration issues, with the objective of supporting Project delivery in a manner that protects human health and wellbeing by maintaining an appropriate acoustic environment. The plan will be developed by ARTC in accordance with the Conditions of Approval and all relevant legislation, and will be finalised prior to the commencement of operational works. The NVMP will include updated assessments of noise and vibration impacts based on the final Project design. It will verify the results of previous assessments and demonstrate compliance with applicable interim guidelines, legislation, and Project-specific requirements.

Monitoring details will be provided to support the management of potential impacts and to confirm the implementation of all reasonable and practicable mitigation measures. These measures will be applied in consultation with affected stakeholders and implemented in advance of, and during, operational works to ensure environmental outcomes are met. Performance will be regularly monitored, with results reported periodically in accordance with the NVMP.

The plan will include:

- Confirmation of operational noise and vibration objectives
- Updated noise and vibration predictions based on final design and additional modelling
- A detailed description of confirmed mitigation measures to meet operational noise criteria
- Community liaison protocols and complaint handling procedures
- A review process to assess the effectiveness of operational mitigation measures post-commencement, including corrective actions and assessment of any need for additional measures to ensure compliance with noise and vibration outcomes.

As the design progresses, the Project would continue to be refined to minimise the potential for noise and vibration associated with railway operations. This process would include continuation of the assessment of airborne noise and ground-noise and vibration to confirm the noise and vibration predictions based on the final design and how predicted impacts would be mitigated.

The mitigation measures will be refined following Project approval. Further assessment of operational noise and vibration impacts will be undertaken based on the final Project design. A suite of reasonable and practicable mitigation measures will be identified, based on those in the EIS, to reduce rail noise and vibration to below the relevant criteria. These measures will be discussed with the impacted community to ensure that their views are considered, and that the mitigation provides the required acoustic benefits.

To validate the predicted noise levels, monitoring would be undertaken after the commencement of operation of Inland Rail on the Project. Monitoring would confirm compliance with the established noise limits and, if required, support verification of predicted railway noise levels for future operations based on the progressive increase in daily traffic up to the 2040 peak train movements.

If the results of modelling indicate that the predicted operational noise and vibration levels are being exceeded, then additional mitigation measures would be identified and implemented to manage residual impacts. Additional measures that involve at-property treatments would be developed in consultation with affected property owners where reasonable and practicable.

The process for identifying and establishing mitigation is outlined below.

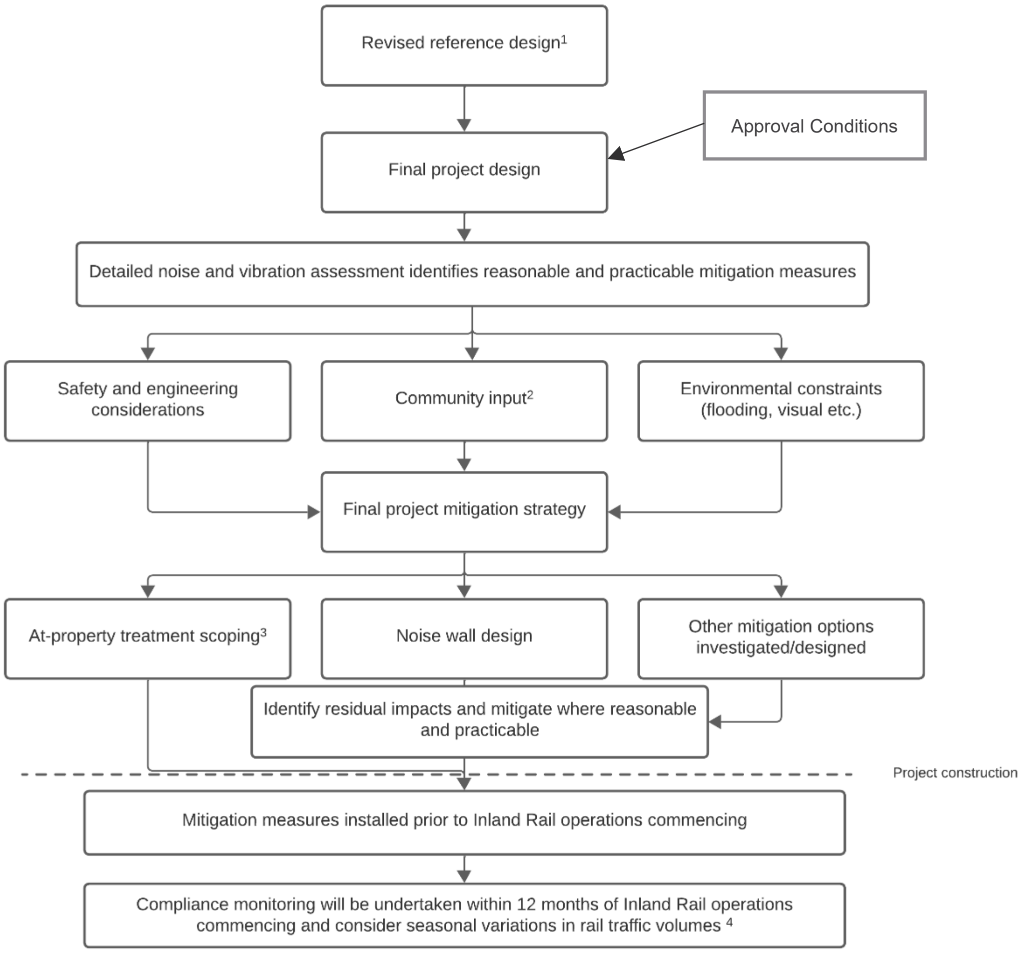

FIGURE 16-15 MITIGATION DETERMINATION PROCESS

1 – Includes conceptual mitigation measures.
2 – Where noise barriers are proposed consultation will be undertaken with relevant councils and community.
3 – At-property treatments to be applied according to Table 16-33
4 – Additional mitigation will be installed where operational monitoring indicates exceedances of the relevant criteria.

16.10.3 Railway noise mitigation concept designs

The assessment considered the potential noise barrier mitigation that could be implemented to reduce railway noise levels, and potential impacts, at the groups of sensitive receptors adjacent to the railway alignment. The noise prediction model was utilised to determine the likely length and height of noise barriers to meet the assessment criteria, where reasonable and practicable. The predicted noise levels and analysis of noise barrier options is detailed in Section 16.4 of Appendix W: Noise and Vibration Assessment—Railway Operations.

The primary objective of the noise barrier investigations was to determine the feasibility of meeting the Interim Guideline noise limits using conventional mitigation measures. Additionally, individual sensitive receptors were reviewed to draft noise barrier designs aimed at reducing railway noise to meet the night-time noise goal of 55 dBA $L_{eq,night}$ (10 pm–6 am). This is particularly relevant for receptors expected to exceed both the Interim Guideline noise limits and the sleep disturbance goal.

This chapter provides a summary of the noise barrier mitigation for concept noise barriers investigated at Kurumbul, Yelarbon, Pampas, Brookstead, Pittsworth, and Gowrie. At the time of the EIS, the investigation of railway noise barriers was based on a range of influencing factors, which as discussed in detail in Section 16.10.5.2. These barrier locations also assist in reducing the potential for sleep disturbance.

Elsewhere on the Project, noise barriers are not anticipated to be the reasonable and practicable noise mitigation and noise mitigation is expected to include at-property treatments. The railway noise mitigation considered by ARTC, including other noise control measures and at-property treatments, is detailed further in Section 16.10.5.2..

The concept barriers presented in the following sections have the potential to be further optimised during detailed design when the Project infrastructure shall be refined and optimised.

16.10.3.1 Kurumbul

At Kurumbul, there are five sensitive receptors where unmitigated railway noise levels are above the Interim Guideline criteria. Noise barriers have been investigated to the north of the railway line (including a gap for South Kurumbul Road level crossing). The height of the barriers is 6 m and the total length is 870 m. The concept noise barriers at Kurumbul are shown in Figure 16-6.

16.10.3.2 Yelarbon

At Yelarbon, there are 18 sensitive receptors within the township where unmitigated railway noise levels are above the Interim Guideline criteria. Noise barriers with heights of 6 m were investigated to the north and south of the railway. The barrier to the south of the railway would run if front of the artwork on the grain silos. The lengths of noise barriers are a total of 940 m to the south of the railway line and 360 m to the north of the railway line.

The concept noise barriers at Yelarbon are shown in Figure 16-17. Landscape and visual amenity matters regarding the grain silos are discussed in Chapter 10: Landscape and Visual Amenity.

16.10.3.3 Pampas

At Pampas, there are seven sensitive receptors where unmitigated railway noise levels are above the Interim Guideline criteria. Concept noise barriers have been investigated to the north and south of the railway line. For the barrier to the north of the railway, the length of the barrier is 540 m and a height of 4 m above ground level was assessed. For the barrier to the south of the railway, the length of the barrier is 580 m and a height of 6 m above ground level was assessed.

The concept noise barriers at Pampas are shown in Figure 16-18.

16.10.3.4 Brookstead

The noise barrier option at Brookstead is located within railway land to the north of the Project alignment to control noise levels at 15 sensitive receptors, including Brookstead State School, where the Interim Guideline criteria are not achieved. A concept noise barrier was modelled in two sections either side of the proposed Mann Silo Road realignment. In total, the concept noise barrier is approximately 1,500 m in length and the height is 4 m.

The concept noise barrier option for Brookstead is presented in Figure 16-19.

16.10.3.5 Pittsworth

At Pittsworth, the alignment in a west to east direction, comes from elevated track on a bridge crossing the new road alignment, to a newly constructed embankment and down into a cutting. There are five sensitive receptors where the unmitigated railway noise levels are predicted to not comply with the Interim Guideline criteria.

The concept noise barrier was positioned on the top edge of the embankment (east of the rail bridge) to take advantage of the screening provided by the new infrastructure to enhance the reduction of railway noise at the township. The concept noise barrier at Pittsworth is approximately 1,200 m in length and has a height of 4 m.

The concept noise barrier option for Pittsworth is shown in Figure 16-20.

16.10.3.6 Gowrie

At Gowrie, there are three sensitive receptors where unmitigated railway noise levels are above the Interim Guideline criteria. A concept noise barrier has been investigated to the south of the railway line. This concept noise barrier has a length of 610 m and a height of 4 m.

The concept noise barrier at Gowrie is shown in Figure 16-21.

16.10.3.7 Summary of noise barrier mitigation

For Kurumbul, Yelarbon, Pampas Brookstead, Pittsworth, and Gowrie, the predicted railway noise levels without railway noise mitigation and with the concept noise barrier are detailed in Table 16-32. Also shown in the table are the additional number of receptors that achieve the Interim Guideline criteria with the noise barrier in place, and any residual noise triggers that would be eligible for measures such as at-property treatments.

For each location, the concept noise barrier mitigation is providing effective mitigation to reduce noise levels at nearby receptors towards the established noise criteria.

TABLE 16-32 REVIEW OF NOISE BARRIER MITIGATION PERFORMANCE

Scenario	Barrier noise reduction	Receptors mitigated to below the criteria	Residual noise triggers
Kurumbul			
No barriers	-	-	5
6 m noise barrier	Up to 8 dBA	4	1
Yelarbon			
No barriers	-	-	18
6 m noise barrier	Up to 14 dBA	11	7
Pampas			
No barriers	-	-	7
4 m / 6 m noise barriers	Up to 10 dBA	7	0
Brookstead			
No barriers	-	-	15
4 m noise barrier	Up to 9 dBA	15	0
Pittsworth			
No barriers	-	-	5
4 m noise barrier	Up to 5 dBA	5	0
Gowrie			
No barriers	-	-	3
4 m noise barrier	Up to 4 dBA	2	1

BORDER TO GOWRIE Noise Barrier - Kurumbul

Figure 16-16

100 m

Coordinate System: GDA 1994 MGA Zone 56

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Date: 18-Oct-2024
Author: JG

- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
- Noise Barrier
- Sensitive Receptors (Residential)
- Sensitive Receptors (Non-Residential)

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BORDER TO GOWRIE Noise Barrier - Yelarbon

Figure 16-17

100 m

Coordinate System: GDA 1994 MGA Zone 56

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BORDER TO GOWRIE Noise Barrier - Pampas

Figure 16-18

100 m

Coordinate System: GDA 1994 MGA Zone 56

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Author: JG

- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
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BORDER TO GOWRIE

Noise Barrier - Brookstead

Figure 16-19

100 m

Coordinate System: GDA 1994 MGA Zone 56

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Author: JG

- Rail Alignment/ Centreline
- Crossing Loops
- Bridges and Viaducts
- Noise Barrier
- Sensitive Receptors (Residential)
- Sensitive Receptors (Non-Residential)

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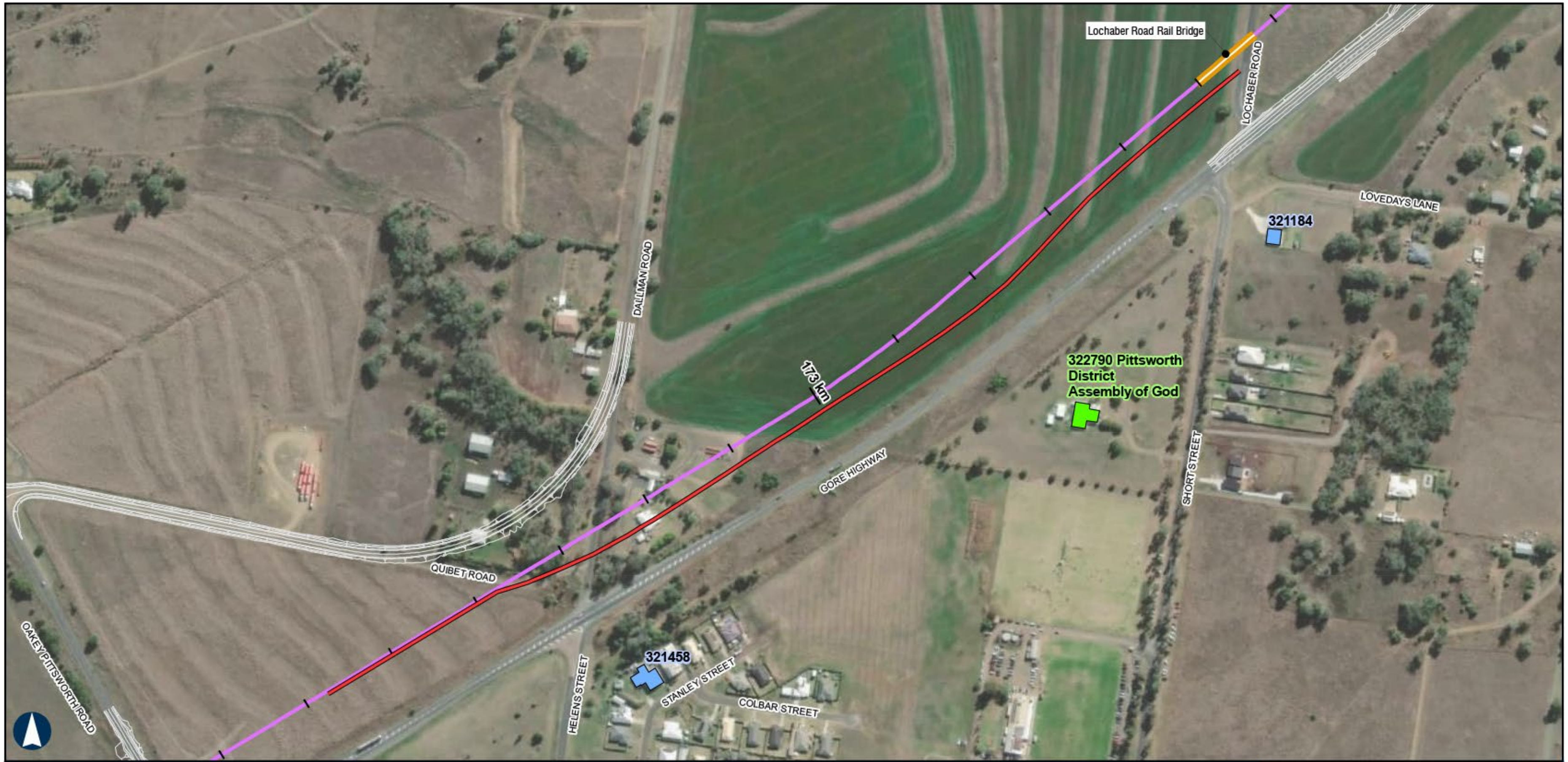

BORDER TO GOWRIE **Noise Barrier - Pittsworth**

Figure 16-20

100 m

Coordinate System: GDA 1994 MGA Zone 56

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Author: JG

Rail Alignment/ Centreline
Crossing Loops
Bridges and Viaducts
Noise Barrier
Sensitive Receptors (Residential)
Sensitive Receptors (Non-Residential)

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BORDER TO GOWRIE Noise Barrier - Gowrie

Figure 16-21

100 m

Coordinate System: GDA 1994 MGA Zone 56

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- Rail Alignment/ Centreline
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16.10.4 Timing for the implementation of mitigation

The noise and vibration management and mitigation measures for construction will be in place during the construction works.

The Project will implement mitigation measures, such as noise barriers, for design year operations and start at property treatments as soon as possible once the assessment of the final design is complete. This includes, where feasible, providing eligible at-property treatments for railway noise at the time of construction works, so the attenuation provided by the treatments also assists in reducing potential impacts from construction noise.

16.10.5 Proposed mitigation measures

Further to the measures incorporated into the revised reference design, it is proposed that the construction and operation of the Project include the adoption of the mitigation and management measures discussed in this section.

16.10.5.1 Construction noise and vibration management

All reasonable and practicable measures will be implemented to achieve the lower limit during the standard and non-standard work periods. Where the upper limit is predicted to be exceeded, this has triggered the investigation of any reasonable and practicable respite, temporary relocation, and at-property treatment requirements.

The management of noise and vibration during construction will consider a range of measures to control emissions, limit the transmission of noise and vibration to sensitive receptors, and incorporate consultation strategies to engage with affected communities. In general, the construction noise and vibration management and mitigation measures cover:

- Plan and design all works, facilities, and construction transport to reduce noise and vibration emissions, and mitigate potential impacts
- Administrative procedures to detail the protocols to reduce noise and vibration emissions, and the education and training provided to site personnel on their responsibilities regarding noise and vibration management
- Procedures to control noise and vibration emissions from plant and equipment, including the construction methodologies, selection of appropriate resources for the works, and the application of source mitigation measures.
- Construction works will be planned and undertaken to implement opportunities to screen the works from nearby sensitive receptors, including utilising acoustic fencing and temporary enclosures. Future noise barriers incorporated into the design of the Project (i.e. required to mitigate rail noise from the Project in the areas of Yelarbon, Brookstead and Pittsworth) should be installed as early as practicable during the construction phase where the barriers would provide some reduction in construction noise at sensitive receptors.
- Management of construction traffic and deliveries through measures such as the careful design of site access, car parking, and scheduling of construction traffic to the standard hours
- When blasting, each blast will be carefully designed to implement the required parameters to minimise air-blast overpressure and vibration emissions whilst balancing the need to efficiently remove material
- Where reasonable and practicable measures are implemented, and impacts are unavoidable, the works can be scheduled to the times when the community is least affected, to minimise potential impacts.

The mitigation and management measures proposed for the Project are described further in Table 16-34.

16.10.5.2 Railway operations

The Interim Guideline advises that mitigation measures to control railway noise and vibration should be considered on rail corridor land, commercial corridor land, or future railway land. Consistent with this approach, ARTC must primarily seek to control noise and vibration at source and through measures implemented within railway lands, e.g. railway noise barriers. Where these measures are not feasible or not fully effective, improvements to receptor properties to reduce the intrusion of noise will be provided (at-property treatments). The same approach will also be adopted for receptors exceeding the sleep disturbance thresholds, subject to further review during detailed design.

The following strategy is to be applied as the basis for selecting reasonable and practicable mitigation. These measures apply to all sensitive receptor types. A more detailed discussion of operational noise mitigation is provided in Section 16 of Appendix W: Noise and Vibration Assessment—Railway Operations.

- Noise barriers are generally only considered where groups of triggered receptors are affected. For isolated receptors, such as single dwellings in rural areas, noise barriers would generally not be considered as the required extent of noise barrier structures would not be reasonable or practicable for single receptors.
- The noise mitigation for isolated receptors is to include:
  - at-property treatments to the building (such as improved glazing or facade constructions) to control rail noise inside building
  - upgrades to the receptor property boundary fencing to improve screening of rail noise levels.

The reasonable and practicable noise mitigation for the Project is expected to be at-property treatments for sensitive receptors outside the towns of Kurrumbul, Yelarbon, Pampas, Brookstead, Pittsworth, and Gowrie where physical mitigation such as barriers are not expected to be reasonable and practicable. The at-property treatment could include upgrading existing glazing and/or the provision of ventilation system to manage the intrusion of rail noise and maintain internal (indoor) noise amenity within habitable rooms.

Based on the findings of this assessment, the noise mitigation strategy for the Project, at the time of the EIS, proposes to include:

- During the detailed design phase, investigate the feasibility of implementing at-source mitigations for the track and railway infrastructure
- Provide railway noise barriers within railway lands at the townships of Kurrumbul, Yelarbon, Pampas, Brookstead, Pittsworth and Gowrie
- Where at-source controls and mitigations within railway lands do not fully reduce noise and vibration levels to comply with the criteria from the Interim Guideline, ARTC will consider at-property treatments for individual landowners to mitigate potential impacts.

The strategy for at-property treatments will be developed by ARTC once the Project is approved and the noise and vibration assessment has been updated as part of the detailed design phase. The property treatments would typically include measures to upgrade glazing, windows, and door seals and the provision of air ventilation or air-conditioning to allow windows to be kept closed as a mitigation option while maintaining air flow.

The treatments would also include upgrading existing property boundary fencing to provide an acoustic fence design to screen railway noise or, in unique circumstances, the property could be relocated on large land holdings to increase the distance between the property and the railway line. In all cases, agreement between the landowner and ARTC would be required for ARTC to undertake works on private property.

Table 16-33 provides example at-property treatments that could be implemented based on predicted or measured railway noise levels.

TABLE 16-33 EXAMPLE AT-PROPERTY NOISE TREATMENT PACKAGES

Scenario	Predicted noise level[1]	Example treatments[3]
All	Does not exceed criterion/threshold levels	No treatment required
New railway	Exceeds criterion/ threshold by up to 5 dBA	▸ A ventilation system (air con, evaporative or mechanical) that meets building code of Australia requirements with the windows and doors shut[5] ▸ Upgrading windows with 10.38 mm laminate glazing and acoustic rated seals ▸ External solid core doors with surface mounted moulds minimum 40mm and provide acoustic rated seals ▸ Fill minor gaps in eaves/external façade ▸ Ceiling fans Other treatments may include: ▸ Upgrades to existing property boundary fencing[2] ▸ Vegetation[4]
	Exceeds criterion/ threshold by more than 5 dBA	▸ A ventilation system (air con, evaporative or mechanical) that meets building code of Australia requirements with the windows and doors shut[5] ▸ Upgrading windows with 10.38 mm laminate glazing and acoustic rated seals ▸ External solid core doors with surface mounted moulds minimum 40mm and provide acoustic rated seals ▸ Fill minor gaps in eaves/external façade ▸ Appropriately treating the sub-floor ▸ Sealing of wall vents, underfloor below the bearers and eaves ▸ Upgrade façade constructions where applicable. This may include wall insulation (e.g. R2.7 90 mm thick) and re-sheeting of lightweight wall construction ▸ Ceiling insulation (e.g. R4.0 21 5mm thick) ▸ Ceiling fans Other treatments may include: ▸ Upgrades to existing property boundary fencing[2] ▸ Vegetation[4]

Table notes:
1. For habitable rooms (i.e. not garages, laundries, bathrooms) where the external façade is exposed to noise levels above the criteria.
2. This may be the only treatment applied to buildings that are unsafe or in a state of disrepair
3. Based on Design Year 2040 predictions (absolute noise levels) – L_{Aeq}, SEM or night-time L_{Aeq} (subject to further review).
4. Seedlings or plants to provide a visual barrier. Sparse vegetation provides no acoustic benefit
5. Where any existing systems are more than 5 years old

16.10.5.3 Summary of proposed noise and vibration mitigation measures

The recommended noise and vibration mitigation measures that shall be adopted for the Project are described in Table 16-34. The table expands on the principles described above to detail the measures that can reduce noise and vibration levels at all sensitive receptors, and mitigate potential impacts at the communities throughout the study area.

TABLE 16-34 PROPOSED NOISE AND VIBRATION MITIGATION MEASURES

<table>
<tr><th>Delivery phase</th><th>Aspect</th><th>Mitigation measures</th></tr>
<tr><td rowspan="3">Detailed design</td><td>Road traffic noise</td><td>Operational road traffic noise impacts will be re-assessed during the detailed design process, in accordance with CoP Vol 1, to confirm the receptors at which noise criteria may be exceeded.
Mitigation of operational road traffic noise impacts from roads will be considered, in accordance with the CoP Vol 1, based on:
exceedance of CoP Volume 1 criteria
mitigation eligibility
mitigation suitability
Consultation with impacted landowners</td></tr>
<tr><td>Rail noise and vibration</td><td>Operational rail noise and vibration will be re-assessed during the detailed design process
Mitigation of railway noise and vibration will be implemented following the process described above based on:
level of exceedance of the interim guideline criteria and sleep disturbance threshold
most suitable reasonable and practicable mitigation option available for the each of the identified exceedances
consultation with the impacted landowners</td></tr>
<tr><td>Construction noise and vibration impacts on sensitive receptors</td><td>Develop and refine the construction methodology, incorporating standard work practices with the aim of achieving compliance with construction noise and vibration performance criteria as specified in CoP Vol 2. Where criteria exceedances are predicted, the construction methodology will be required to incorporate all reasonable and practicable mitigation and management measures; where residual impacts are likely to prevail, additional management measures (see Section 16.12.1) would be required.
Confirm the proximity of sensitive receptors to the finalised locations for construction activities, laydown areas and other construction facilities. Re-assess the predicted noise and vibration levels from these activities.
A Noise and Vibration Management Plan will be developed as a component of the CEMP. This plan will include:
construction noise and vibration criteria for the Project, as detailed in CoP Vol 2
location of sensitive receptors in proximity to the Project footprint
location specific management measures for activities that could exceed the construction noise and vibration criteria, for example:
earthworks and civil works
structural work, including piling
concrete batching
blasting.
location, design, and timing of need for temporary noise barriers
community notification process to advise of significant works with potential for noise nuisance or vibration at sensitive receptors and surrounding residences/premises
locations and procedures for:
pre- and post-condition surveys
noise or vibration measurements in response to noise or vibration complaints where it will assist with resolving the complaint.
Requirements for training, inspections, corrective actions, measurements, notification and classification of environmental incidents/complaints, record keeping and performance objectives for handover on completion of construction.</td></tr>
</table>

Delivery phase	Aspect	Mitigation measures
Detailed design	Construction noise mitigation through detailed design	▸ The need for and practicability of temporary noise barriers will be assessed following confirmation of the construction methodology for the Project during the detailed design phase. ▸ If temporary noise barriers are required, the location, design and timing of need will be documented in the Noise and Vibration Management Plan, as a component of the CEMP.

	Pre-condition surveys	The requirement for building condition/dilapidation surveys will be reviewed during detailed design given it is highly dependent on the type of vibration-intensive works required relative to sensitive structures/buildings. With guidance from the safe working distances recommended in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic, building condition surveys would be recommended for the following:
		▸ Receptors that are predicted to exceed the structural damage vibration criteria recommended by the CoP Vol 2 (i.e. where sensitive receptors are located within the vibration safe working distances detailed in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic).
		▸ Receptors identified as being particularly sensitive to vibration. These are:
		  ▸ heritage buildings within:
		    – 60 m of possible vibratory roller start up/run down—three identified
		    – 86 m of percussive piling—none identified.
		  ▸ other buildings within:
		    – 25 m of possible vibratory roller start up/run down
		    – 34 m percussive piling.
		▸ Structures within the damage radius of a blast location, calculated based on charge mass.

	Baseline monitoring	Additional baseline noise surveys may be required closer to the construction start date where the acoustic environment has changed.
	Development to support operation	▸ The predicted operational noise impact data will be made available to impacted landowners and residents, through a noise model map on the Inland Rail B2G website, allowing stakeholders to understand the modelled noise level at specific locations. Modelling will inform detailed design. Further engagement will continue with all sensitive receptors and properties that are modelled to exceed noise levels. ARTC is committed to developing a Maintenance Management Plan for noise barriers to ensure they are appropriately maintained and that the long-term impacts of operational noise continue can be mitigated.
Construction	Standard work practices	Construction hours: ▸ Where construction works are required during non-standard hours, procedures to minimise the impact of any significant noise and/or vibration works will be prepared and followed Works close to schools will be staged, where practicable, to conduct work outside of school hours or during school holidays
		Stakeholder engagement: ▸ Detailed stakeholder engagement is a key component for the management of potential impacts from construction impacts. Further details regarding stakeholder engagement are provided in the Community Stakeholder Environmental Management Plan.

Delivery phase	Aspect	Mitigation measures
Construction	Standard work practices	Plant and equipment selection: ▸ Plant and equipment will be selected to minimise noise emission, as much as possible while maintaining efficiency of function ▸ Where required, residential-grade mufflers will be fitted, and all noise control equipment will be maintained in good working order ▸ Trucks will avoid use of engine brakes onsite
		Truck noise (offsite): Trucks will not be allowed to queue up outside residential areas prior to the approved start time ▸ All trucks regularly used for the Project (e.g. body trucks, asphalt trucks) are to have mufflers and other noise-control equipment is to be in good working order ▸ Trucking routes will use main roads where feasible
		Clustering or equipment: ▸ Clustering of equipment within fleets will be minimised wherever practicable. Clustering of fleets (e.g. earthworks fleets and pavement fleets) will also be minimised wherever feasible
		Rock hammer noise: The emphasis on managing impacts from this activity generally involves minimising the duration to complete the works (relative to a particular receptor) in addition to ensuring that the community has been thoroughly informed of the works in advance. Implement respite periods involving scheduling work during periods when people are least affected to minimise exposure ▸ Minimise the duration of the rock-breaking construction activities by increasing the number of rock hammers used at one given time and location. For example, doubling the number of rock hammers operating concurrently in the same work spot would result in a marginal increase in the noise levels (in the order of up to 3 dBA) but would reduce the duration of the works
		Site layout and access: ▸ Where possible, plant will be located/orientated to direct noise away from sensitive receptors. Materials and stockpiles are to be used to increase acoustic shielding, where feasible If required, site access roads will be located as far as practicable away from noise sensitive areas. noise-sensitive areas. Wherever possible, site layouts will be designed to minimise the need for vehicles to reverse
		Deliveries to construction sites: ▸ Deliveries will be carried out generally within the standard hours ▸ Loading and unloading will be carried out as far as possible away from sensitive receptors
		Reversing alarms: ▸ Mobile plant and trucks operating onsite for a significant portion of the Project will have tonal reversing alarm noise emissions minimised or replaced with squawker alarms, where practicable, recognising the need to maintain occupational safety ▸ Where possible, drive-on/drive-off arrangements for trucks will be used, eliminating the need for reversing alarms to be used
		Fixed plant: Acoustically significant fixed plant required for the Project (i.e. Whetstone MDC, concrete batch plants and accommodation camps) have been assessed for compliance against the CoP Vol 2 as part of this assessment. These sites will be subject to further investigation during the detailed design stage

Delivery phase	Aspect	Mitigation measures
Construction	Standard work practices	PA systems, radios and stereos: ▸ No public address systems will be used for this Project. Avoid the use of radios or stereos outdoors where neighbours can be affected
		Noise and vibration monitoring: ▸ Noise monitoring may be carried out during critical stages of construction at nearest affected residences. Regular noise compliance checks of equipment will also be made ▸ Vibration monitoring shall be carried out where vibration-intensive activities (e.g. vibratory compaction and rock breaking) are required to be carried out within the established safe working distances, or where there is a risk that levels may exceed the relevant structural damage criteria
		Vibration-intensive works: ▸ Maintain the vibration safe working distances presented in Table 16-16, while operating vibration-intensive plant and equipment. Where vibration levels are predicted to approach the criteria for cosmetic building damage or limits for critical or sensitive areas, attended vibration measurements shall be undertaken at the commencement of vibration-generating activities to confirm that vibration limits are within the acceptable range
		Blasting: ▸ Where vibration and overpressure from blasting or construction activities are predicted to approach the relevant limits, dilapidation surveys on potentially affected buildings shall be undertaken. ▸ In practice, each blast will be carefully planned by a specialist blasting contractor to control the air-blast and vibration levels. The blasting assessment includes calculations to determine the blast parameters that are expected to control the emissions to meet the air-blast and blast vibration criteria
		Building condition surveys: ▸ Building condition surveys to be undertaken at sensitive receptor buildings located within the safe working distances outlined in Table 16-16
		Training: ▸ Site inductions for all employees and contractors will be undertaken and will address: ▸ environmental aspects and impacts ▸ proposal-specific and standard noise-management measures ▸ licence and approval conditions ▸ hours of work ▸ environmental incident reporting and management procedures ▸ complaint management ▸ Daily site-specific briefings for all employees and contractors will include: ▸ site-specific noise management measures ▸ location of nearest noise-sensitive receivers ▸ construction employee parking areas ▸ behavioural practices (e.g. avoid swearing, shouting, dropping materials from heights) ▸ designated loading/unloading areas and procedures

Delivery phase	Aspect	Mitigation measures
Construction	Reasonable and practicable mitigation and management measures	Establishment of laydown areas: ▸ Limiting the number of dump trucks and graders (actual numbers to be confirmed during detailed design) ▸ Selection of quietest available dump trucks or use of noise source controls, such as the use of residential class mufflers. Limiting the number of equipment and using noise source controls can achieve reductions in noise levels in the order of 5 to 10 dBA ▸ Advance stakeholder engagement and ongoing regular communications on the activities and progress of the works shall be provided to the community (e.g. via newsletter, email and/or website)
		Accommodation camps: ▸ Construction and operation of the temporary accommodation camps are predicted to comply with the CoP Vol 2; therefore, no mitigation measures are required at this stage. Nonetheless, the accommodation camps will be further assessed during the detailed design stage, and reasonable and practicable mitigation measures developed if required.

		Temporary concrete batch plants:
		▸ Given the preliminary stage of the design of the concrete batch plant, further assessment during the detailed design stage is required to confirm compliance or otherwise with the CoP Vol 2, and allow for reasonable and practicable mitigation measures to be incorporated into the design. Reasonable and practicable mitigation measures may include:
		  ▸ selection of quieter plant
		  ▸ careful design/layout of the site to direct noise away from sensitive receptors
		  ▸ acoustic screening of elevated components, shielding provided by other site structures (e.g. offices, crib rooms, toilet blocks, etc)

		Whetstone MDC: ▸ Plant selection and acoustic design to limit the noise from the sand blasting activity to no more than 125 dBA SWL. Acoustic design options could include the addition of acoustic screening to the specific item of plant associated with the sand-blasting activity and adding attenuators to fan inlets, outlets or treatment to duct work. ▸ Plant selection to limit the noise from the electric conveyor motors to no more than 101 dBA SWL. If more than 10 conveyor motors are needed, then a reduced SWL for each unit may be required. ▸ Site establishment, rock hammering and/or crushing and screening activities required at the Taits Red Ridge and Heckendorf Road (south-east) borrow pits be restricted to standard hours.
		Borrow pits: ▸ Operation of the D10 dozer during site establishment, rock hammering and/or crushing and screening activities required at the Taits Red Ridge and Heckendorf Road (south-east) borrow pits be restricted to standard hours.
		Earthworks: ▸ Earthworks to be completed during standard hours unless monitoring demonstrates compliance with the CoP Vol 2 non-standard hours limit or where works are required as per the requirements detailed in Section 2.2.2 of Appendix V ▸ Using the quietest available equipment to complete the works ▸ Locating the loudest equipment, as far as practicable, from sensitive receptors. As an example, felled trees can be transported to mulchers. ▸ Locating noisy equipment behind objects (e.g. stockpiles, sheds, temporary barriers) to provide shielding ▸ Provision of respite periods or preferred noise-intensive periods

Delivery phase	Aspect	Mitigation measures
Construction	Reasonable and practicable mitigation and management measures	For highly affected sensitive receptors, consideration of the following where the application of all reasonable and practicable mitigation measures (including respite periods) is deemed to be ineffective: - property treatments where longer-term impacts (i.e. >6 months) associated with the Project are identified - temporary (short-term) alternative accommodation for the duration of impact - preparation works prior to blasting are expected to primarily take place during standard hours; however, these may also be undertaken during non-standard hours where compliance with the CoP Vol 2 can be demonstrated
		Drainage works: - Where available, equipment selection will favour the use of quieter and less vibration-emitting construction methods - Avoid the simultaneous operation of noisy plant within discernible range of noise sensitive receptors where possible - Advance notification of the works to all stakeholders and regular communications on the activities and progress of the works
		Bridge construction: - Conducting community consultation with all sensitive receptors predicted to exceed the noise limits in advance of the works occurring at each bridge site. It is important that the discussion of reasonable and practicable mitigation measures with affected parties consider the overall duration of bridge construction works and exposure of noise levels at any individual receptor - Use of the quietest available equipment to undertake the works particularly during non-standard hours works - Locating of noisy equipment to maximise shielding in the direction of sensitive receptors (e.g. adjacent to bridge abutments or embankments, within cuttings, etc.) - Acoustic screening around the driven piling rigs. Commercially available acoustic screens can provide as much as 15 dBA reduction in noise emission
		Rail civil: - Conducting community consultation with all sensitive receptors predicted to exceed the noise limits in advance of the works occurring, clearly communicating the expected duration of the rail civil works - Use of the quietest available equipment to undertake the works particularly during non-standard hours works
		Road civil: - Conducting community consultation with all sensitive receptors predicted to exceed the noise limits in advance of the works occurring, clearly communicating the expected duration of the rail civil works - Use of the quietest available equipment to undertake the works particularly during non-standard hours works.
Operation	Operational road noise	As per the guidance in the CoP Vol 1, post-construction noise monitoring will be undertaken for sections of new road and upgraded road where noise attenuation treatments have recently been constructed (to be confirmed during the detailed design stage). Post-construction noise monitoring should be undertaken within approximately 3 to 6 months of the opening/operation of the new/upgraded road or following completion of noise attenuation works. It is also recommended that post-construction road traffic noise monitoring be completed at the same representative measurement sites where the baseline noise monitoring was undertaken.
	Noise walls or barriers at the rail corridor boundary	Rail noise barriers can be an effective noise-mitigation option to control the noise emissions from both the wheel–rail interface and from the locomotives. Appropriately designed noise walls and barriers can typically reduce the overall noise levels up to 15 dBA, where the line of sight between the sensitive receptor and the source(s) is fully impeded by the barrier structure. The Project considers noise walls or barriers where the mitigation can effectively control noise at groups of sensitive land uses and receptor buildings, and where the cost of mitigation is reasonable relative to the noise benefit provided, in terms of noise reduction combined with number of impacted receptors mitigated.

Delivery phase	Aspect	Mitigation measures
Operation	Noise walls or barriers at the rail corridor boundary	The key considerations with rail noise walls or barriers, include: ▸ The proximity of key infrastructure such as local roads, crossing, utilities waterways and drainage culverts. Adjacent infrastructure can constrain the location, extent and performance of noise walls or barriers. These factors can prevent noise walls and barriers from being a reasonable or practicable noise mitigation option ▸ There would be little or no reduction in the noise emissions from the locomotive exhaust (relating to SEM) and train horns, unless the wall or barrier structures are constructed to a height of at least 4 m and located within the rail corridor ▸ Availability of suitable land between the rail line and sensitive receptors, which may constrain the construction of the base/foundations of the noise wall or barrier (this includes existing/proposed embankments or sub-surface conditions present) ▸ The design of the noise walls or barriers which would need to achieve a minimum noise reduction performance, control reflected sound and edge diffraction effects and meet specifications for earthworks, cross drainage, flooding, surface water run-off, stabilisation, wind loading, erosion, and durability. Social and environmental factors include loss of open aspect and breezes, connectivity, cohesion, severance, potential for vandalism and a need for graffiti removal, safety in design, collapse consequence, reduction in visual amenity of the landscape, loss of views and vistas and the removal of vegetation.
	Low height noise barriers	In situations where the primary noise source is from the wheel-rail interface, low height barriers (for example ≤ 2 m in height) can be constructed close to the outer rail track. Such barriers can achieve similar noise reductions to noise walls or barriers at the rail corridor boundary. Typically, this mitigation option only suits single tracks and where only the rolling noise (dominant Leq metric) needs to be controlled. Given the overall noise levels from rail freight are a combination of rolling noise and locomotive noise (dominant SEM metric) emissions the low-height noise barriers would have a negligible influence on the compliance to the noise criteria.
	Earth mounds at the rail corridor boundary	The required height of noise walls or barriers can be achieved where the structure is constructed on an earth mound base. This approach provides the required screening of noise and can reduce the associated costs of the noise wall or barrier. When reviewing the practical application of earth mounds, the following should be considered: ▸ The construction of earth bunds can be constrained by the available space between the rail corridor and neighbouring infrastructure. ▸ Earth mounds require considerably more space than the footprint of a rail noise barrier. A 2 m height earth mound could require an 8 m wide base. ▸ Earth mounds could provide a benefit to control perceptible rail noise impacts. Reductions in noise levels by at least 3 dBA could result in a perceptible improvement to the loudness of train passby events. ▸ While earth mounds may not achieve specific noise-reduction performance, as can be achieved with noise walls or barriers, they can assist in reducing the overall noise levels to be closer to the assessment criteria. ▸ In addition to the potential constraints associated with noise walls and barriers, the earth mound would also need to meet environmental and design requirements. ▸ The implications to water through flow and flooding will need careful consideration to ensure the earth mounding does not adversely impede the movement of surface water. ▸ The required extent and height of the earth mounds to achieve reduction in noise levels may exceed the availability of re-usable spoil material.

Delivery phase	Aspect	Mitigation measures
Operation	Rail dampers	Rail dampers may provide localised benefit for the control of rolling noise where the contribution from the rail is a primary factor. International experience suggests a reduction in rolling noise of 3 dBA could be achieved and there is limited evidence that suggests rail dampers can provide some benefit in controlling curving noise. The effectiveness of rail dampers may be limited by the stiffness of the ballasted track and concrete sleepers, the forces exerted by the heavy rail freight and the long-term durability and maintenance of such measures. Sections of generally straight track that are not highly susceptible to prominent or regular wear and would be most suited for the consideration of rail dampers.
	Managing defective rollingstock	Defects with the wagons, such as wheel flats or misaligned axles/ bogies, can cause discrete and potentially annoying high noise events. ARTC currently implements Wayside Monitoring Systems across the rail network to identify individual rollingstock and the specific sources of noise for the targeted mitigation of railway noise. The Wayside Monitoring Systems include: - Wheel impact and load detector, bearing acoustic monitoring (RailBAM) and Squeal acoustic detector (RailSQAD) - Angle of attack, hunting detector and wheel profile monitoring. A similar monitoring program could be implemented to identify sources of high noise events. Once identified, defective rollingstock can be temporarily removed from service and defects repaired to address factors contributing to higher noise levels or discrete annoying noise characteristics. It is likely the overall reduction to L_{Aeq}, and average SEM noise levels would be minor but would assist in managing noise events that could cause disturbance. Note that these measures will not be readily implementable by ARTC without appropriate commitments and funding arrangements from rail operators.
	Level crossings—safety requirements	The operation of devices such as train horns and level crossing alarms are exempt from compliance to airborne noise criteria due to public safety obligations. The following mitigation options are proposed as part of ARTC's commitment to managing noise impacts.
	Level crossings—wayside horns	A wayside horn is an automated audible warning located at the level crossing. Instead of the train sounding its 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 level crossing. The objectives are to remove the need for the train to sound its horn adjacent to sensitive receptors and to implement a horn event that has a noise emission level and sound directivity focused to the users of the level crossing. It is expected that respite from train horns could reduce LAmax noise levels by more than 10 dBA at sensitive receptors and provide a notable improvement in loudness and potential risk for annoyance, particularly where there can be more two train horn events every hour as a result of the Project.
	Level crossings—soft tone alarm bells	The design of level crossing alarm (warning) bells will be required to meet specific design standards. Typically, loud-tone alarm bells are to operate at L_{Amax} noise levels between 85 dBA to 105 dBA at 3 m. A soft-tone bell design, which has a lower L_{Amax} noise emission level between 75 dBA to 85 dBA at 3 m can be applied, where practicable, to reduce maximum noise levels from the alarm bells by approximately 10 dBA. The L_{Aeq} noise level would have a more marginal improvement as the noise environment surrounding level crossings is primarily influenced by the train passby events.

Delivery phase	Aspect	Mitigation measures
Operation	Level crossings-silencing level crossing bells	Where environmental or local situations warrant a reduction in audible warning sound levels, and a risk assessment involving the relevant authorities and human factors provides for safe mitigation, suppression of audible warning will be considered, especially during night periods when background noise levels may be low. At night (for example, between the hours of 22:00 and 06:00), silencing road warning bells will be considered (subject to a risk review) if: The road crossing is provided with booms and dedicated pedestrian audible warning devices are switched on in lieu of the road warning bells during the nominated time An assessment has determined a low likelihood of pedestrians using the road crossing during the nominated time. In such cases, pedestrian audible warning devices will not be silenced.
	Property controls—architectural treatment	Where external rail noise levels are predicted to exceed the assessment criteria and other mitigation measures (such as noise barriers) are not feasible, a potential option is to mitigate the intrusion of rail noise within the affected property. The provision of at-property treatment would depend on a number of factors and is expected to only apply to habitable rooms or acoustically significant rooms/uses of sensitive buildings. Typically, measures such as upgraded acoustic glazing, acoustic window and door seals, and acoustic insulation for the roof are considered to mitigate noise intrusion. The provision of upgrades to ventilation, such as fresh air ventilation (acoustic ducting) or air conditioning will allow windows to be kept closed as a mitigation option while maintaining air flow. Appropriately designed measures, where windows are closed, can mitigate the intrusion of noise by more than 10 dBA; however, these measures can be more effective to control the intrusion of rolling noise, as it is more broadband in nature and often does not have prominent tonal or low-frequency components. All consideration of architectural property treatment would be subject to the individual property. Suitability will be confirmed prior to the implementation of noise control treatments.
	Property controls—property construction	In rural locations, the age and construction of residential properties can influence the practical implementation of modern architectural treatments. The review of architectural treatments will require further review of eligible properties and advice from suitably qualified professionals.
	Property controls—consideration of low frequency noise content	Noise that is considered to have low frequency and/or tonal content can be increasingly annoying. Where the control of low-frequency noise is required at properties, the architectural acoustic treatments would need to consider the control of low-frequency noise intrusion. The approach applied would need to achieve an overall improvement to the internal rail noise levels and potential characteristics that could cause annoyance. The control of low-frequency noise within a property is challenging and care needs to be taken to manage residual impacts such as the architectural treatments controlling the mid and high frequencies, which may cause the low-frequency noise to become more perceptible.
	At-property fence upgrades	Existing fencing at the boundary of individual receptors 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 will be specific to individual properties, upgrades to existing property fencing are likely to be suitable only where noise reductions of less than 10 dBA are required. The potential for upgrading existing property fencing can be limited by the line of sight between the railway and the receptor, the available land, and the requirements of local councils and regulatory authorities with respect to the height and materials permitted for property boundary fencing. Agreement between the landowner and ARTC would be required for ARTC to undertake works on private property.

Delivery phase	Aspect	Mitigation measures
Operation	Property relocation	In rural locations, individual residential property can be located on large landholdings where the location of services allows (i.e. electricity, sewer, water). It may be possible to relocate the residential property within the same land so that it is further from the rail corridor and noise levels would be lower. The relocation of property would be assessed on a case-by-case basis and ensure there would be a notable improvement to the noise environment at the relocation site. As a general rule, where the distance between the dwelling and the rail line is doubled, the rail noise levels can be 3 dBA less.
	Negotiated agreements	The implementation of at-property treatments and other measures to private property would likely be subject to the agreement of commercial and legal terms between ARTC and the property owner.

16.11 Monitoring of railway noise and vibration

A program of noise and vibration monitoring is recommended to be undertaken within 12 months of the commencement of Inland Rail operations on the Project and will be designed to accommodate seasonal variations in rail traffic. The purpose of the monitoring surveys are to:

- Quantify the rail noise and vibration levels from the daily rail operations and determine the $L_{Aeq,\,24hour}$, $L_{Aeq,\,8hour}$ and SEM rail noise levels at the most affected sensitive receptors.
- Assess the Project's compliance with any relevant conditions of approval relating to noise and vibration emissions from the operation of the Project
- Provide an assessment of the effectiveness of any noise and vibration management and mitigation measures implemented on the Project
- Identify, if required, further noise and vibration mitigation measures to meet the Interim Guideline thresholds and relevant conditions of approval
- The recommendations below have been developed to assist the preparation of a noise and vibration monitoring plan:
  - noise and vibration monitoring shall be undertaken in accordance with the requirements of the Interim Guideline
  - provide a monitoring strategy consistent with the requirements of relevant acoustic standards and guidelines for monitoring environmental and transport noise and vibration.
- Plan and schedule the monitoring surveys with consideration to:
  - the rail movements during each daytime and night-time period. The survey period shall include the days during which the highest number of train movements would be expected and cover a period of consecutive days to be representative of typical operations. Monitoring should ideally be undertaken during seasonal peaks where there are more train movements. If that is not feasible, the measured levels must be adjusted to account for possible additional train traffic during seasonal variations.
  - future traffic growth. Measured levels should also be mathematically extrapolated using relevant prediction algorithms to account for the future design year traffic flows, and further modelling may be carried out to support this extrapolation.
  - at locations free from localised buildings and structures (other than noise barriers) that may screen or reflect noise
  - the condition of the rails and other rail infrastructure
  - weather conditions during the monitoring periods.
- Monitoring should be conducted at the sensitive receptors with the potential for the highest received noise and vibration levels from rail operations
- Where feasible, noise levels should be assessed 1 m in front of the most affected building façade. Where noise levels are monitored in the free-field a +2.5 dBA correction should be considered to adjust the free-field level for a noise level at the building façade
- Should monitoring be required within a property, the noise monitoring would be conducted at the centre of the habitable room that is most exposed to noise from rail operations
- Vibration shall be monitored in the three axes representing horizontal, vertical and axial direction of displacement (movement). Vibration shall be monitored as the Peak Particle Velocity (mm/s) and vibration acceleration (m/s^2).
- If required, reference the monitored noise levels to update the predicted rail noise levels and re-assess rail noise and vibration levels at the sensitive receptors aligning the Project
- If the noise and/or vibration levels are above the applicable criteria at any sensitive receptors, allowing for any monitoring and compliance tolerances, the key sources of rail noise and contributing factors (e.g. rail defects, excessive rail roughness levels, turnouts, locomotive engine exhausts) shall be identified to inform the investigation of reasonable and practicable mitigation measures.

The results of the monitoring surveys are to be applied, as required, to revise and update the rail noise and vibration predictions for the rail operations with suitable validation of inputs and model. In this regard, the validated noise and vibration levels can be applied to continually refine the conservatism and uncertainty in the predictions and support the selection of reasonable and practicable mitigation measures.

16.12 Residual impacts

Residual impacts are those which may still occur once reasonable and practicable noise and vibration mitigation measures have been implemented. The potential residual impacts during the temporary construction works and the future road and rail transport operations of the Project are discussed in this section.

Due to the subjective way humans respond to noise and vibration, compliance to the assessment criteria does not preclude the potential for impacts within communities. Sometimes relatively low levels of noise and vibration, that are well within the assessment criteria, may impact those who are more sensitive.

16.12.1 Construction phase

There is potential for noise intensive construction works undertaken close to sensitive receptors to result in impacts even where reasonable and practicable mitigation measures are implemented.

With consideration of the standard work practices, reasonable and practicable mitigation measures, an assessment of the potential for residual noise impacts to residential receptors during Non-Standard hours is included in Appendix V. The assessment of residual impacts determined:

- The number of residential receptors predicted to experience Project construction noise levels that exceed the lower and/or upper noise limits from the CoP Vol 2 can be significantly reduced with the implementation of reasonable and practicable mitigation measures.
- The earthworks and road civil construction scenarios are expected to require activities that can be inherently noisy and will need to be carried out close to existing sensitive receptors. These works are predicted to result in the most residual impacts after the implementation of all reasonable and practicable mitigation measures.
- The construction works will be temporary, and in some cases, the exposure to noise above the lower or upper limits of the CoP Vol 2 may only occur for a few hours or up to a few days as works progress. Nevertheless, there is a clear potential for construction noise to require reasonable and practicable mitigation at all times.

When construction noise and vibration levels are predicted to exceed the lower limits from the CoP Vol 2 and all reasonable and practicable mitigation and management measures have been applied (refer to Table 16-34), the mitigation options may need to be extended to include periods of practical respite and temporary relocation. The at-property treatments proposed to manage future railway noise would, where practicable, be implemented prior to the commencement of construction works.

Guidance on applying these measures is detailed in Appendix V and summarised as follows:

- Communication (CO): the level of noise and vibration impact and duration shall guide communication with receptors by the contractor. Accurate and timely communication is essential to manage and understand community expectations for non-standard hours construction work.
- Respite offer (RO): residential receptors subject to lengthy periods of noise or vibration may be eligible for respite offers for the purpose of providing residents with respite from an ongoing impact.
- Alternate accommodation (AA): alternate accommodation options (i.e. accommodation in motels away from the worksite) may be provided for residents living in close proximity to construction sites.
- Agreements with owners (AO): ARTC may negotiate agreements with residents impacted during the construction period. All negotiated agreements with owners and occupiers of sensitive land uses must be in writing, and include the hours, duration and likely noise levels compared to the CoP Vol 2 limits. The negotiated agreement must be agreed and finalised before the commencement of work affecting the sensitive land uses.

The assessment is based on the information available at the time of the EIS. It is expected that the additional management measures will be refined during the detailed design stage of the Project to ensure any such measures are adapted to suit community expectations.

16.12.2 Railway operations

The potential for annoyance or disturbance from rail noise and vibration is subjective and can remain a potential impact even where mitigation is implemented, and noise and vibration levels are well within the established criteria. Standards such as the Interim Guideline do not require noise from rolling stock operations to be inaudible at sensitive receptors. These standards acknowledge that, aligned with the objectives of the EP Act, noise limits for transport infrastructure provide a necessary balance between economic development and environmental protection.

To manage noise and vibration from railway operations, the proposed mitigation measures include a combined approach of specific designs to reduce noise and vibration at the source, such as eliminating tight radius curves, and the consideration of mitigation, for example noise barriers and at-property treatments.

The noise modelling has identified that with industry standard mitigation measures the Project can reduce noise levels to achieve the established criteria at most of the sensitive receptors, where reasonable and practicable. For the sensitive receptors where the residual noise levels remain above the established criteria, the Project shall investigation further measures to manage noise impacts, including at-property treatments.

At-property treatments provide noise reduction and mitigation of impacts within habitable rooms to maintain internal noise amenity. Upgrades to property boundary fencing can assist in reducing outdoor railway noise levels at the property.

While the primary goal for managing noise will be to meet the established criteria, the Project shall extend the investigation of at-property treatments where a residual noise impact occurs, such as non-compliance to established noise limits and sleep disturbance. If investigations identify at-property treatment is a reasonable and practicable approach the additional property upgrades shall be implemented in consultation with the landowner. However, there may be instances where further action for residual impacts may not be reasonable and practicable, for example when railway noise barriers have been installed and provide a material reduction in railway noise or where a property is not suitable for architectural upgrades.

16.13 Cumulative road traffic and railway noise

The rail alignment of the Project will, in places, intersect and be alongside the existing road network and the future new and upgraded roads proposed within the Project.

While the policies and guidelines referenced in this assessment do not specify criteria or management objectives for combined road and railway transport noise, an overview assessment of potential cumulative transport noise has been undertaken. DTMR's Development Affected by Environmental Emissions from Transport Policy, Version 4 (October 2017) , assess cumulative impacts from road and rail for new developments using the following criteria which can be considered to assist in quantifying and assessing cumulative impacts from the Project (noting that the policy is intended for developers (DTMR, 2017b) developing sensitive uses adjacent to transport corridors, and not directly applicable for this Project).

TABLE 16-35 PRIMARY (EXTERNAL) NOISE CRITERIA FOR NEW SENSITIVE DEVELOPMENTS

State transport corridor	Development type	Location within development	Environmental criteria
Railway or multi-modal corridor which includes a railway	Accommodation activities, educational establishments, childcare centres, healthcare services, hospitals community uses, places of worship, offices	All facades	≤ 65 dB(A) L_{eq} (24hr)[1], L_{eq} (12hr)[2] and L_{eq} (1hr)[3] façade corrected
			≤ 87 dB(A) (single event maximum sound pressure level) façade corrected
		Outdoor spaces for passive recreation	≤ 65 dB(A) L_{eq} (24hr)[1], L_{eq} (12hr)[2] and L_{eq} (1hr)[3] façade corrected
			≤ 62 dB(A) L_{eq} (24hr) free field ≤ 84 dB(A) (single event maximum sound pressure level) free field

Table note:
The L_{eq} descriptor applies for a 24hr period (1) at accommodations sites, 12hr period (2) educational sites and 1hr period (3) healthcare and community sites. Refer Table 3 Development Affected by Environmental Emissions from Transport Policy Version 4 (October 2017).

The assessment criteria in CoP V1 and the Interim Guideline use differing noise metrics. CoP V1 uses the upper 10 percentile noise level over 18 hours, $L_{A10,18h}$ criteria, whereas the Interim Guideline uses an equivalent average noise level over 24 hours, $L_{Aeq,24h}$ criteria. The conversion factor from Table 2 of *Austroads Research Report AP-R277/05 Modelling, Measuring and Mitigating Road Traffic Noise* to convert $L_{A10,18h}$ noise levels to $L_{Aeq,24h}$ noise levels, such that $L_{Aeq} = L_{A10}$ - 3dB could be applied as an approximation.

A comparison of predicted noise levels at receptors from both upgraded and new roads converted to a $L_{Aeq,24h}$ noise level and rail noise levels described with the $L_{Aeq,24h}$ and SEM descriptors identified the following:

- In general terms, cumulative transport noise levels would generally be expected only where road traffic or railway noise is within 10 dBA of each other (where the same noise metric is applied to quantify both sources of transport noise).
- At the majority of sensitive receptors close to both the road network and railway alignment to potentially experience cumulative transport noise, railway noise levels are expected to be the dominant noise contribution (during train passby).
- Most receptors that trigger the road noise criteria for road upgrades were also identified as triggering the rail noise criteria and would require investigation of reasonable and practicable mitigation for rail noise. The exception being two receptors in Brookstead impacted by upgrades to the Gore Highway and trigger road noise criteria but are over 400 m from the rail line. Road noise is the dominant source (greater than 10 dB louder than rail noise) and these receptors will also benefit from the rail noise barrier in Brookstead and would be managed for road noise impacts in accordance with the road noise code of practice.
- No additional receptors were identified where combined noise levels from upgraded roads and new rail would result in noise levels increasing above $L_{Aeq,24h}$ 65 dBA, which were not already identified as triggering the SEM rail noise criteria.
- At receivers that exceed the rail noise criteria (which is more stringent than the cumulative criteria) they will be provided with mitigation for rail noise, which would also assist in controlling cumulative road and rail noise.
- Potential cumulative impacts would be further reviewed at the detailed design stage.

16.14 Impact assessment summary

Potential impacts associated with noise and vibration during construction and operation of the Project are outlined in Table 16-36. These impacts have been subjected to a risk assessment as per the methodology introduced in Chapter 4: Assessment Methodology and are summarised in Section 16.4.

The initial risk assessment is undertaken on the assumption that the design considerations (or initial mitigation measures) factored into the revised reference design stage have been implemented.

Additional mitigation and management measures were then applied as appropriate to the relevant stage of the Project to reduce the level of potential impact. The residual risk level of the potential impacts was then reassessed.

The pre-mitigated risk levels are presented next to the residual risk levels in Table 16-36 to assess the effectiveness of the mitigation and management measures.

TABLE 16-36 RISK ASSESSMENT FOR NOISE AND VIBRATION

Aspect	Potential impact	Stage	Initial risk			Residual risk		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Noise	Standard hours noise impacts to sensitive receptors	Construction	Likely	Moderate	High	Likely	Minor	Low
	Non-Standard hours noise impacts to sensitive receptors	Construction	Likely	Moderate	High	Likely	Moderate	Medium
	Road traffic noise impacts to sensitive receptors	Construction	Likely	Moderate	High	Likely	Minor	Low
	Operational road traffic noise impacts	Operational	Possible	Moderate	Medium	Unlikely	Minor	Low
	Operational rail traffic noise impacts	Operational	Possible	Moderate	Medium	Unlikely	Minor	Low
Vibration	Standard hours vibration impacts to sensitive receptors	Construction	Likely	Moderate	High	Possible	Minor	Low
	Non-Standard hours vibration impacts to sensitive receptors	Construction	Likely	Moderate	High	Possible	Moderate	Medium
	Vibration impacts to sensitive structures (including heritage)	Construction	Likely	Moderate	High	Unlikely	Minor	Low
	Operational rail vibration impacts	Operation	Unlikely	Minor	Low	Unlikely	Minor	Low
Blasting	Airblast overpressure impacts to sensitive receptors	Construction	Possible	Moderate	Medium	Unlikely	Minor	Low
	Ground vibration impacts to sensitive receptors	Construction	Possible	Moderate	Medium	Unlikely	Minor	Low

16.15 Conclusions

This section provides a summary of the potential noise and vibration impacts to sensitive receptors, before and after the application of mitigation measures, from the construction and operational phases of the Project.

16.15.1 Construction

The assessment of noise associated with the construction of the Project indicates exceedances of CoP Vol 2 standard and non-standard hours external noise limits at sensitive receptors at various stages throughout the construction phase. Noise-limit exceedances have been identified for the following:

- 46 of the 78 proposed laydowns areas are predicted to exceed the standard hours lower limit of 50 dBA L_{Aeq} at the closest sensitive receptor, and in most cases at multiple receptor locations. 13 laydown areas are predicted to exceed the upper limit of 65 dBA L_{Aeq} at sensitive receptors during standard hours.
- During operation of the concrete batch plant at laydown area LDN150.5 adjacent to the intersection of Ware Street and the Gore Highway at Brookstead, the standard hours lower limit is predicted to be exceeded (i.e. by up to 6 dBA) at the three closest sensitive (residential) receptors.
- A worst-case scenario modelled for the Whetstone MDC has resulted in marginal 1 dBA exceedances being predicted at two sensitive (residential) receptors in proximity to the site.
- The assessment of noise from the borrow pits in six locations has identified the potential for lower noise limit exceedances at two locations, namely:
  - Taits Red Ridge borrow pit: two exceedances at sensitive (residential) receptors by up to 5 dBA
  - Heckendorf Road (south-east) borrow pits: an 11 dBA exceedance at the closest sensitive (residential) receptor with all proposed activities occurring simultaneously.
- The earthworks stages of the Project are predicted to result in the highest impacts in terms of predicted noise levels and quantum of exceedances. Noise limit exceedances have been predicted for both residential and non-residential sensitive receptors including Yelarbon Soldiers Memorial Hall, Pampas Memorial Hall, Pampas Rural Fire Shed, Brookstead Hall and the Harvest New Life Church. The predicted exceedances are dominated by the operation of mulchers, dozers, scrapers and trucks. During the earthworks, all reasonable and practicable noise mitigation measures detailed in this report would need to be implemented.
- Noise levels predicted for the worst-case stages of bridge construction has identified exceedances of the 45 dBA lower noise limit at up to 30 of the 34 Project bridge sites, with predicted noise levels varying depending on the construction stage and methodology. The majority of noise limit exceedances are predicted for residential receptors, but some marginal exceedances have been predicted for non-residential sensitive receptors including the Yelarbon Soldiers Memorial Hall, Brookstead Hall and the Harvest New Life Church at Pittsworth.
- Construction noise levels comparable to the earthworks stages have been predicted during rail civil and road civil works when these works occur in proximity to sensitive receptors; however, these stages of construction are expected to be significantly shorter in duration, particularly the sleeper and rail installation, and tamping and regulating stages, which steadily progress along the rail alignment. Noise impacts resulting from the rail and road civil stages of construction would be expected to be managed primarily through effective stakeholder engagement and the engineering controls outlined in this report.

The Project construction activities where the CoP Vol 2 standard hours upper limits and non-standard hours noise limits are predicted to be exceeded, reasonable and practicable mitigation measures will be required and will in each instance involve community engagement with impacted sensitive receptors.

For most construction activities, it is expected that the construction noise levels would frequently be lower than the assessed scenarios, as the predicted worst-case noise levels are based on each scenario occurring at the work site boundary that is the closest point to each receptor and assumes all construction equipment operating simultaneously. Further to this, due to the remote nature of a large proportion of the Project, there are substantial Project works that are a sufficient distance from sensitive land uses and receptors to minimise the potential for noise impacts, and works could be undertaken without affecting sensitive land uses and sensitive receptors.

Safe working distances for all vibration-intensive equipment potentially required to be operated on the Project have been calculated in order to avoid damage to sensitive buildings, structures and disturbance to human comfort. The assessment has identified sensitive residential receptors located within the conservative human comfort safe working distances applicable to the Project vibration-intensive construction works. Consequently, it is recommended that human comfort vibration impacts are managed as follows:

- Insofar as practicable, avoid operating vibration intensive equipment during non-standard hours to prevent the risk of human annoyance triggered by exceeding the threshold of perception (i.e. 0.3 mm/s).
- Ensure all vibration sensitive receptors located within the conservative human comfort safe working distances are notified in advance of the potential for vibration levels to be perceptible during the Project construction works.

16.15.2 Road traffic

16.15.2.1 Construction traffic

Construction traffic has the potential to temporarily increase noise levels at receptors located close to the proposed construction access routes. The estimated construction traffic volumes have been used to determine where a noticeable increase in road traffic (i.e. 3 dBA or more) above current road traffic noise levels could occur.

Due to the relatively low existing traffic volumes on many of the proposed haul roads, the assessment has identified up to 149 roads that are predicted to experience an increase of 3 dB or more in road traffic noise level with the addition of Project construction vehicles; however, it should be noted that absolute maximum noise levels associated with vehicle pass-bys on these roads would likely be unaltered by the Project construction vehicles (i.e. being a similar noise event to existing heavy vehicle movements on these roads), only the frequency of such events would increase.

During the detailed design stage of the Project, construction road traffic noise impacts would be subject to further assessment and development of mitigation measures as detailed in Appendix V: Noise and Vibration Assessment—Construction and Road Traffic.

16.15.2.2 Operational

The operational road traffic noise assessment was completed in two stages. Stage 1 involved a conservative desktop assessment of the 31 new road sections and 41 upgraded road sections proposed by the Project. Stage 1 assessed roads against the most stringent CoP V1 criteria for dwellings. Roads which exceeded the CoP V1 criteria went to the Stage 2 assessment. Additionally, all State-controlled roads that passed the Stage 1 assessment but had receptors within 300 m of the road works were also included in the Stage 2 assessment.

The Stage 2 assessment involved noise monitoring at all roads selected for the assessment. Noise monitoring was conducted to quantify the pre-construction road traffic noise levels at representative noise monitoring locations. Comparison between the measured noise levels and the modelled noise levels showed that the noise modelling methodology was generally conservative and verified within the ± 2 dB tolerance as required by the CoP V1. Locations where the noise model underpredicted the measured noise levels were adjusted by the difference for the future scenarios.

Both the year 2028 and 2038 road traffic noise environments were modelled. Future road traffic noise levels in 2038 are predicted to exceed the noise criteria specified in CoP Vol 1 at 10 residential receptors and 3 community receptors without additional noise treatment. These 13 receptors are located in non-accessed controlled road situations under CoP Vol 1 and therefore do not qualify for noise treatment; however, it is recommended that at-property treatments be investigated on a case-by-case basis for these impacted sensitive receptors.

16.15.3 Railway operations

Based on the prediction and assessment of potential noise levels from the daily train movements on the Project, the Interim Guideline criteria for railway operations are achieved at most of the identified sensitive receptors. There are 97 sensitive receptors where noise levels trigger a review of mitigation. The majority (82) of the exceedances are residential buildings, which are in the townships of Kurrumbul, Pittsworth, Pampas, Brookstead, Yelarbon and at other individual dwellings along the alignment.

Based on the worst-case year 2040 scenario, the results of the sleep disturbance assessment are that 169 dwellings are predicted to exceed the threshold, of which 82 dwellings are also predicted to exceed the Interim Guideline criteria.

In addition to source noise controls implemented in the design and construction of the Project, reasonable and practicable noise mitigation has been investigated in the form of noise barriers at Kurumbul, Yelarbon, Pampas, Brookstead, Pittsworth and Gowrie.

Where predicted railway noise levels remain above the noise limits from the Interim Guideline, it is expected at-property treatments would be implemented to assist the management of railway noise where establish noise limits are not met. The management of residual impacts shall include where noise related impacts may occur, including sleep disturbance.

The specifics of at-property treatments will be determined by Inland Rail based on a detailed review that will consider a range of factors, including received railway noise levels, pre-existing condition of the buildings and habitable rooms, construction and design of the property, engineering feasibility, cost, and consultation with the affected landholders.

The assessment did not identify a need for specific vibration treatments; however, vibration and ground-borne noise levels should continue to be investigated at the detailed design stage.

It is important to note that where the Project achieves the noise and vibration criteria, there can still be potential for noise and vibration from railway operations to be audible/perceptible within the environment. It is not unreasonable for outdoor noise from railway operations to be audible and perceptible at least 1 km from the Project alignment depending on weather conditions at the time.

Noise and vibration from railway operations will continue to be assessed during the future phases of the Project to verify the outcomes of this assessment.

16.15.4 Noise and vibration management

Due to the nature of the proposed construction works and railway operations and the proximity of nearby sensitive receptors, it is expected that the Project would influence the local noise environment for sensitive receptors during construction and operations. Inland Rail will implement mitigation measures to manage both temporary (construction) and permanent (operational) noise and vibration emissions generated by the Project. The objective will be to reduce and control construction noise and vibration in a feasible manner and mitigate operational impacts with regard to operational criteria and guidelines.

The noise and vibration levels will continue to be assessed, and the mitigation requirements verified, during the detailed design and construction of the Project to reduce noise and vibration impacts. A program of noise and vibration monitoring will be conducted both during construction and following Project opening and operation of the Project. The findings of the noise and vibration measurement surveys will be applied to confirm noise and vibration levels at sensitive receptors and the requirements for reasonable and practicable mitigation measures.

The Project is committed to applying best practice and innovation in addressing the impacts of Project works. Where performance criteria indicates that the Project will implement management measures that are consistent with the criteria from identified codes of practice, policies and guidelines, it is to be read that those management measures will be informed by the criteria from such codes of practice, policies and guidelines and comply with all applicable conditions of approval including what is reasonably practicable in pursuing approaches of best practice and that support innovation.

ARTC will apply best practice approaches to effectively manage noise and vibration impacts from the Project, ensuring the provision of a suitable acoustic environment. Mitigation measures across relevant Project stages will be informed by confirmed construction programs, updated noise modelling, and the Project's final design, enabling verification of predicted impact levels and the appropriateness of proposed mitigation strategies. All mitigation measures will align with the Conditions of Approval, relevant noise criteria, and applicable guidelines and legislation, and will be in place prior to the commencement of each relevant Project stage.

Noise and vibration management will be delivered through NVMPs, which will form part of both the Construction Environmental Management Plan (CEMP) and the Operations Environmental Management Plan (EMP) for the construction and operational stages, respectively. Each NVMP will define the processes, roles, responsibilities, monitoring requirements, and corrective actions associated with noise and vibration management. The plans will also confirm the mitigation measures to be implemented during the relevant Project stage to ensure compliance with applicable legislation, guidelines, and Project-specific commitments.

Monitoring will support the management of potential impacts and confirm that all reasonable and practicable mitigation measures are effectively applied. These measures will be developed and implemented in consultation with affected stakeholders and will be in place ahead of, and during, the respective Project works to support the achievement of environmental outcomes. The performance of noise and vibration management will be subject to ongoing monitoring, with periodic reporting provided in accordance with the requirements of the NVMP.