

APPENDIX

P

# Fauna Connectivity Strategy

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

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# Glossary

| Term                             | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adaptive management              | Adaptive management is a formalised approach to monitoring, evaluation and reporting that includes a feedback loop to update and improve project or program management.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Alignment                        | The centreline of the proposed railway line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Amphidromous                     | Fish species that migrate between fresh and marine water as part of their life cycle for purposes other than breeding.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Anadromous                       | Fish species that are born in fresh water, mature in the ocean and return to fresh water to spawn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Approval                         | Any permit, authority, licence, self-assessable code, statutory exemption with conditions, protocol, agreement or plan, or other statutory instrument with conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| At-grade crossing (for wildlife) | At-grade crossings are where fauna cross the railway without using a wildlife crossing structure, where they cross at-ground level or by flying or gliding above the track.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Bridge                           | A type of infrastructure that allows for transport to cross waterways, deep valleys or areas prone to flooding. Can be single span or multi-span.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Community                        | All the populations of different species occupying a given area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Connectivity Assessment Area     | An area extending 20 km on each side of the centreline of the railway in which ecological connectivity was assessed. This distance takes into account the scale of movements of the various target species, with an upper limit based on the movement of the species with the greatest movements.                                                                                                                                                                                                                                                                                                       |
| Construction                     | Any work on or in the vicinity of a construction site carried out in connection with the construction, alteration, conversion, improvement, re-alignment, widening, extension, fitting out, commissioning, renovation, repair, maintenance, de-commissioning, demolition or dismantling of any structure.                                                                                                                                                                                                                                                                                               |
| Construction footprint           | The total area of ground or vegetation disturbance associated with a project, including all areas of permanent and temporary impact. Also referred to as the temporary footprint, or the Project footprint. The construction footprint is generally wider than the permanent footprint and includes the area required to accommodate construction activities and facilities of a temporary nature and duration for the construction of project elements such as fencing, erosion and sediment control measures, temporary stockpiling of soil and cleared vegetation, construction laydowns and access. |
| Construction project             | A project involving construction work, including the design, preparation, and planning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Construction site                | The place where construction work occurs. Includes other areas where plant or construction materials are located or stored. The extent of the construction site is defined by the construction footprint.                                                                                                                                                                                                                                                                                                                                                                                               |
| Culvert                          | A circular or rectangular shaped drainage structure, generally constructed of reinforced concrete.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



| Term                             | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dispersal                        | Often used as a generic term to describe species movements, but more accurately refers to a once-in-a-lifetime event, such as offspring leaving their area of birth to establish a new territory.                                                                                                                                                                                                                                                                                                        |
| Ecosystem                        | All living things in a given area, interacting with each other and with the abiotic factors in their environment.                                                                                                                                                                                                                                                                                                                                                                                        |
| FSTIDM                           | Fauna Sensitive Transport Infrastructure Delivery Manual. Published by the Queensland Department of Transport and Main Roads, 2024.                                                                                                                                                                                                                                                                                                                                                                      |
| Functional connectivity          | The amount of movement that occurs between areas of habitat in a landscape, usually assessed by tracking the movement of wildlife or measuring gene flow.                                                                                                                                                                                                                                                                                                                                                |
| Genetic diversity                | The variety of genetic makeup within a population.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Habitat                          | The area in which a species is able to live, either temporarily or permanently.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Habitat fragmentation            | The breaking up of patches of habitat into multiple smaller patches that become divided and are separated by barriers to movement, ranging from a complete barrier for some species through to a filter that reduces movement for other species.                                                                                                                                                                                                                                                         |
| Habitat loss                     | The process by which a natural habitat is altered to the point where it is no longer capable of supporting the native species that naturally occur in the area.                                                                                                                                                                                                                                                                                                                                          |
| Home range                       | The daily movement over a specific area which a species regularly travels in search of food, resources or mates.                                                                                                                                                                                                                                                                                                                                                                                         |
| Least cost path (LCP)            | Least cost paths identify all the possible movement pathways fauna may use when moving through the landscape where there are suitable habitat elements.                                                                                                                                                                                                                                                                                                                                                  |
| Locality                         | Refers to a 10 km buffer around the Project footprint and is inclusive of the Project footprint.                                                                                                                                                                                                                                                                                                                                                                                                         |
| Metapopulation                   | A set of subdivided populations interacting at a landscape or regional scale, also sometimes referred to as a population of populations.                                                                                                                                                                                                                                                                                                                                                                 |
| Migration                        | Relocation of animals from one area, or body of water, to another.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Migratory species                | A species from which a significant proportion of the entire population or a geographically separate part of the population undertake regular and typically predictable movements between areas in response to food, climate or other conditions.                                                                                                                                                                                                                                                         |
| Nomadic                          | Species that have no fixed territories and no stable home range.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Permanent Project footprint      | The area required to accommodate permanent infrastructure associated with the project, including rail, road and other miscellaneous infrastructure. Rail infrastructure includes rail tracks, crossing loops, turnouts, earthworks, bridges, drainage, level crossings, grade separations, rail maintenance access roads, signalling and fencing. Road related works resulting from the Project encompasses new and upgraded roads, realignments and diversions, intersection improvements and closures. |
| Priority Connectivity Zone (PCZ) | Higher priority locations in the landscape where ecological connectivity for target fauna species currently exists and intersects with the Project.                                                                                                                                                                                                                                                                                                                                                      |
| Population                       | All the members of a species that occupy a particular area at the same time.                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Term                                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail Maintenance Access Road (RMAR)    | Road parallel to railway required to allow vehicle access for operational maintenance of rail infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Reinforced concrete box culvert (RCBC) | A concrete box shaped structure generally used for drainage and installed under roads and rail infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Reinforced concrete pipe (RCP)         | A concrete pipe typically used for drainage and installed under roads and rail infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Revised reference design               | The current design as presented in the revised draft EIS (as described in Chapter 5: Project Description and Appendix B1: Design Drawings and with respect to flooding infrastructure, the Cross Drainage Register in Appendix T1: Flooding and Hydrology Technical Report – Volume 1 (Appendix B)).                                                                                                                                                                                                                                   |
| Riparian corridor                      | Linear links of existing wetlands, watercourses and drainage lines, with or without native vegetation.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Routine management                     | Where the results of monitoring trigger a routine management response. For example, fence repair or de-silting a culvert.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Sedentary                              | Species having stable home ranges or territories, where an individual occupies a relatively small area compared to the population distribution.                                                                                                                                                                                                                                                                                                                                                                                        |
| Stepping stone                         | Typically, smaller-sized patches of native vegetation or habitat that allow for some connectivity for certain species by providing resources and refuge that assist them with moving through the landscape between larger patches of habitat.                                                                                                                                                                                                                                                                                          |
| Study area                             | <p>Generally, includes the Project footprint plus a 1km buffer used to inform threatened species habitat and likelihood of occurrence through desktop assessments and field validated surveys (which occurred primarily within the Project footprint) for the ecological assessment. See also connectivity assessment area.</p> <p>See revised draft EIS Chapter 11: Flora and Fauna, Appendix L: Terrestrial and Aquatic Ecology Technical Report and Appendix O: Matters of National Environmental Significance Technical Report</p> |
| Subpopulation                          | A subset of individuals from within a larger population or metapopulation that operate somewhat independently from the remainder of the population.                                                                                                                                                                                                                                                                                                                                                                                    |
| Terrestrial corridor                   | A linear strip of vegetation that provides a continuous, or near continuous, pathway between two larger areas of habitat.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Threatened species                     | Species listed as Extinct, Critically Endangered, Endangered, Vulnerable and Near Threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> and/or the <i>Nature Conservation Act 1992</i> .                                                                                                                                                                                                                                                                                                           |
| Transport corridor                     | Area of land formally reserved or identified for roads and railways and includes existing infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| USQ                                    | University of Southern Queensland.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Viaduct                                | A bridge that consists of a series of arches, piers or columns supporting a long, elevated railway or road.                                                                                                                                                                                                                                                                                                                                                                                                                            |

# Executive Summary

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## Introduction

This report is the Fauna Connectivity Strategy (the Strategy) for the Inland Rail—Border to Gowrie Project (the Project) for the revised draft Environmental Impact Statement (rdEIS). This strategy has been developed to address relevant components of the Project's Terms of Reference (ToR) and additional information requirements from the Office of the Coordinator-General following the public notification of the draft EIS.

The objectives of this strategy were to identify and prioritise important connectivity areas within the Project for a suite of threatened species or guilds of species (i.e. groups of species that share broadly similar habitat and movement attributes), referred to as 'target species' and to assess the Project's design elements at facilitating movement and maintaining connectivity for these species. Mitigation measures and design considerations to be incorporated into the Project's detailed design phase have been provided to reduce the risk of fragmentation during the operational phase of the Project for target species where possible. A determination of the Project's ability to maintain connectivity for target species was then assessed as having either a high, moderate or low residual risk to connectivity for each of the target species. SMART - Specific, Measurable, Achievable, Realistic and Time-framed - mitigation goals for each target species provided in this report informed the specific assessments, guided the design of the mitigation measures and will enable evaluation of mitigation success during operation. The SMART goals will be refined and incorporated into a Wildlife Connectivity Plan during detailed design.

The Project is a 217.48 kilometres (km) section of new dedicated single track, open access freight railway between the NSW/QLD border and Gowrie, in QLD. The Project is comprised of 7.00 km of standard-gauge rail (1,435 mm) and 210.48 km of dual standard/narrow-gauge rail (1,435 mm standard and 1,067 mm narrow). The new railway will comprise approximately 149.48 km of new rail corridor (greenfield) and approximately 68.00 km of upgrade to existing open access rail corridor (brownfield), that forms part of Queensland Rail's (QR) South Western Line and Millmerran Branch Line.

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## Connectivity assessment methods

The potential impacts of the operation of the Project on the movement and dispersal of threatened species known, likely, or having the potential to occur was assessed. Nine target species or guilds are considered potentially impacted by the Project and have been assessed further. These are woodland birds, spotted-tailed quoll, gliding mammals, koala, woodland reptiles, cracking clay reptiles, Condamine earless dragon, Murray cod and Brigalow woodland snail. An assessment to identify important connectivity areas for the target species has been undertaken through:

- Quantitative connectivity modelling and a habitat proximity assessment (based on the proximity of species records and habitat to the Project) were used to identify areas of connectivity for each target species.
- Identification of higher priority locations in the landscape where ecological connectivity for both target fauna and non-threatened species currently exists and intersects with the Project, termed Priority Connectivity Zones (PCZs).
- Assessment of the suitability of the revised reference design elements, including drainage structures (culverts and bridges) and other design features such as embankments, fencing, noise walls, and width of footprint to facilitate the movement of the target species. There are more than 3000 culverts and bridges in the revised reference design and a total of 393 arrays of bridges and culverts (i.e. many arrays included > 10 culverts) have been assessed. A single representative culvert was assessed at each array of culverts, for their suitability to facilitate movement of the target species.
- Assessment of the likelihood of success of the revised reference design plus mitigation on target species connectivity.

The results of the assessment inform selection of a suite of mitigation measures proposed to maintain fauna connectivity and mitigate connectivity impacts for the target species. These will be considered on a case by case basis and detailed in the Wildlife Connectivity Plan and include:

- New or modified fauna crossing structures.
- Reduced clearing widths.
- Fauna fencing to limit access to the railway to prevent wildlife-train collisions and funnel fauna to crossing structures.
- Targeted connectivity facilitation measures such as shrubs, groundcover and fauna furniture in the approach and within fauna crossing structures.

The Project's ability to mitigate the risk to connectivity for each target species and any residual risk was also assessed followed by provision of SMART goals to evaluate mitigation success during operation.

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## Results

Connectivity values across the Connectivity Assessment Area vary with the habitat requirements and movement patterns of different target species. Generally, woodland, forest, and waterways with fringing repairing vegetation provide habitat and connectivity for a high number of target species. Large areas of these habitat types occur within various State Forests, including Yelarbon, Whetstone and Bringalily, while smaller patches providing habitat and connectivity are associated with waterways and road reserves, and scattered patches of vegetation on farmland. Cleared areas associated with cracking clay and the Condamine floodplain have also been identified as high connectivity value for some target species, including cracking clay reptiles and the Condamine earless dragon.

Most of the 393 arrays of structures (>70%) are satisfactory for spotted-tailed quoll, woodland reptiles, cracking-clay reptiles, Condamine earless dragon, Murray cod and Brigalow woodland snail. Gliding mammals have the highest number of unsatisfactory structures, followed by woodland birds and koala.

Unsatisfactory locations, as currently designed, are primarily unsuitable for co-use for fauna crossing structures for reasons including:

- The height and/or width of culverts and bridges are too small, or culverts too long, to facilitate fauna crossing.
- The presence of barbed wire fencing which presents a risk of fauna injury or mortality reducing the likelihood of successful crossings.
- The size of the gap in woodland cover exceeds the glide capability of gliders or the gap-crossing threshold of woodland birds.
- The structure is not sufficiently connected to surrounding habitat.

The assessment also identifies locations within the revised reference design where additional fauna crossing structures are required to facilitate target species movement in areas of suitable habitat.

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## Mitigation

Specific mitigation measures to be adopted by the Project for each target species to maintain ecological connectivity have been identified and include:

- The provision of additional fauna crossing structures, where suitable crossing opportunities are currently absent for the target species.
- Measures to facilitate successful fauna crossing including:
  - Converting pipe culverts to box culverts and culverts to bridge underpasses.
  - Modifying the dimensions of drainage structures to facilitate fauna movement through the structure.
  - Reducing the extent of vegetation and habitat clearing, where possible, at waterways, PCZs and other important crossings to reduce the size of gaps in habitat cover to facilitate movement of gap-sensitive woodland birds, gliders and other target species. This includes protecting soil structure and ground-layer vegetation and features to facilitate movement of reptiles.
  - Inclusion of fauna furniture within and adjacent to entrances and exits of crossing structures.
  - Fencing to funnel fauna into crossing structures and prevent them from accessing the railway to reduce the risk of wildlife-train collision.
  - Installation of glider poles and canopy bridges to bridge gaps in canopy cover for successful crossing by arboreal mammals.
  - Installation of koala refuge poles and rails within and adjacent to crossing structures for koalas.
  - Noise and light mitigation where required based on case by case assessment (location and species specific) where noise and light impacts have the potential to impede the use of the fauna crossing structures.
  - Landscaping and strategic revegetation, including recreating soil structure and placing logs and other artificial habitat within PCZs and in approaches to fauna crossing structures to enable fauna movement.

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## Conclusion and next steps

A fauna connectivity impact assessment has been undertaken concluded that fauna connectivity can generally be maintained for many target species with the adoption of design changes including increasing the height and width of existing culverts and the addition of dedicated wildlife crossing structures for koala, spotted-tailed quoll, woodland birds, and gliding mammals.

However, there remains significant uncertainty about the effectiveness of mitigation for Brigalow woodland snail, Condamine earless dragon, cracking clay reptiles and woodland reptile, which arises from limited knowledge on the ability of these species to use the crossing structures to move across the Project footprint, given that they are relatively sedentary species. The assessment of suitability has only been able to determine whether the structure may facilitate the movement of these species with modifications, not whether they will, or are known from previous literature, to use the structures. Further research on the likelihood of Brigalow woodland snail, Condamine earless dragon, cracking clay reptiles and woodland reptiles to utilise crossing structures is recommended to reduce uncertainty around Project impacts.

A Wildlife Connectivity Plan will be prepared during detailed design and will specify in detail how the operational impacts of the Project on fauna connectivity will be mitigated. Mitigation effectiveness, goals and adaptive management provided in this Strategy, as well as findings from various research programs and best practice will guide the final management strategies in the Wildlife Connectivity Plan.

# 1 Introduction

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## 1.1 Background

This report presents the Fauna Connectivity Strategy (the Strategy) to guide the detailed design of the Inland Rail—Border to Gowrie Project (the Project) (Figure 1.1) for the revised draft EIS. This Strategy has been developed to address relevant components of the Project's Terms of Reference (ToR) and additional information requirements from the Office of the Coordinator-General following the public notification of the draft EIS.

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## 1.2 Scope

The scope of this Strategy is to:

- Assess the current and predicted levels of connectivity for the operational Project for a suite of target fauna species and guilds, hereafter referred to as target species.
- Identify and prioritise locations and specify structures and designs to maintain ecological connectivity across the operational Project.
- Outline a process to ensure the requirements for fauna connectivity are addressed in the Wildlife Connectivity Plan and incorporated into the detailed design.

The Strategy provides the necessary context to inform the connectivity and fragmentation determination of the Significant Impact Assessment of the operational Project within Appendix O of the rdEIS for the target species assessed in this Strategy. This Strategy also provides guidance for detailed design of the Project to ensure the connectivity needs of target species are addressed and mitigated. The Strategy identifies a suite of guiding principles and mitigation measures that ARTC will take into the detailed design stage of the Project, which is where the detailed specifications of each crossing structure and other mitigation measures will be developed and confirmed. These details will be documented and fully described in a Wildlife Connectivity Plan, which will be implemented during the construction and operation of the Project. The context for the Strategy is shown in Figure 1.2.

This Strategy does not specify exactly which type of crossing structure or other design feature will be constructed at each specific location, because there are numerous aspects of the design of the Project that are yet to be determined. These aspects will be finalised during detailed design.

This approach to developing this Fauna Connectivity Strategy and the Wildlife Connectivity Plan is innovative because it outlines the design outcomes to be achieved and specifies the design criteria of crossing structures and other features for each of the target species to inform detailed design requirements. This approach ensures that the needs of the various target species and the requirements for ecological connectivity are incorporated hand-in-hand with other design considerations being finalised in detailed design, such as hydrology and flooding. The explicit inclusion and consideration of ecological connectivity requirements early and throughout detailed design maximises connectivity outcomes because every design change must consider how the potential change affects ecological connectivity. The 'road map' to implement the Strategy is described in Section 7.2.



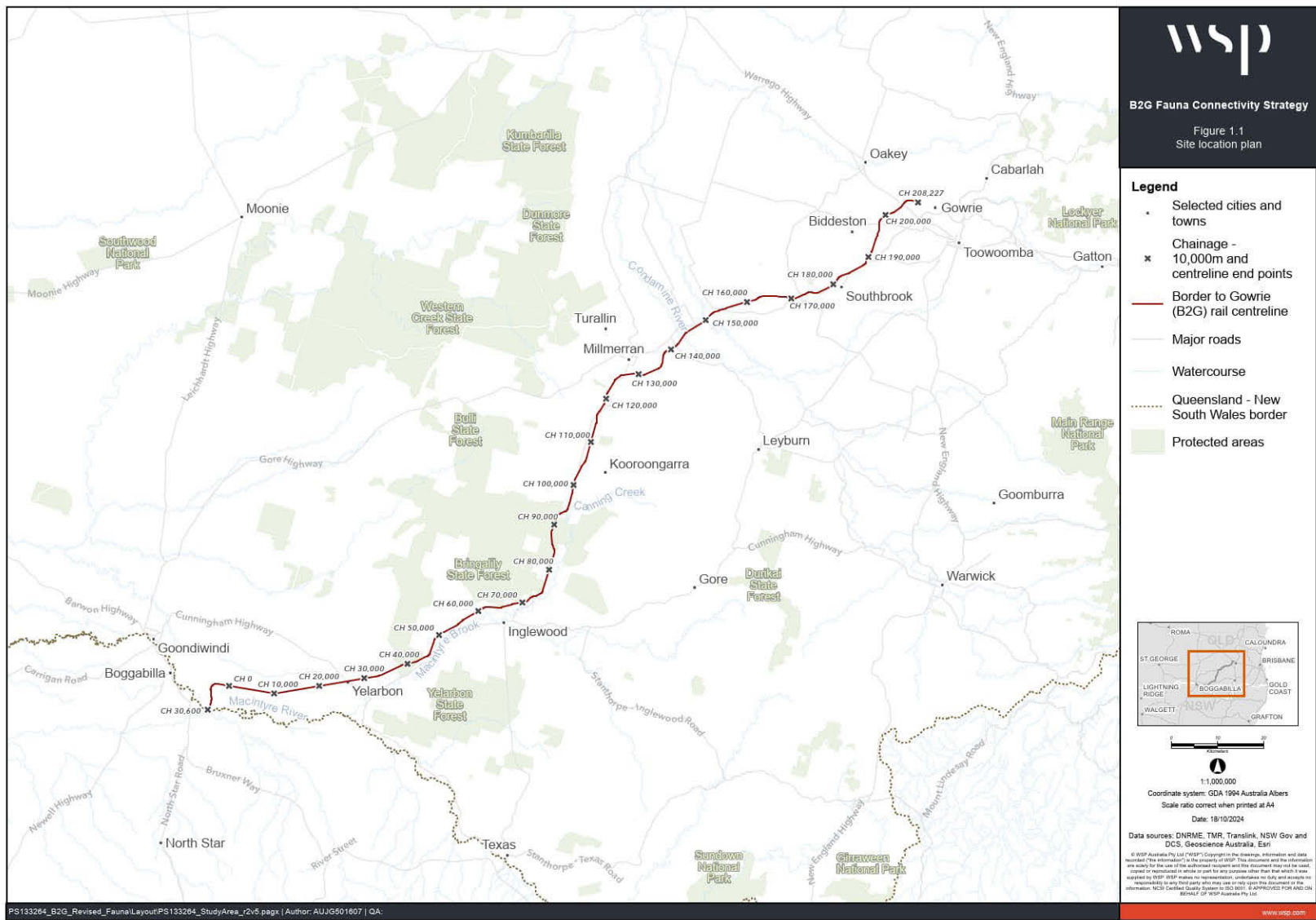


Figure 1.1. The Project alignment.



Figure 1.2 Implementation of the Fauna Connectivity Strategy in Project Works.



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## 1.3 Objectives

The overarching goals of the Fauna Connectivity Strategy are to:

1. Maintain ecological connectivity which encompasses both daily activity movements and dispersal of fauna across the Project through implementation of mitigation measures; and
2. Minimise the risk of injury and mortality of fauna from wildlife-train collisions (WTC), especially for listed threatened fauna species.

The Strategy will identify areas of existing ecological connectivity across the Project and assess the likely future connectivity during operation of the Project based on the revised reference design. The assessment will use a scientifically rigorous and evidence-based approach for the available data and verification with field data to inform the design and placement of mitigation measures and other treatments for the Project.

The specific objectives of the Strategy are to:

- Identify and prioritise locations (i.e. linkages, movement pathways) across the landscape that currently facilitate the movement of target species across and around the Project.
- Assess the potential impact of the Project footprint (i.e. revised reference design) and operation (including noise, light, train movements, etc) on the existing linkages and movement pathways for a suite of target species.
- Identify and prioritise locations on the Project revised reference design where fauna connectivity should be maintained through the installation of species-specific wildlife crossing structures and other mitigation measures for each target species. These locations are indicative and will be revised during the detailed design phase of the Project.
- Describe and specify the typical design parameters of wildlife crossing structures and other mitigation measures to be considered for the Strategy during detailed design. The specific design of each mitigation measure will be finalised during detailed design and will take into consideration a range of design parameters, including specifically hydrological modelling.
- Establish the requirement to develop a Wildlife Connectivity Plan during the detailed design phase.
- Provide performance criteria and design outcomes to allow fauna connectivity function to be integrated in the Project's design progression.

This Strategy identifies locations for wildlife crossing structures and recommends the type and size of mitigation measures that will achieve the objectives of the Strategy for each of the target species.

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## 1.4 Mitigation of fauna impacts

Mitigation measures to maintain fauna connectivity during the operation of the Project include:

- A Rehabilitation and Landscaping Management Plan will be prepared to guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas within the temporary disturbance footprint that are not required as part of the permanent footprint (such as laydowns and compounds).
- Habitat linkages are recommended to be included in the rail corridor where practicable and consistent with the safe operation and maintenance of Inland Rail. Linkages would involve retaining or rehabilitating groundcovers and low shrubs, with a focus on those areas of the rail corridor in PCZs such as waterways, BPA corridors and LCPs. As part of consideration of fauna connectivity requirements during the Project's design progression, opportunities to avoid and reduce clearing within PCZs and other specific crossing locations will be identified and detailed in the Wildlife Connectivity Plan.

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## 1.5 Project description

The Project is a 217.48 kilometres (km) section of new dedicated single track, open access freight railway between the NSW/QLD border and Gowrie, in QLD. The Project is comprised of 7.00 km of standard-gauge rail (1,435 mm) and 210.48 km of dual standard/ narrow-gauge rail (1,435 mm standard and 1,067 mm narrow). The new railway will comprise approximately 149.48 km of new rail corridor (greenfield) and approximately 68.00 km of upgrade to existing open access rail corridor (brownfield), that forms part of Queensland Rail's (QR) South Western Line and Millmerran Branch Line.

The Project commences at Chainage (Ch) 30.60 km (North Star to NSW/QLD Border (NS2B)) at the NSW/QLD border, at the Macintyre River approximately 18.00 km south-east of Goondiwindi. The Project runs north-east via Yelarbon, Inglewood, Millmerran, Pampas, Brookstead, Pittsworth, Southbrook and the Toowoomba Wellcamp Airport to Ch 208.48 km at Gowrie Junction, northwest of Toowoomba.

The Project will utilise a combination of existing and new rail corridors and at the commencement of operation, will accommodate the use of double-stacked 1,800 m long freight trains.

The Project is one of the sections of the broader Inland Rail Program being developed sequentially. The Program provides a more direct route for the movement of freight between Melbourne and Brisbane and enables a modal shift for the movement of freight from road to rail.

The scope of this Fauna Connectivity Strategy is relevant to the operational components of the Project contained within the permanent Project footprint defined as the area required to accommodate permanent infrastructure associated with the Project, including rail, road and other miscellaneous infrastructure. Rail infrastructure includes rail tracks, crossing loops, turnouts, earthworks, bridges, drainage, level crossings, grade separations, rail maintenance access roads, signalling and fencing. Road related works resulting from the Project encompasses new and upgraded roads, realignments and diversions, intersection improvements and closures.

The width of the operational rail corridor is variable depending on site-specific design features factors such as earthwork embankments (cut /fill batters), drainage infrastructure such as sediment ponds, scour and culverts, rail infrastructure, signalling, access roads and fencing, however, generally ranges from a minimum of 30 m to greater than 100 m. The corridor allows for a rail maintenance access road (RMAR) required to allow vehicle access for essential operational maintenance of rail infrastructure including the track and drainage infrastructure. The RMAR typically runs parallel to the rail alignment, and does not traverse watercourses, however, provides for a vehicle turnaround pad at approach of watercourses to allow inspection and maintenance access for bridge abutments.

Watercourse crossings have been designed to minimise impacts to riparian vegetation and the bed and banks of defined watercourses as much as possible whilst still meeting the performance specifications for the Inland Rail Project, including hydraulic and structural requirements of the crossing infrastructure in terms of structure's placement, size and design criteria. The type of structure, such as bridges or culverts, will vary based on local conditions such as the land's shape, water flow direction, and soil type. Drainage structures across the alignment includes over 3,000 reinforced concrete box and pipe culverts, scour and erosion infrastructure, and viaducts/bridge structures spanning a total of over 10 km over watercourses and floodplains.

To prevent erosion around culverts and the adjacent properties downstream of the rail corridor, scour protection has been included in the revised reference design. These include concrete aprons, wingwalls, and rock mattress scour protections at culvert entrances and exits. These designs will be tailored to control the flow velocity based on the soil type at each location, ensuring the structure can withstand potential flooding without causing damages to property or infrastructure.

The design life of the infrastructure is 50 years for track formation and earthworks including slope protection / stabilisation and 100 years for the culverts, rail bridges and abutments and retaining structures. The hydraulic design criteria for the rail line includes a 1% AEP flood immunity to formation level.

The Project will implement fencing along most of its length to prevent public access, protection from trespass, and keep livestock away from the railway corridor, except at designated crossing locations. Standard rural fencing will typically be utilised according to ARTC guidelines, with specific considerations discussed with local landowners during the detailed design phase.

In the Condamine floodplain area, traditional fencing has been excluded from the revised reference design due to concerns raised by landowners regarding debris blockage and flooding risks. Instead, alternative boundary markers, such as guideposts, will be installed to delineate the rail corridor whilst not blocking the mobilisation of debris during flood events.

Additionally, the Project will intersect existing pest exclusion fences, specifically the wild dog check and rabbit proof fences. The revised reference design realigns and reinstates these fences where necessary, coordinating with stakeholders like the Department of Resources, impacted landholders, Department of Agriculture and Fisheries (DAF) and GRC to ensure compliance and maintain effective pest control measures (see Section 2.4).

The key components of the revised reference design relevant to fauna connectivity are described in the following components of the Project revised draft EIS:

- Chapter 5: Project Description
- Appendix B1: Design Drawings
- Cross Drainage Register in Appendix T1: Hydrology and Flooding Technical Report – Volume 1 (sub-Appendix B).

The Project's reference design has been revised in response to engagement with key stakeholders (including landowners, communities, contractors, Councils and technical authorities), with further assessments and review of design optimisation opportunities conducted to incorporate efficiencies and impact reduction to the environment and community. Future design stages will see further refinements to the Project's drainage infrastructure design where potential residual flood impacts remain in accordance with the Project's Flood and Geomorphic Impacts Mitigation Framework involving quantitative Flood Impacts Objectives (FIO) developed in consultation with the Flood Panel as described in revised draft EIS Chapter 14: Flooding and Geomorphology. In accordance with the flooding mitigation approach, alternative flooding design measures will be investigated to mitigate these impacts.

## 2 Existing environment

### 2.1 Landscape context

The Project is located within the Brigalow Belt South bioregion. The Brigalow Belt South bioregion is characterised by a dry subtropical climate, with variable soils and vegetation types based on the underlying geology (New South Wales Department of Environment and Heritage 2023). The bioregion has experienced a long history of human disturbance as a result of agricultural practices and resource development. Agricultural activities are particularly prominent within the low-lying fertile floodplains associated with the Dumaresq River, Macintyre River, Macintyre Brook, and Condamine River, which are renowned for their fertile soils and productive agricultural landscapes. Tracts of remnant vegetation are also present (largely to the south of Millmerran), generally being limited to steeper terrain on isolated mountains and hills (typically associated with granite and basaltic outcrops and sandstone hills), road reserves and State Forest reserves.

The Project footprint traverses two major catchments, the Condamine and Border Rivers. The Condamine River catchment is one of the largest catchments in the Murray Darling Basin.

### 2.2 State-mapped biodiversity corridors

The Biodiversity Planning Assessment (BPA) mapping for the Brigalow Belt (Queensland Government 2016) recognises Regional and State corridors within the vicinity of the Project, which identifies vegetation that is significant for the movement of flora and fauna. Both riparian and terrestrial State ecological corridors have been mapped as listed in Table 2.1 and shown in Figure 2.1 and Figure 2.2.

Table 2.1 Biodiversity significance of Regional and State corridors.

| Corridor                                                                                                     | Biodiversity significance                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| State significance – areas assessed as being significant for biodiversity at the bioregional or State scales | <ul style="list-style-type: none"><li>Corridor (Terrestrial)</li><li>Corridor (Riparian)</li><li>Habitat for threatened taxa</li></ul> |
| Regional significance – areas assessed as being significant for biodiversity at the sub-bioregional scale    | <ul style="list-style-type: none"><li>Corridor (Terrestrial)</li><li>BPA habitat values (regional)</li></ul>                           |
| Local significance and or other values – local values that are of significance at the local government scale | <ul style="list-style-type: none"><li>BPA habitat values (local or other)</li></ul>                                                    |

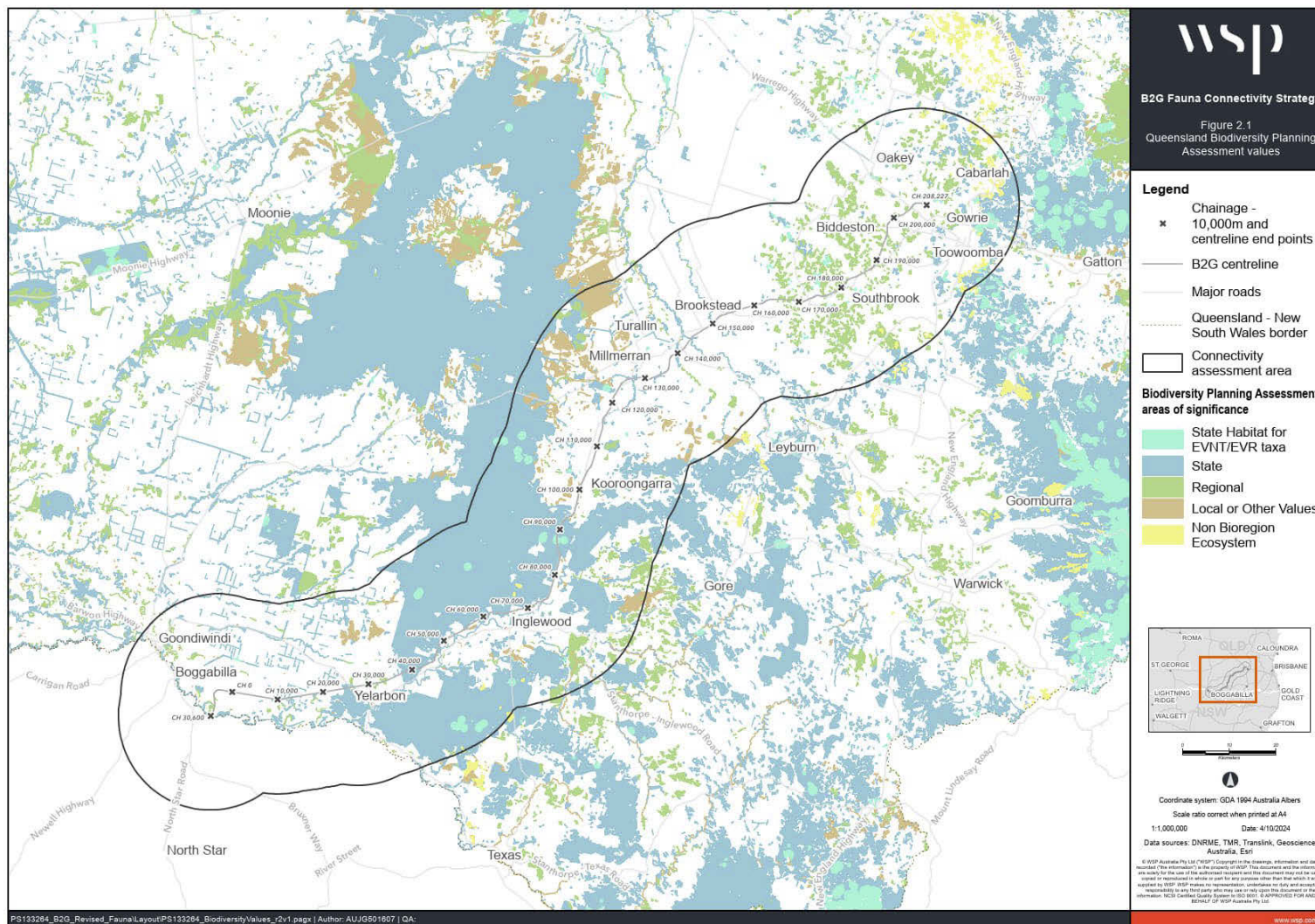


Figure 2.1 Queensland biodiversity planning assessment values.



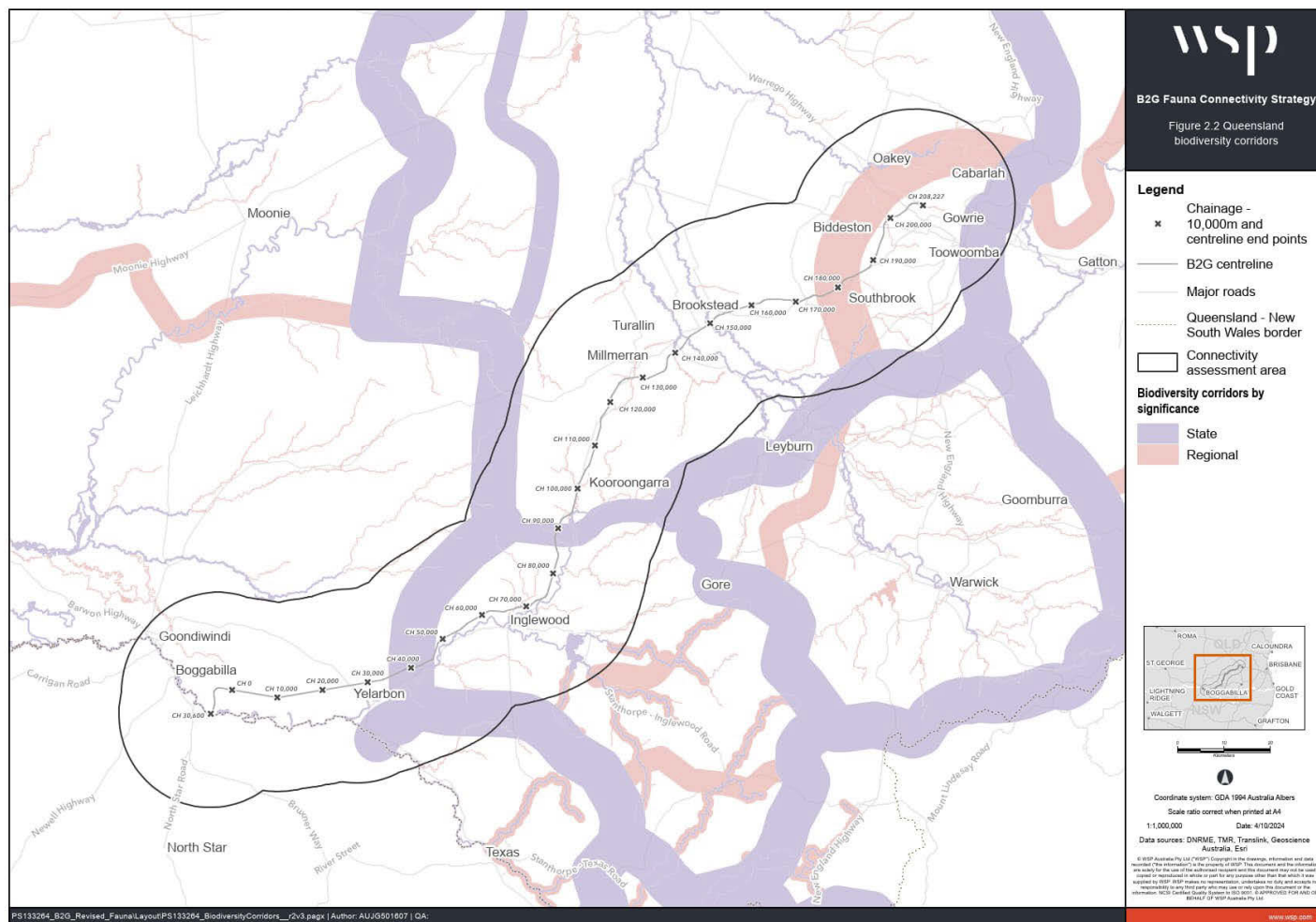


Figure 2.2. Department of Environment and Science (DES, 2022) Biodiversity Corridors

The landscape between the NSW/QLD border and Gowrie is dominated by agricultural industries and much of the Connectivity Assessment Area has been cleared of native vegetation. Native grasslands, poplar box (*Eucalyptus populnea*) and/or brigalow (*Acacia harpophylla*) communities persist as shade lines, strips and patches of remnant or regrowth vegetation. Large contiguous patches of vegetation are contained within numerous State forests. There are two State forests that are intersected by the Project footprint:

- Bringalily State Forest (35,695 ha); and
- Whetstone State Forest (41,282 ha).

Other State Forests in the vicinity of the Project includes Milmeran, Domville, McEwan, Devine and Yelarbon. Protected conservation areas in the vicinity of the Project includes Wondul Range National Park, Irongate Conservation Park and the Mount Basalt Environmental Park. These areas are dominated by eucalypt woodlands on sandy plains or shallow soils in areas of higher elevation and support a high diversity of terrestrial fauna including MNES species such as Dunmall's snake (*Furina dunmalli*), greater glider (southern and central) (*Petauroides volans*) and spotted-tailed quoll (*Dasyurus maculatus maculatus*) (DES, 2018).

## 2.3 Fauna species and habitat

The Project footprint supports a diversity of fauna species, with a total of 39 threatened fauna species listed under the EPBC Act or NC Act that are considered known, likely or having the potential to occur (rdEIS Chapter 11: Flora and Fauna, Appendix L: Terrestrial and Aquatic Ecology Technical Report and Appendix O: Matters of National Environmental Significance Technical Report). These species are detailed in Appendix A. In addition to threatened fauna, many common, widely distributed fauna species were recorded in the Project footprint during field surveys that are able to persist within agricultural-dominated landscapes and the fragmented woodlands and grasslands of the Brigalow Belt.

A total of eight broad habitat types were identified within the Project footprint that provide habitat for threatened species that are listed under the NC Act and EPBC Act. The extent of ground-truthed habitat types within the Project footprint is provided in Table 2.2. Groundwater dependent ecosystems are considered minor occurrences within other habitat types. As a result of the dry conditions during survey periods, the extent of GDEs and watercourses was unable to be ground truthed.

Table 2.2 Fauna habitat within the Project footprint

| Fauna habitat type                                                | Extent (ha) in Project footprint |
|-------------------------------------------------------------------|----------------------------------|
| Non-remnant disturbed pasture, cropping areas and other land uses | 2,516.87                         |
| Remnant dry sclerophyll eucalypt woodlands                        | 430.65                           |
| Regrowth eucalypt communities                                     | 190.07                           |
| <i>Acacia harpophylla</i> - <i>Casuarina cristata</i> open forest | 151.19                           |
| Natural grassland                                                 | 77.73                            |
| Freshwater wetlands                                               | 15.67                            |
| <b>Total</b>                                                      | <b>3,382.17</b>                  |

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## 2.4 Existing fencing

A Wild Dog Check Fence is present within the Connectivity Assessment Area between Yelarbon and Millmerran and encompasses much of Whetstone and Bringalily State Forests. The fence is managed by Goondiwindi Regional Council and Toowoomba Regional Council and is approximately 1.8 metres (m) tall and made of rabbit-proof wire mesh that is in variable condition. The specific goal of the Wild Check Dog Fence is to control the movement of wild dogs and dingoes and prevent them moving into farming areas to kill sheep and cattle.

The Project impacts operational sections of the wild dog check fence at three separate locations including:

- From Springborg Road to Whetstone (Ch 37.7 km to Ch 43.5 km) the rail corridor runs parallel to the existing wild dog check fence and is impacted by the necessary corridor widening works of the existing QR South Western Line.
- Direct severance from McDougalls Road and Cremascos Road (Ch 50.2 km to Ch 51.2 km) requiring a realignment along the rail corridor boundary fence.
- Direct severance from Cremascos Road heading north east (Ch 54.6 km to Ch 56.0 km) requiring a realignment along the rail corridor boundary fence.

The existing and reinstated wild dog check fence has the potential to limit the movement of many species of wildlife, including some of the target species considered in this Strategy, because they are unable to climb over the fence or pass through the mesh. The Strategy only considers locations where the Project intersects with the fence.

ARTC will reinstate the wild dog check fence at the three locations of impact on a like-for-like basis in consultation and agreement with relevant stakeholders, notably Department of Environment, Science and Innovation, impacted landholders and lessees, DAF, and GRC. DAF consultation is required before any amendments are made to the wild dog check fence under Section S91(3) of the *Biosecurity Act 2014* (Qld).

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## 2.5 Overcoming data deficiencies

ARTC have commissioned targeted research focussing on better understanding the habitat requirements and movements of various fauna, including koala, yakka skink, Dunmall's snake, collared delma, five-clawed worm skink, Condamine earless dragon and Brigalow woodland snail. This research is currently underway by the University of Southern Queensland (USQ) and the findings to date have been used to inform this Strategy and future findings will be used to fill knowledge gaps in their general ecology and biology, as well as inform site-specific mitigation measures, such as the design of wildlife crossing structures and habitat protection and restoration techniques, in order to maintain ecological connectivity. New information collected after the Strategy is finalised will be incorporated during the detailed design phase (Figure 1.2).

Targeted surveys will also be undertaken during detailed design to determine the presence and/or habitat of target species for mitigation and assist in prioritising the need for mitigation measures as required.



# 3 Connectivity assessment methods

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## 3.1 Overview

This section provides an overview of the approach taken to assess connectivity for target species. Detailed methods for each step below is provided in subsequent sections:

- Assess the potential impact of the operation of the Project on the movement of all threatened species that are known, likely or have the potential to occur in the Project locality (Section 3.2; Appendix D- Likelihood of Occurrence tables).
  - Undertake connectivity assessments for species whose movements are potentially impacted by the operation of the Project, hereafter referred to as ‘target species’. Two methods were used to achieve this: quantitative modelling (Section 3.3) and an assessment based on the proximity of species records and habitat to the Project (Section 3.4).
  - Use model and proximity assessment results to identify areas of connectivity for each target species (Section 3.5).
  - Identify PCZs for the target species (Section 3.6).
  - Specify the design and treatment of wildlife crossing structures and other design features required on the Project to maintain fauna connectivity for the target species (Section 3.7).
  - Assess the suitability of the revised reference design (including drainage structures and other design features such as noise walls, proximity of trees to the railway, lighting shields and fencing) to facilitate movement of the relevant target species (Section 3.8).
  - Assess the likely suitability of the revised reference design at providing adequate levels of connectivity for the target species and identify specific improvements and/or additional crossing structures required to mitigate connectivity impacts (Section 3.8).
  - Assess the likely suitability of the revised reference design post mitigation on target species connectivity (Section 3.8).
  - Outline a process to ensure the detailed design of the Project incorporates fauna connectivity needs (Section 7.2).
- 

## 3.2 Selection of target species and fauna guilds

The movement of a wide range of common and threatened fauna species are potentially impacted by the Project. This Strategy has focussed on maintaining connectivity for a range of threatened species identified as known, likely or with potential to occur in the locality of the Project according to Appendix A – Threatened Species Likelihood of Occurrence tables. This approach ensures that species most at risk are explicitly considered and common species are also accounted for by accommodating the needs of the typically more specialist threatened species.

An assessment of threatened species that are known, likely or have potential to occur in the Project footprint (Appendix B Threatened Species Likelihood of Occurrence table in revised draft EIS, Appendix L: Terrestrial and Aquatic Ecology Report), was undertaken to determine which of these species have the potential for their movements to be impacted by the Project (Appendix ED). The assessment involved a review of habitat characteristics, movement (ability, pattern and mode), geographic distribution and the potential impact of the Project. Potentially impacted species were then either grouped into ‘guilds’ or assessed as individuals. Species which shared similarity in their movement and/or habitat association were grouped, while those with unique or niche attributes remained as individuals.

Species grouped into fauna guilds share similar ecological roles or niches within an ecosystem and the use of guilds to assess responses to habitat fragmentation and landscape-scale movement has been widely used, including in connectivity assessments and strategies (Lechner and Lefroy 2014, Lechner et al. 2017, Fung et al. 2023). By grouping species based on their movement, habitat association and other ecological parameters, guilds generally reflect similarity in strategies, behaviours, and adaptations that enable similar species within the same guild to navigate their environment (e.g. Bregman et al. 2014, Olivier and van Aarde 2017). Understanding the movement patterns of species within guilds can be critical for conservation and management efforts and can help identify corridors or habitats necessary for the survival of certain guilds and guide conservation strategies.

Individual species and guilds of target species are collectively referred to as ‘target species’ in this strategy. Where a guild of species has been assessed, the movement parameters adopted in the assessment correspond to the species with the most restricted or constrained requirements, thereby ensuring all other species in that guild are accommodated for.

The assessment of target species using the relevant connectivity assessment method (Table 3.1, and described in Sections 3.3 and 3.4) was then assessed against the revised reference design to determine its effectiveness at mitigating connectivity impacts (Section 3.8). The two methods used to formally assess ecological connectivity across the Project, were quantitative modelling (Section 3.3) and an assessment of the proximity of target species records and habitat to the Project footprint (Section 3.4). Both methods use a rule-based approach to identifying movement pathways, ensuring an objective, transparent and repeatable methodology can be applied.

The selection of which method to use for each potentially impacted species was based on the amount and type of data available for each target species. Quantitative modelling was used for three target species (Table 3.1) with enough reliable data to characterise their habitat preferences, minimum patch sizes, and movement distances, and the proximity assessment was used for six target species where there was either little reliable data for those parameters or where known habitat preferences were not able to be accurately assessed at the spatial scale of this study (Table 3.1). Quantitative ecological connectivity modelling was attempted for koala but failed due to the large spatial extent of the Connectivity Assessment Area for koalas and the fine spatial resolution of the data (i.e. individual trees were mapped as koala habitat).

Table 3.1 Summary of target species habitat and dispersal characteristics and the connectivity assessment method. Note more detailed descriptions of habitat associations and movement parameters are given in Appendix D.

| Target species          | Habitat and movement characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Connectivity assessment method (refer to Section 3.3 and 3.4 for details) |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Brigalow woodland snail | <ul style="list-style-type: none"> <li>– Inhabits brigalow and/or eucalypt dominated woodlands associated with waterways and floodplains of the Condamine River and MacIntyre Brook.</li> <li>– Limited knowledge on movement, but likely sedentary. Single study found movements of less than 3.5 m per survey night (Ridgeway et al. 2014).</li> <li>– Dispersal and movement between patches likely occurs during rain events. This movement is limited spatially by the arrangement of habitat patches.</li> </ul> | Habitat proximity assessment                                              |

| Target species                                                          | Habitat and movement characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Connectivity assessment method (refer to Section 3.3 and 3.4 for details) |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Condamine earless dragon                                                | <ul style="list-style-type: none"> <li>– Inhabits intensively cropped black-cracking clays particularly along road reserves, remnant native grassland and exotic grassland with short, open structure, tussocks grasses and cracking soils.</li> <li>– Endemic to the eastern Darling Downs, particularly occurring on the Condamine River floodplain.</li> <li>– UniSQ have recorded this species from the Cecil Plains in the north to Brookstead in the south (UniSQ 2024).</li> <li>– Geographic distribution of this species is uncertain but known extent of occurrence is estimated at less than 2000 km<sup>2</sup> and its area of occupancy estimated at 76 km<sup>2</sup>.</li> <li>– Dispersal habitat and breeding and foraging habitat have not been defined for this species.</li> </ul>                           | Habitat proximity assessment.                                             |
| Cracking clay reptile guild<br>— Five-clawed worm-skink<br>— Grey snake | <ul style="list-style-type: none"> <li>– The five-clawed worm skink inhabits areas containing bluegrass and/or Mitchell grass dominated grasslands or mixed grasslands on cracking clay soils or self-mulching, friable basalt soils. May also occur in river red gum–Queensland blue gum–coolabah–bimble/poplar box grassy woodland/open forests.</li> <li>– The five-clawed worm-skink occurs in the Darling Downs bordering the lower western slopes of the Great Dividing Range and the Condamine River floodplain in QLD.</li> <li>– The grey snake occurs near the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt region.</li> <li>– Movement patterns and dispersal abilities are unknown. Both species are expected to have limited movement and dispersal abilities.</li> </ul> | Habitat proximity assessment.                                             |

| Target species                                                                                                                  | Habitat and movement characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Connectivity assessment method (refer to Section 3.3 and 3.4 for details) |
|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <p>Gliding mammal guild</p> <ul style="list-style-type: none"> <li>— Greater glider</li> <li>— Yellow-bellied glider</li> </ul> | <ul style="list-style-type: none"> <li>– Eucalypt forest and woodland across eastern Australia. Greater gliders prefer moist, tall montane forest. Yellow-bellied glider prefers wet and dry forest and woodland.</li> <li>– Greater glider home range is generally &lt; 5 ha but can be up to 20 ha. This species is generally sedentary, gliding between trees and rarely seen on the ground.</li> <li>– Yellow-bellied glider home range is between 30-60 ha and may move up to 2 km per night.</li> <li>– Glide distances vary among species. Yellow-bellied gliders can glide in excess of 100 m in tall forest, while greater gliders can glide up to 70 – 80 m in forest that was 40 – 45 m tall (Rod Kavanagh, pers. comm., Kita Ashman, pers. com.), and 27 m in forest that was 20 – 25 m tall (Ben Nottidge pers. comm.).</li> </ul>                                                                                                                                                                                                                                                                                                                                                    | Quantitative ecological connectivity modelling.                           |
| Koala                                                                                                                           | <ul style="list-style-type: none"> <li>– Eucalypt woodland to open forest with mature box, ironbark and red gum species.</li> <li>– Koala within the Connectivity Assessment Area are moving on average-males: mean <math>173 \pm 220</math> m/day, median 95 m/day; females: mean <math>106 \pm 185</math> m/day, median 52 m/day, with the highest travel distances occurring between July and December (UniSQ 2024). Daily movement rates were recorded nearly three times higher during the dispersal phase (<math>341 \pm 498</math> m/day) compared with the non-dispersal phase (<math>107 \pm 188</math> m/day (UniSQ 2024).</li> <li>– Home ranges for dispersing koala within the Connectivity Assessment Area is also higher (mean = <math>2.45 \pm 2.4</math> km<sup>2</sup>) compared with non-dispersing (mean = <math>0.57 \pm 0.5</math> km<sup>2</sup>) and variable among sexes, with males moving greater distances compared with females (UniSQ 2024).</li> <li>– Koalas generally move on the ground when moving between trees.</li> <li>– Grassland or field type habitats are traversed frequently by koala to trees and preferred habitat patches (UniSQ 2024).</li> </ul> | Habitat proximity assessment.                                             |

| Target species                                                                                                                                                                                                                                                                    | Habitat and movement characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Connectivity assessment method (refer to Section 3.3 and 3.4 for details) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Murray cod                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>– Endemic and widespread in the Murray-Darling Basin. Occurs in various habitats ranging from clear, stony streams to slow flowing turbid rivers, lakes and billabongs.</li> <li>– Seasonal migrations upstream to cooler waters during warmer months, shorter daily movements in search of food and suitable habitat, and long-range movements related to reproductive behaviours.</li> </ul>                                                                                                                                                                                                                          | Habitat proximity assessment.                                             |
| Spotted-tailed quoll                                                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>– Forest, woodland, shrubland. Occasionally, grassland and pastoral areas adjacent to woodland or forest.</li> <li>– Home range up to 5000 ha (males) or 1500 m (females).</li> <li>– Able to move large distances and partially arboreal.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                   | Quantitative ecological connectivity modelling.                           |
| Woodland bird guild <ul style="list-style-type: none"> <li>— Brown treecreeper</li> <li>— Regent honeyeater</li> <li>— Southern whiteface</li> <li>— Squatter pigeon</li> <li>— Painted honeyeater</li> <li>— Hooded robin (south-eastern)</li> <li>— Diamond firetail</li> </ul> | <ul style="list-style-type: none"> <li>– Eucalypt woodland to open dry forest. Species specific attributes can include the presence of mistletoe or a grassy understory.</li> <li>– Movement ability varies between species in this guild from highly mobile species capable of travelling large distances for flowering food resources (e.g. regent honeyeater) to more sedentary species which occupy permanent territories (e.g. brown treecreeper).</li> <li>– The focal species for this guild, brown treecreeper is gap sensitive and rarely crosses gaps of &gt;100m between trees. Breeding pairs occupy territories between 1.1 – 10.7 ha.</li> </ul> | Quantitative ecological connectivity modelling.                           |
| Woodland reptile guild <ul style="list-style-type: none"> <li>— Death adder</li> <li>— Dunmall's snake</li> <li>— Collared delma</li> <li>— Yakka skink</li> </ul>                                                                                                                | <ul style="list-style-type: none"> <li>– Primarily eucalypt forests and woodlands. Species specific attributes can include well-draining soil, leaf litter and fallen trees.</li> <li>– There is limited information on the dispersal habits of Common death adder, Dunmall's snake and the Yakka skink, however, they are unlikely to have a high dispersal ability.</li> <li>– Collared delma are a sedentary species with many individuals living in a 10 x 10 m area.</li> <li>– Yakka skinks have high site fidelity and limited capacity for dispersal from their colony.</li> </ul>                                                                     | Habitat proximity assessment.                                             |

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### 3.3 Quantitative ecological connectivity modelling

The quantitative connectivity modelling used to develop this Strategy represents leading-practice in spatial modelling methods and enables the simulation of the very complex ecological process of wildlife movement and dispersal (Keeley et al. 2021). Understanding how wildlife movement functions and how it affects the survival of species is a property of several factors ranging from the number and size of habitat patches, the spatial distribution of those patches and the permeability (i.e. ability of species to move through a landscape) of the matrix (i.e. the land cover between patches) (LaPoint et al. 2015).

Quantitative connectivity modelling considers the location, total area and connections among patches and was used to assess the potential implications of the Project on fauna connectivity. Existing landscape connectivity modelling tools, including least-cost path analysis, circuit theory, and graph theory, provide a sophisticated and diverse toolkit for investigating various aspects of connectivity (McRae et al. 2008, Rayfield et al. 2010, McRae and Kavanagh 2011, Foltête et al. 2012). These approaches identify non-habitat (also referred to as the matrix) based on a species' dispersal costs, which reflects the mortality risk, behavioural changes and metabolic expense of travelling across the unsuitable habitat (Figure 3.1).

Land-use and land cover features are often used to indicate movement or dispersal costs and are described by species-specific dispersal cost probabilities. The different land uses and the movement costs adopted in this project are given in Table 3.2. These movement costs are then used to model least-cost paths, which are the pathways potentially used by a species to move between two patches of habitat. Least cost paths simply identify all the possible pathways and they do not by themselves assess their significance or priority ranking. Least cost paths informed the identification of PCZs (Section 3.6) and will also inform the Wildlife Connectivity Plan (Figure 1.2) when finalising the detailed design of specific wildlife crossing structures and other mitigation measures. The significance of habitat patches and the significance of least cost paths for connecting patches in a landscape were then quantified using graph theoretic mathematical models.

Circuit theory uses the concept of electrical current (representing fauna) flowing through a circuit (representing the landscape) where the individual movement probabilities across every grid cell is calculated in a raster (McRae et al. 2008).

The software Graphab (Foltête et al. 2012) was used to calculate graph-metrics and least-cost paths between patches and Linkage Mapper (with Circuitscape) (McRae et al. 2008, McRae and Kavanagh 2011) was used to characterise least-cost corridors and individual movement probabilities within corridors. In addition, a graph theoretic approach was used to characterise the importance of patches and linkages for connecting the landscape.

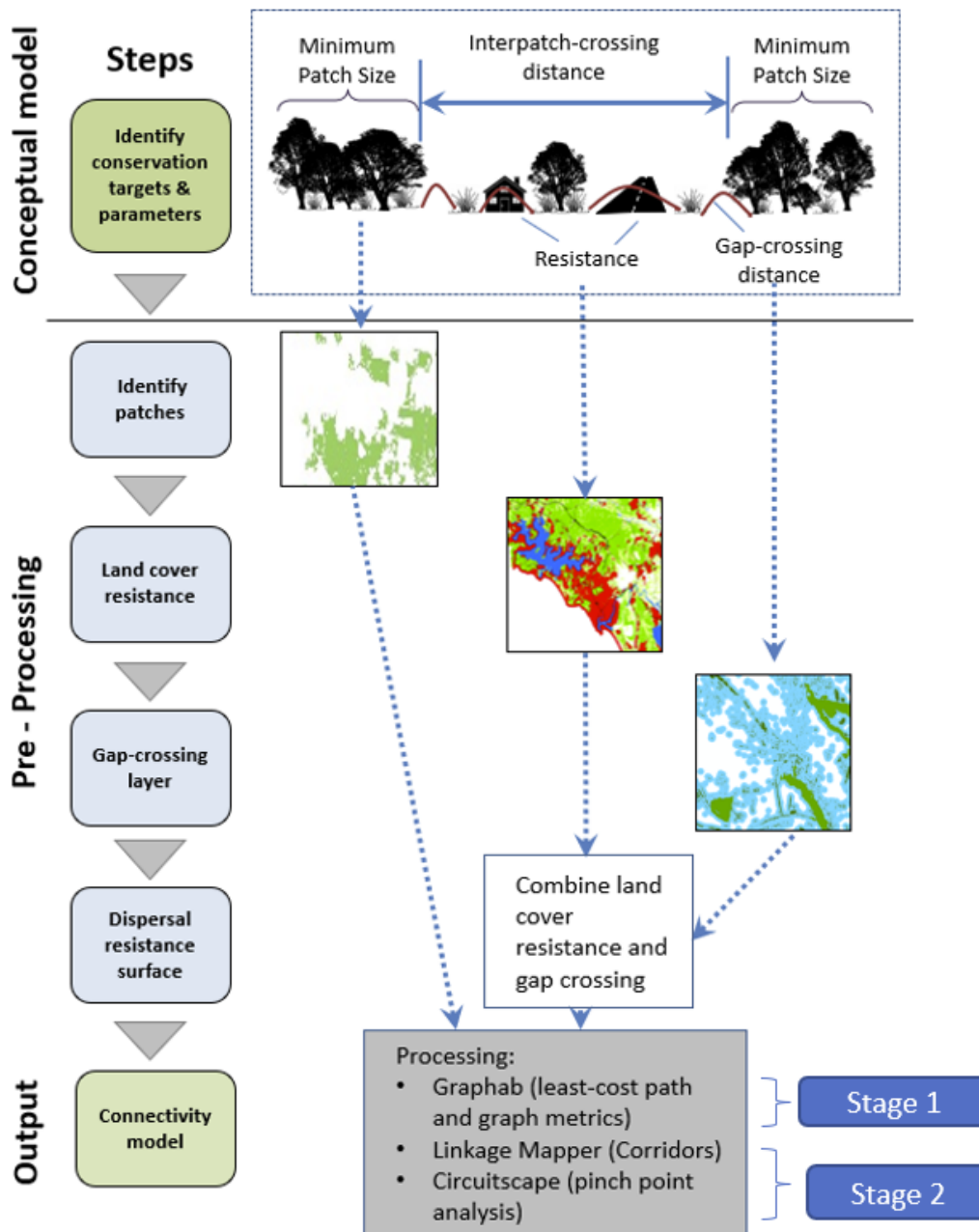


Figure 3.1: Summary of geospatial processing steps used to model ecological connectivity for spotted-tailed quolls, woodland birds and gliding mammals for the Project (Source: (Lechner et al. 2015). Stage 1 is the baseline or existing conditions, and stage 2 is the operational conditions.

The quantitative modelling was done in two stages, with the first representing the current existing movement pathways or baseline conditions (i.e. before the Project) and the second stage predicting the future movement pathways based on the specific features of the revised reference design. The second stage included specific movement costs for the three target species (gliding mammals, woodland birds and spotted-tailed quoll) for:

- Culverts and bridges of different sizes, including rail over waterways, rail over road, and road over rail.
- The presence and design of noise walls and perimeter fencing.
- Rail formation, specifically the height of sections of fill and depth of cuts. It is assumed that the slope of embankments and approaches to crossing structures will be designed to allow the movement of the specific target species at each crossing location.
- The presence of the existing and reconstructed Wild Dog Check Fence.



The habitat requirements and movement parameters for the three target species are shown in Table 3.2, and includes current and future scenario parameters. Resistance values are given as multipliers of the cost to move through optimal habitat (i.e. a value of 1 = no cost and a resistance value of 2 means the land cover type is twice as costly to travel through when compared to optimal habitat). The parameters in Table 3.2 were obtained through consultation with species experts (Appendix B) and a desktop review of peer-reviewed research published in scientific journals, previous connectivity assessments, and statutory documents including approved conservation advice, action plans and recovery plans. In many cases, the resistance values were estimated or scaled (e.g. major road has higher resistance than minor road) based on an understanding of the ecological requirements, movement capabilities and response to transport infrastructure of the actual species or similar species.

The resistance values are applied to each pixel in the following ways:

- The parameter with the highest resistance value is applied to each pixel. If a pixel includes a minor road (for example, with a resistance value of 2) and a noise wall (for example with a resistance value of 10), the noise wall ‘trumps’ or overrides the attribute with the lesser value, and the resistance value for that pixel is therefore 10.
- The resistance of an area is derived from the cumulative resistance values of adjacent pixels. For example, 10 adjacent pixels with a resistance value of 10 has, in effect, a cumulative or combined resistance of 100. At each pixel, the model evaluates the ‘cost’ to traverse the next pixel, and the cumulative cost is made up of the sum of the resistance value of adjacent pixels.
- Where mitigation measures are applied to increase connectivity, the value of the least resistant feature is applied to that pixel. For example, a bridge with >2.4 m clearance has half the resistance of the railway and bridges with low clearance.
- The resistance values take into account the way a species moves (e.g. glides, flies etc) and whether they are more or less likely to go through culverts and bridges or fly above the railway. For example, crossing structures that are not used by a species (e.g. gliders don’t use small culverts) do not have a ‘complete barrier’ resistance value because it is the same for a glider to cross the railway regardless of the presence of a culvert.
- The resistance values of the potential crossing structures is based on them being an optimal design, as described in Section 3.7.

The outputs of modelling were a series of maps showing least-cost paths and least cost corridors (or areas with high current density), which were interrogated, along with habitat maps and other inputs to identify crossing locations and PCZs (described in Section 3.6).

Table 3.2 Parameters used for quantitative connectivity modelling for the woodland birds guild, gliding mammals guild and the spotted-tailed quoll.

| Parameter                      |                                                         | Woodland birds   | Gliding mammals                                                                                                                                          | Spotted-tailed quoll                                             |
|--------------------------------|---------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Habitat</b>                 | Broad habitat classification                            | Woody vegetation | Woodlands, forest, feed tree regrowth (can be non-remnant), including riparian zones<br>Remnant old growth forest and woodland, including riparian zones | Remnant old growth forest and woodland, including riparian zones |
| <b>Movement and patch size</b> | Minimum habitat patch size (ha)                         | 5                | 10                                                                                                                                                       | 250                                                              |
|                                | Gap-crossing distance threshold (m)                     | 106              | 40                                                                                                                                                       | 500                                                              |
|                                | Inter-patch crossing distance threshold (m)             | 1,000            | 2,000                                                                                                                                                    | 15,000                                                           |
| <b>Resistance (multiplier)</b> | Habitat                                                 | 1                | 1                                                                                                                                                        | 1                                                                |
|                                | Major roads                                             | 2.5              | 2                                                                                                                                                        | 2.5                                                              |
|                                | Minor roads                                             | 2                | 1.5                                                                                                                                                      | 1.5                                                              |
|                                | Water                                                   | 2                | 1.5                                                                                                                                                      | 1.5                                                              |
|                                | Intensive agriculture                                   | 1.5              | 2                                                                                                                                                        | 1.5                                                              |
|                                | Existing rail                                           | 2                | 1.5                                                                                                                                                      | 1.5                                                              |
|                                | High disturbance infrastructure                         | 2                | 10                                                                                                                                                       | 10                                                               |
|                                | Modified pastures and open space                        | 1                | 1.5                                                                                                                                                      | 1                                                                |
|                                | Powerline easement                                      | 1                | 1.5                                                                                                                                                      | 1                                                                |
|                                | Project rail alignment (includes clearing in footprint) | 3                | 2                                                                                                                                                        | 2                                                                |
|                                | Noise wall                                              | 3                | 4                                                                                                                                                        | 10,020 (complete barrier)                                        |
|                                | Baseline sections of wild dog check fence               | 1                | 1                                                                                                                                                        | 1                                                                |
|                                | <b>Bridges</b>                                          |                  |                                                                                                                                                          |                                                                  |

| Parameter                              |                                                                                                              | Woodland birds                                                        | Gliding mammals                   | Spotted-tailed quoll        |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------|-----------------------------|
|                                        | Bridge sections < 2.4 m high at highest point                                                                | 3                                                                     | 2                                 | 2                           |
|                                        | Bridge sections ≥ 2.4 m high at highest point                                                                | 1.5                                                                   | 2                                 | 1                           |
|                                        | <b>Alignment Classes</b>                                                                                     |                                                                       |                                   |                             |
|                                        | Elevation < 2 m (alignment value)                                                                            | 1                                                                     |                                   | 2                           |
|                                        | Elevation: >+2m – +5 m                                                                                       | 2                                                                     | 1                                 | 3                           |
|                                        | Elevation: ≥ +/- 5m - +/-10m                                                                                 | 3                                                                     | 1                                 | 3                           |
|                                        | Elevation: ≥ 10m                                                                                             | 4                                                                     | 1                                 | 820<br>(complete barrier)   |
|                                        | Tunnel:                                                                                                      | 5                                                                     | -                                 | 1                           |
|                                        | <b>Culverts*</b>                                                                                             |                                                                       |                                   |                             |
|                                        | Culverts: ≥1.21-2.39m, <30m long                                                                             | 3                                                                     | 2                                 | 2                           |
|                                        | Culverts: ≥1.21-2.39m, >30m long                                                                             | 3                                                                     | 2                                 | 2                           |
|                                        | Culverts: ≥ 2.4 m, <30m long                                                                                 | 3                                                                     | 2                                 | 2                           |
|                                        | Culverts: ≥ 2.4 m, >30m long                                                                                 | 3                                                                     | 2                                 | 2.5                         |
|                                        | <b>Fences</b>                                                                                                |                                                                       |                                   |                             |
|                                        | Standard rural fence - wire                                                                                  | 1                                                                     | 2                                 | 2                           |
|                                        | Standard chain link fence                                                                                    | 3                                                                     | 820<br>(complete barrier)         | 10020<br>(complete barrier) |
|                                        | Crossover knot mesh fence (standard fence)                                                                   | 3                                                                     | 820<br>(complete barrier)         | 10020<br>(complete barrier) |
|                                        | Wild dog check fence (5 updated sections with koala poles that quolls are able to climb and cross the fence) | 1                                                                     | 1                                 | 1.5                         |
| <b>REFERENCES FOR PARAMETERISATION</b> |                                                                                                              | See (Lechner and Lefroy 2014, O'Malley and Lechner 2017), Appendix D. | See Appendix B and D, (TMR 2024f) | See Appendix B and D        |

\*For quantitative modelling for spotted-tailed quoll culverts < 1.2 m high are considered ineffective to facilitate fauna passage and not considered further. Woodland birds and gliding mammals do not use culverts of any height proposed for this Project.

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## 3.4 Species records and habitat proximity assessment

Ecological connectivity for species identified in Table 3.1 (habitat proximity assessment only) were assessed by interrogating species records and field-verified or modelled habitat within the Study Area and Connectivity Assessment Area and inferring where these species are likely to interact with and attempt to cross the Project. This method is called the ‘species records and habitat proximity assessment’ which is referred to in this Strategy as the ‘habitat proximity assessment’ method. The habitat proximity assessment identifies where connectivity for the six target species assessed is required on the revised reference design.

Four sources of data and/or methods were used to identify habitat for the six target species, namely:

- 1 Peer-reviewed scientific literature, recovery plans and approved conservation advice were reviewed to identify any known habitat associations for each species.
- 2 The Queensland DAF waterways for waterway barrier works mapping layer informs the likely characteristics of the waterway and the potential presence of Murray cod. All watercourses intersected by the Project were mapped, field verified and assessed for ecological, hydrology and geomorphological characteristics and impacts. A visual evaluation of the aquatic habitat from satellite imagery was used to evaluate the likely presence of Murray cod during flow conditions. Murray cod habitat occurs in main river channels featuring complex microhabitat features such as large rocks, large snags, woody debris, undercut banks and over-hanging vegetation, particularly where riparian habitat with river red gum *Eucalyptus camaldulensis* is present. These features are required for foraging, habitat, navigation, and spawning. Dams and minor waterways that lacked microhabitat or riparian vegetation were considered generally unsuitable for Murray cod.
- 3 To incorporate field verified habitat associations for the Connectivity Assessment Area, records of target species identified during surveys completed for the revised draft EIS (Appendix L and Appendix O in revised draft EIS) were compiled, along with other confirmed records in public databases. Habitat associations were then identified within ArcGIS by intersecting all records with the field verified vegetation mapping where available, and where not available, state mapped regional ecosystem mapping was used.
- 4 The same intersect method (as described in point 3 above) was used for Atlas of Living Australia (ALA) records within the Connectivity Assessment Area (i.e. 20 km buffer of the Project footprint).

These methods of identifying habitat have resulted in a list of habitat associations which are consistent with those used in Appendix L and Appendix O in the revised draft EIS, acknowledging the spatial scale of this assessment, are recognised in the scientific literature, and were correlated with species records. This approach is also consistent with the approach taken in the revised draft EIS, where any species with potential habitat or records within the Study Area (i.e. 1 km buffer) is assumed to potentially occur and connectivity must be provided.

The habitat mapping developed for the connectivity assessment may differ slightly to that used for the ecological impact assessments (revised draft EIS Chapter 11: Flora and Fauna, Appendix L: Terrestrial and Aquatic Ecology Technical Report and Appendix O: MNES Report) because it was developed for use at a different spatial scale. The habitat mapping used in the ecological impact assessment is focussed at fine spatial scales (i.e. restricted to the Project footprint) to identify habitat for the various species while the habitat mapping used for connectivity assessments is used to identify dispersal and movement areas and applies to a much larger landscape-scale assessment spanning up to 20 km on both sides of the Project footprint. In addition, the habitat mapping used in the impact assessment requires a high level of accuracy to quantify the amount of habitat lost and inform offset calculations. In contrast, the habitat mapping for connectivity assessment is principally required to identify all the potential areas where target species might interact with and attempt to cross the Project footprint.

This assessment identified broad areas in which the target species could potentially cross the Project footprint. The next step in the method was to identify with more precision where they would likely cross – this was done using the methods described in Section 3.5.

### 3.5 Assessing fauna connectivity along the Project footprint

The importance of locations for landscape connectivity were classified for each target species along the Project footprint. Classifications were determined using the following information sources applied to the criteria summarised in Table 3.3:

- Results of quantitative modelling, including least-cost paths and least cost corridors (Section 3.3).
- Broad-scale habitat identified by proximity assessments (Section 3.4).
- Fine-scale habitat identified using satellite mapping imagery.
- Species records.
- Waterway presence and type.
- Fencing presence and type.

Where more than one parameter applies, the highest resulting categorisation was used.

Table 3.3 Criteria for determining connectivity classification for each target species along the Project footprint.

| Parameter             | Relevant target species | Importance of location for fauna connectivity                                                                                                                                                                                                                                                                                                             |                                                                                                                                 |                                                                                                                            |                                   |
|-----------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
|                       |                         | High                                                                                                                                                                                                                                                                                                                                                      | Medium                                                                                                                          | Low                                                                                                                        | Nil                               |
| Habitat* <sup>+</sup> | All                     | The Project intersects a continuous corridor (including the BPA State and Regional Corridors) or habitat patch.                                                                                                                                                                                                                                           | A continuous corridor or patch is nearby on one side of the Project, and a non-continuous habitat patch is nearby on the other. | A continuous or non-continuous habitat patch is nearby on one side of the Project only.                                    | No habitat is nearby the Project. |
|                       | Murray cod              | Clear streams, turbid lowland rivers and billabongs, rivers and tributaries, inundated floodplain channels and anabranches. Particularly in association with river red gum woodland and with complex in-stream or riverbank structure and vegetation (i.e., large rocks, snags, overhanging vegetation, tree stumps, logs branches and woody structures). | Minor waterways with some limited suitable habitat features.                                                                    | Dams, streams with no microhabitat or riparian vegetation present. Minor waterways entirely lacking any permanent habitat. | NA                                |
| Records*              | All                     | A species record is < 1 km from the Project footprint.                                                                                                                                                                                                                                                                                                    | NA                                                                                                                              | NA                                                                                                                         | NA                                |

| Parameter                                                                                                              | Relevant target species                                      | Importance of location for fauna connectivity                                                                                                                                                                               |                                                                                             |                                                                                        |                                                                             |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
|                                                                                                                        |                                                              | High                                                                                                                                                                                                                        | Medium                                                                                      | Low                                                                                    | Nil                                                                         |
| Quantitative model results – presence and relative density of least cost paths and current density per target species. | Spotted-tailed quoll, gliding mammals, woodland birds        | Movement probability is relatively high at this location according to modelling output.                                                                                                                                     | Movement probability is relatively moderate at this location according to modelling output. | Movement probability is relatively low at this location according to modelling output. | Movement probability is nil at this location according to modelling output. |
| Waterways <sup>^</sup>                                                                                                 | Spotted-tailed quoll, gliding mammals, woodland birds, koala | The Project footprint intersects a stream order 4 waterway, which likely supports riparian woodland along its banks suitable for gliders and woodland birds and stream order 3 waterway for koala and spotted-tailed quoll. | The Project footprint intersects a stream order 3 waterway for gliders and woodland birds.  | NA                                                                                     | NA                                                                          |
|                                                                                                                        | Murray cod                                                   | DAF classification of major creeks and rivers (i.e. purple and red).                                                                                                                                                        | DAF classification of ephemeral creeks and tributaries. (i.e. amber).                       | DAF classification of overland drain (i.e. green).                                     | NA                                                                          |

\*Habitat and records are considered ‘nearby’ when they occur within the gap crossing distance of the target species. Due to variable and unknown survey effort for all species, species records were used to indicate a higher priority for connectivity, and not classified from low to high based on the number and/or proximity of records.

<sup>+</sup>Habitat is inclusive of habitat identified through modelling results, proximity assessments, and/or satellite imagery. Habitat patches and continuous habitat are inclusive of riparian and roadside corridors.

<sup>^</sup>Only stream order 4 waterways are considered potential habitat for the glider and woodland bird assessment due to the requirement for riparian woodland vegetation, which predominantly occurs in stream order 4 waterways and only sometimes occurs in stream order 3 waterways. Stream order 3 are considered potential habitat for koala and spotted-tailed quoll because they are capable of moving in areas with limited tree cover.

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## 3.6 Identification of priority connectivity zones

The importance of different sections of the Project footprint for fauna connectivity was assessed to identify areas that currently contribute comparatively more to ecological connectivity and were classified as Priority Connectivity Zones (PCZs). PCZs are areas where the mitigation of connectivity impacts is a higher priority for multiple target species.

It should be noted that specific locations outside of PCZs may still be important crossing locations for individual target species and mitigation measures such as wildlife crossing structures and fauna exclusion fencing will likely be required outside of the PCZs to support a holistic fauna connectivity solution for target species. The details of mitigation to be installed within PCZs and outside PCZs will be determined during detailed design and documented in the Wildlife Connectivity Plan.

The identification of PCZs also enables a prioritisation for both ecological outcomes and financial investment.

PCZs were identified in areas where:

- There are high levels of existing connectivity crossing the permanent Project footprint, such as where the Project intersects a BPA State or Regional Corridor, a local vegetation corridor, least cost paths and corridors, waterways, etc.
- Least cost paths contributed to the identification of the PCZs but were not definitive because they identify all possible movement pathways for a species without any prioritisation and were only identified for the three target species assessed using the quantitative connectivity modelling approach. Over-reliance of least cost paths to determine movement pathways and PCZs would under-emphasise the species assessed using the habitat proximity assessment method.
- Habitat for threatened species with geographically restricted ranges or species with very small movement capacity occurs (e.g. Murray cod, Condamine earless dragon, Brigalow woodland snail). For example, the Murray cod is restricted to crossing the Project footprint at a waterway, and thus that waterway is a priority mitigation location for that species. In contrast, the spotted-tailed quoll moves over large areas and is generally able to move along the Project footprint to find a suitable crossing location or structure.
- The Project footprint occurs in areas which contain broader connectivity elements, such as stepping stone habitat, where it runs parallel or adjacent to a waterway, and where an adjacent waterway connects to a higher order stream, BPA corridors, or state forest.
- There are known koala movement paths and home ranges, based on the results of tracking of koalas being undertaken by the University of Southern Queensland. This research was commissioned and funded by ARTC to better understand the ecology of koalas in the area and inform the mitigation strategies for the Project.
- There is proposed long-term security of ecological communities in areas adjacent to the Project footprint, such as offset properties established by the ARTC that contain habitat for threatened species and / or existing high levels of existing connectivity. The presence of these properties provides long-term security for crossing structures and prescribed land management that would increase the chances of mitigation effectiveness.
- The intent of the PCZs is that the spatial extent of each PCZ shall correspond with various relevant spatial features, such as the abutment of bridges (e.g. the PCZ shall encompass a whole bridge, rather than part of a bridge), the whole extent of an array of culverts, the high-quality habitats within BPA corridors, strips of riparian and/or roadside habitat, etc.



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## 3.7 Crossing structures and other design features for target species

This section describes the approach (Section 3.7.1) and specific mitigation measures for each target species (Section 3.7.2 to Section 3.7.9) adopted by the Project to maintain ecological connectivity. This detail informs the assessments made in Section 3.8 by describing the types and sizes of crossing structures suitable for each target species.

Specific design considerations and specifications for different types of crossing structures and other treatments are given in Section 5.

### 3.7.1 *Approach to maintaining fauna movement and preventing wildlife-train collisions*

There are two approaches that will be used to maintain fauna movement across the Project, namely wildlife crossing structures and at-grade crossings.

At-grade crossings are where wildlife are allowed or encouraged to cross the railway in the absence of any crossing structure - i.e. they walk, hop, climb or fly over the Project footprint and tracks. At-grade crossings enable the movement of wildlife but there remains a risk of collision with trains as fauna attempt to traverse the railway track and associated elements such as fencing and noise walls. There is also a risk of dehydration of species including turtles, amphibians and reptiles getting trapped between the tracks and dehydrating (Kornilev et al. 2006, Budzik and Budzik 2014, Dorsey et al. 2015). Therefore, at-grade crossings are not generally recommended for terrestrial species due to the risk of collision and only recommended for specific locations for species that fly (birds and bats) or glide (gliders) where they can pass safely above trains.

Wildlife crossing structures (i.e., underpasses and overpasses) are physical structures that allow for the safe movement of wildlife above or below the railway and eliminates the risk of wildlife-train collision (Smith et al. 2015, Denneboom et al. 2021).

Underpasses include:

- Bridge underpasses (Section 5.3)
- Dedicated fauna culverts (Section 5.4) and multi-use culverts (Section 5.5)
- Bridge underpasses with canopy bridges and/or glider poles (Sections 5.7, 5.8)

Overpasses include:

- Vegetated land bridges (which includes cut and cover tunnels and bored tunnels) (Section 5.2)
- Above-rail and below-rail canopy bridges (Section 5.7)
- Above-rail and under-bridge glider poles (Section 5.8)
- Canopy connectivity (Section 5.6).

Other considerations include fencing to prevent target species from accessing the railway and funnelling them to safe crossing locations (Section 5.14), fauna furniture (5.10) and revegetation to enhance the quality of the approaches to crossings as well as the crossing structure itself, and mitigation measures to reduce the disturbance caused by noise, artificial light at night, and vibrations (Section 5.12).

Fencing along the Project will be designed to exclude target species of wildlife from the railway to reduce the risk of wildlife-train collision and simultaneously direct wildlife to nearby wildlife crossing structures.

The spacing of crossing structures is an important consideration and is based on the movement distances and frequency of movements of the target species and the SMART goals (refer Section 6.1). For example, frequent and regular crossings by koalas are expected while greater gliders, reptiles and Brigalow woodland snails are more likely to cross infrequently while dispersing. The distance between crossing structures also depends on the distribution of habitat for the target species and the quality of that habitat. Indicative distances used in this Strategy are 400 m to 800 m for koalas (see Table 5.5 for rationale) and approximately 1 km apart to allow dispersal and gene flow for other target species.

The mitigation measures and other strategies in this Strategy are based on the revised and updated designs and advice in the Queensland Fauna Sensitive Transport Infrastructure Delivery Manual (FSTIDM) (TMR 2024i). The Wildlife Connectivity Plan for the Project will be developed during detailed design and will take into consideration any further revisions or updates to the FSTIDM, the results of targeted research commissioned by ARTC (e.g. koala tracking, reptile habitat experiments) or other evidence or updates to relevant best practise in fauna connectivity.

### 3.7.2 *Dimensions of bridges and culverts*

The dimensions of culverts and bridge underpasses is based on how fauna see or experience the crossing structure, as defined below and shown in Figure 3.2:

- Structure length is typically the biggest dimension of the structure - from one culvert opening to the other opening or from one bridge abutment to the other.
- Structure width is typically the smallest horizontal dimension of a structure - from one side of the culvert to the other, or the distance across the bridge as an animal moves across.
- Structure height is measured from ground level to the underside of the roof of culverts or bridge structure.

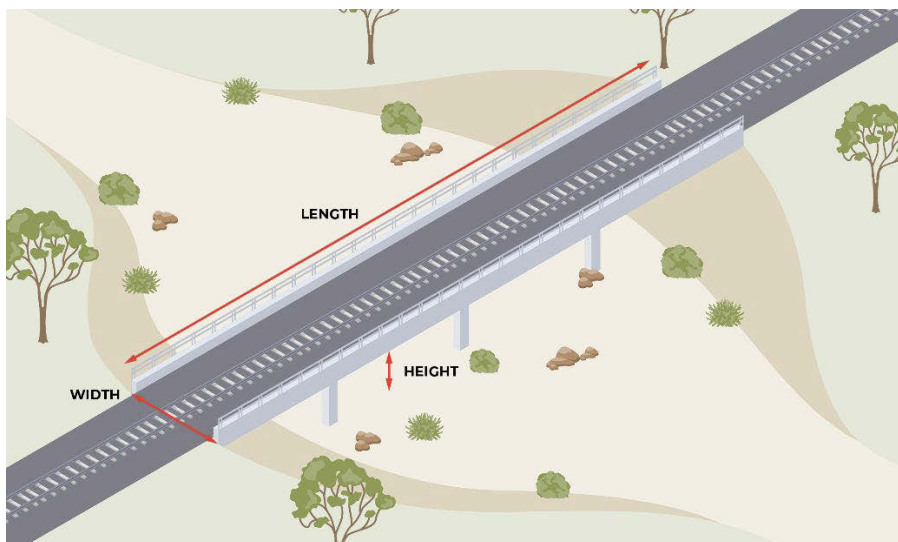
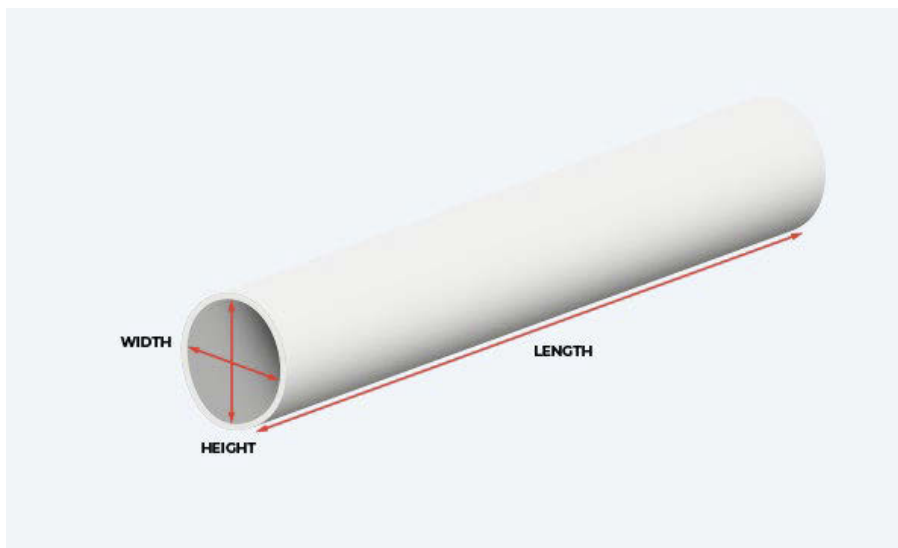
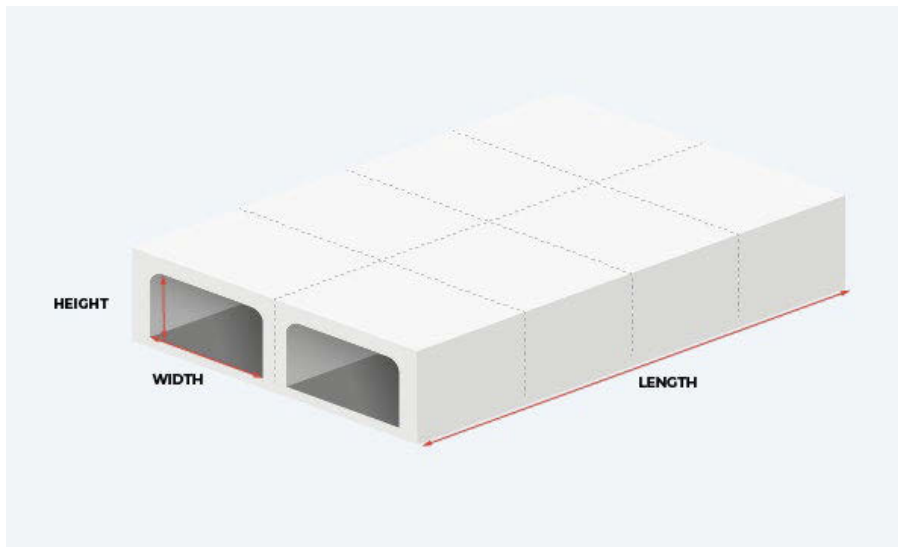


Figure 3.2. Definition of the size of (upper figure) reinforced concrete box culverts (RCBC), (middle) reinforced concrete pipe (RCP) culverts and (lower figure) bridge underpasses used in the Strategy.

### 3.7.3 *Woodland birds*

Despite being able to fly, linear clearings and transport infrastructure can be a barrier to the movement of some species of birds, especially woodland-dependent species and gap-sensitive species that avoid large clearings (Kociolek et al. 2015, TMR 2024d). The facilitation of safe movement of woodland birds across rail infrastructure is influenced by the size and design of the infrastructure, the size of associated clearings, inclusion of mitigation measures as well as the behaviour and movement of the species of bird (TMR 2024d). More mobile woodland birds that can fly across gaps in canopy cover are likely to fly over at-grade rail infrastructure, compared with more sedentary, gap-sensitive or ground-dwelling birds, which may see the infrastructure as a filter or barrier to movement. A conservative gap-crossing threshold of ~100 m was adopted for this Project, based on the well-studied movements of the brown treecreeper (Doerr et al. 2011). Species within the woodland bird guild with greater scales of movement will be largely unaffected by the railway and fly above the tracks (Appendix E4).

While there has been relatively little research on the use of wildlife crossing structures by birds, there is anecdotal evidence to guide the selection and design of crossing structures for birds on the Project. For example, wetland birds and other terrestrial birds that skulk have been observed walking under bridges and through culverts that are wet and not too enclosed (A. Richardson, pers. comm; Foster and Humphrey 1995). However, woodland birds and open-country birds are unlikely to regularly use culverts and many of those species are more likely able and willing to fly across the gaps created by the Project. Gap-sensitive woodland birds, such as the brown-treecreeper, are unlikely to frequently fly across large clearings, and they will require:

- Woodland vegetation or other suitable habitat occurring on both sides of the railway and in proximity to the railway to reduce gap-size and enable them to fly above the railway (i.e. at-grade crossings).
- High-clearance open-span bridges to fly under with vegetation and other habitat up to and under the structure. Open-span bridges with a low-clearance height may restrict bird movement where the underpass is enclosed, forcing birds to fly above the track, and potentially increasing the risk of wildlife-train collisions. Therefore, the optimal approach is high-clearance open span bridges or the railway on low formations or in cuttings where birds can more easily fly up and over the railway and trains.
- Vegetated land bridges are also very effective, with numerous species using them and many of those appearing to preferentially select the vegetated land bridge for crossing, rather than attempt to cross the road itself (Jones and Bond 2010, Jones and Pickvance 2013, Pell and Jones 2015).

Fencing is not effective for woodland birds, as they will easily fly above the fence or through the mesh.

### 3.7.4 *Spotted-tailed quoll*

Spotted-tail quolls are arboreal and physically capable of climbing and undertaking at-grade crossings of the Project (TSSC 2020), however this places them at increased risk of injury and mortality from collisions with trains. In addition, fencing installed to funnel koalas to underpasses will likely limit the movement of quolls and thus crossing structures are required to ensure connectivity for the species.

The only recorded use of crossing structures by the species was a box culvert and a Bebo arch under the Pacific Highway in northeast NSW (Sandpiper Ecological 2017, Michniewicz and Danvers 2021). The box culvert was a 3 m x 3 m x 66 m long combined drainage and fauna culvert and the Bebo arch was 9 m wide x 3 m high x 33 m long. These observations suggest that optimal culverts should be a minimum of 2.4 m x 2.4 m and < 50 m in length. Bridge underpasses of any size and vegetated land bridges would also likely be suitable for spotted-tailed quolls. The rate of use of crossing structures by quolls will likely be higher where furniture and habitat is provided, as is the case for many other species.

Fencing will be used to funnel spotted-tailed quolls to crossing structures and keep them off the railway.

### 3.7.5 *Gliding mammals*

The standard approach for maintaining connectivity across transport infrastructure for gliding mammals includes maintaining canopy connectivity, keeping glide distances within the glide capacity of the species, and installing canopy bridges and glider poles (Soanes and van der Ree 2015). Vegetated land bridges with mature trees and open span bridges with trees underneath are also highly likely to be used by gliders.

Canopy connectivity is not feasible on the Project because trees are not permitted above the track due to safety requirements. Minimising gap size and enabling glides from tree to tree across the track is also not feasible on the Project because greater gliders have a steep glide angle – and hence short glide – that is insufficient to traverse the track. Experts have reliably recorded maximum glide lengths of 70 – 80 metres in forest that was 40 – 45 metres tall, sometimes including slight downhill slopes (Rod Kavanagh pers. comm., Kita Ashman pers. comm.), equating to a glide angle of approximately 30°. In shorter forest (~20 – 25 metre height) in central Queensland, maximum length of six observed glides was 27 metres, equating to a glide angle of ~32° – 42° (Ben Nottidge pers. comm.). Other sources estimated a maximum glide angle of 40° (down from the horizontal) (Wakefield 1970a).

A conservative glide angle should be used to calculate maximum glide distances and glides must be achievable in both directions, always be above the height of the tallest trains and land at least two metres above the ground. For example, from the top of a 20-metre-high tree, using an estimated 40° glide angle and assuming the glider must land at two metres above the ground, a greater glider could cross an estimated gap of 21.5 metres.

Sugar gliders, Krefft's gliders, squirrel gliders, yellow-bellied gliders and mahogany gliders have been recorded using glider poles at many locations and by numerous individuals multiple times per night over extended periods of time (Taylor and Goldingay 2013, Soanes et al. 2015, Goldingay et al. 2018b, Soanes et al. 2018, Taylor and Rohweder 2020).

No greater gliders have been observed using glider poles to cross roads or railways. Greater gliders have been detected on glider poles on a 30 – 60 metre wide cleared pipeline easement in Victoria (GHD 2017). It is unclear if successful crossings were made and also unclear if greater gliders glided to the poles or climbed up the poles from the ground (although the latter is unlikely) (GHD 2017). Nevertheless, greater gliders were detected on six arrays of glider poles out of 13 arrays, thus suggesting a potential willingness and/or ability for the species to use glider poles.

Greater gliders have been observed using a rope bridges in managed temperate eucalypt forest in the Central Highlands of Victoria (Slapp 2023). The rope bridge was a single strand of 100 mm diameter sisal rope approximately 6 m long suspended between two trees across an access road to a logging coupe. Two bridges were installed in areas where greater gliders had been observed previously. Three individual visits by greater gliders on the rope bridge were captured by remote sensing cameras at one site 270 days after installation. No greater gliders were observed using the second rope bridge. Krefft's gliders were observed using the rope to launch from, potentially acting as a surrogate branch, however, although greater gliders appeared to attempt this, the rope bridge was not stable enough to facilitate this action. The study noted that a thicker rope or a larger ladder-style rope bridge may be better suited to allow greater gliders to walk along the ladder and to launch to and from the ladder.

An incidental observation of a greater glider using a timber fence rail approximately 170 cm high in Maryborough, Queensland, was made by a member of the public in May 2024 (pers. comms).

The lack of records of use of glider poles and canopy bridges over major roads or railways by greater gliders is likely to be partially due to a paucity of monitoring of these crossing types in areas where greater gliders occur. The low frequency of train passage at night, coupled with retained trees at crossing zones (where feasible), are expected to facilitate the movement of greater gliders across the Project, subject to corridor width, vertical height of the railway formation and other physical infrastructure in the rail corridor. Greater gliders and yellow-bellied gliders are also expected to use open-span bridges with high clearance (>10 – 15 m) and mature trees underneath, as well as vegetated land bridges with mature trees. Neither species is expected to routinely use culverts of any dimension.

Fencing is not effective for gliders as they can glide above the fence, and barbed-wire fencing can pose a risk of entanglement where gliders get caught up on the barbs when their glide trajectory passes fences (van der Ree 1999).

### 3.7.6 Koala

There has been extensive research and monitoring to develop and install crossing structures across transport infrastructure for koalas (TMR 2024i). Extensive use of culverts and bridge underpasses by koalas have been reported in the literature, including under railways (Jones et al. 2013, Dexter et al. 2016, Goldingay and Taylor 2017, Hanger et al. 2017). A wide range of culvert sizes have been used, with some as small as 900 mm diameter. However, larger structures (>1.8 m to >2.4 m) and box culverts permit inclusion of antipredator features, such as log rails and refuge poles and are thus preferred over smaller-sized structures, and thus structure suitability varies according to its dimensions (Table 3.4).

Koalas have not been observed using rope ladder canopy bridges during targeted trials (Goldingay and Taylor 2017) or at the many canopy bridges installed at locations where koalas are present. A recent report of a single koala using a canopy bridge made of logs in Brisbane has been reported in the media, suggesting this approach might be suitable, but further testing is required.

Koalas will use vegetated land bridges, once the trees have matured. As koalas can traverse cleared farmland between trees, they may also use unvegetated land bridges with or between scattered mature trees, however the inclusion of trees and refuge poles are required to provide protection from predators.

Correctly designed fencing (1.8 m cyclone mesh fencing, with sheet metal panels to prevent climbing – Section 5.14.2) will funnel koalas to crossing structures and keep them off the railway. There is uncertainty about the effectiveness of escape mechanisms (e.g. climbing poles over fences, jump-outs and one-way doors) for koalas (Section 5.15) and there are trials currently underway to further test and evaluate these devices. The most up to date information available during detailed design will be adopted for the species.

### 3.7.7 Woodland reptiles, cracking clay reptiles, and Condamine earless dragon

The amount of research globally and in Australia on the use of crossing structures across roads and railways by reptiles is significantly lower than for mammals and similar to birds and amphibians (Rytwinski et al. 2016, Soanes et al. 2024).

Within Australia, numerous records of medium to large-sized reptiles, such as lace monitors, blue tongue skinks and stumpy-tail lizards have been observed using culverts, bridge underpasses and vegetated land bridges (Soanes and van der Ree 2009a, Chambers and Bencini 2015, McGregor et al. 2015, Goldingay et al. 2022). Lace monitors used large culverts under the Pacific Highway in NE NSW (Goldingay et al. 2022) and small slotted open-top culverts under a narrow and low-volume road at the Royal Botanic Gardens Cranbourne were used by blotched blue-tongue lizards, lowland copperhead snake, eastern tiger snake, long-necked turtle, and tree dragon (Terry Coates, pers. comm.). Other species of snakes have been observed passing under bridges during site inspections (R. van der Ree, pers. obs.).

There is little published information about smaller reptile species and snakes in Australia, which is at least partially because they are not detected using standard thermal/heat-sensitive cameras used for mammals.

There has been no specific research or monitoring of underpasses for woodland reptiles, cracking clay reptiles or Condamine earless dragons that occur in the vicinity of the Project. Due to the lack of available information on Brigalow Belt reptiles such as the yakka skink, Dunmall's snake, collared delma, five-clawed worm skink and the Condamine earless dragon, ARTC commissioned the University of Southern Queensland (USQ) to research a number of aspects for reptiles including survey methods, habitat associations and habitat preferences including artificial habitat design. The outcomes of this on-going research will be used to bridge gaps in current ecological knowledge for reptile species known to be present in the project area and will be used to inform site-specific mitigations for fauna connectivity. The following design features are expected to be important and will be adopted on the Project, with updates based on the USQ research outcomes:

- Floor of culvert with natural substrate, including logs and rocks, to mimic their preferred habitat. Slow-moving species and habitat specialists will require habitat elements to survive while passing through.
- Culverts are as short and as open (i.e. as high and wide) as possible.
- Bridge underpasses, with continuous habitat and vegetation, are highly likely more effective than culverts.
- High quality and extensive vegetation and habitat leading to underpass entrances critical.
- Funnel fencing to funnel reptiles to underpasses likely required, unless other natural features, such as rock ballast, are similarly effective.



The ARTC will commission further research on approaches to protect the structure and function of the cracking clay soils which provides important habitat for numerous reptile species. This research may include, for example:

- The use of plates and other physical structures that prevent or minimise soil compaction.
- The use of geotextile and crushed rock during construction, which is removed after construction, re-exposing the natural structure of the cracking clays.

### 3.7.8 *Brigalow woodland snail*

There are no targeted trials or monitoring of snails using crossing structures in Australia or internationally (TMR 2024h), H. Reck, pers. comm). Given their slow and short movements, all crossing structures for snails must include suitable habitat for them to occupy while they traverse the crossing structure.

Snail movements are most likely to occur during wet periods and overland flooding events, and crossing structures must permit flow of water and snails.

Bridge underpasses associated with waterways, and containing natural soil substrate with extensive leaf and log cover are likely most effective for brigalow woodland snail as they contain natural light, are relatively short, support natural hydrological flows and allow vegetation to grow underneath (TMR 2024h). Habitat for snails to occupy while they traverse will be required.

Culverts with natural floor substrates, including leaves, logs, depressions with retained moisture may also be effective, but they must remain moisture to prevent snails from drying out. Snails are unlikely to cross directly on the concrete floor of culverts due to desiccation (H. Reck pers. comm). Culverts should be as short as possible.

Land bridges are likely effective if they contain suitable habitat for the snails and allow overland flow of water and/or remain moist. This can be achieved where the railway is in a cutting and the surface of the land bridge is close to horizontal and occurs in an area where water may flow or can be redirected to pass over the land bridge.

Funnel fencing or other natural barriers (e.g. rock ballast) to snail movement are required to funnel snails to crossing structures.

### 3.7.9 *Murray cod*

There are multiple sources of evidence that many fish species are able to pass under roads and railways when the bridge spans both banks and there are no major changes to water velocity, turbidity, light levels or water temperature (!!! INVALID CITATION !!! (O'Connor et al. 2015, Ottburg and Blank 2015, O'Connor et al. 2017a, O'Connor et al. 2017b, O'Connor et al. 2017, DAF 2018, Franklin et al. 2018, DAF 2019, TMR 2024h)). Culverts are generally less effective than bridge underpasses for fish passage but may be adequate for many species when the in-stream velocity is not increased and when the entrances or exits of the culvert are not perched (TMR 2024i). Poorly designed and poorly maintained culverts can be barriers to fish migration if the water flow through the culvert is too fast or highly turbulent. In addition to physical barriers, water quality can also impact Murray cod movement.

No specific data is available on the use of waterway crossings by Murray cod, however the impacts of culverts, road crossings and gauging weirs on fish movement is generally described in O'Connor et al. (2017) and they also provide a suite of measures to improve their function that are relevant to Murray cod.

All waterways that potentially support Murray cod will be designed with bridges that prevent disruption to the movement of Murray cod.



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## 3.8 Suitability assessment of culverts and bridges as wildlife crossing structures

This section describes the methods used to assess the revised reference design (including the type, location and design of fencing, culverts and bridges) for its ability to support fauna passage and landscape connectivity for target species. The details of the drainage structures, including over 3,000 culverts, are summarised in the culvert register in Appendix T1 of the revised draft EIS: Hydrology and Flooding Technical Report Vol 1 (sub-appendix B) and have been digitised for location and dimension in the biodiversity modelling. Assessment of the Project culverts and bridges was against the criteria in Section 3.6 and Table 3.4

Identified fauna connectivity deficiencies has been summarised in Section 4.3, such as culvert conflicts or the lack of a suitable crossing structure, or due to the lack of design maturity allowing effective mitigation (such as fauna furniture, landscaping and crossing structure baffling). A framework for mitigating conflicts in the design phase is presented in Section 7.2 to guide detailed design for incorporation of these requirements into the Wildlife Connectivity Plan to ensure the Project does not pose an unacceptable risk to fauna connectivity and cause fragmentation from barrier impacts.

The parameters used in this assessment included:

- Dimensions of revised reference design crossing structures (detailed in Table 3.4). Only crossing structures were assessed at this step because the permeability of the revised reference design was assessed during modelling with resistance values for clearing width, height of fill and depth of cuttings (Section 3.3, Table 3.2).
- Only a single culvert or bridge span was assessed where that culvert formed part of an array of culverts, or the bridge was a multi-span bridge. In other words, the array was represented by a single culvert or bridge span.
- Accessibility of revised reference design crossing structures, including:
  - Connectedness to surrounding habitat.
  - Access to the crossing structure without leaving the canopy for gliding mammals.
  - Presence of knot mesh fencing.
  - Suitability identified by species expert (Murray cod only).

These parameters were applied according to the criteria summarised in Table 3.3. Culverts were not assessed for gliding mammals and woodland birds because they are too small in size to be effective crossing structures for these target species.

The revised reference design was then evaluated by cross-referencing the importance of the location for connectivity (as described in Section 3.5) against the structure suitability classified in Table 3.4. The matrix used to classify revised reference design locations as satisfactory or unsatisfactory for mitigating impacts to landscape connectivity using these classifications is provided in Table 3.6.

For the assessment of culverts and bridges, key design changes required to improve the suitability of structures that were classified as unsatisfactory were noted. In addition, any crossing locations without design features that could be modified for a wildlife crossing structure were also identified.

It was assumed that each drainage structure that is within a connectivity area for a target species that is to function as a crossing structure will be modified or managed in the following ways (relevant for each target species) in accordance with ARTC's approach to maintain fauna connectivity to ensure it functions adequately as a crossing structure for the target species:

- The drainage structure will be re-designed and maintained primarily for the movement of fauna by providing dry passage for species that require dry passage (most terrestrial species), except during occasional flood events. Dry passage will be achieved according to the species-specific requirements outlined in Section 5, and could include the raising of one culvert in an array of culverts, inclusion of a shelf or ledge, or extending bridge lengths to provide a section of dry embankment above the waterway.

- Drainage structures that are to remain damp (i.e. for Brigalow woodland snail) will be re-designed during detailed design to retain sufficient moisture to remain damp for as long as possible.
- Pipe culverts that are to function as crossing structures will be converted to box culverts to enable natural substrate and other fauna furniture on the floor of the culvert. When part of an array of multiple culverts, only the outer two pipe culverts will be converted to box culverts. All culverts intended for stock and machinery movement would be modified to also effectively function for wildlife through inclusion of fauna furniture and modified fencing.
- The specific 'fauna furniture' required for each target species will be provided within the wildlife crossing structures, as described in Section 5.10.
- Appropriate fencing, where required, is provided to funnel fauna to the crossing structures. Fencing along the Project footprint will be designed to not hinder the movement of fauna to the crossing structures or crossing locations by funnelling fauna to these locations and limiting access to the track elsewhere.
- The wildlife crossing structures, approaches to crossing structures, and fencing is managed and maintained into perpetuity to enable the movement of fauna.
- The spacing of bridges and culverts as potential crossing structures was not considered when assessing suitability of individual drainage structures because structures may change during detailed design. The spacing of structures for different target species will be determined during detailed design and based on the movement distances and frequency of movements of the target species and the SMART goals.
- Existing vegetation and/or habitat within the Project footprint that facilitates connectivity to crossing structures will be retained where possible (e.g. subject to safe operation of the railway), and/or re-instated or created after construction to enable fauna to access the entrances to culverts and bridges and achieve connectivity from the adjacent habitat (Section 5.13). This strategic revegetation of habitat is specifically focussed on providing connectivity to the crossing structures and differs from general habitat rehabilitation elsewhere on the Project. The need for strategic revegetation at locations where suitable vegetation or habitat is absent but is required to increase effectiveness of the crossing structures has been noted in Appendix F. This is particularly relevant for reptiles and Brigalow woodland snail which have low mobility, and greater gliders with relatively short glides from shorter trees. Gap-sensitive woodland birds have a gap-crossing threshold of ~100m, and thus woodland vegetation within the Project footprint is not required where the gap is less than this threshold.
- The construction methods will consider approaches to protect, retain and restore relevant habitat that is important for achieving connectivity for target species in key locations, where required. This could include measures to protect the cracking clay soil profile for various reptiles and reducing the extent of clearing at PCZs and specific crossing locations where possible for woodland dependent species.

These assumed modifications are relatively minor and can be accommodated within the current design without major structural changes to the Project. For example, a 1.8 m diameter pipe culvert can be swapped out for a 1.8 m box culvert without raising the height of the railway. Other similar changes include adding a dedicated fauna culvert at each end of an array of drainage culverts or adding furniture inside an existing structure.

The site-specific mitigation measures that are essential for ensuring successful fauna connectivity outcomes (e.g. fauna furniture, funnel fencing and ground cover) will be determined on a case-by-case basis for each crossing location and will be finalised when there is sufficient design maturity to enable the detailed requirements to be specified and incorporated into the Wildlife Connectivity Plan. The framework presented in Figure 1.2 and described Section 7.2 demonstrates how the Project's design progression will integrate fauna connectivity requirements and be documented in the Wildlife Connectivity Plan.

Table 3.4 outlines crossing structure dimensions and an assessment of suitability for each target species, which was classified as high, medium or low. This classification scheme acknowledges that structure suitability varies along a continuum and is not typically a binary suitable or unsuitable, as fauna may still occasionally use under-sized culverts. Where possible, high-suitability structure sizes will be adopted on the Project. Dimension criteria are based on published literature and guidelines, specifically the TMR FSTIDM (TMR 2024i). Structure dimension is one of the factors used to classify overall structure suitability, other factors are included in Table 3.5.

Table 3.4 Criteria for determining structure suitability classification based on structure dimensions.

| Target species                         | Suitability of structure dimensions |                   |                                 |                                |                   |                   |                                   |                   |                                 |
|----------------------------------------|-------------------------------------|-------------------|---------------------------------|--------------------------------|-------------------|-------------------|-----------------------------------|-------------------|---------------------------------|
|                                        | High                                |                   |                                 | Medium                         |                   |                   | Low                               |                   |                                 |
|                                        | Culvert<br>(H x W,<br>L) (m)        | Bridge<br>(H) (m) | Noise<br>wall (L)               | Culvert<br>(H x W,<br>L) (m)   | Bridge<br>(H) (m) | Noise<br>wall (L) | Culvert<br>(H x W,<br>L) (m)      | Bridge<br>(H) (m) | Noise<br>wall (L)               |
| Koala and spotted-tailed quoll         | ≥2.4 x 2.4, <50                     | ≥2.4              | < species gap crossing distance | 1.2 x 1.2 - 2.399 x 2.399, <50 | 1.2 – 2.399       | NA                | < 1.2 x 1.2, ≥50 OR any size, ≥50 | <1.2              | ≥ species gap crossing distance |
| Gliding mammals                        | NA                                  | ≥10               |                                 | NA                             | NA                |                   | NA                                | <10               |                                 |
| Woodland birds                         | NA                                  | ≥10               |                                 | NA                             | 5 – 9.99          |                   | NA                                | <5                |                                 |
| All reptiles*, brigalow woodland snail | Any size (H x W), <50               | Any size          |                                 | Any size (H x W), <50          | NA                |                   | Any size (H x W), ≥50             | NA                |                                 |

\*Cracking clay reptiles, woodland reptiles and Condamine earless dragon.

Table 3.5 Criteria for determining suitability of revised reference design for each target species along the Project. Where more than one parameter applies, the lowest resulting categorisation is used.

| Parameter                                         | Relevant target species                          | Suitability of revised reference design                                                                       |                     |                                                                                                                                                                                                        |
|---------------------------------------------------|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                   |                                                  | High                                                                                                          | Medium              | Low                                                                                                                                                                                                    |
| Dimensions of revised reference design structures | All                                              | Refer to Table 3.4.                                                                                           | Refer to Table 3.4. | Refer to Table 3.4.                                                                                                                                                                                    |
| Connectedness to surrounding habitat              | All                                              | Gaps in vegetation between the crossing and surrounding habitat < species gap crossing ability.               | -                   | Gaps in vegetation between the crossing and surrounding habitat ≥ species gap crossing ability.                                                                                                        |
| Accessibility from canopy (for gliders)           | Gliding mammals                                  | A crossing structure is accessible without leaving the canopy.                                                | -                   | A crossing structure is not accessible without leaving the canopy.                                                                                                                                     |
| Accessibility due to fencing                      | Spotted-tailed quoll, gliding mammals, and koala | Fencing is not causing a barrier that prevents access to the crossing structure. Barbed wire is not proposed. | -                   | Knot mesh fencing with barbed wire is causing a barrier that prevents access to the crossing structure. Barbed wire can cause injury and mortality of wildlife as they attempt to climb or glide over. |

Table 3.6      Assessment matrix used to classify reference design locations as satisfactory or unsatisfactory for mitigating impacts to landscape connectivity for each target species.

| Importance of location for fauna connectivity (refer Table 3.3) | Structure suitability |                |                |
|-----------------------------------------------------------------|-----------------------|----------------|----------------|
|                                                                 | High                  | Medium         | Low            |
| High                                                            | Satisfactory          | Unsatisfactory | Unsatisfactory |
| Medium                                                          | Satisfactory          | Satisfactory   | Unsatisfactory |
| Low                                                             | Satisfactory          | Satisfactory   | Satisfactory   |

# 4 Connectivity assessment results

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## 4.1 Overview of results

This section of the Strategy summarises the results of connectivity modelling and the habitat association assessment and describes where the wildlife crossing structures are to be installed along the Project footprint, where the PCZs are located and the details of the crossing structures for each target species. The specific results are:

- 1 The broad-scale distribution of habitat and landscape-scale connectivity for the target species (Section 4.2).
  - 2 The location and description of the PCZ (Section 4.3).
  - 3 The assessment of the potential suitability of structures and features of the revised reference design (e.g. drainage structures, indicative location of noise walls, fencing, other bridges such as road over rail) as potential wildlife crossing structures (Section 4.4).
  - 4 An assessment of the likely effectiveness of proposed mitigation measures across the Project and within the PCZs (Section 5.16).
- 

## 4.2 Broad-scale distribution of habitat and landscape-scale connectivity

This section describes the broad-scale distribution of habitat areas and ecological connectivity for each target species within the Connectivity Assessment Area. The overview maps provided in this section are illustrative of the distribution of habitat and show known target species records. Detailed maps for the target species are provided at a finer scale in the relevant map series provided in Appendix E.

## 4.2.1 Woodland birds

The greatest connectivity for woodland birds in the Connectivity Assessment Area is located near Yelarbon State Forest, Whetstone State Forest, and Bringalily State Forest in the central portion of the Project (Figure 4.1). These State forests are also connected to habitat along the Dumaresq River and MacIntyre Brook at the NSW border. These areas provide important habitat and connectivity for woodland birds in the Connectivity Assessment Area. North of Bringalily State Forest, habitat occurs primarily along waterways and road reserves, and as small scattered patches on farmland. These linear strips and small patches of habitat are important for supporting populations of woodland birds and enabling connectivity across the landscape. See Appendix E4 for detailed maps.

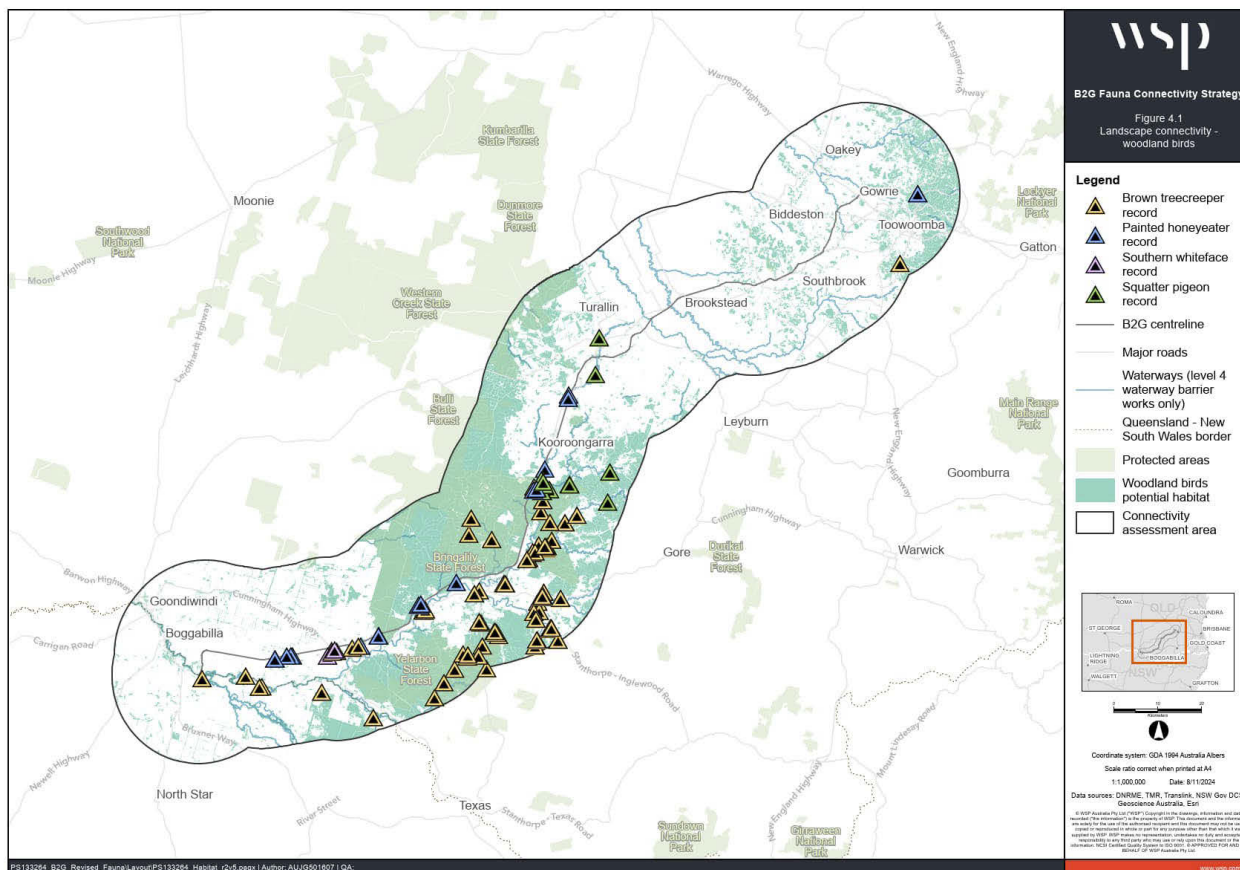


Figure 4.1 Broad-scale distribution of habitat and records for woodland birds within the Connectivity Assessment Area.

## 4.2.2 Spotted-tailed quoll

There are scattered patches of habitat for the spotted-tailed quoll in the north-east of the Connectivity Assessment Area in an already fragmented landscape and long distances between larger patches of habitat (Figure 4.2). The area south of Millmerran contains large areas of habitat and high connectivity for terrestrial mammals, especially the forest-dependent spotted-tailed quoll. The large forest patches associated with Whetstone State Forest, Yelarbon State Forest and Bringalily State Forest south of Millmerran provide the highest value connectivity in the Connectivity Assessment Area. These forest patches and linkages are critical for connectivity and without them, the landscape would not be connected along the north-west boundary of the Connectivity Assessment Area. Connectivity north of Pittsworth is fragmented as the larger patches of habitat associated with State forests are replaced with smaller patches of habitat associated with road reserves, riparian corridors, and scattered patches of vegetation. A recent (04/2024) record of a spotted-tailed quoll in habitat fragmented by agricultural land near Millmerran highlights the likely importance of riparian corridors for landscape permeability for terrestrial mammals. See Appendix E3 for detailed maps.

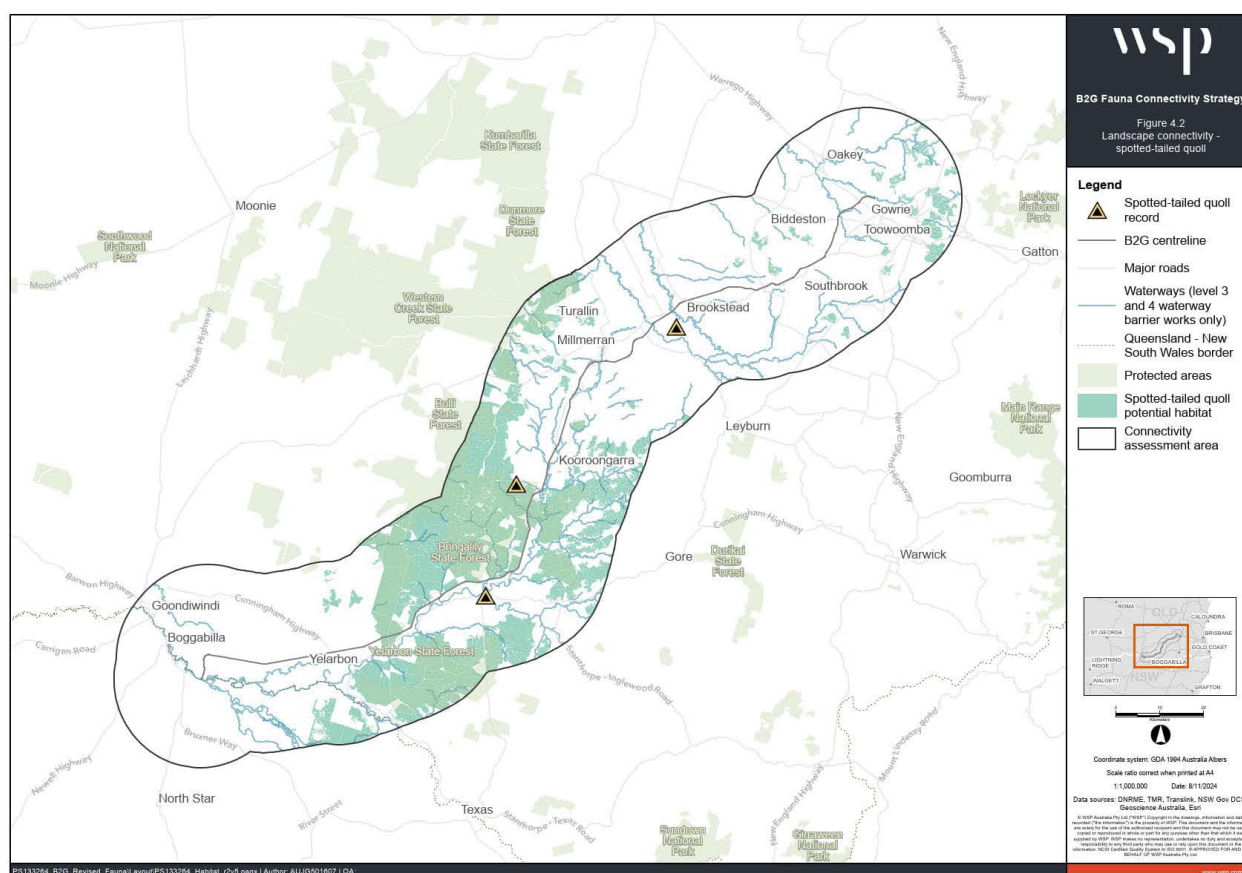


Figure 4.2 Broad-scale distribution of habitat and areas of landscape-scale connectivity for the spotted-tailed quoll within the Connectivity Assessment Area.



### 4.2.3 Gliding mammals

There are scattered patches of wooded habitat throughout the Connectivity Assessment Area, highlighting an already fragmented landscape for gliding mammals (Figure 4.3). The area south of Millmerran contains large patches of wooded habitat and high levels of connectivity for gliding mammals, containing the highest value connectivity in the Assessment Area. Connectivity is present through the Whetstone State Forest, Yelarbon State Forest and Bringalily State Forest areas, continuing north along both the western and eastern boundaries of the Connectivity Assessment Area. These patches and linkages are critical for connectivity and without them, the landscape would not be connected along the north-west boundary of the Connectivity Assessment Area. Connectivity north of Pittsworth is fragmented as larger patches associated with State forests are replaced with smaller patches of wooded vegetation associated with road reserves, riparian corridors, and scattered patches within agricultural landscapes. See Appendix E4 for detailed maps.

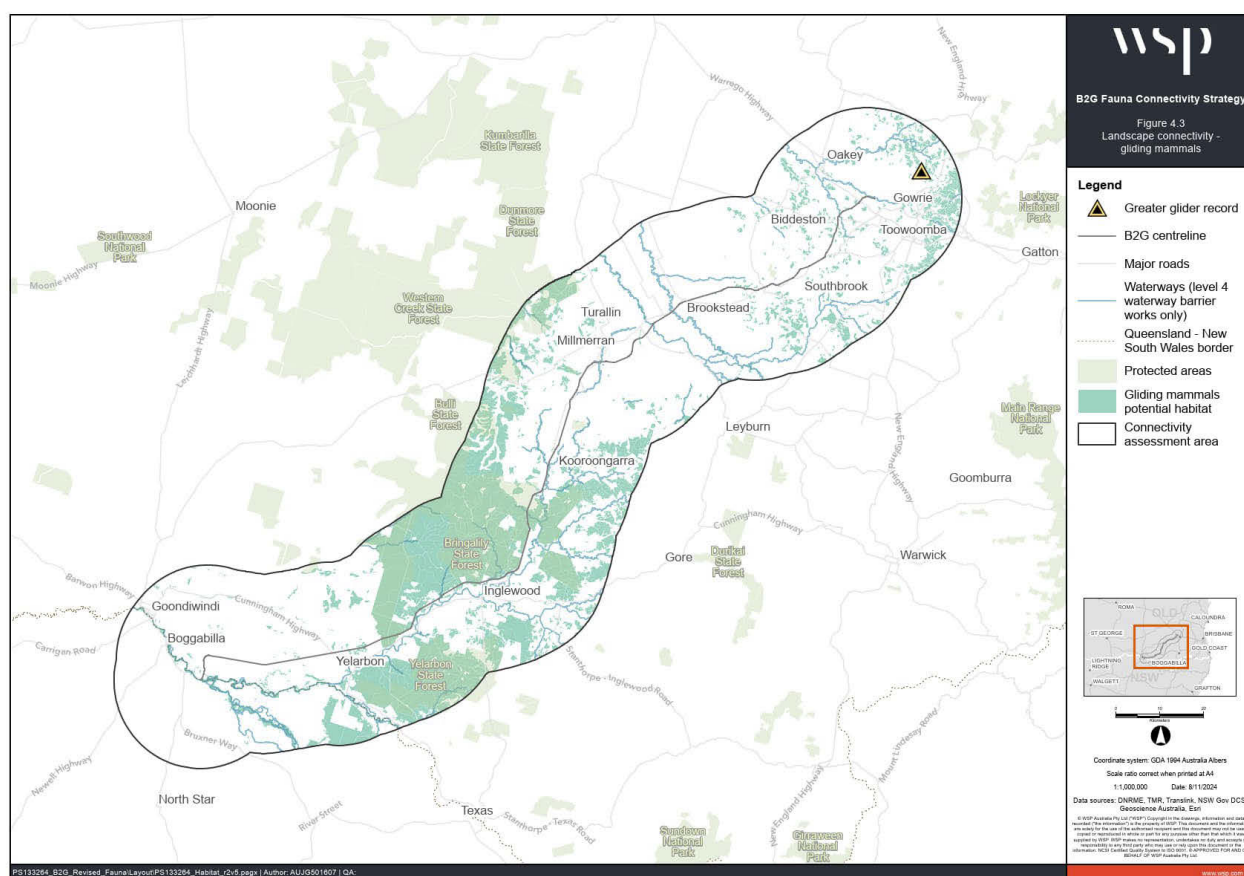


Figure 4.3 Broad-scale distribution of habitat and areas of landscape-scale connectivity for gliding mammals within the Connectivity Assessment Area.

#### 4.2.4 Koala

Connectivity for koalas is widespread across the Connectivity Assessment Area, reflecting the ability of this species to utilise scattered trees in otherwise highly cleared and fragmented landscapes (Figure 4.4). The large forest patches associated with Whetstone State Forest, Yelarbon State Forest and Bringalily State Forest provide extensive contiguous habitat and high connectivity in the Connectivity Assessment Area. The highest density of koala records occurs to the east of Pittsworth, largely originating in smaller patches of trees associated with road reserves, riparian corridors and in scattered trees in farmland.

Through a research partnership between ARTC Inland Rail and the University of Southern Queensland (UniSQ), a total of 47 koalas between Southbrook and Canning Creek have been captured and fitted with GPS collars to identify habitat utilisation and movement pathways (UniSQ 2024). Koala habitat selection showed a preference for wooded habitat comprising of preferred feed and resting trees including *Eucalyptus populnea*, which was the most significantly utilised, and a variety of canopy and midstorey species not limited to *E. crebra*, *E. brunnea*, *E. melanophloia*, and *Acacia* sp. (UniSQ 2024). Grassland habitat was the second most utilised habitat type, demonstrating movement of koala through grassland and agricultural fields to feed trees and patches of habitat within a fragmented landscape (UniSQ 2024). Breeding was also confirmed across the survey sites, with 54% of captured females recorded with joeys (UniSQ 2024).

Between April 2023 and May 2024, UniSQ obtained usable GPS location data from 38 collared koalas, comprising 18 males and 20 females (UniSQ 2024). Male and female koalas within the Connectivity Assessment Area are moving an average of  $173 \pm 220$  m/day and  $106 \pm 185$  m/day, respectively, with the highest travel distances occurring between July and December (UniSQ 2024). Daily movement rates were nearly three times higher during the dispersal phase ( $341 \pm 498$  m/day) compared with the non-dispersal phase ( $107 \pm 188$  m/day (UniSQ 2024). Home ranges for dispersing koalas were also higher (mean =  $2.45 \pm 2.4$  km<sup>2</sup>) compared with non-dispersing (mean =  $0.57 \pm 0.5$  km<sup>2</sup>) and variable among sexes, with males moving greater distances than females (UniSQ 2024). Monitoring also identified 132 crossing occurrences of the proposed Project footprint by 11 koalas during the survey period (UniSQ 2024), indicating that habitat trees or patches of trees occur on both sides of the Project footprint which require effective crossing structures to facilitate continued movement post-construction.

The movement paths of tracked koalas are shown as red lines in Figure 4.4 (UniSQ 2024).

The stability of the koala population and high levels of connectivity in the Connectivity Assessment Area are further confirmed by results from a genetic study which identified high levels of genetic diversity ( $H_e$  0.29), low levels of inbreeding ( $F_s$  0.12) and low levels of genetic differentiation among samples collected from Lockyear Valley/Toowoomba Region ( $F_{st}$  0.3), northern New South Wales (0.07) and the Tenterfield Region (0.03) (ERM 2023). The low levels of genetic differentiation demonstrate high gene flow across the Connectivity Assessment Area and evidence that koalas are currently navigating existing roads, railway lines and agricultural areas to maintain a healthy, outward-breeding population. See Appendix E3 for detailed maps.

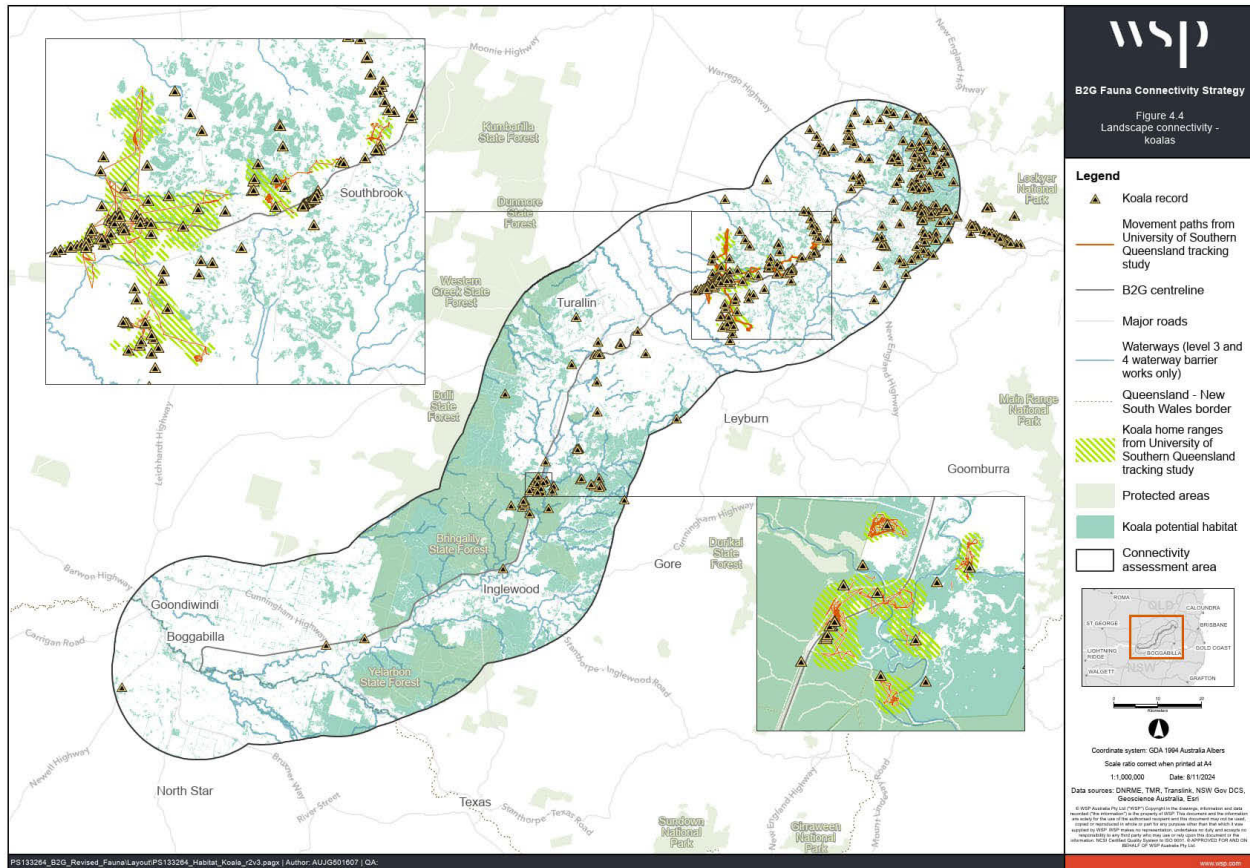


Figure 4.4 Broad-scale distribution of habitat and areas of landscape-scale connectivity for koala within the Connectivity Assessment Area

## 4.2.5 Woodland reptiles

The majority of habitat and landscape-scale connectivity for woodland reptiles is primarily associated with the State forests to the south of Millmerran through the Whetstone State Forest and Bringalily State Forest (Figure 4.5). North of Millmerran, clearing and fragmentation increases as larger areas of habitat associated with State forests are replaced with smaller areas associated with road reserves, riparian corridors, and scattered patches of vegetation within cleared farmland. Habitat and connectivity are also present around Toowoomba and is mostly associated forest and woodland in the Great Dividing Range.

Through a research partnership between ARTC Inland Rail and the UniSQ, a total of 19 collared delma were recorded under tile grids at Ballard within eucalypt forest (UniSQ 2024). Mark and recapture techniques of these 19 individuals did not detect any recaptures, to date, indicating that the population of collared delma is possibly larger than expected or moving greater distances than expected (UniSQ 2024). Future results of this research will be used in the detailed design of crossing structures and other mitigation for this species.

See Appendix E1 for detailed maps.

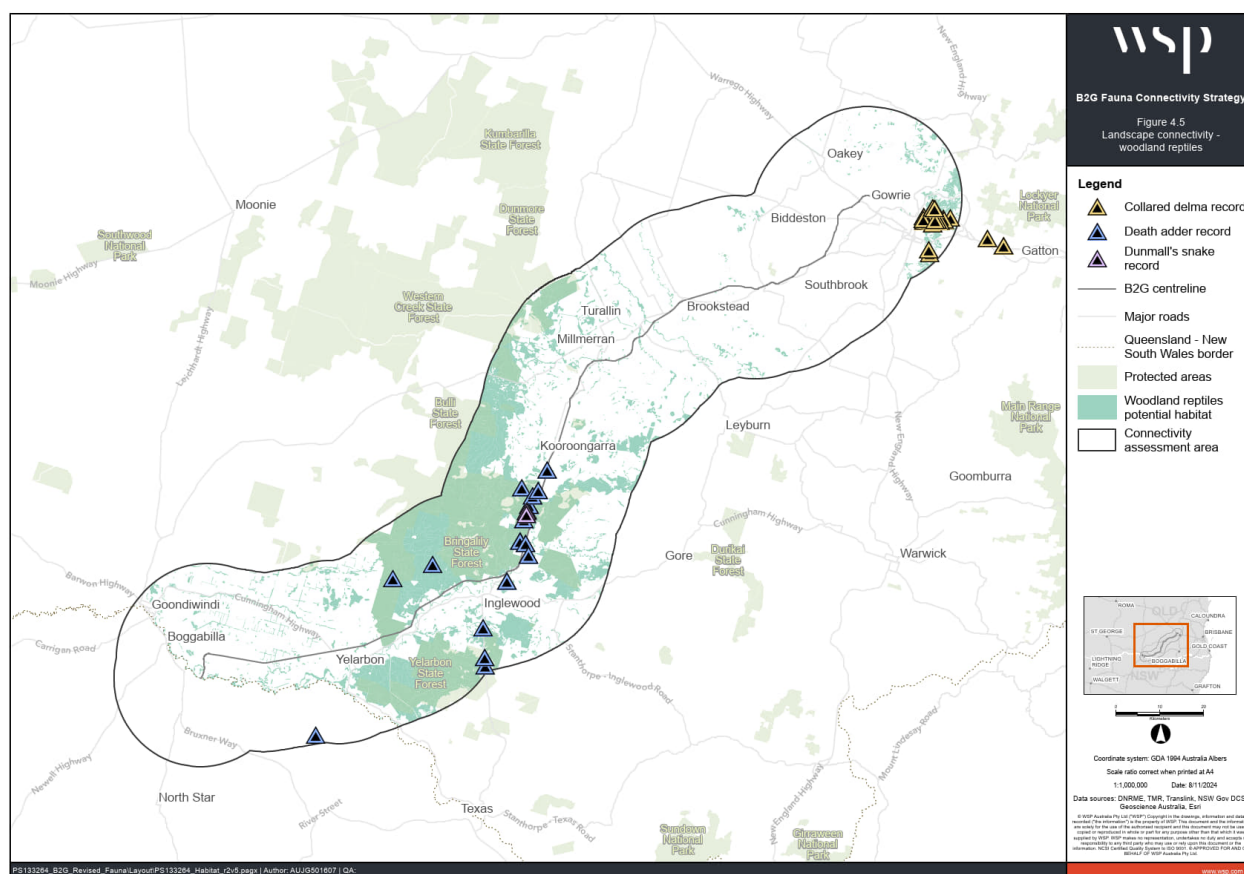


Figure 4.5 Broad-scale distribution of habitat and areas of landscape-scale connectivity for woodland reptiles within the Connectivity Assessment Area.



## 4.2.6 Cracking clay reptiles

Habitat and connectivity for reptiles dependent on cracking clay soils is primarily associated with the State forests to the south of Millmerran, principally Whetstone State Forest, Yelarbon State Forest and Bringalily State Forest (Figure 4.6). North of Millmerran, habitat and connectivity is present in road reserves, riparian corridors and for some species, agricultural land. Connectivity around Toowoomba is present and is associated with the Great Dividing Range.

Through a research partnership between ARTC Inland Rail and UniSQ, one five-clawed worm skink was recorded in March 2024 in a roadside near Bowenville, and three near Yarranlea (UniSQ 2024). See Appendix E1 for detailed maps.

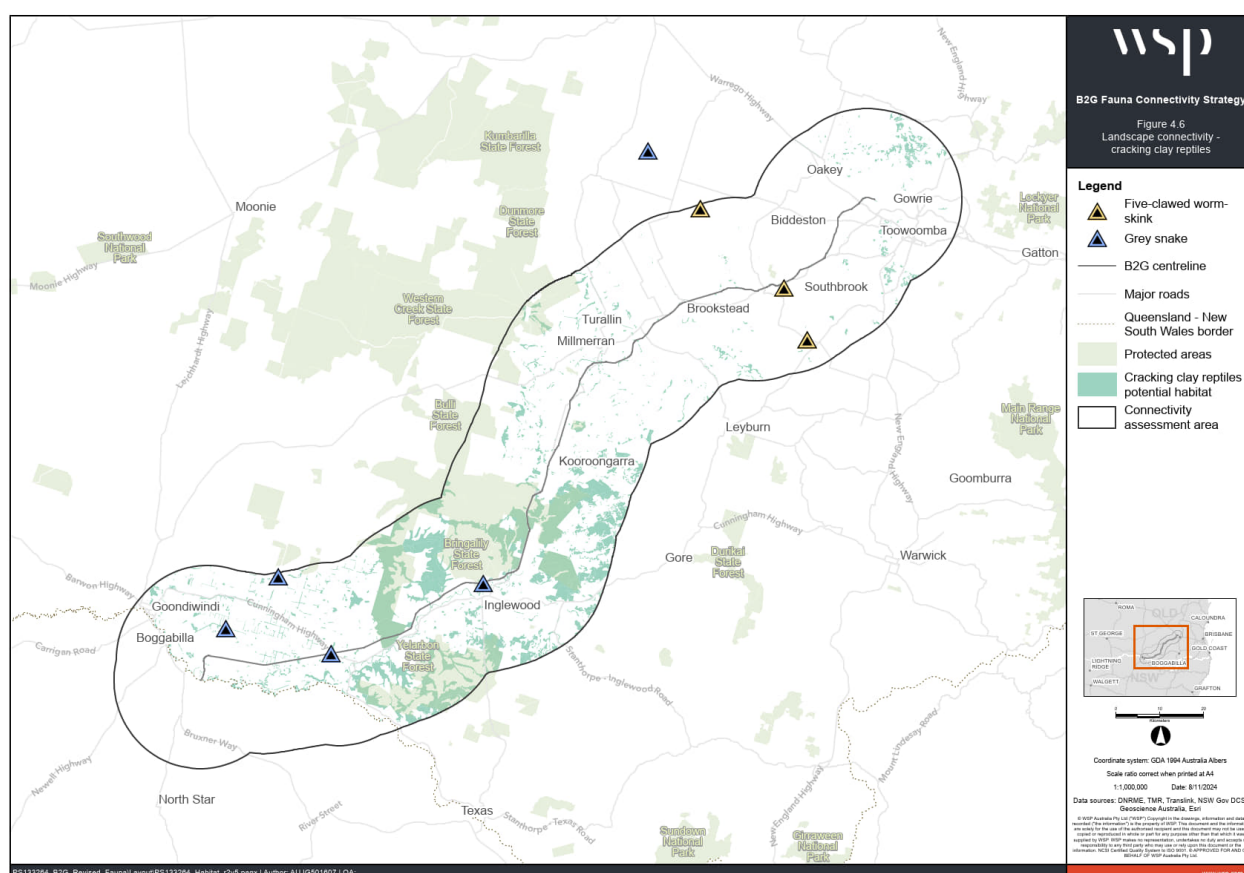


Figure 4.6 Broad-scale distribution of habitat and areas of landscape-scale connectivity for cracking-clay reptiles within the Connectivity Assessment Area.

## 4.2.7 Condamine earless dragon

The Condamine earless dragon is endemic to the eastern Darling Downs, resulting in a geographically restricted range. Consequently, habitat and landscape-scale connectivity for this species is limited to the area where this habitat occurs along the floodplain of the Condamine River and other major rivers in the north east of the Connectivity Assessment Area (Figure 4.7).

Through a research partnership between ARTC Inland Rail and UniSQ, targeted Condamine earless dragon surveys have been conducted to identify habitat utilisation and conservation genetics. To date, 144 Condamine earless dragons have been recorded from the Cecil Plains in the north to Brookstead in the south, with the majority centred on the Bongeena area (UniSQ 2024). Tissue samples have been collected for 122 of the 144 individuals captured for future genetic analysis (UniSQ 2024). The results of this analysis and other ongoing research on the species will be incorporated into the design of mitigation measures during detailed design and specified in the Wildlife Connectivity Plan. The Condamine earless dragon has a preference for shorter grassland with an open structure or open areas, particularly where soil cracks, tussock grasses, mats of dead vegetation exist (UniSQ 2024). These preferred habitats can be found on grassy road reserves, cropland, native grassland and exotic grassland (UniSQ 2024). See Appendix E1 Appendix E for detailed maps.

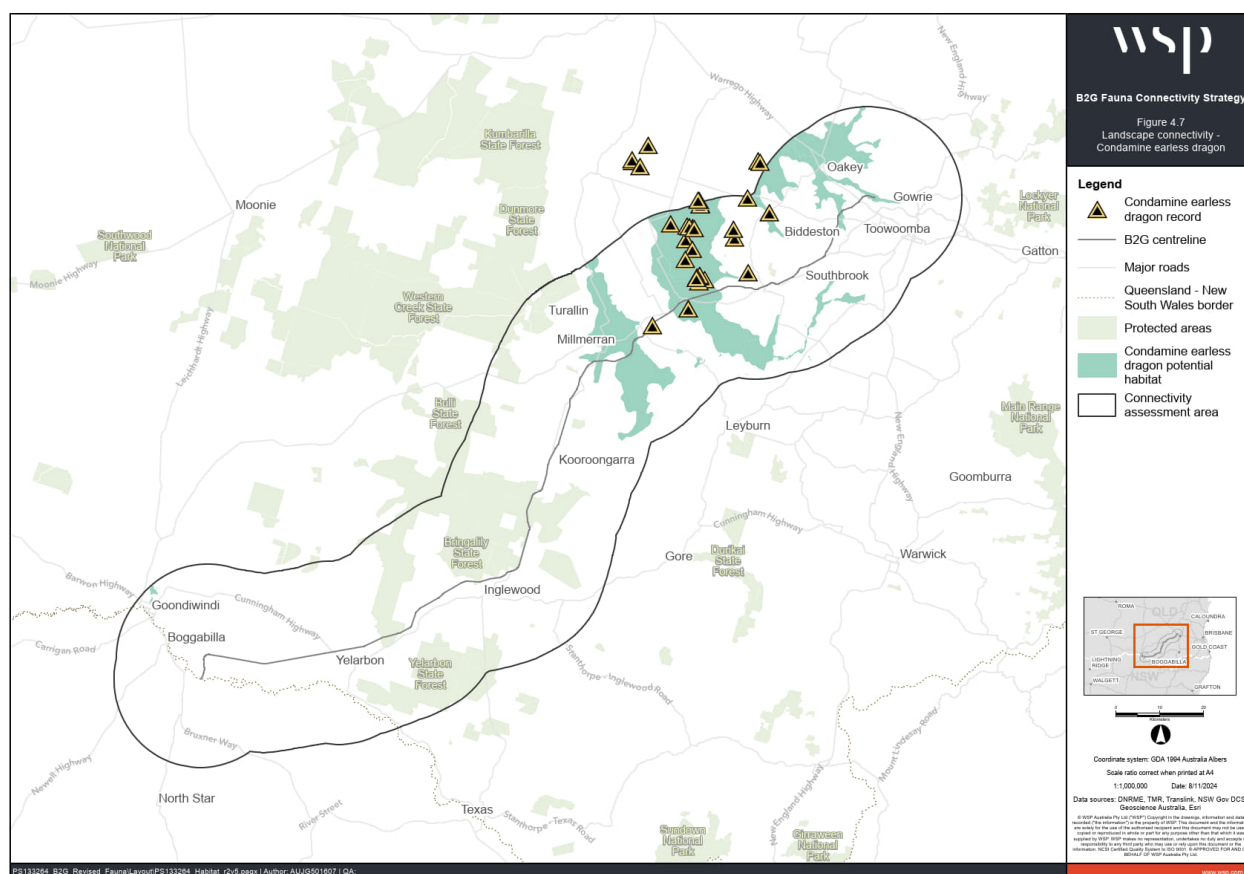


Figure 4.7 Broad-scale distribution of habitat and areas of landscape-scale connectivity for the Condamine earless dragon within the Connectivity Assessment Area.

## 4.2.8 Murray cod

The Project crosses 100 DAF designated waterways, with approximately half identified as overland drainage (e.g. drains, irrigation channels) and approximately one third comprising ephemeral creeks and floodplains, which do not provide habitat for Murray cod. Overland drainage sites are typically set amongst farmland and have already experienced substantial habitat loss with highly degraded banks, removal of riparian and in-stream vegetation and poor water quality. Many of the ephemeral creeks have highly degraded banks and no riparian or in-stream vegetation.

Of the remaining waterway crossings, only nine locations within the Project footprint were determined to have suitable Murray cod habitat, being the Macintyre and Condamine River North Branch as well as Bringalily Creek (two crossings), Nicol Creek, Back Creek (three crossings) and Grasstree Creek (Figure 4.8).

See Appendix E2 for detailed maps.

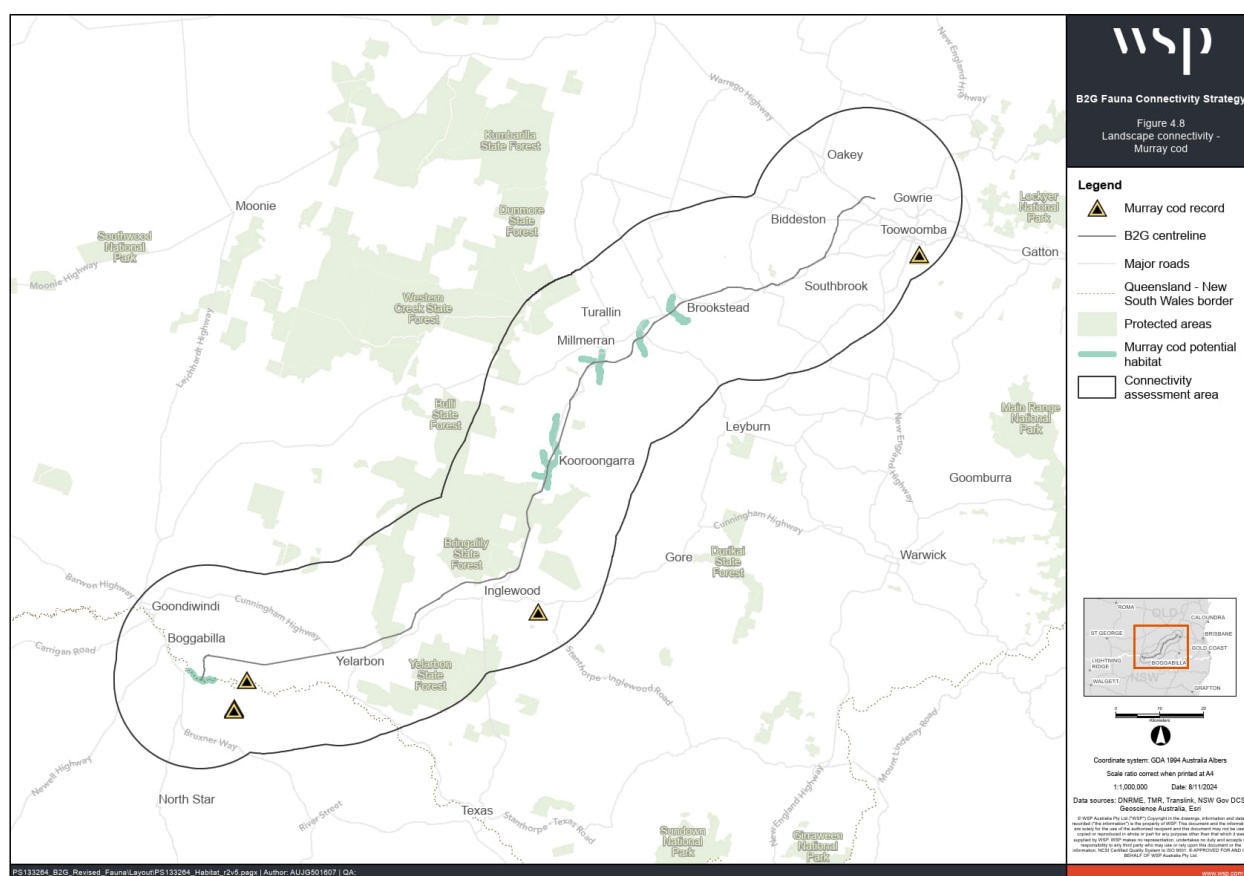


Figure 4.8 Broad-scale distribution of habitat and areas of landscape-scale connectivity for Murray cod within the Connectivity Assessment Area.



## 4.2.9 Brigalow woodland snail

The Brigalow woodland snail (BWS) has a restricted distribution and is endemic to South-east Queensland (Threatened Species Scientific Committee 2016). There are no records within the Atlas of Living Australia in the Connectivity Assessment Area. However, a targeted search by ARTC detected them at and near the Project footprint (Figure 4.9), indicating that they are potentially more widespread than the mapped records indicate. Brigalow woodland snail records are associated with patches of vegetation on black alluvial soils and adjoining undulating low hills with heavy clays, indicating high water retention. The association between BWS and predominantly alluvial land suggests dispersal occurs during flooding events. See Appendix E1 for detailed maps.

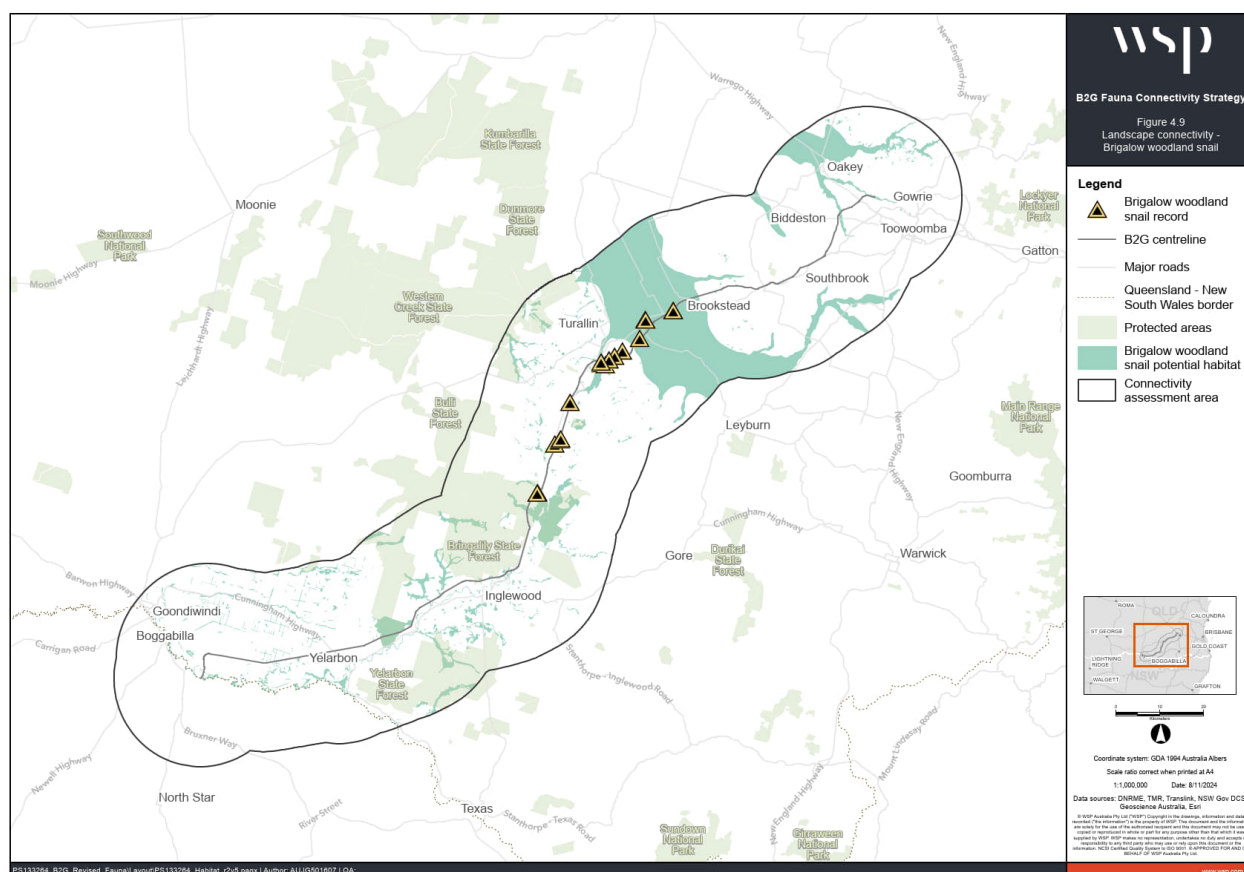


Figure 4.9 Broad-scale distribution of habitat and areas of landscape-scale connectivity for Brigalow woodland snail within the Connectivity Assessment Area.

## 4.3 Priority connectivity zones

A total of 35 PCZs were identified along the Project (Table 4.1, Figure 4.10). These zones are located where high levels of ecological connectivity currently exists (e.g. at waterways with fringing vegetation, BPA corridors, LCPs, species habitat and records, etc) which will be impacted by the Project footprint and mitigation is required to maintain landscape connectivity for both target fauna and non-threatened species (see Section 3.6 for more details). All BPA corridors that intersect the Project have corresponding PCZs, which is shown on Figure 4.10.

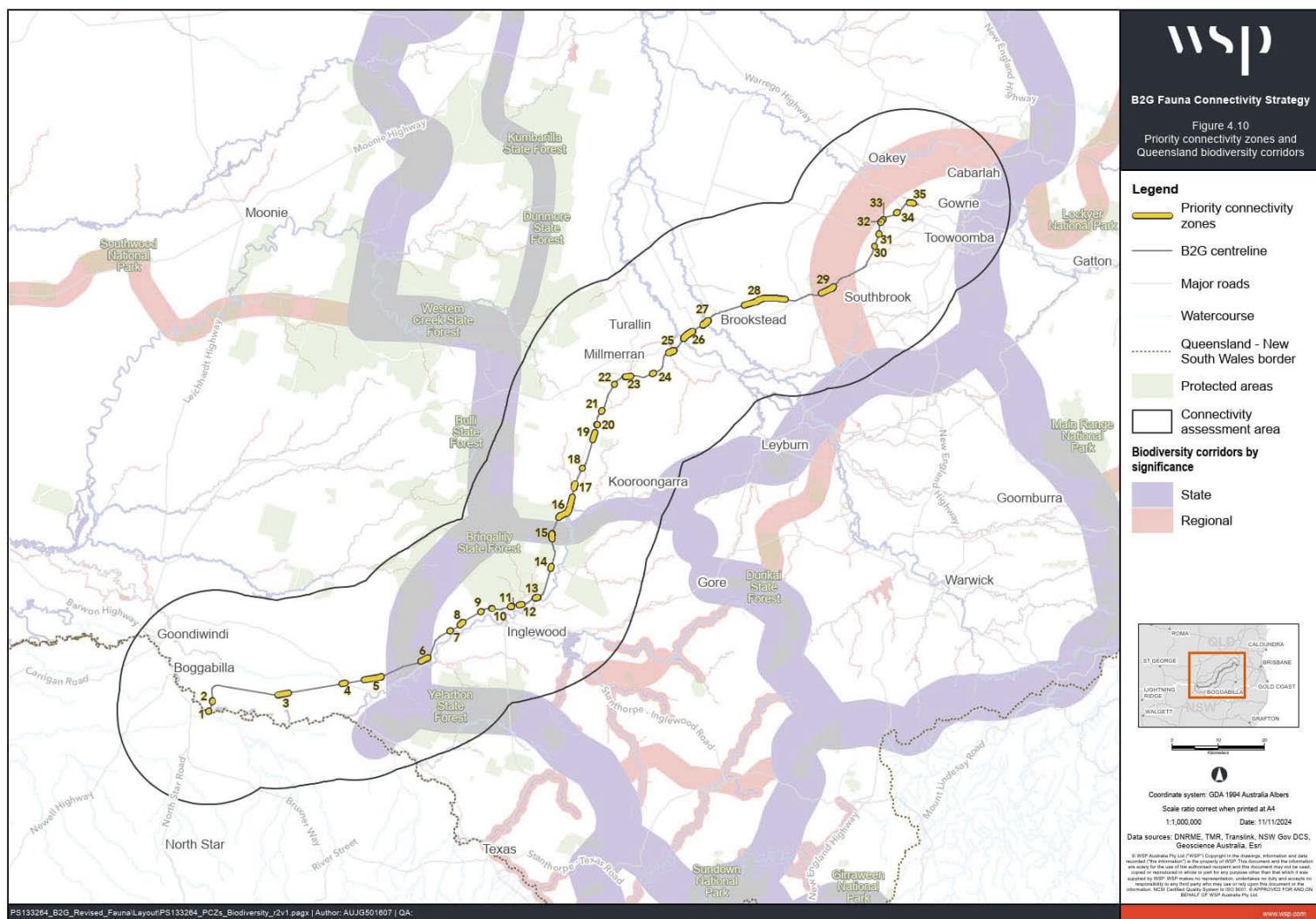


Figure 4.10 Priority connectivity zones for fauna connectivity along the Project footprint.

Table 4.1 Priority connectivity zones on the Project for target species. X indicates the zone is relevant for the target species. WR = woodland reptiles, CCR = cracking clay reptiles, BWS = brigalow woodland snail, CED = Condamine earless dragon, MC = Murray cod, STQ = spotted-tailed quoll, WB = woodland birds, GM = gliding mammals, K = koala. 'X' indicates that the target species is relevant to this zone.

| Zone | Chainage           | Length of zone (m) | Rationale for prioritisation (SO = stream order, numbers refer to Regional Ecosystem classification)                                                           | WR | CCR | BWS | CED | MC | STQ | WB | GM | K |
|------|--------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|-----|-----|----|-----|----|----|---|
| 1    | 30508-30673 (NS2B) | 165                | Bridge intersects waterway (SO4) and provides East-West connectivity along the Macintyre River riparian corridor                                               | X  | X   | X   |     | X  | X   | X  | X  | X |
| 2    | 32800-33000 (NS2B) | 200                | Intersects waterway (SO2) and provides South-West connectivity to remnant vegetation patches                                                                   | X  |     |     |     |    |     |    |    | X |
| 3    | 10600-13000        | 2400               | Intersects remnant vegetation (11.4.3) which provides North-South connectivity                                                                                 | X  |     | X   |     |    | X   |    |    | X |
| 4    | 24840-25649        | 809                | Intersects remnant vegetation (11.5.14) which provides North-South connectivity                                                                                |    |     |     |     |    | X   |    |    | X |
| 5    | 29800-33665        | 3865               | Intersects remnant vegetation (11.5.1a/11.3.14) and adjacent to ARTC offset property                                                                           | X  |     |     |     |    | X   | X  | X  | X |
| 6    | 42873-44670        | 1797               | Intersects waterways (SO2), BPA terrestrial corridors and remnant vegetation (11.5.1/11.3.2/11.5.20)                                                           | X  | X   | X   |     |    | X   |    |    | X |
| 7    | 52479-52686        | 207                | Bridge intersects waterways (SO3) and remnant vegetation (11.3.14/11.3.2/11.3.25)                                                                              | X  | X   | X   |     |    | X   | X  | X  | X |
| 8    | 55056-56000        | 944                | Intersects waterways (SO4) and remnant vegetation (11.3.14/11.3.2/11.3.25)                                                                                     | X  | X   | X   |     |    | X   | X  | X  | X |
| 9    | 60400-60587        | 187                | Intersects waterways (SO1) and remnant vegetation (11.5.4/11.5.1/11.7.7)                                                                                       | X  |     |     |     |    | X   | X  | X  | X |
| 10   | 62940-63148        | 208                | Intersects waterways (2 x SO1) and remnant vegetation (11.5.4/11.5.1/11.7.7)                                                                                   | X  | X   | X   |     |    | X   | X  |    | X |
| 11   | 67171-67526        | 355                | Bridge intersects waterway (SO4) and BPA riparian corridor                                                                                                     | X  | X   | X   |     |    | X   | X  | X  | X |
| 12   | 69097-69801        | 704                | Intersects remnant vegetation (11.3.4 and 11.9.7/11.3.4) corridor                                                                                              | X  | X   | X   |     |    | X   | X  | X  | X |
| 13   | 73000-73685        | 685                | Intersects a waterway (SO1) and North-South connectivity between a BPA riparian corridor and patches of remnant vegetation adjacent to Bringalily State Forest |    | X   | X   |     |    | X   |    |    | X |

| Zone | Chainage      | Length of zone (m) | Rationale for prioritisation (SO = stream order, numbers refer to Regional Ecosystem classification)                                                                                                                                                         | WR | CCR | BWS | CED | MC | STQ | WB | GM | K |
|------|---------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|-----|-----|----|-----|----|----|---|
| 14   | 80647-81184   | 537                | Intersects waterway (SO1) that provides East-West connectivity between Bringalily State Forest and BPA riparian corridor                                                                                                                                     | X  | X   | X   |     |    | X   |    | X  | X |
| 15   | 87181-88348   | 1167               | Intersects waterways (SO4 and SO3), BPA riparian and terrestrial corridors and multiple contiguous patches of remnant vegetation                                                                                                                             | X  | X   | X   |     |    | X   | X  | X  | X |
| 16   | 92080-97836   | 5756               | Intersects waterways (8 x SO2), BPA riparian corridor, multiple contiguous patches of remnant vegetation, intersects ARTC offset property connected to Bringalily State Forest and includes home ranges and movement pathways from koalas tracked by the USQ | X  | X   | X   |     | X  | X   | X  | X  | X |
| 17   | 99765-100699  | 934                | Intersects waterway (SO4) and BPA riparian corridor                                                                                                                                                                                                          | X  | X   | X   |     | X  | X   | X  | X  | X |
| 18   | 104338-104440 | 102                | Bridge intersects waterway (SO3) that provides East-West connectivity                                                                                                                                                                                        | X  | X   | X   |     | X  | X   |    | X  | X |
| 19   | 110912-112590 | 1678               | Intersects waterway (SO1) that provides East-West connectivity and connects to remnant vegetation (11.8.3)                                                                                                                                                   |    | X   | X   |     |    |     |    |    | X |
| 20   | 114269-114360 | 91                 | Intersects waterway (SO1) that provides East-West connectivity and connects to remnant vegetation (11.8.3)                                                                                                                                                   |    | X   | X   |     |    |     |    |    | X |
| 21   | 117401-117706 | 305                | Intersects waterways (SO2 and SO3) which provides East-West connectivity                                                                                                                                                                                     |    | X   | X   |     |    | X   |    |    | X |
| 22   | 123908-123983 | 75                 | Bridge intersects waterways (SO1 and SO2) which provide East-West connectivity                                                                                                                                                                               | X  | X   | X   |     |    | X   |    |    | X |
| 23   | 126884-128186 | 1302               | Intersects remnant vegetation (11.3.2/11.3.25), BPA riparian corridor and waterway (SO4) which provides North-South connectivity                                                                                                                             | X  | X   | X   | X   | X  | X   | X  | X  | X |
| 24   | 133020-133400 | 380                | Intersects remnant vegetation (11.3.2) and waterway (SO2) which provides North-South connectivity                                                                                                                                                            | X  | X   | X   | X   |    | X   | X  |    | X |

| Zone | Chainage      | Length of zone (m) | Rationale for prioritisation (SO = stream order, numbers refer to Regional Ecosystem classification)                                                                                                                                   | WR | CCR | BWS | CED | MC | STQ | WB | GM | K |
|------|---------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|-----|-----|----|-----|----|----|---|
| 25   | 139293-140623 | 1330               | Bridge intersects waterway (SO4), BPA riparian corridor and connects patches of remnant vegetation (11.3.25)                                                                                                                           | X  | X   | X   | X   | X  | X   | X  | X  | X |
| 26   | 143882-146459 | 2577               | Bridge intersects waterway (SO4), BPA riparian corridor and connects patches of remnant vegetation (11.3.25)                                                                                                                           | X  | X   | X   |     |    | X   | X  | X  | X |
| 27   | 149045-150623 | 1578               | Bridge intersects waterway (SO4), BPA riparian corridor and connects patches of remnant vegetation (11.3.25)                                                                                                                           | X  | X   | X   | X   | X  | X   | X  | X  | X |
| 28   | 159245-168611 | 9366               | North-South connectivity present in patches of remnant vegetation (11.8.5) and includes home ranges and movement pathways from koalas tracked by the USQ                                                                               |    | X   | X   | X   |    | X   | X  | X  | X |
| 29   | 176892-180000 | 3108               | Intersects remnant vegetation (11.8.4, 11.8.5) and BPA terrestrial corridor, adjoins ARTC owned offset property and connectivity to McEwan State Forest, and includes home ranges and movement pathways from koalas tracked by the USQ | X  |     | X   |     |    | X   | X  |    | X |
| 30   | 193096-193111 | 15                 | Waterway (SO2) connecting multiple patches of remnant vegetation (11.8.5)                                                                                                                                                              |    | X   | X   |     |    | X   |    |    | X |
| 31   | 195800-195976 | 176                | Intersects remnant vegetation (11.8.5) corridor                                                                                                                                                                                        |    | X   | X   | X   |    | X   | X  | X  | X |
| 32   | 198400-198770 | 370                | Intersects BPA riparian corridor and waterway (SO4)                                                                                                                                                                                    |    | X   | X   | X   |    | X   | X  | X  | X |
| 33   | 199132-199326 | 194                | Bridge intersects waterway (SO3) that connects to BPA riparian corridor                                                                                                                                                                |    | X   | X   | X   |    | X   |    | X  | X |
| 34   | 202524-202802 | 278                | Waterway (SO1) that connects to larger waterway (SO3) and remnant vegetation (11.8.5)                                                                                                                                                  |    | X   | X   |     |    | X   |    |    | X |
| 35   | 206167-207146 | 979                | Provides North-South connectivity to BPA riparian corridor and waterway (SO4)                                                                                                                                                          |    | X   | X   | X   |    |     |    |    | X |

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## 4.4 Assessment of revised reference design

The revised reference design was the starting point to assess the degree to which the connectivity impacts of the Project can be mitigated and to determine where additional mitigation measures are required. All of the culverts and bridges in the revised reference design were assessed for their suitability as potential crossing structures for the target species based on the criteria detailed in Section 3.6 and Table 3.4. The culverts and bridges were assessed and categorised as either (i) satisfactory, (ii) not satisfactory or (iii) not relevant if they were based outside the habitat for the target species.

The suitability of the revised reference design varied among target species, and the unsatisfactory structures will be assessed and redesigned during detailed design according to the specifications in Sections 3.6 and Section 5.

Important points to note:

- There are more than 3000 culverts and bridges in the revised reference design and a total of 393 arrays (or locations) of bridges and culverts were assessed. Where culverts were part of an array of the same type and size of culverts, only a single representative culvert was assessed for suitability.
- Not all satisfactory culverts need to be made into wildlife crossing structures in the Wildlife Connectivity Plan. For example, only one of two satisfactory culverts for koalas that are located within 100 m of each other in koala connectivity areas, is needed.
- Not all unsuitable culverts or bridges need to be made suitable. For example, an unsuitable culvert for koala within 50 m of a suitable culvert does not need to be made suitable. Similarly, culverts in areas outside habitat and outside connectivity areas do not need to be made suitable.
- The details of which culvert and bridge will become a dedicated wildlife crossing structure will be determined in the Wildlife Connectivity Plan.
- The number of new structures proposed is based on a combination of the presence of habitat for the target species, the distance to the next suitable crossing structure and mitigation measures proposed such as strategic revegetation (i.e. for woodland birds, no new structures required, only strategic revegetation).

Table 4.2 summarises the suitability of crossing structures in the revised reference design for the target species inclusive of the assumptions listed in Section 3.8 but excluding additional mitigation measures recommended in Sections 3.6 and Section 5. Detailed discussion for each species is provided in Sections 4.4.1 - 4.4.9. The number of satisfactory structures does not reflect the overall acceptability of the design at mitigating impacts to connectivity – it is simply an assessment of the suitability of each drainage structure in the revised reference design. The specific drainage structures that will be constructed as dedicated wildlife crossing structures will be determined in detailed design and will be based on distance to the next suitable structure, and the presence, quality and extent of habitat at each location.



Table 4.2 Summary of crossing structure suitability in revised reference design

| Target species           | Structure type | Assessment results across whole reference design |                                   |                                      |                              | Assessment results within PCZs only |                                   |                                      |                              |
|--------------------------|----------------|--------------------------------------------------|-----------------------------------|--------------------------------------|------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|------------------------------|
|                          |                | Number of structures assessed                    | Number of satisfactory structures | Number of un-satisfactory structures | % of satisfactory structures | Number of structures assessed       | Number of satisfactory structures | Number of un-satisfactory structures | % of satisfactory structures |
| Woodland reptiles        | Bridge         | 17                                               | 14                                | 3                                    | 82%                          | 16                                  | 14                                | 2                                    | 88%                          |
|                          | Culvert        | 94                                               | 70                                | 24                                   | 74%                          | 41                                  | 31                                | 10                                   | 76%                          |
|                          | Total          | 111                                              | 84                                | 27                                   | 76%                          | 57                                  | 45                                | 12                                   | 79%                          |
| Cracking clay reptiles   | Bridge         | 32                                               | 16                                | 16                                   | 50%                          | 21                                  | 15                                | 6                                    | 71%                          |
|                          | Culvert        | 307                                              | 278                               | 29                                   | 91%                          | 86                                  | 73                                | 13                                   | 85%                          |
|                          | Total          | 339                                              | 294                               | 45                                   | 87%                          | 107                                 | 88                                | 11                                   | 82%                          |
| Brigalow woodland snail  | Bridge         | 33                                               | 16                                | 17                                   | 48%                          | 21                                  | 15                                | 6                                    | 71%                          |
|                          | Culvert        | 257                                              | 235                               | 22                                   | 91%                          | 65                                  | 56                                | 9                                    | 86%                          |
|                          | Total          | 290                                              | 251                               | 39                                   | 87%                          | 86                                  | 71                                | 15                                   | 83%                          |
| Condamine earless dragon | Bridge         | 11                                               | 5                                 | 6                                    | 45%                          | 8                                   | 5                                 | 3                                    | 63%                          |
|                          | Culvert        | 54                                               | 44                                | 10                                   | 81%                          | 18                                  | 13                                | 5                                    | 72%                          |
|                          | Total          | 65                                               | 49                                | 16                                   | 75%                          | 26                                  | 18                                | 8                                    | 69%                          |
| Murray cod               | Bridge         | 7                                                | 7                                 | 0                                    | 100%                         | 7                                   | 7                                 | 0                                    | 100%                         |
|                          | Culvert        | 2                                                | 2                                 | 0                                    | 100%                         | 2                                   | 2                                 | 0                                    | 100%                         |
|                          | Total          | 9                                                | 9                                 | 0                                    | 100%                         | 9                                   | 9                                 | 0                                    | 100%                         |
| Spotted tailed quoll     | Bridge         | 32                                               | 20                                | 12                                   | 63%                          | 23                                  | 11                                | 12                                   | 48%                          |
|                          | Culvert        | 223                                              | 164                               | 59                                   | 74%                          | 86                                  | 62                                | 24                                   | 72%                          |
|                          | Total          | 255                                              | 184                               | 71                                   | 72%                          | 109                                 | 73                                | 36                                   | 67%                          |
| Woodland birds           | Bridge         | 20                                               | 6                                 | 14                                   | 30%                          | 16                                  | 2                                 | 14                                   | 13%                          |
| Gliding mammals          | Bridge         | 17                                               | 2                                 | 15                                   | 12%                          | 17                                  | 2                                 | 15                                   | 12%                          |
| Koala                    | Bridge         | 35                                               | 21                                | 14                                   | 60%                          | 23                                  | 9                                 | 14                                   | 39%                          |
|                          | Culvert        | 302                                              | 120                               | 182                                  | 40%                          | 101                                 | 32                                | 69                                   | 32%                          |
|                          | Total          | 337                                              | 141                               | 196                                  | 42%                          | 124                                 | 41                                | 83                                   | 33%                          |



#### 4.4.1 *Woodland birds*

The Project footprint has 21 structures located within connectivity areas for woodland birds (Table 4.2). A total of 14 structures (67%) were assessed as unsatisfactory to facilitate the movement of woodland birds and seven structures (33%) were assessed as satisfactory (Table 4.2). Structures identified as unsatisfactory were predominantly bridges < 5 m in height, which is likely to restrict the safe movement under the railway due to low clearance height. While flight above the railway is achievable where gaps in canopy are <100 m, it places the low-flying gap-sensitive birds at a slightly increased risk of wildlife-train collision. Therefore, the priority is to use suitable bridge underpasses.

Connectivity for gap-sensitive woodland birds can be achieved by increasing the clearance height of bridges as well as strategic revegetation to provide structural vegetation to facilitate movement under and adjacent to the rail alignment. If increasing the clearance of these bridges is not feasible, connectivity for woodland birds will be achieved by reducing the extent of vegetation clearance at PCZs and crossing locations to keep the gap in canopy less than the gap-crossing distance of woodland birds (i.e. <100 m). The feasibility of this approach will be assessed on a site-by-site basis during detailed design and take into consideration sight-lines and other safety considerations for the operation of Inland Rail, as well as land tenure to ensure long-term persistence of woodland. This will enable woodland birds to fly across the railway at-grade, and important areas for this treatment for woodland birds are provided in Section 4.3 and Appendix E4.

#### 4.4.2 *Spotted-tailed quoll*

The Project footprint has 260 structures located within connectivity areas for spotted-tailed quoll. A total of 71 structures (27%) were assessed as unsatisfactory to facilitate the movement of spotted-tailed quolls and 189 structures (73%) were assessed as satisfactory (Table 4.2). Structures identified as unsatisfactory were associated with fence designs along the Project footprint using mesh and barbed wire which may limit use by spotted-tailed quolls, low culverts ranging between 0.9-2.1 m in height and long culverts (>50 m) (Table 4.2). These impacts will be mitigated by replacing barbed wire and mesh fencing with plain wire fencing that allows the movement of quolls, increasing the clearance height of culverts where needed to support effective connectivity, and providing fauna furniture within long culverts to facilitate movement under the rail alignment. A total of 17 proposed new crossing locations for spotted-tail quolls have been identified to facilitate connectivity in areas where connectivity is impacted by the revised reference design (Appendix F). See Appendix E3 for detailed maps.

#### 4.4.3 *Gliding mammals*

The Project footprint has 17 structures located within connectivity areas for gliding mammals. A total of 15 structures (88%) were assessed as unsatisfactory to facilitate the movement of gliding mammals and 2 structures (12%) were assessed as satisfactory (Table 4.2). Structures identified as unsatisfactory were associated with fence designs using barbed wire which gliding mammals can get caught on and die, as well as bridges with a height of 10 m or less which will prevent the movement of gliding mammals under the rail alignment due to low clearance heights. Gliding above the railway between trees outside the Project footprint is not feasible, given the relatively short trees, the large gaps across the Project footprint and the relatively steep gliding angle of the gliding mammals.

Impacts to connectivity for gliding mammals will be mitigated by removing barbed wire and replacing with plain wire, increasing the clearance height of bridges, where possible, as well as strategic revegetation to provide structural vegetation to facilitate movement under the rail alignment. Canopy bridges and glider poles will be installed as interim measures to facilitate movement while revegetation grows. A total of 24 proposed new crossing structures for gliding mammals, namely canopy bridges and glider poles, have been identified to mitigate impacts to canopy connectivity (Appendix F).

Connectivity for gliding mammals can also potentially be achieved by reducing the Project footprint and minimising tree clearing in key areas to a distance that is within the gap-crossing distance of the gliders (i.e. <40 – 60 m apart, depending on launch height and the relative height of the railway). The feasibility of this approach will be assessed on a site-by-site basis during detailed design and take into consideration sight-lines and other safety considerations. Important areas for this treatment for gliding mammals are provided in Section 4.3 and Appendix E4.

Greater gliders and many other species of possum and gliding mammals have been observed living adjacent to or in close proximity to roads, residential areas and other infrastructure, indicating a degree of acceptance to these conditions, including noise and light (R van der Ree, unpub. data, Soanes and van der Ree 2009b, Soanes et al. 2018). Thresholds in noise and light are unable to be determined due to a lack of specific research, however the occurrence of sugar gliders, Krefft's gliders and Squirrel Gliders adjacent to major roads, and use of crossing structures across wide and busy roads, indicates a high level of tolerance.

#### 4.4.4 *Koala*

The Project footprint has 342 structures located within connectivity areas for koalas. A total of 196 structures (57%) were assessed as unsatisfactory to facilitate the movement of koalas and 146 structures (43%) were assessed as satisfactory (Table 4.2). Of the unsatisfactory structures, most were low culverts < 2.4 m in height and bridges that were 1.4 m or less in height. Smaller culverts are still used by koala, but they were deemed less suitable because they didn't allow the inclusion of fauna furniture, such as log rails, to provide opportunity for koalas to escape potential predators. Fence designs within areas of connectivity for the species using knot mesh and barbed wire were assessed as unsuitable because while they are not absolute barriers, they can limit the movement of koalas. Impacts to connectivity to koalas will be mitigated by increasing clearance heights of unsatisfactory culverts and bridges, where possible, replacing barbed wire and mesh fencing with plain wire fencing in areas identified as koala habitat, and providing additional crossing structures in areas where they are lacking. A total of 23 proposed new crossing locations for koalas have been identified to facilitate connectivity in areas where connectivity is impacted by the revised reference design (Appendix F). See Appendix E3 for detailed maps.

#### 4.4.5 *Woodland reptiles*

The Project footprint has 111 structures located within connectivity areas for woodland reptiles. A total of 27 structures (24%) were assessed as unsatisfactory to facilitate the movement of woodland reptiles and 84 structures (76%) were assessed as satisfactory (Table 4.2). Structures identified as unsatisfactory for woodland reptiles were associated with road/rail intersections (road over rail) which would limit their ability to cross the railway or were long culverts (>50 m) which is likely beyond their ability to pass through (Appendix F). The effectiveness of all crossing structures will be enhanced by providing habitat and fauna furniture (e.g. logs, rocks, artificial cover, etc) within the structure and on the approaches to encourage use by reptiles. Ongoing research by USQ on woodland reptiles will inform the design of crossing structures for these species and further discussion of the effectiveness of underpasses for reptiles is given in Section 5.16. A total of 26 proposed new crossing locations for woodland reptiles have been identified to facilitate connectivity in areas where connectivity is impacted by the revised reference design (Appendix F). Of the 26 proposed new structures, 23 have been identified to mitigate impacts to connectivity where current structure spacing results in crossing opportunities of > 1 km (Appendix E1). See Appendix E1 for detailed maps.

#### 4.4.6 *Cracking clay reptiles*

The Project footprint has 341 structures located within connectivity areas for cracking clay reptiles. A total of 47 structures (14%) were assessed as unsatisfactory to facilitate the movement of cracking clay reptiles and 294 structures (86%) were assessed as satisfactory (Table 4.2). Ongoing research by USQ on cracking clay reptiles will inform the design of crossing structures for these species and further discussion of the effectiveness of underpasses for reptiles is given in Section 5.16. Crossing structures will be enhanced by providing habitat and fauna furniture (e.g. cracking clay soil profile, logs, rocks, artificial cover, etc) within the structure and on the approaches to encourage use by cracking clay reptiles. Ongoing research by USQ on cracking clay reptiles will inform the design of crossing structures for these species and further discussion of the effectiveness of underpasses for reptiles is given in Section 5.16. A total of 16 proposed new crossing locations for cracking clay reptiles have been identified to facilitate connectivity in areas where connectivity is impacted by the revised reference design (Appendix F). See Appendix E1 for detailed maps.

#### 4.4.7 *Condamine earless dragon*

The Project footprint has 67 structures located within connectivity areas for Condamine earless dragon. A total of 18 structures (27%) were assessed as unsatisfactory to facilitate the movement of Condamine earless dragon and 49 structures (73%) were assessed as satisfactory (Table 4.2). The indicative location of a noise wall in the revised reference design creates a barrier for Condamine earless dragon and will be redesigned in detailed design to allow movement of the species. Crossing structures will be enhanced by providing habitat and fauna furniture (e.g. appropriate soil profile, logs, rocks, artificial cover, etc) where possible within the structure and on the approaches to encourage use by the Condamine earless dragon. Ongoing research by USQ on Condamine earless dragon will inform the design of crossing structures for this species and further discussion of the effectiveness of underpasses is given in Section 5.16. A total of four proposed new crossing locations for Condamine earless dragon have been identified to facilitate connectivity in areas where connectivity is impacted by the revised reference design (Appendix F). See Appendix E1 for detailed maps.

#### 4.4.8 *Murray cod*

The Project footprint has nine structures located within identified Murray cod habitat. All nine structures (100%) were assessed as satisfactory to facilitate the movement of Murray cod (Table 4.2). Many of the bridges are long structures that are elevated above the floodplain, which resulted in no significant changes to water velocity or flow and will provide no barrier to floodplain movement for Murray cod. No culvert structures are proposed for areas considered to be Murray cod habitat. Approaches to maintain connectivity for Murray cod during construction and operation are described in Section 5.11. See Appendix E2 for detailed maps.

#### 4.4.9 *Brigalow woodland snail*

The Project footprint has 293 structures located within connectivity areas for the brigalow woodland snail. A total of 42 structures (14%) were assessed as unsatisfactory to facilitate the movement of brigalow woodland snail and 251 structures (86%) were assessed as satisfactory (Table 4.2). ARTC will commission targeted research to assist in informing the detailed design of crossing structures for Brigalow woodland snail. A total of four additional structures are recommended to facilitate passage of brigalow woodland snail (Appendix F). Crossing structures will be enhanced by providing habitat and fauna furniture (e.g. appropriate soils, logs, rocks, artificial cover, etc) where needed to support effective connectivity within the structure and on the approaches to encourage use by the snail. See Appendix E1 for detailed maps.

# 5 Connectivity mitigation measures and design considerations

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## 5.1 Overview

This section outlines the mitigation measures that will be implemented through future stages of the Project to avoid, manage and mitigate the potential impacts to ecological connectivity from the Project for the target species. The measures are relevant to the design delivery stage of the Project and represent best practice environmental management for fauna connectivity. Details of the mitigations will be documented in the Wildlife Connectivity Plan, prepared by a suitably qualified and experienced person(s) based on the approach and outcomes in the Fauna Connectivity Strategy (this document) and will guide the detailed design of the Project.

The specific wildlife crossing structures and other design features for each of the target species is described in Section 3.6. Table 5.1 provides an overview of the mitigation measures to be considered on a case-by-case basis and detailed in the Wildlife Connectivity Plan, consistent with the safe operation and maintenance of Inland Rail and which are further described in Section 5.2 to Section 5.15. Detailed design specifications and treatments in the TMR FSTIDM (TMR 2024i), as well as the results of ongoing research, will inform the type, design and dimensions of wildlife crossing structures and other mitigation measures for the Project.

An assessment of the expected overall effectiveness of the various mitigation measures is provided in Section 5.16.

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## 5.2 Vegetated land bridges and tunnel overpasses

Vegetated land bridges and tunnel overpasses are some of the most effective techniques to facilitate the movement of fauna above transport infrastructure because they provide a continuous cover of natural vegetation from one side to the other (Figure 5.1). Vegetated overpasses allow for uninterrupted movement of wildlife, plants and ecosystem processes (Smith et al. 2015).

Vegetated land bridges are typically built by constructing a bridge over the railway, placing soil on it and revegetating it with plant species that are native to the area to connect both sides of the infrastructure. Land-bridges are most cost-effectively built at locations where the railway is within a cutting, however they can also be built where the railway is at-grade.

Tunnel overpasses include cut and cover tunnels which are excavated from the surface and backfilled after construction and revegetated like land bridges. Bored or excavated tunnels are constructed without disturbing the soil or vegetation and are the least disruptive to wildlife.

There are currently three vegetated land bridges installed on the Pacific Highway in northern NSW and three in the suburbs around Brisbane, Queensland - all of which have shown high levels of fauna use. A land bridge across the Tonkin Highway at Ellenbrook near Perth was recently constructed and others are being built in NSW and QLD.

Table 5.1. Overview of mitigation measures to maintain ecological connectivity across the Project.

| Category                  | Mitigation and management measure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fauna crossing structures | <ul style="list-style-type: none"> <li>— Modify existing drainage structures (e.g. size, configuration, shape etc) to facilitate fauna movement through the structure. Modifications include increasing culvert height and width, increasing bridge height, reducing culvert length, converting pipe culvert to box culvert, changing culvert to bridge, etc.</li> <li>— Providing additional fauna crossing structures, including underpasses and overpasses, canopy rope bridges under bridges and above-rail and glider poles where suitable crossing opportunities are currently absent and required for the target species.</li> <li>— Installation of refuge poles and rails within and adjacent to crossing structures for koalas.</li> <li>— Assess designs to ensure two-way movement is feasible (e.g. glide angles feasible in both directions across railway).</li> </ul>                                                                                                                                                                        |
| Habitat and vegetation    | <ul style="list-style-type: none"> <li>— Design to minimise vegetation clearing requirements within Project footprint, particularly at watercourse crossings, PCZs and other crossing locations to reduce the size of gaps in habitat to facilitate movement of gap-sensitive woodland birds, gliding mammals and other target species.</li> <li>— Where possible, protect important habitat attributes (e.g. soil structure for cracking clay reptiles) during construction through the use of protective groundcover, which are important factors contributing to success of mitigation measures.</li> <li>— Inclusion of fauna furniture within and adjacent to entrances and exits of crossing structures to encourage movement of fauna.</li> <li>— Landscaping and strategic revegetation within and adjacent to entrances and exits of crossing structures to encourage movement of fauna, including planting of shrubs and ground cover, installation of logs, rocks and artificial habitats, and creation/restoration of soil structure.</li> </ul> |
| Fencing / noise / light   | <ul style="list-style-type: none"> <li>— Fencing to funnel fauna into crossing structures and prevent them from accessing the railway to reduce the risk of wildlife-train collision.</li> <li>— Include noise and light mitigation where noise and light impacts have the potential to impede the use of the wildlife crossing structures.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

The land bridge over Compton Road in Brisbane has been monitored regularly since its construction in 2005 and a diverse suite of taxa regularly use the land bridge, including terrestrial and arboreal mammals, birds, reptiles, microbats and invertebrates (Bond and Jones 2008, Taylor and Goldingay 2010, Jones and Pickvance 2013, McGregor et al. 2015, McGregor et al. 2017). As with all crossing structures, there is a delay in rates of use that for ranges from months to years, depending on the species and growth of vegetation.

To date, vegetated land bridges are the only type of overpass that koalas have been observed using, with recent evidence from the Compton Road bridge showing frequent use on a regular basis by koalas (Darryl Jones, unpublished data). Land bridges are not included in the revised reference design for the Project but will be considered in subsequent design stages where underpasses are not feasible (e.g. where the railway is in a cutting) and where there is a significant demonstrated benefit (e.g. where multiple species will benefit). While less effective than a dedicated wildlife overpass, a multi-use land bridge (i.e. with small roads, walking trails, farm access) may provide cost-effective overpass solutions for some species of fauna (van der Grift et al. 2011, Van der Grift and van der Ree 2015) and the suitability of these will be considered during detailed design.



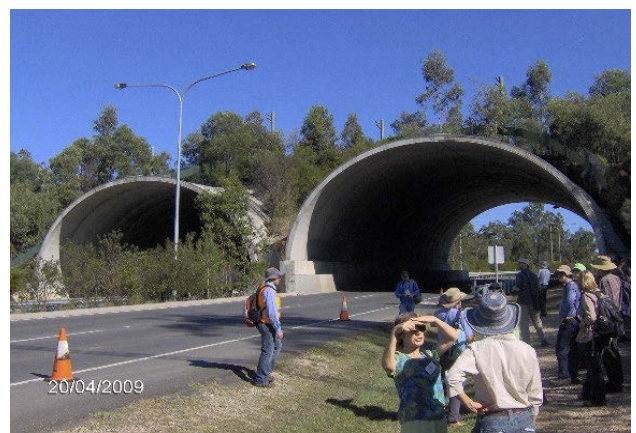


Figure 5.1 Examples of land bridges from The Netherlands (top left), Banff National Park, Canada (top right), Pacific Highway northern NSW, Australia (bottom left) and Compton Road, Brisbane, Australia (bottom right). Photos: Rodney van der Ree

## 5.3 Bridge underpasses and viaducts

Bridge underpasses enable the movement of wildlife under railway lines and range in length from single-span bridges to multi-span bridges and viaducts (Figure 5.2). Bridge underpasses can range in height from at least 1 m above the ground to up to 10 or 20 m at viaducts which cross deep valleys. Most bridge underpasses are typically 3 – 5 m above the ground. Bridges are often used where the transport infrastructure crosses waterways, deep valleys or areas prone to flooding.

Bridges and viaducts are generally the most effective underpass option for fauna (Bhardwaj et al. 2017, Denneboom et al. 2021, Jensen et al. 2023), and the preferred method for waterway crossings for all fauna including fish because they are usually larger and more open than culverts. Larger and more open structures are usually used at higher rates by a greater diversity of species than smaller underpasses (Jensen et al. 2023). Bridge underpasses also have a natural substrate which is favoured by most fauna and can thus support more shrubs, logs and other habitat features than culverts, and bridge designs can be easily modified to accommodate the movement of fauna.

Bridges disrupt the flow, velocity and structure of waterways significantly less than culverts because the waterway is relatively untouched. Importantly, bridge underpasses are typically open and are therefore less of a behavioural and physical barrier to the movement of fish and other aquatic species in the waterways (DAF 2019). Bridges will be considered for use as underpasses rather than culverts in PCZs where fauna movement is a high priority because they are more open than culverts (allowing light filtration, increased predator avoidance options etc.) and the conditions, including substrate and vegetation growth, are more natural.



Figure 5.2 The Slaty Creek Bridge on the Calder Freeway in Victoria was designed to be higher and longer than required simply for drainage in order to encourage wildlife movement. In this example, the vegetation has been planted underneath the structures, and tall trees retained between the two carriageways. Photos: Rodney van der Ree

## 5.4 Dedicated fauna culverts

Dedicated fauna culverts are rectangular or square underpasses, typically made of concrete, that will be installed on the Project to facilitate the movement of fauna under the railway (Figure 5.3). Culverts that allow the movement of wildlife as well as water, stock or people are called multi-use culverts and these are described in Section 5.5. Dedicated fauna culverts may occasionally allow the movement of water (e.g., in occasional flood events) but they will be optimised for wildlife and other uses are incidental. Dedicated fauna culverts typically have higher rates of use and are more effective than multi-use culverts (Denneboom et al. 2021) and the ways in which drainage culverts are optimised are described below.

Culverts are typically targeting terrestrial wildlife, including mammals, reptiles, amphibians and, if they are large enough or with appropriate features, they may permit some limited movement of certain species of birds and bats. The size of a culvert is determined by the requirements of the target species of wildlife and the relative height of the track above the ground and are best suited where the railway is on fill. However, it is always better to install larger culverts than the minimum required by the target species because the majority of studies evaluating the effectiveness of underpasses from Australia and around the world indicate that larger (tall and wide) and shorter in length underpasses are better than those that are smaller in height and longer (Jensen et al. 2023).

The recommended sizes of culverts for a range of common species are provided in Table 5.2. All culverts installed on the Project for wildlife will be the maximum size possible for the target species that will fit given the height of the railway above the ground. Culverts will also be as short as possible, as shorter culverts are more effective for fauna movement than longer culverts.

Where culverts are long, such as where they span multiple tracks (e.g. at passing loops), consideration will be given to increasing the height and width of the culvert, breaking the culvert into two sections (i.e. one under each track) and/or the inclusion of light wells between each set of tracks to increase light levels in the culvert. This detail will be determined during detailed design and specified in the Wildlife Connectivity Plan.

Box culverts are generally more effective than pipes at facilitating the movement of wildlife because they have flat bottoms and larger openings than pipes of the same height, and thus facilitate greater movement of wildlife. Therefore, all dedicated fauna culverts on the Project will be box culverts. Where there is an array of pipe culverts proposed, the first and last in each array will be converted to box culverts for dedicated use by fauna.



Table 5.2 Preferred minimum sizes of box culverts for different wildlife\*

| Target species                                            | Minimum size (H x W) | Minimum size (H x W) for incidental use |
|-----------------------------------------------------------|----------------------|-----------------------------------------|
| <b>Eastern grey kangaroo</b><br><i>Macropus giganteus</i> | 2.4 m x 2.4 m        | 1.8 m x 1.8 m                           |
| <b>Red kangaroo</b><br><i>Osphranter rufus</i>            | 3.0 m x 3.0 m        | 2.4 m x 2.4 m                           |
| <b>Koala</b><br><i>Phascolarctos cinereus</i>             | 2.4 m x 2.4 m        | 1.2 m x 1.2 m                           |
| <b>Wallaby</b><br><i>Wallabia</i> spp.                    | 1.8 m x 1.8 m        | 1.5 m x 1.5 m                           |
| <b>Possums</b><br><i>Phalangeridae</i> spp.               | 3 m x 3 m            | 1.8 m x 1.8 m                           |

\* Dimensions given are the minimum for a single railway track where culverts are ~ 40 – 50 m in length. Height and width will be increased for culverts exceeding 50 m in length.

Culverts for species such as reptiles and snails will have a natural substrate according to the needs of the target species. All fauna culverts will also include furniture specific to the needs of the target species, such as logs and scattered rocks, koala rails (Section 5.10), and refuge poles (Section 5.9) to provide natural cover/shelter from predators and improve habitat suitability, and therefore rates of use. Furniture will be installed on the ground, attached to walls and/or built into the structure itself (i.e., bat roosts built into culverts).

The entrances to culverts will be kept as natural as possible, and the use of large rocks for erosion control will be avoided as this will restrict entry by some species. Wildlife culverts will be positioned in the landscape to be above drainage lines and flood levels as much as possible, as wet culverts are likely to deter most terrestrial wildlife. Culverts for the movement of Brigalow woodland snail and amphibians will remain wet and moist to facilitate their movement. Further research on the optimal substrate conditions, furniture and habitat conditions within crossing structures and the approaches is underway and will inform the detailed design.

Where the needs of different target species are in conflict at a culvert, the needs of the more specialised species will take precedence. If the conflict is unable to be resolved, separate culverts will be installed for the conflicting species, ensuring crossing structures are suitable for each species.

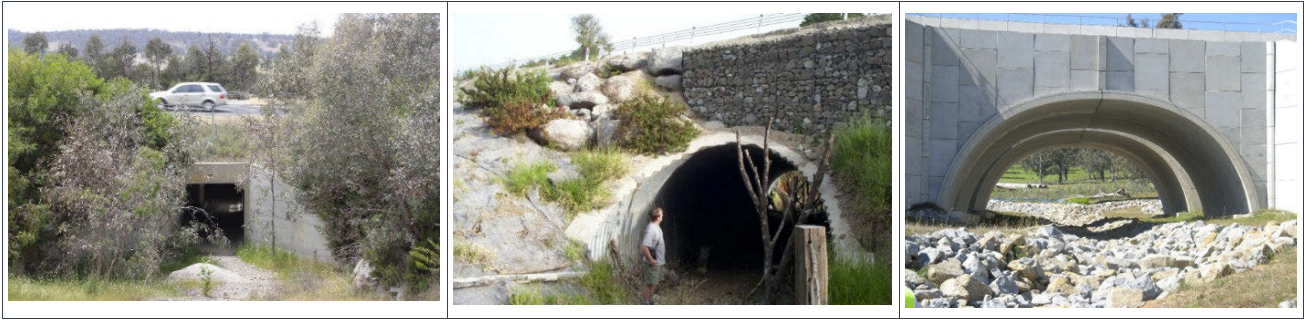


Figure 5.3 Examples of wildlife culverts designed specifically for the movement of wildlife, located under the Calder Freeway in central Victoria (left), under East Evelyn Rd in Far North Queensland (middle) and the first arch underpass for birds on the Hume Highway at Woomargama NSW (right). Note that a strip on both sides of the waterway at Woomargama is free of the large rocks to facilitate movement by terrestrial wildlife. Photos: Rodney van der Ree.

## 5.5 Multi-use box culverts, arches and pipe culverts

The optimal approach to crossing structures is to design and manage them specifically for wildlife (i.e. dedicated fauna culverts described in Section 5.4), and to keep wildlife movement and drainage separate (Denneboom et al. 2021). When this is not feasible on the Project, culverts that allow the movement of wildlife and other uses (e.g., drainage, stock, people) are possible. These structures will be carefully planned and designed to ensure the movement of wildlife is not compromised by the additional uses (TMR 2024c). Drainage culverts on the Project that allow the movement of water during floods but are dry most of the year will be designed to facilitate fauna crossings during dry periods (Figure 5.4). A significant problem in multi-use culverts is standing water, which often occurs due to poor design and ponding at the entrances and/or within the culvert and will be avoided on the Project (Figure 5.5).

Strategies to provide dry passage in drainage culverts to be adopted on the Project include:

- Adding a dedicated fauna culvert (Section 5.4) a short distance away from the drainage culvert to provide dedicated passage for fauna and reducing any conflict between drainage and fauna use.
- Raising the height of the floor of the two outer cells so they remain dry except during major flood events (Figure 5.6).
- Lowering the height of the floor of the middle cell(s) to provide drainage during typical flow events and keeping the outer cells dry most of the time.

Installing ledges and shelves above the height of the typical water level on the outer walls of the culvert(s) (Figure 5.7).





Figure 5.4 Bridge for drainage and vehicle movement under railway at Bowral (left) and drainage culvert at Ettamogah (right) provide incidental movement opportunities for wildlife. Simple improvements such as increasing the width of the bridge and reducing ponding can improve effectiveness for wildlife as well as fulfil its primary function. Photos by Thomas Haffner ARTC.



Figure 5.5 Poor drainage and ponding can reduce the effectiveness of all types of culverts and they must be carefully designed, constructed and managed to effectively enable both uses. Photos (left) Rodney van der Ree and (right) Scott Watson VicRoads.





Figure 5.6 Example of multi-cell culverts on the Pacific Highway NSW where the middle cell is designed to take water flow year-round, with the outer cells remaining dry except during flood events. Photos Rodney van der Ree WSP.



Figure 5.7 Example of strategies that provide dry passage if the culvert contains standing or flowing water. Note that the concrete ledge and timber shelf in the left photo are still to be connected back to the adjacent habitat. Photos by Rodney van der Ree WSP.

## 5.6 Canopy connectivity

Canopy connectivity is an effective non-engineering approach to be used on the Project to facilitate connectivity for arboreal mammals, birds, and bats by maintaining trees and shrubs as close to the tracks as possible. Full canopy connectivity (i.e. where tree canopies on opposite sides of the track remain connected) is unlikely to be feasible on the Project and is not considered further. Partial canopy connectivity is achieved when full canopy connectivity is unable to be achieved and when the size of the gap in canopy is reduced as much as possible, encouraging gap-sensitive wildlife to traverse the railway.

Partial canopy connectivity in PCZs and at specific crossing locations will support effective connectivity by minimising the clearing of mature and native vegetation to the greatest extent practicable and through strategic revegetation after construction with consideration of connectivity requirements. For example, the set-back distance of trees from the railway will be the minimum possible and based on the gap-crossing ability of the target species. Other approaches include pruning trees to reduce height and reduce canopy weight on the track side of the tree to have them fall away from the track, should they fall. Shrubs and grasses will be planted up to 5 m from the track edge ([artc.com.au/community/vegetation](http://artc.com.au/community/vegetation)) to provide cover and shelter, especially for gap-sensitive woodland birds and bats, as well as provide shelter and habitat for relevant terrestrial species as they approach underpass entrances.

Canopy connectivity at relevant crossing locations will be implemented where the Project is at-grade, in cuttings and on small amounts of fill. Canopy connectivity is less feasible where the Project is on many metres of fill, but it still helps by reducing the size of the vegetated gap to be crossed. Canopy connectivity can also be achieved under high bridges where trees and tall shrubs can grow right up to and under the bridge structure.

The length of track at a site being treated with canopy connectivity will be a minimum of 20 m or match the width of the patch of vegetation being traversed, whichever is the greater.

Canopy connectivity, and the maintenance of vegetation and habitat as close as possible to the edge of the railway will be of significant benefit to other woodland-dependent species, such as koalas, reptiles, possums and gliders and small mammals. Connectivity for these species using crossing structures is enhanced when they are funnelled to the entrances of the structures by the strategic planting or provision of suitable habitat, including canopy cover. Specific details of funnelling (e.g. plant species, habitat components, gap sizes) at each crossing structure will be determined during detailed design.

The value of revegetation is species dependent and will increase over time as the vegetation matures and increases in height and complexity. Trees and shrubs will begin to facilitate movement for species that require vegetative cover in a few years, and for gliders, it may take a few decades for trees to reach maximum height to facilitate glides. Glider poles and/or canopy bridges will be installed as interim measures at crossing locations for gliding mammals while the plantings mature to sufficient height.

Areas in PCZs and other crossing locations with important canopy connectivity to be retained for birds and gliders will be mapped and marked with fencing to ensure construction and maintenance does not reduce the effectiveness of this approach.

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## 5.7 Above- and below-rail canopy bridges

A canopy bridge is a rope ladder suspended above the railway from poles or trees that connects woodland or forest habitat on either side of the barrier. Canopy bridges are used for arboreal mammals, including possums and smaller gliders (e.g., sugar glider, Krefft's glider, squirrel glider), and occasional use by arboreal reptiles, such as goannas, has been recorded (Soanes et al. 2013, Soanes et al. 2015, Soanes et al. 2018). One study on the Pacific Highway has detected yellow-bellied gliders using one canopy rope bridge (Taylor and Rohweder 2020). Greater gliders have been observed using a single-strand rope across a narrow road to a logging coupe in central Victoria and preliminary results of captive trials indicate a willingness of greater gliders to use ropes and rope ladders (R. van der Ree, unpub. data). Canopy rope bridges are not suitable for koalas (Goldingay and Taylor 2017).

The design of canopy bridges for the Project will follow those that have successfully been used on numerous road projects, such as along the Pacific Highway in northern NSW, Hume Freeway in Victoria and southern NSW and across Moreton Bay Regional Council (Figure 5.8) (TMR 2024f). A flat ladder design will be used because it is wider and more stable than single strands of rope, which can twist when spanning long distances. 'Box' designs will not be used because possums and gliders often walk along the top of the box (Bax 2006), reducing the benefit of this extra cost. This approach may be updated based on the results of ongoing research on the use of box-design canopy bridges currently underway at the University of Sydney.

Canopy bridges will be the maximum height possible with standard-length timber poles and will be a minimum of 2 m above the height of the tallest trains (i.e., 9.1 m above the railway tracks given that the height of double-stacked train is 7.1 m) and suspended from two hardwood timber poles. Poles will be a rough-sawn timber pole, enabling fauna to climb the pole. The pole shall be treated hardwood and the cross-arms untreated hardwood, to minimise risk of poisoning.

The canopy bridges will be as short as possible and positioned within good-quality habitat for the target species. Both ends of each bridge will be tied back to at least two, and preferably three large and/or hollow-bearing trees to improve access and increase the likelihood of use by wildlife. This is best achieved by identifying existing large trees in and near the Project footprint before clearing commences and protecting them during construction, where possible. Connecting the ends of the canopy bridges back to multiple trees builds in redundancy if some of the feeder trees collapse. Strategic



revegetation around the poles and leading up to the poles is likely required to increase their medium-term connection to adjacent habitat.



Figure 5.8 Canopy rope bridge across the railway and under the Olympic Highway at Kapooka, NSW, showing the flat rope ladder attached to two steel cables, as well as the predator shield and attachment detail. Photos by Allan Richardson, WSP.

Poles will be accessible with an elevated work platform for inspections and maintenance and to install and maintain cameras or other monitoring equipment. A gravel hard stand beneath each pole will enable access during wetter months of the year.

Canopy bridges will be built at crossing locations for possums and gliders under railway bridges where there is sufficient clearance, typically at least 6 m above the ground for small gliders and at least 10 m for greater gliders, which often sit higher in the canopy (Figure 5.9). These canopy bridges are functionally similar to the above-rail canopy bridges and provides safe connectivity for arboreal and semi-arboreal mammals. Under-bridge canopy bridges do not need to be engineered to the same high standards as the above-rail canopy bridges because the consequences of collapsing are much less. However, given the majority of bridges on the Project are in flood zones, they will be designed to withstand floods. Therefore, most of the design features for under-rail canopy bridges are the same as for above-rail canopy bridges because the support poles are typically positioned outside the bridge underpass and exposed to UV, potential predators etc and are likely to support fauna movement.





Figure 5.9 Canopy rope bridge under twin bridges on the Hume Highway at Mountain Creek, NSW. Photos Josie Stokes, WSP.

## 5.8 Glider poles and under-bridge glider poles

Glider poles are timber poles installed on one or both verges of the railway and/or between sets of tracks and provide a sufficiently tall launch platform for gliders to glide across the railway and any other infrastructure (e.g. noise walls) and land on another glider pole or tree (Figure 5.10). Glider poles have been used successfully for numerous glider species across roads in Australia and internationally (Asari et al. 2010, Taylor and Goldingay 2013, Soanes et al. 2015, Goldingay et al. 2018b, Soanes et al. 2018). Greater gliders have also been observed using glider poles to traverse a 30-60 m wide cleared pipeline easement in Victoria (GHD 2017).

There is recent evidence from monitoring conducted at one location on the Oxley Highway in northern NSW which showed that squirrel gliders and sugar gliders preferred to use glider poles over rope bridges, with 12 - 18% of detections on pole-pairs and 1% of detections on the rope bridge (Goldingay et al. 2018a). The study was based on data from two pairs of poles and one rope bridge and therefore cannot be generalised, because the poles may have been placed in areas of higher quality habitat or be more easily accessed than the rope bridges, thus likely explaining the variation in rates of use. Similarly, monitoring of the rates of use of glider poles and rope bridges along the Hume Freeway in southern NSW showed variable rates of use of both types of crossing structures (Soanes et al. 2015). Therefore, a key factor influencing rate of use is the placement of structures in high quality habitat and ease of access from adjacent vegetation.



Figure 5.10 Glider poles installed in the centre median of the Hume Freeway, Victoria. Note that the cross-arm should be perpendicular to the road or railway and point towards the opposite side of the infrastructure. Photos by Rodney van der Ree, WSP.

Glider pole arrays will be designed according to a conservative estimate of the gliding capability of the target species and other gliders that may occur in the area to minimise the risk of collision with trains. The calculations of glide trajectories are site and species-specific, and the Project will design the glide pole arrays for the most sensitive species at each location using conservative glide ratios in Table 5.3. Greater gliders have the steepest glides of all of the medium- to large-sized gliders, at about 40° (Section 3.7.5) and will be used to design the height and spacing of glider poles in areas with this species. Where safe glides in both directions across the railway are not achievable, canopy bridges (Section 5.7) will be used.

Glider poles will be installed under bridges where required through the installation of timber poles and/or retained or installed tree trunks (Figure 5.11). The intention is to achieve a row or ideally a 10 – 20 m wide strip of tall tree trunks under bridges which allows gliders to traverse the gap using multiple small glides, rather than a single long glide or via a rope ladder. The use of under-bridge glider poles eliminates the risk of gliders colliding with trains while attempting to cross by gliding above the railway. The use of 'natural' glider poles (i.e., retained tree trunks) offers a number of likely advantages over timber poles.



Table 5.3 Glide angles and horizontal glide distances used to design glider pole arrays for the Project.

| Species <sup>1</sup>                                                                   | Glide ratio <sup>2</sup><br>(angle) | Horizontal glide distance <sup>3</sup> | Source                           |
|----------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------|----------------------------------|
| <b>Squirrel glider</b><br><i>Petaurus norfolcensis</i>                                 | 1.84 (29°)                          | 29.8 m                                 | (Goldingay and Taylor 2009)      |
| <b>Sugar glider / Krefft's glider</b><br><i>Petaurus breviceps</i> / <i>P. notatus</i> | 1.82 (28.8°)                        | 28.8 m                                 | (Jackson 1999)                   |
| <b>Greater glider</b><br><i>Petauroides</i> spp.                                       | 1.19 (40°)                          | 13.8 m                                 | (Wakefield 1970b), Section 3.7.5 |
| <b>Yellow-bellied glider</b><br><i>Petaurus australis</i>                              | 2.0 (27.3°)                         | 32 m                                   | (Goldingay 2014)                 |



Figure 5.11 (left) Two arrays of artificial glider poles under a road in Ontario, Canada, installed for the northern flying squirrel and (right) retained tree trunks under bridge along Pacific Highway NSW for squirrel gliders, which can also double as a koala refuge pole. Glider poles under bridges should only be used where retained tree trunks are not feasible. Photo at left courtesy of Christine Kelly and right by Rodney van der Ree, WSP.

## 5.9 Refuge poles

Refuge poles are installed in areas with few mature trees to provide koalas with opportunities to climb and rest and avoid potential terrestrial predators (TMR 2024e) (Figure 5.12). Refuge poles can be made of treated pine posts with a diameter of 150 – 200 mm or salvaged and re-instated tree trunks or timber telephone poles. Poles will be a minimum of 3 m tall

<sup>1</sup> No data for Feathertail Glider, but average glide length 14 m (launch and landing height not recorded) Perth Zoo fact sheet.

<sup>2</sup> Glide ratio is horizontal distance travelled divided by the vertical drop. Glide angle measured from horizontal.

<sup>3</sup> Glide distance assumes launch height of 16.5 m and landing height of 5 m, on flat ground. Launch height based on 20 m pole set 3.5 m into the ground with launch from cross beam at 0.5 m from top of pole. Landing height assumes a 3 m landing height plus a 2 m buffer. Detailed designs must be completed for all projects. Taller and/or more poles in an array may be required to achieve 'safe' glides.

and have a short cross-arm or fork to provide a spot for koalas to sit and sleep (Figure 5.12). Non-treated timber poles can be used but resistance to termite attack should be considered.

Refuge poles will be installed at the approaches to culverts and bridge underpasses and in areas that have been revegetated for koalas.



Figure 5.12 Koala refuge pole constructed from recycled telephone pole (left), treated pine at end of koala rail (middle) or salvaged tree trunks. Photo on right shows one method to attach the fork to provide a resting spot for koalas. Photos: Rodney van der Ree.

## 5.10 Fauna furniture to facilitate movement and reduce the risk of predation

There is a common belief that underpasses and overpasses are prey-traps for fauna because predators learn to hunt at locations where prey are funnelled. However, there is no evidence that predators systematically use crossing structures in this way such that any cost outweighs the benefits (Little et al. 2002, Mata et al. 2015, Soanes et al. 2017, Goldingay et al. 2022). Research quantifying the use of canopy bridges over the Hume Freeway in Victoria and NSW recorded the same individuals using the structures over multiple years, demonstrating successful long-term use without substantial predation by owls (Soanes et al. 2015). Nevertheless, predation can occur at crossing structures because predators and potential prey may use the same structure (Goldingay et al. 2022). Therefore, crossing structures and their approaches will be equipped with specific structures, designs and ‘furniture’ to minimise the risk of predation and encourage movement. The design of the furniture will be specific to the relevant target species at each location, be determined during detailed design, and will be specified in the Wildlife Connectivity Plan.

Rails will be installed within culverts and under bridges for koalas and other crossing locations for koalas where trees are unable to grow or where trees pose unacceptable risks to the railway infrastructure (Figure 5.13, Figure 5.14). Koala rails provide a stable and relatively horizontal platform a minimum of 1.5 m above the ground to facilitate movement for koalas above ground and away from the reach of predators, primarily wild dogs. Rails can be free standing or attached to the walls of culverts or bridge abutments. The rail will be a minimum of 250 mm wide, and either a flat beam or round logs. There is limited evidence of use of these, likely because the research is limited.

Logs, rocks and piles of branches that provide shelter and protection within crossing structures are also helpful for other species, particularly those that avoid open areas and are at risk of predation. For example, monitoring of the use of timber rails in two culverts in northern NSW found that the brown antechinus (*Antechinus stuartii*) was detected more often on the rails than on the ground (Goldingay et al. 2018a). Predator shields will be attached to the top of glider poles and the



supports of canopy bridges, and short lengths of PVC pipe will be attached to glider poles and canopy bridges to provide shelter to arboreal animals from owls.



Figure 5.13 Koala rails installed in approach areas to culverts and bridge underpasses. Note the use of salvaged tree trunks as part of the railing (left) also providing a refuge function. In this installation, animals must climb up and over the trunk, potentially reducing ease of use. Overgrown vegetation may also reduce function. Photos: Rodney van der Ree.



Figure 5.14 Koala rails in culverts under the Pacific Highway, Woolgoolga to Ballina. The installation on the left has a concrete floor, and the rail is attached to the wall with brackets and climbable posts secured to the floor and the rail. In contrast, the installation on the right has an earthen floor and the rail is stand-alone. In both cases, the post does not interrupt movement along the rail. Photos: Rodney van der Ree.

## 5.11 Murray cod passage

There is detailed advice and designs for bridges and culverts in waterways to ensure fish passage is maintained and these are provided in TMR (2024g). Bridges are more effective than culverts, and all crossings of potential Murray cod waterways use bridges with consideration of the following design criteria:

### New single span bridges:

- The bridge abutments do not extend into the waterway beyond the high bank.
- The bank revetment works do not extend beyond the toe of the bank.
- No scour protection is placed on the bed of the waterway upstream, downstream or under the structure.

### **New multi-span bridges:**

- In all waterways, the abutments do not extend into the waterway beyond the high bank, and the abutment revetment works do not extend into the waterway beyond the toes of the banks.
- In all waterways, bed scour protection is placed at, or below the natural bed level of the waterway, and does not change the characteristics of the low-flow channel.
- In purple, red, amber and green waterways, bed scour protection cannot extend more than 20 m upstream, or 20 m downstream beyond the footprint of the bridge.
- In grey waterways, bed scour protection cannot extend more than 5 m upstream, or 5 m downstream beyond the footprint of the bridge.
- In amber and green waterways, the pier/pile and/or pier/pile platform are completely outside the low-flow channel.
- In purple, red and grey waterways, the pier/pile and/or pier/pile platform can be within the low-flow channel but does not change the characteristics of the low-flow channel (i.e. cause scouring of the low-flow channel banks or bed).
- Re-snagging, where large woody debris is placed into a waterway for the purposes of fish habitat creation, bank stabilisation and/or the reinstatement of an eroded bank, is recommended where it does not cause a bund, riffle or weir structure within the waterway. The suitability of specific locations in Murray cod waterways will be determined by a Murray cod specialist during detailed design and detailed in the Wildlife Connectivity Plan.

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## **5.12 Noise and light mitigation**

There is an increasing understanding of the potential impacts of anthropogenic noise and light from transport infrastructure on wildlife (TMR 2024j). However, quantitative information on thresholds where impacts are observed and the significance of these impacts to wildlife is unknown, as well as impacts to animal movement at wildlife crossing structures. The Project will take a conservative approach and implement the following noise and light avoidance and mitigation strategies wherever the effectiveness of wildlife crossing structures may be affected. If there is any uncertainty about the severity and consequences of these impacts, ARTC will undertake research to assess the potential impacts and develop appropriate avoidance and mitigation strategies.

- Artificial lighting will be avoided in close proximity to wildlife crossing structures and within PCZs, as this may deter some species. Where lighting is required, it will be managed through careful design of the fixture, operating only when essential if possible (e.g., through a sensor), using the minimum brightness possible and warm colours.
- Noise and light walls will be considered above culverts and underpasses to reduce the disturbance of train lights and noise to wildlife entering and exiting the underpasses.
- Use of light shields on lights where appropriate to direct light to the rail infrastructure and avoid light spill into adjacent vegetation.
- The edges of vegetated land bridges (if land bridges are adopted) will be planted with dense vegetation and fitted with noise and light walls (Figure 5.15) to minimise the amount of noise and light from the Project on the land bridge. Soil berms can be used on the edges of land bridges and tunnels however, they are wider than screens or walls, which reduces the amount of space available for wildlife on the land bridge. Noise, light and vibration on vegetated land bridges with noise and light walls is significantly reduced on roads and no impacts of noise, light and vibration on fauna have been reported in the literature at those structures.
- While not a mitigation measure per se., the frequency of train movements, and indeed the timing and duration of train-free intervals is an important consideration because the risk of collision is related to exposure, which is the number of train movements. Therefore, for species that may cross above the tracks (e.g. birds and gliders), the number and duration of train-free periods is an important consideration.



- Detailed designs will be developed in accordance with the DCCEEW light pollution guidelines (DCCEEW 2023f) and will adopt the best practise avoidance and mitigation measures outlined in that document and other available sources.
- The details of the noise and light mitigation for ecological connectivity will be determined during detailed design and detailed in the Wildlife Connectivity Plan and the Wildlife Lighting Management Plan, where relevant.

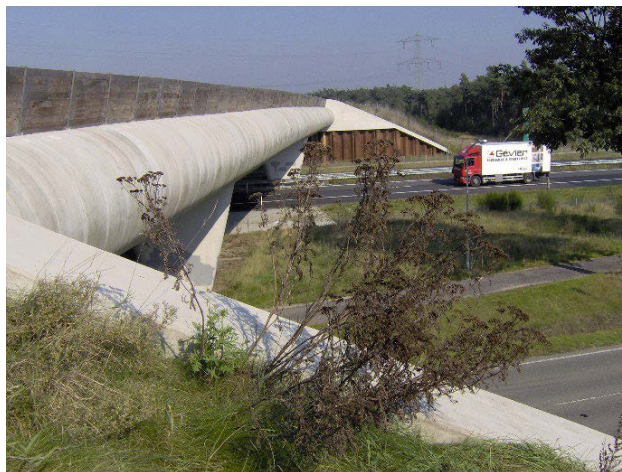


Figure 5.15 Example of a standard concrete noise wall along railway near Albury, NSW, and a more-aesthetically pleasing design of noise and light wall on a vegetated land bridge in The Netherlands. Photos Rodney van der Ree, WSP.

## 5.13 Landscaping and strategic revegetation

A critical aspect of the success of the Strategy is ensuring fauna can access the crossing structures safely and without hinderance. Strategic revegetation is the placement of habitat features (e.g. logs, rocks, artificial habitats) and plantings of vegetation to specifically encourage and facilitate movement of wildlife towards and across the crossing structures. The specific landscaping and strategic revegetation required to support ecological connectivity will be determined during detailed design and described in the Wildlife Connectivity Plan for the Project

These measures include:

- Clearing of native vegetation will be minimised to the greatest extent practicable at PCZs and other crossing locations with the objective of reducing impacts to functional connectivity provided by vegetation and other habitat features.
- Undertaking landscaping on approaches to underpasses to ensure water drains away from structures and does not pond, which can reduce rates of use by terrestrial species.
- Defining key habitat attributes critical for each target species. For example, greater gliders and koalas require regrowth or mature trees, cracking clay reptiles require certain soil conditions and other reptiles and snails require logs, depressions and other ground-layer features. The time taken for the growth or development of habitat features will vary according to the feature and target species and will be taken into account when assessing success of the mitigation measure. For example, trees with hollows can take in excess of 120 years to develop (Gibbons and Lindenmayer 2002), while trees that a koala can climb may take 10 years.
- At crossing locations and where important habitat elements exist, no-go areas that contain these habitat features will be established where possible and maintained throughout construction.

- At crossing locations where no go zones are unable to be established, detailed habitat creation and/or restoration will be undertaken to established standards for the specific target species, where possible. This will include, for example, placement of salvaged logs and rocks and the re-creation of natural soil profile and structure to support cacking-clay reptiles, and tree hollows for gliders. Research on methods to protect cracking clays during construction will be undertaken by ARTC to ensure the soil structure can be protected during construction and restored after construction.
- Strategic revegetation will take place at crossing locations where important features are currently lacking, where possible. This includes the restoration of woody vegetation to reduce canopy gap-size within and adjacent to the Project footprint (e.g. at secure offset sites) in PCZs and at crossing locations for woodland birds and other relevant species.
- All suitable habitat elements cleared during the Project will be carefully salvaged, transported, stored and re-used where practicable to enhance connectivity outcomes.

A Rehabilitation and Landscaping Management Plan will be prepared to guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas within the temporary disturbance footprint that are not required as part of the operational footprint (such as laydowns and compounds), subject to the requirements of landowner agreements.

Habitat linkages will be included in the rail corridor where practicable and consistent with the safe operation and maintenance of Inland Rail. Linkages would involve retaining or rehabilitating groundcovers and low shrubs, with a focus on those areas of the rail corridor in PCZs such as waterways, BPA corridors and LCPs. As part of consideration of fauna connectivity requirements during the Project's design progression, opportunities to avoid and reduce clearing within both the temporary and permanent the footprints will be considered for PCZs and crossing locations, and detailed in the Wildlife Connectivity Plan.

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## 5.14 Fauna fencing

A review of the international scientific literature showed that roadside fencing that is correctly designed, installed and maintained can reduce rates of mortality on roads by an average of approximately 50%, and up to almost 100% in some situations (Rytwinski et al. 2016). While the risk of fauna-train collisions on the Project is expected to be lower than on major roads with high traffic volume, a primary goal of the Strategy is to minimise injury and mortality of fauna. Therefore, fencing is a key component of the Strategy to reduce fauna-vehicle collision (Rytwinski et al. 2016) and it necessarily increases the barrier effect. Consequently, in almost all situations, fencing and crossing structures should be installed together.

The fencing component of the Strategy for the Project is complicated because there are a range of types of fencing with different purposes and designs, including:

- Perimeter security fencing – to exclude people from the Project footprint.
- Perimeter fencing to prevent stock from entering the railway corridor.
- Fauna exclusion fencing to prevent wildlife from entering the railway corridor and reducing rates of wildlife-train collision, thereby reducing potential injury and mortality of fauna.
- Fauna fencing to funnel wildlife to the wildlife crossing structures, thereby increasing their effectiveness.

This section describes the designs and types of fauna exclusion fencing, which is intended to prevent target species from accessing the railway and to funnel them towards crossing structures. The specific locations and lengths of fauna exclusion fencing at wildlife crossing structures will be determined during detailed design and detailed in the Wildlife Connectivity Plan. The feasibility of different types of fencing will be determined during detailed design depend on the needs of fauna, operational and safety requirements and land holder requirements.

- Fauna exclusion fencing will be designed specifically for the target species to maximise its effectiveness. Other types of structures, such as noise and light walls can also function as fauna fences if designed appropriately.
- All fauna exclusion fencing will be design and installed in accordance with best practise guidelines, including the TMR FSTIDM (TMR 2024i) and the Koala Sensitive Design Guideline (DES 2022).

- Perimeter fencing is recommended to not impact the movement of target species at crossing locations, especially at PCZs and other crossing locations. The design of perimeter and other fencing will be finalised during detailed design, ensuring that the target species at each crossing location can pass through boundary fencing and access the crossing structures.

#### 5.14.1 *Fauna exclusion fencing*

Fauna exclusion fencing will be installed along the Project at locations where target species need to be excluded from accessing the railway and funnelled towards crossing structures. Exclusion fencing that excludes at-risk fauna from the railway is required because a fundamental objective of the strategy is to minimise the risk of wildlife-train collisions (Section 1.3). Koalas are at the greatest risk of injury and mortality from collisions with trains and are the primary target species for physical fencing, while other species are be funnelled to underpasses using strategic revegetation and habitat placement (Section 5.14.3).

Koala exclusion fencing will be installed on the Project in high priority areas and where suitable crossing structures for koalas have been installed. These fences are designed to prevent koalas from accessing the railway and to funnel them towards crossing structures. Koala exclusion fencing will not be installed in low-priority areas for koalas.

Koalas are excellent climbers and the fencing will be planned and designed specifically for koalas, including:

- Standard height is 1.8 m, with a 600 mm wide strip of sheet metal at the top. Fences can be lower but other species, such as kangaroos, will be able to jump over. In almost all cases, koala fencing will double as kangaroo fencing and security fencing.
- Other structures, such as noise and light walls, retaining walls and sections of cliff or cuttings can also act as barriers to koala movement, provided they are unable to be climbed by koalas.
- Attention to detail is required to prevent koala egress, such as the inclusion of concrete strips along the base of the fence to prevent gaps forming, ensuring gates close tightly and without gaps underneath, and ensuring no gaps between fences and crossing structures.
- Where possible, maintenance tracks will be placed along the fence edge to provide access for maintenance and provide a clear delineation between the fence and the habitat.
- Escape mechanisms will be included at regular intervals along the fence (Section 5.15).
- Fencing on the Project will be integrated with koala grids where roads cross the Project (Section 5.14.2).

Effective exclusion fencing for reptiles and snails consists of solid fencing or mesh with very fine holes. In many areas along the Project, this is unlikely to be effective in the long-term due to damage during flooding and the impacts of the fence on flooding and hydrology. Other approaches are recommended (5.14.3).

#### 5.14.2 *Koala grids*

Gaps in fencing along the Project are required for level crossings across the railway. Where possible, these will include gates or koala grids to prevent fauna from accessing the fenced railway, especially in high priority areas for koalas. Consideration will be given during detailed design to identify and resolve any instances where koala fences and grids might conflict with the movement of other target species.

Koala grids are essentially cattle grids used by farmers to control stock (Figure 5.16), and with the right spacing of the bars, can be used to prevent movement of koalas.

Grids are a safety hazard to pedestrians and cyclists and a grate may be an effective option. However, trials of 90 x 45 mm grates (i.e., square mesh) at David Fleay Wildlife Park found that koalas readily traversed these (Rick Haywood, pers. comm.). Further trials of different sized mesh are required to further explore this option.



Figure 5.16 Koala grid at Evans Head, New South Wales (Source: TfNSW).

### 5.14.3 Strategic revegetation and habitat placement to funnel fauna to crossing structures

For many species, there are no suitable fencing designs to exclude fauna from the railway and/or funnel them towards crossing structures on this Project. For example, brigalow woodland snail and the cracking clay and woodland-dependent reptile species are able to pass through the mesh fences proposed for the Project, and solid fencing may only be suitable in specific areas that are not prone to flooding. In addition, birds and gliders can fly or glide above the fence and quolls are expected to be able to pass through or climb over many types of fencing.

These species will be encouraged towards the crossing structures through strategic revegetation and habitat enhancement that extends from adjacent habitat across the Project footprint and to the entrances of crossing structures, where possible. This will include the retention and/or replanting of vegetation that funnels fauna to specific crossing structures, as well as placement of natural habitat, such as logs, rocks, branch piles, or artificial habitat, such as roof tiles or iron (e.g. for reptiles), as intermediate steps to crossing structures. The effectiveness of different approaches varies among species, and the optimal approach for each target species will be determined during detailed design and be considered on a site-by-site basis. Where plantings take time to develop, artificial features will be provided as interim measures while the plantings grow and mature.

## 5.15 Fence escape mechanisms

Escape mechanisms are one-way structures within fences that allow fauna that have breached the fence to leave the rail or road corridor. Escape mechanisms will be installed for koalas and other species on the Project and on the Wild Dog Check Fence where it interacts with the Project.

Escape mechanisms are required where the Project has long lengths of continuous fauna fencing relative to the movement parameters of the species. They are not required for short lengths of fencing where fauna can quickly move to the ends of fencing to leave the fenced reserve. The length of fauna fencing where escape mechanisms are required is species-specific and dependent on their typical movement parameters.



Escape mechanisms without moving parts (e.g., jump outs (Section 5.15.1), escape ramps (Section 5.15.1) or escape poles (Section 5.15.2)) are preferred over those with moving parts (e.g., one-way gates (Section 5.15.3)) because they are less prone to failure and require less maintenance. However, the design must be suitable for the target species. Trials with one-way gates for koalas are currently underway by Endeavour Veterinary Ecology ([Fauna Escape Hatch](#)) and results of those trials will be incorporated during detailed design. The most effective designs available at the time of detailed design will be adopted for the Project. If there are no effective designs, and target species are prone to being trapped in the railway, ARTC will consider a targeted capture and relocation program, depending on the rate of ingress and causes. The details of this will be developed as part of the adaptive management of the Project (Section 6.2.3).

The ARTC will also review results of monitoring of fence escape mechanisms on other sections of Inland Rail and incorporate these results into the detailed design for the Project.

### 5.15.1 *Jump outs and escape ramps*

Jump-outs allow animals trapped inside the fenced reservation to drop or jump ‘down and out’ into the adjacent habitat areas, while preventing them from climbing up into the railway (Figure 5.17).

Jump-outs have been trialled on the Oxley and Pacific Highways in northern New South Wales, with seven structures on the Oxley Highway near Port Macquarie being monitored from June 2013 to September 2016 (Goldingay et al. 2018c). These were earthen ramps approximately 3 m in length with a 60 – 80 cm vertical face that acted as the drop-down, positioned within the fauna-proof fencing. While numerous species were detected using the jump-outs, including in both directions, no koalas were ever detected using them, despite occurring at low density in the area. The trial concluded that the vertical face must be at least 120 – 140 cm high (Brendan Taylor, pers. comm.).

Jump-outs can also be constructed where the rail is on fill with a retaining wall, rather than earthen ramps inside the fence that animals must climb in order to exit the fenced area. Another approach is to integrate the jump-out with the wing-walls of culverts, which have the advantage of:

- depositing animals at a crossing structure; and,
- making use of the existing height of the culvert wall rather than requiring the construction of an earthen ramp.



Figure 5.17 Jump-outs for Koalas on the Pacific Highway, including two options for a ramp on the road-side of the fence (left and middle) and integrating the jump-out with the wing-wall of a wildlife culvert (right). Photos Rodney van der Ree (left and middle) and TfNSW (Right).

### 5.15.2 *Escape poles*

Escape poles allow koalas (and other arboreal species) that breach fauna fencing to climb up and out of the fenced area and into habitat on the other side of the fence (Figure 5.18). Escape poles will be installed in high quality koala habitat at intervals of approximately 250 m to provide koalas with sufficient opportunity to escape before attempting to cross the railway.

- There is little evidence of use of escape poles by koalas, however this is probably at least partly related to a lack of effective monitoring. In addition, the likelihood of actually detecting a koala using such a pole is very low because:
- Fencing is typically effective at excluding koalas and thus, koalas needing to use such poles happens very occasionally.
- There are potentially many poles for the koala to choose to use.
- Monitoring needs to be happening at the time that the koala is inside the fence and be focussed on the pole the koala attempts to use.



Nevertheless, a tracking study of koalas along the Moreton Bay Rail Line shortly after construction found that one sub-adult male Koala which entered the fenced rail corridor passed at least two escape poles, but never actually climbed and used one to exit the corridor (Hanger et al. 2017). He was captured on the same day as he was detected and released on the opposite side of the railway. The same study suggests that koalas are more likely to encounter and use ground-based escape options (see Section 5.15.3) than escape poles, however the evidence base for all escape options remains low.

Two-way escape poles will be installed along Wild Dog Check Fence where it interacts with the Project, allowing koalas to move in both directions over the fence. Both sides of these ‘n’ shaped poles are able to be climbed by koalas and other arboreal and semi-arboreal species, including the spotted-tailed quoll.



Figure 5.18 ‘n’-shaped koala escape pole (two-way escape pole), shown from (left) the road- or railway-side of the fence and (middle and right) the habitat side of the fence. The pole on the habitat side of the fence includes plastic or sheet metal wrapping that prevents koalas from climbing into the transport reserve. Sheet metal is also attached to the fence at the pole to prevent climbing up the fence and then the pole above the wrapping. Escape poles can also terminate at the top of the wrapping, requiring koalas to jump down. ‘Two-way’ escape poles do not have plastic or sheet metal, allowing fauna to use the structure in either direction. Photos Rodney van der Ree.

### 5.15.3 One-way gate

One-way gates enable fauna to move through a gate which self-closes behind the animal as it passes, enabling egress from the rail corridor only. There are numerous designs, including wire mesh, metal rakes and Perspex with various funnel designs to encourage animals to find and use the gate.

A series of trials of one-way gates (Figure 5.19) using captive koalas concluded the most effective design had two- lightly-sprung Perspex doors at 45° angle, which koalas push through but are unable to open it in the opposite direction (Hanger et al. 2017). More recent trials by Endeavour Veterinary Ecology ([Fauna Escape Hatch](#)) include the use of metal rakes, which show some potential. These designs may be more effective than escape poles for koalas and if further trials show they are effective and maintenance is feasible, they will be considered for the Project.



Plate 6.7: Prototype of the most successful koala egress valve, with two vertically-hinged, lightly-sprung Perspex® doors.

Figure 5.19 (Left) The design of a prototype of one-way gates for koalas, tested on captive animals as part of the Moreton Bay Rail Project. Koalas can push through the lightly-sprung doors at a 45° angle, but are (right photo) unable to pass through in the opposite direction (Hanger et al. 2017).

## 5.16 Effectiveness of mitigation in revised reference design for maintaining connectivity for target species

### 5.16.1 Effectiveness of mitigation - Overview

The likely effectiveness of the revised reference design (with minor assumptions as described in Section 3.8) to generally maintain connectivity for target species and concomitantly other species with similar movement and habitat characteristics, has been assessed using criteria in Table 5.4 and detailed in Table 5.5. The likely effectiveness is based on a combination of:

- The number or percentage of satisfactory crossing structures and new proposed structures in areas of habitat for the target species.
- The movement distances or movement capability of the species (i.e. are they likely to travel long distances to find crossing structures and/or pass through crossing structures quickly).
- The degree of certainty around the ability and willingness of the species to use crossing structures (i.e. is there evidence the species will use the crossing structures and if not, is use expected or likely?).

Key assumptions outlined in Section 3.8 were used to assess the revised reference design and form the baseline determination for connectivity without major mitigation measures applied (e.g. without glider poles, larger culverts, additional crossing structures, etc). Consideration was then given to current knowledge of design and use of mitigation strategies by target species, footprint management, number and percent of satisfactory structures to determine whether connectivity is likely, possible or unlikely to be maintained.

Table 5.4. Assessment matrix to determine the likely effectiveness of revised reference design of the Project without major mitigation measures

| Likely effectiveness of mitigation Criteria    | High          | Moderate          | Low          | Negligible |
|------------------------------------------------|---------------|-------------------|--------------|------------|
| Percentage of satisfactory crossing structures | 75 – 100 %    | 50 – 75 %         | 25 – 50 %    | < 25 %     |
| Certainty species will use crossing structures | Certain       | Mostly certain    | Uncertain    | Uncertain  |
| Movement of species                            | High mobility | Moderate mobility | Low mobility | Sedentary  |
| Mitigation effectiveness                       | 75 – 100 %    | 50 – 75 %         | 25 – 50 %    | < 25 %     |

Based on the revised reference design (with minor assumptions), connectivity for most species is unlikely to be maintained (see column labelled ‘Impact to connectivity of RRD before mitigation’ in (Table 5.5). Connectivity is likely to be maintained by implementing the major mitigation measures identified for each target species, such as:

- Minimising tree clearing and canopy gap size at crossing locations for gliding mammals and installing canopy bridges and glider poles to achieve two-way movement for gliders.
- Ensuring underpasses for reptiles are short (e.g. < ~40 – 50 m), have natural substrates and provide habitat in the footprint that enables them to access the underpass entrances. In high priority locations for reptiles and Brigalow woodland snails, consider installing bridge underpasses rather than culverts.
- Ensuring that ground protection is implemented during construction to avoid and minimise soil compaction at crossing locations within the Project footprint and adjoining areas where applicable for reptiles that rely on cracking clays.
- Increasing the height and width of culverts for koala and spotted-tailed quolls, minimising length of long culverts (> 50 m) and installing light wells in very long culverts.
- Increasing the clearance of bridge underpasses, where possible, and/or minimising vegetation clearance and retaining and/or revegetating shrubs in the Project footprint at crossing locations for woodland birds, such that gap sizes are less than ~100m in size.

Table 5.5 provides the number of proposed new structures for each target species along the Project.

### 5.16.2 Effectiveness of mitigation in Priority Connectivity Zones

The number of satisfactory crossing structures in the revised reference design (i.e. prior to major mitigation measures being applied such as increasing dimensions or adding a crossing structure) but including the minor assumptions outlined in Section 3.8 (e.g. converting pipe culverts to box culverts) within the PCZ is shown in Table 4.2. This assessment shows that there are greater numbers of satisfactory structures within the PCZs than unsatisfactory structures for most target species, except for gliders, woodland birds and koala. Structures for these three species are typically unsatisfactory because:

- The structure is too small to facilitate fauna crossing.
- The presence of barbed wire presents a risk of injury or mortality of the target species, reducing the likelihood of successful crossing.
- The bridge height and/or absence of connected canopy within glide/ gap crossing capability of gliders and woodland birds.

Table 5.5 Likelihood of maintaining connectivity for target species based on revised reference design (RRD) with minor assumptions (column 4) and additional major mitigation measures (last column). PCZ = priority connectivity zone

| Species              | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                              | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                                                                             | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                                                                                                                                        | Residual impact to connectivity after mitigation |
|----------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Woodland birds       | 7 out of 21 (33%)<br>2 out of 16 (13%) within PCZs                              | Gap-sensitive woodland birds will traverse gaps between trees of up to ~100 m.<br><br>Low-flying woodland birds will use bridge underpasses with high clearance, otherwise flying at-grade above the railway. | High                                            | Connectivity for gap-sensitive woodland birds achieved by reducing width of clearing and/or through retention and/or revegetation of shrubs in Project footprint to reduce gaps < 100 m in size.                                                                                                                   | 0 (0%)                                                                                                     | Connectivity is likely to be maintained by reducing gap size to < 100 m by reducing width of clearing and/or through retention and/or revegetation of shrubs in Project footprint.<br><br>Bridge underpasses will further assist safe passage under railway.<br><br>Connectivity unlikely to be maintained if gap in woodland cover exceeds 100 m | Low                                              |
| Spotted-tailed quoll | 189 out of 260 (73%)<br>73 out of 109 (67%) within PCZs                         | Two records of spotted-tailed quoll using large (>2.4 m) culverts under highway.<br><br>Spotted-tailed quolls likely capable of crossing Project at-grade, but low risk of collision.                         | Low                                             | No mesh fencing or barbed wire preventing access to culverts and bridge underpasses.<br><br>No specific habitat treatment in Project footprint required, but where practicable reduce width of clearing and/or through retention or revegetation of trees and shrubs to provide shelter and connectivity elements. | 17 (2%)                                                                                                    | Connectivity likely to be maintained with large culverts and bridge underpasses.<br><br>Habitat in Project footprint will provide additional connectivity elements to support movement.                                                                                                                                                           | Low                                              |
| Gliding mammals      | 2 out of 17 (12%)                                                               | A few records of greater gliders using glider poles in pipeline easements and short canopy                                                                                                                    | High                                            | Possible that greater glider will traverse 60 m clearings across Project footprint using glider poles and/or canopy bridges.                                                                                                                                                                                       | 24 (52%)                                                                                                   | Connectivity for both species likely to be maintained where canopy gap is relatively small (< ~50 - 60 m) and canopy bridges and/or glider poles within the Project footprint                                                                                                                                                                     | Low                                              |

| Species | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                                                                                                                                                                                                                                                                    | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                                                                                         | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                                                                                                                                                                                     | Residual impact to connectivity after mitigation |
|---------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|         | 2 out of 17 (12%) within PCZs                                                   | <p>bridge across forest road. Yellow-bellied glider observed using canopy bridges and glider poles across highway. Greater glider observed living right next to Pacific Highway and other roads, suggesting tolerance of conditions.</p> <p>Greater glider has relatively steep glide angle, meaning short glides of 30 m expected in woodland near Project.</p> <p>Use of glider poles and canopy bridges well-documented for smaller gliders.</p> |                                                 | <p>Likely that yellow-bellied glider will use canopy bridges and glider poles to cross a 60 m easement.</p> <p>Ideally, reduce clearing width to support use of canopy bridges and glider poles by greater glider and yellow-bellied glider.</p> <p>No barbed wire in areas targeting gliders due to risk of entanglement.</p> |                                                                                                            | <p>will provide safe crossings in both directions across the railway.</p> <p>Connectivity for both species is unlikely to be maintained via natural canopy connectivity due to clearing widths required for safe operational requirements.</p> <p>Reducing width of clearing will reduce the size of the canopy gap and enhance connectivity outcomes via canopy bridges and glider poles.</p> |                                                  |
| Koala   | <p>146 out of 342 (43%)</p> <p>41 out of 124 (33%) within PCZs</p>              | Extensive use of culverts and bridge underpasses, including under railways has been reported.                                                                                                                                                                                                                                                                                                                                                       | <b>High</b>                                     | Appropriately sized culverts and bridge underpasses every 400 m within foraging habitat and 800 m in dispersal habitat to allow for daily and dispersal movements.                                                                                                                                                             | 23 (4%)                                                                                                    | Connectivity likely to be maintained with large culverts and bridge underpasses every 400 m in foraging habitat or 800 m in dispersal habitat. This spacing is the approximate radius of average home range size of koalas tracked                                                                                                                                                             | <b>Low</b>                                       |



| Species | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                                                                                                                        | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                   | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                              | Residual impact to connectivity after mitigation |
|---------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|         |                                                                                 | <p>Koala not recorded using canopy bridges. Will use vegetated land bridges with mature trees or refuge poles.</p> <p>Correctly designed fencing (1.8 m cyclone mesh fencing, with sheet metal panels to prevent climbing) will funnel koalas to crossing structures and keep them off the railway.</p> |                                                 | <p>Ideally, reduce clearing width to support use of underpasses by koalas. Install refuge poles at koala crossings in Project footprint and outside footprint</p> <p>No barbed wire or fencing preventing access to culverts and bridge underpasses.</p> |                                                                                                            | <p>in the study area by USQ (Section 4.2.4).</p> <p>Reduce clearing width and install refuge poles within and outside Project footprint at koala crossing locations.</p> <p>Increase height of bridges and culverts where required.</p> |                                                  |

| Species                | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                                                                                                                       | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                                                                                                                                     | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                                                                                                                                                                                                                                                                                                   | Residual impact to connectivity after mitigation |
|------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Woodland reptiles      | 84 out of 111 (77%)<br>45 out of 57 (79%) within PCZs                           | No studies of use of crossing structures by woodland reptiles.<br><br>Given relatively short movement distances and specific habitat requirements, bridge underpasses with natural habitat conditions likely most effective.<br><br>Short culverts with natural substrates also likely effective.      | Moderate at bridges                             | Appropriate soil conditions and other habitat features (e.g. trees, logs, rocks, native grasses and shrubs) within and on the approach to crossing structures are required to support movement of woodland reptiles.                                                                                                                                                       | 26 (4%)                                                                                                    | Connectivity for woodland reptiles is likely to be maintained with bridge underpasses and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity for woodland reptiles possibly maintained with short culverts with natural substrate and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity unlikely to be maintained where habitat in Project footprint leading to underpass entrances unable to be retained or revegetated.           | Low at bridges                                   |
|                        |                                                                                 |                                                                                                                                                                                                                                                                                                        | High at culverts                                |                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Moderate at culverts*                            |
| Cracking clay reptiles | 294 out of 341 (86%)<br>88 out of 107 (82%) within PCZs                         | No studies of use of crossing structures by cracking clay reptiles.<br><br>Given relatively short movement distances and specific habitat requirements, bridge underpasses with natural habitat conditions likely most effective.<br><br>Short culverts with natural substrates also likely effective. | Moderate at bridges                             | Cracking clay reptiles must be able to survive in Project footprint in order to live near and/or to access underpass entrances.<br><br>Appropriate soil conditions (cracking clays) and other habitat features (e.g. logs, rocks, native grasses and shrubs) within bridges and on the approach to all crossing structures are required to support cracking clay reptiles. | 16 (1%)                                                                                                    | Connectivity for cracking clay reptiles is likely to be maintained with bridge underpasses and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity for cracking clay reptiles possibly maintained with short culverts with natural substrate and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity unlikely to be maintained where habitat in Project footprint leading to underpass entrances unable to be retained or revegetated. | Low at bridges                                   |
|                        |                                                                                 |                                                                                                                                                                                                                                                                                                        | High at culverts                                |                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Moderate at culverts*                            |

| Species                  | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                                                                                                                    | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                                                                                | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                                                                                                                                                                                                                                                                                                       | Residual impact to connectivity after mitigation |
|--------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Condamine earless dragon | 49 out of 67 (73%)<br>23 out of 31 (74%) within PCZs                            | No evidence of use of crossing structures by Condamine earless dragon.<br><br>Given specific habitat requirements, structures most likely used are bridge underpasses with natural substrate and natural light/moisture levels, followed by culverts with natural substrate.                        | Moderate at bridges                             | Suitable habitat for Condamine earless dragon is critical within Project footprint, allowing dragon to reach the underpass. Habitat includes natural soil structure, logs, leaf litter, tussock grasses etc.                                                                                                          | 4 (1%)                                                                                                     | Connectivity for Condamine earless dragon is likely to be maintained with bridge underpasses and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity for Condamine earless dragon possibly maintained with short culverts with natural substrate and where habitat is retained or revegetated in the Project footprint.<br><br>Connectivity unlikely to be maintained where habitat in Project footprint leading to underpass entrances unable to be retained or revegetated. | Low at bridges                                   |
|                          |                                                                                 |                                                                                                                                                                                                                                                                                                     | High at culverts                                |                                                                                                                                                                                                                                                                                                                       |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Moderate at culverts*                            |
| Murray cod               | 9 out of 9 (100%)<br>9 out of 9 (100%) within PCZs                              | Fish passage well documented under bridges and through well-designed culverts (i.e. short in length, open with natural light levels, no increase to velocity, set below stream bed level, roughness to provide rest areas).<br><br>No specific studies of use of crossing structures by Murray cod. | Low                                             | Waterways used by Murray cod to retain bank and in-stream natural conditions (trees on bank, natural pools and riffles, snags etc) through Project footprint.<br><br>All Murray cod crossings are with bridge structures. Short breaks in natural conditions from bridges unlikely to disrupt movement of Murray cod. | 0 (0%)                                                                                                     | Connectivity for Murray cod likely to be maintained with bridge underpasses.<br><br>Bank and in-stream habitat in Project footprint will enhance connectivity.                                                                                                                                                                                                                                                                                                                                                   | Negligible                                       |

| Species                 | Number and % of RRD structures within habitat that are satisfactory (Table 5.2) | Is appropriate design of crossing structures known and is there evidence of use?                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Impact to connectivity of RRD before mitigation | Management of Project footprint to enable target species to access crossing structures                                                                                                                                                                                                                   | Number of proposed new structures (and % increase of structures that are satisfactory with implementation) | Outcome of revised reference design with assumptions, actions to improve structure suitability (refer final column in Appendix F), management of footprint, and addition of new structures                                                                                                                                                                                                                                                                                                                            | Residual impact to connectivity after mitigation |
|-------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Brigalow woodland snail | 251 out of 293 (86%)<br>71 out of 86 (83%) within PCZs                          | <p>No studies of the Brigalow woodland snail using crossing structures.</p> <p>Given short movement distances and high habitat specificity, bridge underpasses with natural habitat conditions likely most effective.</p> <p>Open bottomed culverts with natural substrate may work if short and contains habitat that supports survival of snails. With slow movement, they must be able to survive in the crossing structure.</p> <p>Most movement of snails expected during wet conditions, possibly at higher rates during floods.</p> | <b>Moderate at bridges</b>                      | <p>Brigalow woodland snail must be able to survive in Project footprint in order to live near to and/or access underpass entrances.</p> <p>Moist microclimate/soil conditions, and natural shrubby/grassy vegetation likely critical to supporting Brigalow woodland snail in the Project footprint.</p> | 4 (0.2%)                                                                                                   | <p>Connectivity for Brigalow woodland snail is likely to be maintained with bridge underpasses and where habitat is retained or revegetated in the Project footprint.</p> <p>Connectivity for Brigalow woodland snail possibly maintained with short culverts with natural substrate and where habitat is retained or revegetated in the Project footprint.</p> <p>Connectivity unlikely to be maintained where habitat in Project footprint leading to underpass entrances unable to be retained or revegetated.</p> | <b>Low at bridges</b>                            |
|                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>High at culverts</b>                         |                                                                                                                                                                                                                                                                                                          |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Moderate at culverts*</b>                     |

\*There remains significant uncertainty about the effectiveness of culvert mitigation for Brigalow woodland snail, Condamine earless dragon, cracking clay reptiles and woodland reptiles. This uncertainty is due to a lack of available research which confirms use of crossing structures, particularly culverts by these species.

# 6 Mitigation goals and mitigation effectiveness

## 6.1 SMART mitigation goals

The overarching objectives of the Fauna Connectivity Strategy for the Project are outlined in Section 1.3 and set the broad direction and outcomes to be achieved by the Strategy. The SMART - Specific, Measurable, Achievable, Realistic and Time-framed - mitigation goals for each target species outlined in Table 6.1 informed the specific assessments, guided the design of the mitigation measures and will enable evaluation of mitigation success during operation.

The SMART goals will be refined and incorporated into the Wildlife Connectivity Plan during detailed design. The final connectivity mitigation measures will be specified in the Wildlife Connectivity Plan, developed in the Project detailed design in line with the approach and rationale described in the Fauna Connectivity Strategy (this document).

Table 6.1 and informed by site-specific information, further research, fauna requirements, safety requirements and flooding constraints. This will be particularly important for species where there is insufficient information about their current distribution to develop more refined goals at this stage.

The use of SMART goals to guide mitigation strategies and plans is recognised as a standard approach in the transportation ecology literature to ensure the mitigation addresses the specific impacts and enables evaluation of success (Van der Grift et al. 2013, Van der Grift et al. 2015) and has been adopted by TMR on future projects (TMR 2024b).

Corrective actions will be developed and implemented if the SMART goals outlined in Table 6.1 and finalised in the Wildlife Connectivity Plan are not reached. The specific corrective actions to be implemented will be developed based on the results of the monitoring and evaluation program and in accordance with the adaptive management framework (Section 6.2.3) to ensure the actions address the specific cause of the failure.

Table 6.1 SMART mitigation goals for each target species

| Target species | SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Survey methods and study design considerations to evaluate success at achieving SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Woodland birds | <ul style="list-style-type: none"><li>— The rate of daily movement across the Project at designated bird crossing locations (i.e., under bridges and at the at-grade crossings) and elsewhere along the alignment occurs at a similar rate to movement across comparable control sites with similar gap sizes and vegetation characteristics before construction and at five years after operation.</li><li>— Higher rates of daily crossing at designated bird crossing locations compared to elsewhere on the Project.</li></ul> | <ul style="list-style-type: none"><li>— Assessment to adopt a replicated Before-After-Control-Impact study design.</li><li>— Field studies quantify the rate of movement of woodland birds across gaps in woodland cover. Study design to take into account woodland type, gap size, type of barrier (e.g., rail, powerline, farmland etc), and to commence prior to clearing of vegetation for Project construction. Studies to commence before construction, continue during construction and for at least five years after construction.</li><li>— Targeted surveys of dead birds due to wildlife-train collisions within areas where woodland birds have been observed crossing the railway.</li></ul> |



| Target species                                                      | SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                     | Survey methods and study design considerations to evaluate success at achieving SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Spotted-tailed quoll                                                | <ul style="list-style-type: none"> <li>— Spotted-tailed quoll use the crossing structures (e.g. culverts and bridge underpasses) at five years after construction at rates in proportion to their occurrence in the landscape in the vicinity of each wildlife crossing structure.</li> <li>— No genetic differentiation of populations on opposite sides of the Project at 10 years post operation.</li> </ul>                                 | <ul style="list-style-type: none"> <li>— Installing motion-triggered cameras on targeted crossing structures and in adjacent habitat to assess presence, abundance, and rate of use of crossing structures.</li> <li>— Use GPS or satellite tracking to assess movement of animals living in the vicinity of the Project.</li> <li>— If insufficient spotted-tailed quolls occur in the broader area for effective monitoring, consider using other species of small- to medium-sized ground-dwelling mammals as surrogates.</li> <li>— Explore DNA survey options if spotted-tailed quoll are found in proximity to the Project. Investigate feasibility of evaluating effectiveness of crossing structures using DNA sampling or tracking methods before and after construction.</li> <li>— Undertake mortality surveys of quolls on railway.</li> </ul> |
| Gliding mammals                                                     | <ul style="list-style-type: none"> <li>— Gliding mammals use the crossing structures (e.g. above-rail and below-rail canopy bridges and glider poles) at five years after construction at rates in proportion to their occurrence in the landscape in the vicinity of each wildlife crossing structure.</li> <li>— No genetic differentiation of populations on opposite sides of the Project at 10 years post operation.</li> </ul>            | <ul style="list-style-type: none"> <li>— Install motion-triggered cameras on targeted crossing structures and in adjacent habitat to assess presence, abundance, and rate of use of crossing structures.</li> <li>— If insufficient greater gliders in area for effective monitoring, use other species of glider and/or possums as surrogates.</li> <li>— Explore DNA survey options if greater gliders are found during field assessment in proximity to rail. Investigate feasibility of evaluating effectiveness of crossing structures using DNA sampling or tracking methods before and after construction.</li> <li>— Undertake mortality surveys of greater glider on railway.</li> </ul>                                                                                                                                                          |
| Woodland reptiles, cracking-clay reptiles, Condamine earless dragon | <ul style="list-style-type: none"> <li>— Target reptile species are present in habitat within Project footprint leading to the crossing structures at five years after construction.</li> <li>— Target species use crossing structures (e.g. culverts and bridge underpasses) at five years after construction for dispersal at rates in proportion to their occurrence in the landscape in the vicinity of each crossing structure.</li> </ul> | <ul style="list-style-type: none"> <li>— Undertake surveys of target species in habitats adjacent to crossing structures and in habitats away from the railway.</li> <li>— Use capture-mark-recapture methods, sensitive cameras and/or other techniques to detect reptiles using the crossing structures.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Target species          | SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Survey methods and study design considerations to evaluate success at achieving SMART goals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Brigalow woodland snail | <ul style="list-style-type: none"> <li>— Brigalow woodland snail are present in habitat within Project footprint leading to snail crossing structures at five years after construction.</li> <li>— Brigalow woodland snails use the crossing structures (e.g. culverts and bridge underpasses) at five years after construction for dispersal at rates in proportion to their occurrence in the landscape in the vicinity of each crossing structure.</li> </ul>                                                                                                                                                                          | <ul style="list-style-type: none"> <li>— Undertake surveys of target species in habitats adjacent to crossing structures and in habitats away from the railway.</li> <li>— Use capture-mark-recapture methods and/or other techniques to detect snails using the crossing structures.</li> <li>— If insufficient brigalow woodland snails occur in the area for effective monitoring, use other species of snail as surrogates.</li> <li>— Undertake genetic studies to measure gene flow.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Koala                   | <ul style="list-style-type: none"> <li>— The movement of koalas around and across the railway will reach pre-construction levels within five years of opening to train movements.</li> <li>— Koalas use the crossing structures (e.g. culverts and bridge underpasses) at five years after construction for daily movements and dispersal at rates in proportion to their occurrence in the landscape in the vicinity of each crossing structure.</li> <li>— Sufficient gene flow across the Project within 10 years of operation that ensures no genetic differentiation of populations on opposite sides due to the Project.</li> </ul> | <ul style="list-style-type: none"> <li>— The movement of individual koalas will be assessed using GPS tracking using same methods as currently employed by the University of Southern Queensland.</li> <li>— Ongoing collection and analysis of koala DNA samples from adjacent and broader areas from the Project and an analysis of gene flow at five-yearly intervals for 20 years. Koala DNA samples to be collected from a range of sources, including scat samples, tissue biopsies to be collected as part of ongoing research sponsored by ARTC, roadkill animals, rescued animals, etc.</li> <li>— The use of targeted crossing structures by koala is measured using camera traps and tracking of koalas in vicinity of the Project.</li> <li>— Mortality of koalas to be measured from train driver reporting, tracking results and targeted wildlife-train collision surveys conducted during and after construction</li> </ul> |
| Murray cod              | <ul style="list-style-type: none"> <li>— No reduction in cross-rail movement within 12 months of construction.</li> <li>— Murray cod use bridge underpasses for daily movements and dispersal at rates in proportion to their occurrence in the landscape in the vicinity of each bridge structure.</li> <li>— Murray cod present in waterways upstream and downstream of each bridge.</li> <li>— No genetic differentiation of populations on opposite sides of the Project at five years post operation.</li> </ul>                                                                                                                     | <ul style="list-style-type: none"> <li>— Investigate feasibility of eDNA and other genetic sampling techniques to assess presence of Murray cod in waterways and to measure changes in population structure across the Project.</li> <li>— The rate of use of crossing structures by Murray cod is in proportion to their occurrence in the adjacent area.</li> <li>— Use surrogate fish species if Murray cod occur at low densities and are unable to be effectively studied.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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## 6.2 Monitoring, maintenance and adaptive management of the fauna connectivity infrastructure

Operational ecological monitoring and evaluation of the on-ground implementation of the Strategy will be undertaken to determine whether the Strategy goals are progressively being achieved at the various time periods for each species. Well-conducted monitoring, evaluation and reporting (MER) is the fundamental basis for evidence-based decision-making (TMR 2024a).

The application of MER enables an assessment of the ability of chosen structures and other designs to maintain connectivity for the target species across the Project. The results of the assessment inform adaptive management of the structures, to progressively ensure Strategy goals are being met. The details of the MER program will be developed and detailed in the Wildlife Connectivity Plan and the following four principles apply.

### 6.2.1 *Evaluation of use and effectiveness*

A comprehensive MER plan that evaluates the use of crossing structures (i.e., rate of crossing by different species) and the effectiveness of crossing structures and other strategies (i.e., are the SMART goals being achieved) will be developed during the detailed design phase and detailed in the Wildlife Connectivity Plan. The timing of this ensures that any remaining uncertainties about mitigation effectiveness can be incorporated into the MER program and evaluated in a targeted and scientifically rigorous approach. Consideration of mitigation uncertainty for the calculation of offset requirements is separate to how mitigation uncertainty informs and directs the MER program and will be addressed in the offsets plan. For example, crossing structures for a specific target species could be varied in size or shape or choice of substrate or furniture and the details of such an experiment is determined during detailed design.

The monitoring and evaluation program will adopt a scientifically robust approach in accordance with guidance described in Chapter 3 of the TMR FSTIDM (TMR 2024a). For example, a replicated BACI study design will be adopted where appropriate and feasible to ensure any impacts can be attributed to the project and not to other factors or causes. The monitoring will evaluate both the rate of use of crossing structures as well as effectiveness at achieving the SMART goals, such as tracking population size, animal movement, gene flow and species distribution. The types of aspects to be measured are given in Table 6.1.

### 6.2.2 *Inspections and maintenance*

ARTC will establish and maintain an ecological asset register which includes all wildlife crossing structures and other infrastructure and designs with an ecological goal, such as noise and light walls for fauna, or plantings and strategic revegetation to funnel fauna to crossing locations. The register will include information about the target species, goal of the asset, design requirements, inspection frequency, description of maintenance requirements, etc.

Regular inspections and timely maintenance of crossing structures and other treatments is critical to success. Inspections will focus on the structural integrity of the asset using standard schedules, as well as ecological effectiveness.

Schedules for inspecting and maintaining ecological effectiveness will be set and undertaken in accordance with TMR standards for fauna connectivity, as published in the TMR Fauna Sensitive Transport Infrastructure Delivery Manual (TMR 2024i). These guidelines include extensive details about the timing of inspections, the specific attributes that need to be assessed at each inspection and the timing and nature of repairs. For the Project, ARTC will undertake the following inspections:

- Immediately after construction to ensure it meets the design specification.
- At least once within 12 months of operation commencement to ensure it remains compliant and any repairs needed can be quickly applied.
- Two years after operation commencement.
- At two-yearly intervals after year 2, except fauna fencing, which is to be inspected annually.

- Within three months after major flood events, or as soon as safe to undertake inspections.
- Any urgent ecological repairs will be completed within one month of the inspection and within 12 months for non-urgent action. Urgent ecological repairs are those that affect the safety of target species of fauna, especially listed or target species.
- Ecological inspections of environmental assets focus on aspects of the structure that will limit or enhance use of the structures by wildlife, such as:
  - Presence and depth of soil substrate in culvert.
  - Density of vegetation growth and weeds that limit the visibility or access through the culvert or in the bridge underpass.
  - Extent, depth and duration of ponding of water at culvert entrances and/or within the culvert or bridge underpass.
  - Condition of fauna furniture that encourages use by fauna and/or provides protection from predators.
  - Presence of holes, gaps underneath or vegetation growth on fences that enables fauna to cross the fence.

### 6.2.3 *Adaptive management*

Information learnt through the Project MER program will be used to inform management of the Project in an adaptive management framework.

Adaptive management is a formalised approach to MER that includes a feedback loop triggered by a result of monitoring to undertake management actions as well as update and improve management procedures or processes. There is an expectation in adaptive management that the results will trigger an evaluation of management effectiveness and result in an update of what is considered best-practice.

In contrast, routine or ‘business as usual’ management is where the results of monitoring or observations of structure failure trigger a management response, such as fence repair, revegetation, re-attaching a canopy bridge feeder rope after failure, or de-silting a culvert.

The adaptive management framework for the Project will be developed during detailed design and specified in the Wildlife Connectivity Plan.

### 6.2.4 *Predator control program*

A monitoring program to assess the abundance and use of crossing structures by predators that may reduce usage rates by target species will be undertaken. Monitoring will be undertaken at crossing structures for specific target species, at crossing locations generally and at PCZs. A predator control program will be undertaken at crossing structures for up to five years or until the habitat has been restored to a level that provides threatened fauna with protection from predators. The details of the predator control program will be developed during the detailed design stage of the Project and detailed in the Wildlife Connectivity Plan, and be implemented in response to adaptive management thresholds and triggers.

# 7 Conclusion and next steps

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## 7.1 Conclusion

This strategy is a comprehensive first step (see Figure 1.2) in the development of a Wildlife Connectivity Plan that will mitigate the operational impacts of the Project on fauna connectivity.

The Strategy concluded that connectivity can likely be maintained for many target species with the adoption of minor design changes as well as changing structure type (e.g. pipe culvert to box culvert, culvert to bridge), increasing the height and/or width of specific existing culverts and bridges, and the addition of dedicated wildlife crossing structures in the revised reference design for koala, spotted-tailed quoll, woodland birds and gliding mammals.

The uncertainty of the effectiveness of culverts as crossing structures for Brigalow woodland snail, Condamine earless dragon, cracking clay reptiles and woodland reptiles will be resolved with targeted research and the results used to inform detailed design of wildlife crossing structures. Targeted research will also focus on protecting and/or restoring vegetation and habitat conditions within the Project footprint that enables target species to access and use the crossing structures to traverse the Project.

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## 7.2 Implementing the Strategy

This Strategy will inform the development of the Wildlife Connectivity Plan during the detailed design stage of the Project. A structured approach will be used to deliver a Project design which integrates fauna connectivity in design decisions progressively throughout detailed design and in conjunction with other requirements and constraints such as safety, cost, engineering and flooding.

Subject matter experts will be represented during design progression to ensure the requirements for the various species are understood and integrated in the design as it occurs. For fauna connectivity, this will mean representation during design decisions and at each design review gate to ensure the design outcomes are meeting fauna connectivity requirements appropriate for the progressive level of design maturity.

A re-assessment(s) of ecological connectivity will be undertaken during the detailed design stage of the Project to assess the degree to which connectivity has been maintained by different design and mitigation options. The connectivity models and/or assessments will be re-run as required for each target species to ensure the proposed wildlife crossing structures and other treatments are meeting the objectives of the Strategy.

Connectivity models and assessments will be re-run when there are design changes, such as re-alignments, changes to the placement or design of noise walls and fencing, depth of cuts and height of fill, or modifications to confirmed wildlife crossing structures necessitated by other design changes. The re-runs will include the following kinds of information:

- Project footprint, including habitat to be retained and/or re-vegetated.
- Wildlife crossing structures and other treatments, such as mitigation for noise and light, suited to each target species.
- The location of fencing to keep wildlife off the railway and funnel them to crossing structures.
- Other railway infrastructure already used in models, such as noise walls or new elements, such as sidings, cuttings and embankment locations where they influence fauna movement.

Specific considerations to be considered throughout the detailed design include:

- Investigating whether a larger culvert or bridge can fit within the Project design, given the height of fills and depth of cuts etc.
- Determine whether all drainage structures identified in connectivity areas for each target species are required to maintain connectivity. For example, two culverts located within the daily movement range of the target species are not necessarily required. Koalas in the area around the Project area moving ~400 – 800 m per day, and thus two culverts located 100 m apart do not need to be made suitable for koalas to maintain connectivity.



- Undertake surveys of target species in PCZs or other specific areas to confirm habitat suitability and/or species abundance to inform the need for, type and design of wildlife crossing structures.
- Assess the feasibility of proposed additional crossing structures and identify alternative options (such as land bridges) where underpasses are not feasible.
- Assess whether culverts with natural substrates for reptiles and snails are feasible in areas prone to flooding and identifying and assessing alternative locations for these culverts if they are not feasible.
- Assessing and reducing conflict between fencing and drainage requirements and fauna movement where possible.
- Determining what design modifications are required and feasible to turn unsuitable drainage structures into an effective wildlife crossing structure for a specific target species or group of target species, such as adding an additional dry cell to a culvert raising a cell, changing the floor to a natural substrate, etc.
- Assessing whether the fauna-movement function of multi-use culverts has been compromised by other uses, such as drainage or stock movement.
- Identifying and resolving any conflict between designs for different target species. For example, raising the height of the railway to fit a larger culvert to facilitate the movement of terrestrial fauna such as koalas may conflict with the need to lower the height of the railway to construct glider poles or canopy bridges for greater gliders.
- Identify and delineate no-go areas where vegetation and habitat are not cleared or degraded during construction. This includes reducing the extent of tree clearing at crossing locations for gliding mammals and woodland birds, protecting natural soil structure for cracking clay reptiles and protecting shrubs and natural grassland for other species of fauna.
- Review any new research and information on crossing structures and other mitigation measures for the target species and incorporate that into the Wildlife Connectivity Plan.
- Undertake targeted research to inform detailed design parameters of crossing structures, such as assessing the height and spacing of trees for glider poles, investigating methods to maintain the structure and profile of soils during construction to enable cracking clay reptiles to access crossing structures, assessing use of crossing structures by reptiles and snails, and assessing how the addition and/or modification of drainage structures affects hydrological performance.
- Undertake targeted species surveys and habitat mapping, as well as incorporate results from ongoing research to refine the micro-location and design of wildlife crossing structures. For example, use known koala movement paths and location of target species records, as well as presence of field-verified habitat to position crossing structures to be as close as possible to the individuals likely to use the structures. This will be especially critical for species with small movement distances.

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# References

- !!! INVALID CITATION !!! (O'Connor et al. 2015, Ottburg and Blank 2015, O'Connor et al. 2017a, O'Connor et al. 2017b, O'Connor et al. 2017, DAF 2018, Franklin et al. 2018, DAF 2019, TMR 2024h).
- ACT Government. 2013. Glossy BlackCockatoo (*Calyptorhynchus latham*) Action Plan No. 33. ACT Government, Canberra.
- Allen-Ankins, S., R. J. Stoffels, P. A. Pridmore, and M. T. Vogel. 2012. The effects of turbidity, prey density and environmental complexity on the feeding of juvenile Murray cod *Maccullochella peelii*. *Journal of Fish Biology* **80** 1:195-206.
- Allen, G. R., S. H. Midgley, and M. Allen. 2002. Field Guide to the Freshwater Fishes of Australia. . Western Australian Museum, Perth.
- Asari, Y., C. N. Johnson, M. Parsons, and J. Larson. 2010. Gap-crossing in fragmented habitats by Mahogany Gliders (*Petaurus gracilis*). Do they cross roads and powerline corridors? *Australian Mammalogy* **32**:10 - 15.
- Australian Government. 2022. Conservation advice for *Petauroides volans* (greater glider (southern and central)).
- BAAM. 2023. Microbat surveys and research. Report prepared for ARTC. .
- Bax, D. 2006. Karuah Bypass. Fauna crossing report. Thiess Pty Ltd.
- Bhardwaj, M., K. Soanes, T. M. Straka, J. J. Lahoz-Monfort, L. F. Lumsden, and R. van der Ree. 2017. Differential use of highway underpasses by bats. *Biological Conservation* **212**:22 - 28.
- Bino, G., R. T. Kingsford, M. Archer, J. H. Connolly, J. Day, K. Dias, D. Goldney, J. Gongora, T. Grant, J. Griffiths, T. Hawke, M. Klamt, D. Lunney, L. Mijangos, S. Munks, W. Sherwin, M. Serena, P. Temple-Smith, J. Thomas, G. Williams, and C. Whittington. 2019. The platypus: evolutionary history, biology, and an uncertain future. *Journal of Mammalogy* **100**:308-327.
- Bino, G., R. T. Kingsford, T. Grant, M. D. Taylor, and L. Vogelnest. 2018. Use of implanted acoustic tags to assess platypus movement behaviour across spatial and temporal scales. *Scientific Reports* **8**:5117.
- Bond, A. R., and D. N. Jones. 2008. Temporal trends in use of fauna-friendly underpasses and overpasses. *Wildlife Research* **35**:103-112.
- Bregman, T. P., C. H. Sekercioglu, and J. A. Tobias. 2014. Global patterns and predictors of bird species responses to forest fragmentation: Implications for ecosystem function and conservation. *Biological Conservation* **169**:372-383.
- Budzik, K., and K. Budzik. 2014. A preliminary report of amphibian mortality patterns on railways. *Acta Herpetologica* **9**:103 - 107.
- Carter, N., R. Cooke, J. White, D. Whisson, B. Isaac, and N. Bradsworth. 2019. Joining the dots: How does an apex predator move through an urbanizing landscape? *Global Ecology and Conservation* **16**.
- Chambers, B., and R. Bencini. 2015. Factors affecting the use of fauna underpasses by bandicoots and bobtail lizards. *Animal Conservation* **18**:424-432.
- Comport, S. S., S. J. Ward, and W. J. Foley. 1996. Home ranges, time budgets and food-tree use in a high density tropical population of greater gliders, *Petauroides volans minor* (Pseudocheiridae: Marsupialia). *Wildlife Research* **23**:401-419.
- Cunningham, R. B., M. Pope, and D. B. Lindenmayer. 2004. Patch use by the greater glider (*Petauroides volans*) in a fragmented forest ecosystem. III. Night-time use of trees. *Wildlife Research* **31**:579-585.
- DAF. 2019. What is not a waterway barrier work?
- DAWE. 2021. National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus*.
- DAWEH. 2022. Conservation advice for *Petaurus australis* (yellow-bellied glider south-eastern).in W. a. t. E. a. H. Department of Agriculture, editor.
- DCCEEW. 2022a. Conservation Advice for *Calyptorhynchus latham latham* (South-eastern Glossy Black Cockatoo). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67036-conservation-advice-10082022.pdf>. In effect under the EPBC Act from 10-Aug-2022., Canberra, ACT.
- DCCEEW. 2022b. Conservation Advice for *Hemiaspis damelii* (grey snake) in E. Department of Climate Change, the Environment and Water, editor.
- DCCEEW. 2023a. Conservation advice for *Aphelocephala leucopsis* (southern whiteface). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/529-conservation-advice-31032023.pdf>. In effect under the EPBC Act from 31-Mar-2023., Canberra, ACT.
- DCCEEW. 2023b. Conservation Advice for *Calidris ferruginea* (curlew sandpiper). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice-18122023.pdf>. In effect under the EPBC Act from 18-Dec-2023., Canberra, ACT.
- DCCEEW. 2023c. Conservation advice for *Climacteris picumnus victoriae* (brown treecreeper (south-eastern)). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67062-conservation-advice-31032023.pdf>. In effect under the EPBC Act from 31-Mar-2023., Canberra, ACT.

- DCCEEW. 2023d. Conservation Advice for *Melanodryas cucullata cucullata* (hooded robin (south-eastern)). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67093-conservation-advice-31032023.pdf>. In effect under the EPBC Act from 31-Mar-2023., Canberra, ACT.
- DCCEEW. 2023e. Conservation Advice for *Stagonopleura guttata* (diamond firetail). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/59398-conservation-advice-31032023.pdf>. In effect under the EPBC Act from 31-Mar-2023., Canberra, ACT.
- DCCEEW. 2024a. Collared Delma, Adorned Delma. Available at <https://www.dcceew.gov.au/environment/biodiversity/threatened/action-plan/priority-reptiles/collared-delma>. Accessed 9 May 2024. Department of Climate Change, Energy, the Environment and Water, Canberra, ACT.
- DCCEEW. 2024b. Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/874-conservation-advice-05012024.pdf>. In effect under the EPBC Act from 05-Jan-2024., Canberra, ACT.
- DCCEEW. 2024c. Conservation Advice for *Gallinago hardwickii* (Latham's snipe). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/863-conservation-advice-05012024.pdf>. In effect under the EPBC Act from 05-Jan-2024., Canberra, ACT.
- DCCEEW. 2024d. Conservation Advice for *Tringa nebularia* (common greenshank). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/832-conservation-advice-05012024.pdf>. In effect under the EPBC Act from 05-Jan-2024., Canberra, ACT.
- Denneboom, D., A. Bar-Massada, and A. Shwartz. 2021. Factors affecting usage of crossing structures by wildlife – A systematic review and meta-analysis. *Science of The Total Environment* **777**:146061.
- Department of Environment, L., Water and Planning,. 2016. National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus*.in C. Australian Government, editor.
- Department of the Environment, W., Heritage and the Arts. 2008. Approved Conservation Advice for *Anomalopus mackayi* (Five-clawed Worm-skink). .in W. Canberra: Department of the Environment, Heritage and the Arts., editor.
- DES. 2022. Koala Sensitive Design Guideline. A guide to koala-sensitive design measures for planning and development activities.
- Dexter, C. E., R. G. Appleby, J. P. Edgar, J. Scott, and D. N. Jones. 2016. Using complementary remote detection methods for retrofitted eco-passages: a case study for monitoring individual koalas in south-east Queensland. *Wildlife Research* **43**:369-379.
- DOE. 2015a. Conservation Advice *Anthochaera phrygia* regent honeyeater. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/82338-conservation-advice.pdf>. In effect under the EPBC Act from 08-Jul-2015. Canberra, ACT.
- DOE. 2015b. Conservation Advice *Grantiella picta* painted honeyeater. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf>. In effect under the EPBC Act from 08-Jul-2015., Canberra, ACT.
- DOE. 2015c. Draft referral guideline for 14 birds listed as migratory species under the EPBC Act. <https://www.dcceew.gov.au/sites/default/files/documents/migratory-birds-draft-referral-guideline.pdf>. Canberra, ACT.
- DOE. 2024a. *Apus pacificus* in Species Profile and Threats Database, Available from: <https://www.environment.gov.au/sprat>. Accessed 22 February 2024. Department of the Environment, Canberra, ACT.
- DOE. 2024b. *Hirundapus caudacutus* in Species Profile and Threats Database. Available from: <https://www.environment.gov.au/sprat>. Accessed 22 February 2024. Department of the Environment, Canberra, ACT.
- DOE. 2024c. *Myiagra cyanoleuca* in Species Profile and Threats Database. Available from: <https://www.environment.gov.au/sprat>. Accessed 22 February 2024. Department of the Environment, Canberra, ACT.
- DOE. 2024d. *Plegadis falcinellus* in Species Profile and Threats Database. Available from: <https://www.environment.gov.au/sprat>. Accessed 22 February 2024. Department of the Environment,, Canberra, ACT.
- DOE. 2024e. *Rhipidura rufifrons* in Species Profile and Threats Database. Available from: <https://www.environment.gov.au/sprat>. Accessed 22 February 2024. Department of the Environment, Canberra, ACT.
- Doerr, E. D., V. A. J. Doerr, M. J. Davies, and H. M. McGinness. 2014. Does structural connectivity facilitate movement of native species in Australia's fragmented landscapes?: a systematic review protocol. *Environmental Evidence* **3**:9.
- Doerr, V., E. Doerr, and M. Davies. 2011. Dispersal behaviour of Brown Treecreepers predicts functional connectivity for several other woodland birds. *Emu* **111**:71-83.



- Dorsey, B., M. Olsson, and L. Rew. 2015. Ecological effects of railways on wildlife. Pages 219 - 227 in R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. John Wiley and Sons.
- DSEWPAC. 2013. Approved Conservation Advice for *Rostratula australis* (Australian painted snipe). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf>. In effect under the EPBC Act from 15-May-2013., Canberra, ACT.
- Eddie, C., and Hardwick, L. 2022. Targeted survey for Brigalow Woodland Snail *Adclarkia cameroni* within selected parts of the Inland Rail Project area, Queensland.
- Ellis, W. A. H., A. Melzer, F. N. Carrick, and M. Hasegawa. 2002. Tree use, diet and home range of the koala (*Phascolarctos cinereus*) at Blair Athol, central Queensland. Wildlife Research **29**:303-311.
- ERM. 2023. Koala Genetics Study Project: Inland Rail Program. Prepared for Australian Rail Track Corporation. .
- Foltête, J.-C., C. Clauzel, and G. Vuidel. 2012. A software tool dedicated to the modelling of landscape networks. Environmental Modelling & Software **38**:316-327.
- Foster, M. L., and S. R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. Wildlife Society Bulletin **23**:95-100.
- Fung, D. T. C., R. van der Ree, N. McCaffrey, C. Gibbins, and A. M. Lechner. 2023. Ecological connectivity in environmental impact assessments: Modelling alternative highway bypass scenarios. Impact Assessment and Project Appraisal **41**:349 - 373.
- GHD. 2017. Sugarloaf Pipeline Project Toolangi Habitat Linkage Monitoring. Effectiveness of Glider Pole Linkages. Report for Melbourne Water Corporation.
- Gibbons, P., and D. B. Lindenmayer. 2002. Tree hollows and wildlife conservation in Australia. CSIRO Publishing, Melbourne.
- Goldingay, R. L. 2014. Gliding performance in the yellow-bellied glider in low-canopy forest. Australian Mammalogy **36**:254 - 258.
- Goldingay, R. L. 2023. Yellow-bellied Glider. Pages 230 - 232 in A. M. Baker and I. C. Gynther, editors. Strahan's mammals of Australia. Fourth Edition. Reed New Holland Publishers, Sydney, Australia.
- Goldingay, R. L., D. Rohweder, B. D. Taylor, and J. L. Parkyn. 2022. Use of road underpasses by mammals and a monitor lizard in eastern Australia and consideration of the prey-trap hypothesis. Ecology and Evolution **12**:e9075.
- Goldingay, R. L., and B. D. Taylor. 2009. Gliding performance and its relevance to gap crossing by the squirrel glider (*Petaurus norfolcensis*). Australian Journal Of Zoology **57**:99-104.
- Goldingay, R. L., and B. D. Taylor. 2017. Targeted field testing of wildlife road-crossing structures: koalas and canopy rope-bridges. Australian Mammalogy **39**:100-104.
- Goldingay, R. L., B. D. Taylor, and J. L. Parkyn. 2018a. Movement of small mammals through a road-underpass is facilitated by a wildlife railing. Australian Mammalogy:-.
- Goldingay, R. L., B. D. Taylor, and J. L. Parkyn. 2018b. Use of tall wooden poles by four species of gliding mammal provides further proof of concept for habitat restoration. Australian Mammalogy **41**:255 - 261.
- Goldingay, R. L., B. D. Taylor, J. L. Parkyn, and J. M. Lindsay. 2018c. Are wildlife escape ramps needed along Australian highways? Ecological Management & Restoration **19**:198-203.
- Hanger, J. d. V., D. N. Forbes, B. No'dge, H. Beyer, J. Loader, and P. Timms. 2017. Moreton Bay Rail Koala Management Program. (Koala Tagging and Monitoring Program/Koala Translocation/AKHO-CM/GOSMP). Final Technical Report. Endeavour Veterinary Ecology, Pty Ltd.
- Henderson, T., B. A. Fancourt, R. Rajaratnam, K. Vernes, and G. Ballard. 2023. Habitat use by the endangered spotted-tailed quoll in a fragmented landscape. Mamm Res **68**:93-103.
- Jackson, S. M. 1999. Glide angle in the genus *Petaurus* and a review of gliding in mammals. Mammal Review **30**:9-30.
- Jensen, A. J., J. D. Perrine, A. Schaffner, R. Brewster, A. J. Giordano, M. Robertson, and N. Siepel. 2023. Mammal use of undercrossings is influenced by openness and proximity to riparian corridors. Wildlife Research **50**:495-506.
- Jones, D., C. Dexter, L. Bernede, and J. Scott. 2013. Koala Retrofit Works Program. Evaluation Monitoring for Koala-Specific Overpass Structure. Final Report. Environmental Futures Centre, Griffith University.
- Jones, D., and J. Pickvance. 2013. Forest birds use vegetated fauna overpass to cross multi-lane road. Oecologia Australis **17**:147-156.
- Jones, D. N., and A. R. F. Bond. 2010. Road barrier effect on small birds removed by vegetated overpass in South East Queensland. Ecological Management & Restoration **11**:65-67.
- Jones, M. E., R. K. Rose, and S. Burnett. 2001. *Dasyurus maculatus*. Mammalian Species:1-9.
- Kavanagh, R. P., and M. J. Lambert. 1990. Food selection by the greater glider, *Petauroides volans*: is foliar nitrogen a determinant of habitat quality? Australian Wildlife Research **17**:285-299.
- Keeley, A. T. H., P. Beier, and J. S. Jenness. 2021. Connectivity metrics for conservation planning and monitoring. Biological Conservation **255**:109008.
- Kociolek, A. V., C. Grilo, and S. L. Jacobson. 2015. Flight doesn't solve everything: Mitigation of road impacts on birds. Pages 281 - 289 in R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. John Wiley and Sons, Oxford, U.K.

- Kornilev, Y., S. Price, and M. Dorcas. 2006. Between a rock and a hard place: Responses of Eastern Box Turtles (*Terrapene carolina*) when trapped between railroad tracks. *Herpetological Review* **37**:145–148.
- LaPoint, S., N. Balkenhol, J. Hale, J. Sadler, and R. van der Ree. 2015. Ecological connectivity research in urban areas. *Functional Ecology* **29**:868–878.
- Law, B. S., L. Gonsalves, M. A. Chidel, and T. Brassil. 2016. Subtle use of a disturbance mosaic by the south-eastern long-eared bat (*Nyctophilus corbeni*): an extinction-prone, narrow-space bat. *Wildlife Research* **43**:153 - 168.
- Lechner, A., and T. Lefroy. 2014. General Approach to Planning Connectivity from Local Scales to Regional (GAP CLoSR): combining multi-criteria analysis and connectivity science to enhance conservation outcomes at regional scale in the Lower Hunter.
- Lechner, A. M., V. Doerr, R. M. Harris, E. Doerr, and E. C. Lefroy. 2015. A framework for incorporating fine-scale dispersal behaviour into biodiversity conservation planning. *Landscape and Urban Planning* **141**:11–23.
- Lechner, A. M., D. Sprod, O. Carter, and E. C. Lefroy. 2017. Characterising landscape connectivity for conservation planning using a dispersal guild approach. *Landscape Ecology* **32**:99–113.
- Lintermans, M. 2023. Fishes of the Murray–Darling Basin. Australian River Restoration Centre, Canberra.
- Little, S. J., R. G. Harcourt, and A. P. Clevenger. 2002. Do wildlife passages act as prey-traps? *Biological Conservation* **107**:135–145.
- Mata, C., R. Bencini, B. K. Chambers, and J. E. Malo. 2015. Predator-prey interactions at wildlife crossing structures: between myth and reality. Pages 190 - 197 in R. van der Ree, D. J. Smith, and C. Grilo, editors. *Handbook of Road Ecology*. John Wiley and Sons, Oxford, UK.
- McGregor, M., K. Matthews, and D. Jones. 2017. Vegetated fauna overpass disguises road presence and facilitates permeability for forest microbats in Brisbane, Australia. *Frontiers in Ecology and Evolution* **5**.
- McGregor, M. E., S. K. Wilson, and D. N. Jones. 2015. Vegetated fauna overpass enhances habitat connectivity for forest dwelling herpetofauna. *Global Ecology and Conservation* **4**:221–231.
- McRae, B. H., B. G. Dickson, T. H. Keitt, and V. B. Shah. 2008. Using circuit theory to model connectivity in ecology, evolution and conservation. *Ecology* **89**:2712 - 2724.
- McRae, B. H., and D. M. Kavanagh. 2011. Linkage mapper connectivity analysis software. The Nature Conservancy, Seattle WA.
- Michniewicz, R. J., and J. Danvers. 2021. Use of a combined drainage/fauna underpass by the spotted-tailed quoll, “*Dasyurus maculatus*”. *Australian Zoologist* **41**:283–286.
- National Murray Cod Recovery Team. 2010. National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*. in M. Department of Sustainability and Environment, editor.
- New South Wales Department of Environment and Heritage. 2023. Brigalow Belt South bioregion.
- New South Wales Department of Environment and Heritage. 2024. Brown Treecreeper (eastern subspecies) - profile.
- O'Connor, J., I. Stuart, and R. Campbell-Beschoner. 2017. Guidelines for fish passage at small structures. Technical Report Series No. 276.
- O'Malley, A., and A. Lechner. 2017. Northwest Ecological Connectivity Investigation. Prepared for Hume City Council and Brimbank City Council., Practical Ecology.
- Olivier, P. I., and R. J. van Aarde. 2017. The response of bird feeding guilds to forest fragmentation reveals conservation strategies for a critically endangered African eco-region. *Biotropica* **49**:268–278.
- Pell, S., and D. Jones. 2015. Are wildlife overpasses of conservation value for birds? A study in Australian sub-tropical forest, with wider implications. *Biological Conservation* **184**:300–309.
- Pope, M. L., D. B. Lindenmayer, and R. B. Cunningham. 2004. Patch use by the greater glider (*Petauroides volans*) in a fragmented forest ecosystem. I. Home range size and movements. *Wildlife Research* **31**:559–568.
- Queensland Government. 2024. Species profile—*Grantiella picta* (painted honeyeater).
- Rayfield, B., M.-J. Fortin, and A. Fall. 2010. The sensitivity of least-cost habitat graphs to relative cost surface values. *Landscape Ecology* **25**:519–532.
- Ridgeway, P., K. Lindsay, D. Pou, and A. Visintin. 2014. Indications of diverse behavioural ecologies in the morphologically conservative Australian land snails *Pommerhelix* and *Meridolum* (Stylommatophora: Camaenidae). *Molluscan Research* **34**:25–39.
- Rus, A., C. McArthur, V. Mella, and M. Crowther. 2021. Habitat fragmentation affects movement and space use of a specialist folivore, the koala. *Animal Conservation* **24**:26–37.
- Rytwinski, T., K. Soanes, J. A. G. Jaeger, L. Fahrig, C. S. Findlay, J. Houlahan, R. van der Ree, and E. A. van der Grift. 2016. How effective is road mitigation at reducing road-Kill? A meta-analysis. *PLOS ONE* **11**:e0166941.
- Sandpiper Ecological. 2017. Pacific Highway upgrade - Glenugie. Operational phase fauna crossing monitoring program (years 1 to 3). Prepared for NSW Roads and Maritime Services by Sandpiper Ecological.
- Serena, M., J. L. Thomas, G. A. Williams, and R. C. E. Officer. 1998. Use of stream and river habitats by the platypus (*Ornithorhynchus anatinus*) in an urban fringe environment. *Australian Journal Of Zoology* **46**:267–282.
- Slapp, J. 2023. Monitoring faunal use of single rope bridges in a managed temperate eucalypt forest. University of Melbourne.

- Smith, D. J., R. van der Ree, and C. Rosell. 2015. Wildlife crossing structures. Pages 172 - 183 in R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. John Wiley & Sons, Oxford, U.K.
- Smith, G. C., M. Mathieson, and L. Hogan. 2007. Home range and habitat use of a low-density population of Greater Glider, *Petauroides volans* (Pseudocheiridae: Marsupialia), in a hollow-limiting environment. Wildlife Research **34**:472-483.
- Soanes, K., M. Carmody Lobo, P. A. Vesk, M. A. McCarthy, J. L. Moore, and R. van der Ree. 2013. Movement re-established but not restored: inferring the effectiveness of road crossing mitigation for a gliding mammal by monitoring use. Biological Conservation **159**:434 - 441.
- Soanes, K., B. Mitchell, and R. van der Ree. 2017. Quantifying predation attempts on arboreal marsupials using wildlife crossing structures above a major road. Australian Mammalogy **39**:254-257.
- Soanes, K., T. Rytwinski, L. Fahrig, M. P. Huijser, J. A. G. Jaeger, F. Z. Teixeira, R. van der Ree, and E. A. van der Grift. 2024. Do wildlife crossing structures mitigate the barrier effect of roads on animal movement? A global assessment. Journal of Applied Ecology **61**:417-430.
- Soanes, K., A. C. Taylor, P. Sunnucks, P. A. Vesk, S. Cesarini, and R. van der Ree. 2018. Evaluating the success of wildlife crossing structures using genetic approaches and an experimental design: lessons from a gliding mammal. Journal of Applied Ecology **55**:129 - 138.
- Soanes, K., and R. van der Ree. 2009a. Arboreal mammals use an aerial rope bridge to cross a major highway. Pages 441 - 451 in International Conference on Ecology and Transportation Center for Transportation and the Environment, North Carolina State University, Raleigh, NC, United States, Duluth Minnesota, United States.
- Soanes, K., and R. van der Ree. 2009b. Highway impacts on arboreal mammals and the use and effectiveness of novel mitigation techniques. Pages 441 - 451 in International Conference on Ecology and Transportation. Centre for Transportation and the Environment, North Carolina State University, Raleigh, NC, USA, Duluth, Minnesota, USA.
- Soanes, K., and R. van der Ree. 2015. Reducing road impacts on tree-dwelling animals. in R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. Wiley-Blackwell, London.
- Soanes, K., P. A. Vesk, and R. van der Ree. 2015. Monitoring the use of road-crossing structures by arboreal marsupials: insights gained from motion-triggered cameras and passive integrated transponder (PIT) tags. Wildlife Research **42**:241 - 256.
- Soderquist, T., and D. Gibbons. 2007. Home-range of the Powerful Owl (*Ninox strenua*) in dry sclerophyll forest. Emu **107**:177 - 184.
- Taylor, B., and R. Goldingay. 2010. Roads and wildlife: Impacts, mitigation and implications for wildlife management in Australia. Wildlife Research **37**.
- Taylor, B. D., and R. Goldingay. 2009. Can road-crossing structures improve viability of an urban gliding mammal? Ecology and Society **14**:13.
- Taylor, B. D., and R. L. Goldingay. 2003. Cutting the carnage: wildlife usage of road culverts in north-eastern New South Wales. Wildlife Research **30**:529-537.
- Taylor, B. D., and R. L. Goldingay. 2013. Squirrel gliders use roadside glide poles to cross a road gap. Australian Mammalogy **35**:119-122.
- Taylor, B. D., and D. A. Rohweder. 2020. Yellow-bellied gliders use glide poles to cross the Pacific Highway at Halfway Creek, north-east New South Wales. Australian Mammalogy **42**:385-387.
- Threatened Species Scientific Committee. 2016. Conservation Advice *Adclarkia cameroni* Brigalow woodland snail. in E. Department of Climate Change, the Environment and Water, editor., Canberra.
- TMR. 2024a. Chapter 3: Ecological monitoring, evaluation, reporting and adaptive management. Fauna Sensitive Transport Infrastructure Delivery Manual. Queensland Department of Transport and Main Roads.
- TMR. 2024b. Chapter 5 - Planning and design. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024c. Chapter 6 - Mitigation. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024d. Chapter 9 - Birds. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024e. Chapter 12: Species profile – Koalas. Page 27 Fauna Sensitive Transport Infrastructure Delivery Manual. Department of transport and Main Roads.
- TMR. 2024f. Chapter 14 - Arboreals. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024g. Chapter 19: Species profile – Fish. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024h. Chapter 20 - Invertebrates. Fauna Sensitive Transport Infrastructure Delivery Manual. Queensland Department of Transport and Main Roads.
- TMR. 2024i. Fauna Sensitive Transport Infrastructure Delivery Manual.
- TMR. 2024j. Fauna Sensitive Transport Infrastructure Delivery Manual. Chapter 4: Impacts of roads, railways, traffic, and trains on fauna. October 2024.
- TSSC. 2015a. Conservation Advice *Geophaps scripta scripta* squatter pigeon (southern). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/64440-conservation-advice-31102015.pdf>. In effect under the EPBC Act from 27-Oct-2015., Canberra, ACT.

- TSSC. 2015b. Conservation Advice *Nyctophilus corbeni* south-eastern long-eared bat. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/83395-conservation\\_advice-01102015.pdf](http://www.environment.gov.au/biodiversity/threatened/species/pubs/83395-conservation_advice-01102015.pdf). In effect under the EPBC Act from 01-Oct-2015., Canberra, ACT.
- TSSC. 2016a. Conservation Advice *Lathamus discolor* swift parrot. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/744-conservation-advice-05052016.pdf>. In effect under the EPBC Act from 05-May-2016., Canberra, ACT.
- TSSC. 2016b. Conservation Advice *Tympanocryptis condaminensis* Condamine earless dragon.
- TSSC. 2019. Conservation Advice *Botaurus poiciloptilus* Australasian Bittern. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-conservation-advice-18012019.pdf>. In effect under the EPBC Act from 18-Jan-2019., Canberra, ACT.
- TSSC. 2020. Conservation Advice *Dasyurus maculatus maculatus* (southeastern mainland population) Spotted-tailed Quoll, south eastern mainland. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/75184-conservation-advice-01092020.pdf>. In effect under the EPBC Act from 01-Sep-2020., Canberra, ACT.
- UniSQ. 2024. ARTC Inland Rail Border to Gowrie (B2G) Ecology Partnership. Progress Report: Milestone 3 (1 January 2024 to 30 June 2024). University of Southern Queensland.
- Van der Grift, E. A., J. A. G. Jaeger, and R. van der Ree. 2015. Guidelines for evaluating the effectiveness of road mitigation measures. *in* R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. Wiley-Blackwell, London.
- van der Grift, E. A., F. G. W. A. Ottburg, R. Pouwels, and J. Dirksen. 2011. Multi-use overpasses: does human use impact the use by wildlife? Pages 125-133 *in* P. J. Wagner, D. Nelson, and E. Murray, editors. 2011 Conference on Ecology and Transportation. Centre for Transportation and the Environment, North Carolina State University, Seattle, Washington, USA.
- Van der Grift, E. A., and R. van der Ree. 2015. Recreational co-use of wildlife crossing structures. *in* R. van der Ree, D. J. Smith, and C. Grilo, editors. Handbook of Road Ecology. Wiley-Blackwell, London.
- Van der Grift, E. A., R. van der Ree, L. Fahrig, S. Findlay, J. Houlahan, J. A. G. Jaeger, N. Klar, L. F. Madriñan, and L. Olson. 2013. Evaluating the effectiveness of road mitigation measures. *Biodiversity and Conservation* **22**:425 - 448.
- van der Ree, R. 1999. Barbed wire fencing as a hazard for wildlife. *The Victorian Naturalist* **116**:210-217.
- Wakefield, N. 1970a. Notes on the glider-possum, *Petaurus australis* (Phalangeridae, Marsupialia). *Victorian Naturalist* **87**:36.
- Wakefield, N. A. 1970b. Notes on the glider-possum, *Petaurus australis* (Phalangeridae, Marsupialia). *The Victorian Naturalist* **87**:221 - 236.
- Welbergen, J. A., J. Meade, H. E. Field, D. Edson, L. McMichael, L. P. Shoo, J. Praszczalek, C. Smith, and J. M. Martin. 2020. Extreme mobility of the world's largest flying mammals creates key challenges for management and conservation. *BMC Biology* **18**:101.
- White, N. A. 1999. Ecology of the Koala (*Phascolarctos cinereus*) in rural south-east Queensland, Australia. *Wildlife Research* **26**:731-744.
- Wilkinson, D., G. C. Grigg, and L. A. Beard. 1998. Shelter selection and home range of echidnas, *Tachyglossus aculeatus* (Monotremata: Tachyglossidae) in the highlands of south-east Queensland. *Wildlife Research* **25**:219.
- Youngentob, K. N., H.-J. Yoon, N. Coggan, and D. B. Lindenmayer. 2012. Edge effects influence competition dynamics: A case study of four sympatric arboreal marsupials. *Biological Conservation* **155**:68-76.

# APPENDIX P

Fauna Connectivity Strategy

## Appendix A Likelihood of occurrence

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



# Appendix A

## Likelihood of occurrence

Threatened species with a known, likely or potential to occur on the Project. Refer to rdEIS Chapter 11: Flora and Fauna, Appendix L: Terrestrial and Aquatic Ecology Technical Report and Appendix O: Matters of National Environmental Significance Technical Report for more detail.

| Scientific name                        | Common name                           | Likelihood of occurrence (final) |
|----------------------------------------|---------------------------------------|----------------------------------|
| BIRDS                                  |                                       |                                  |
| <i>Anthochaera phrygia</i>             | Regent honeyeater                     | Potential                        |
| <i>Aphelocephala leucopsis</i>         | Southern whiteface                    | Known                            |
| <i>Botaurus poiciloptilus</i>          | Australasian bittern                  | Likely                           |
| <i>Calidris ferruginea</i>             | Curlew sandpiper                      | Potential                        |
| <i>Calyptorhynchus lathami lathami</i> | Glossy black-cockatoo (south-eastern) | Known                            |
| <i>Climacteris picumnus victoriae</i>  | Brown treecreeper (south-eastern)     | Known                            |
| <i>Geophaps scripta scripta</i>        | Squatter pigeon (southern)            | Likely                           |
| <i>Grantiella picta</i>                | Painted honeyeater                    | Known                            |
| <i>Hirundapus caudacutus</i>           | White-throated needletail             | Known                            |
| <i>Lathamus discolor</i>               | Swift parrot                          | Potential                        |
| <i>Melanodryas cucullata cucullata</i> | Hooded robin (south-eastern)          | Potential                        |
| <i>Ninox strenua</i>                   | Powerful owl                          | Potential                        |
| <i>Rostratula australis</i>            | Australian painted snipe              | Likely                           |
| <i>Stagonopleura guttata</i>           | Diamond firetail                      | Likely                           |
| <i>Apus pacificus</i>                  | Fork-tailed swift                     | Known                            |
| <i>Calidris acuminata</i>              | Sharp-tailed sandpiper                | Likely                           |
| <i>Cuculus optatus</i>                 | Oriental cuckoo                       | Potential                        |
| <i>Gallinago hardwickii</i>            | Latham's snipe                        | Known                            |
| <i>Myiagra cyanoleuca</i>              | Satin flycatcher                      | Known                            |
| <i>Plegadis falcinellus</i>            | Glossy ibis                           | Known                            |

| Scientific name                     | Common name                                             | Likelihood of occurrence (final) |
|-------------------------------------|---------------------------------------------------------|----------------------------------|
| <i>Rhipidura rufifrons</i>          | Rufous fantail                                          | Known                            |
| <i>Tringa nebularia</i>             | Common greenshank                                       | Likely                           |
| MAMMALS                             |                                                         |                                  |
| <i>Dasyurus maculatus maculatus</i> | Spotted-tailed quoll (southeastern mainland population) | Likely                           |
| <i>Nyctophilus corbeni</i>          | South-eastern long-eared bat                            | Known                            |
| <i>Petauroides volans</i>           | Greater glider (southern and central)                   | Potential                        |
| <i>Petaurus australis australis</i> | Yellow-bellied glider (south-eastern)                   | Potential                        |
| <i>Phascolarctos cinereus</i>       | Koala                                                   | Known                            |
| <i>Pteropus poliocephalus</i>       | Grey-headed flying-fox                                  | Known                            |
| <i>Ornithorhynchus anatinus</i>     | Platypus                                                | Known                            |
| <i>Tachyglossus aculeatus</i>       | Short-beaked echidna                                    | Known                            |
| REPTILES                            |                                                         |                                  |
| <i>Anomalopus mackayi</i>           | Five-clawed worm-skink                                  | Likely                           |
| <i>Acanthophis antarcticus</i>      | Common death adder                                      | Known                            |
| <i>Delma torquata</i>               | Collared delma                                          | Potential                        |
| <i>Egernia rugosa</i>               | Yakka skink                                             | Potential                        |
| <i>Furina dunmalli</i>              | Dunmall's snake                                         | Known                            |
| <i>Hemiaspis damelii</i>            | Grey snake                                              | Known                            |
| <i>Tympanocryptis condaminensis</i> | Condamine earless dragon                                | Known                            |
| FISH                                |                                                         |                                  |
| <i>Maccullochella peelii</i>        | Murray cod                                              | Known                            |
| INVERTEBRATES                       |                                                         |                                  |
| <i>Adclarkia cameroni</i>           | Brigalow woodland snail                                 | Known                            |

# APPENDIX P

Fauna Connectivity Strategy

## Appendix B Engagement with species experts

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

# Appendix B

## Engagement with species experts

| Species                                                                      | Species expert                                            | Date of consultation |
|------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------|
| Koala                                                                        | Dr Ben Allen, University of Southern Queensland           | 6/10/23, 17/1/24     |
|                                                                              | Dr Damber Bista, University of Southern Queensland        | 6/10/23              |
|                                                                              | Professor Peter Murray, University of Southern Queensland | 6/10/23              |
|                                                                              | Dr Rosie Booth, University of Southern Queensland         | 6/10/23              |
|                                                                              | Dr Amy Blacker, ERM                                       | 17/1/24              |
|                                                                              | Dr David Dique, ERM                                       | 17/1/24              |
|                                                                              | Dr Cathryn Dexter, Redlands City Council                  | 17/1/24              |
| Greater Glider                                                               | Paul Revie, Wildlife Preservation Society of Queensland   | 22/2/23              |
|                                                                              | Dr Teresa Eyre, Qld Herbarium                             | 4/10/23              |
| Spotted-tailed quoll                                                         | Paul Revie, Wildlife Preservation Society of Queensland   | 22/2/23              |
| Woodland reptiles,<br>cracking clay reptiles,<br>Condamine earless<br>dragon | Dr JP Emery, University of Southern Queensland            | 4/10/23              |
|                                                                              | Dr Ben Allen, University of Southern Queensland           | 4/10/23              |

# APPENDIX P

Fauna Connectivity Strategy

## **Appendix C** Regional ecosystem association habitat mapping

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



# Appendix C

## Regional ecosystem association habitat mapping

| Assessment type   | Species         | Regional ecosystem from literature                                                                                                                                                              | RE/HVR from record intersect                                                                           | REs used in mapping habitat associations                                                                                                                                                               |
|-------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Woodland reptiles | Death adder     | Mitchell downs bioregion (X.3.X),<br>2.3.39, 4.3.22, 5.3.23, 6.3.23, 10.3.31, 11.3.22                                                                                                           | 11.3.14, 11.3.18, 11.3.25, 11.4.10, 11.4.12, 11.5.1, 11.5.4, 11.5.20, 11.7.4, 11.7.5, 12.8.17, non-rem | Mitchell downs bioregion (X.3.X),<br>2.3.39, 4.3.22, 5.3.23, 6.3.23, 10.3.31, 11.3.14, 11.3.18, 11.3.22, 11.3.25, 11.4.10, 11.4.12, 11.5.1, 11.5.4, 11.5.20, 11.7.4, 11.7.5, 12.8.17                   |
|                   | Dunmall's snake | 6.4.2, 11.3.1, 11.3.2, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.10.7a, 11.10.9, 11.10.11, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26                  | 11.5.1, 11.5.2, 11.5.4                                                                                 | 6.4.2, 11.3.1, 11.3.2, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.1, 11.5.2, 11.5.4, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.10.7a, 11.10.9, 11.10.11, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26 |
|                   | Collared delma  | LZ3, LZ9, LZ10, 11.3.2, 11.9.10, 11.10.1, 11.10.4,                                                                                                                                              | 12.8.14a, 12.8.17, 12.8.24                                                                             | LZ3, LZ9, LZ10, 11.3.2, 11.9.10, 11.10.1, 11.10.4, 12.8.14a, 12.8.17, 12.8.24                                                                                                                          |
|                   | Yakka skink     | LZ3, LZ4, LZ5, LZ7, LZ8, LZ9, LZ10, 11.3.1, 11.3.2, 11.3.28, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2, | None                                                                                                   | LZ3, LZ4, LZ5, LZ7, LZ8, LZ9, LZ10, 11.3.1, 11.3.2, 11.3.28, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2         |

| Assessment type        | Species                  | Regional ecosystem from literature                                                                                                                                                                                                                                                                                                                                          | RE/HVR from record intersect | REs used in mapping habitat associations                                                                                                                                                                                                                                                                                                                                    |
|------------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cracking clay reptiles | FCWS                     | 6.4.2, 11.3.1, 11.3.2, 11.3.3, 11.3.15, 11.3.16, 11.3.21, 11.3.23, 11.3.24, 11.3.26, 11.3.28, 11.3.27, 11.3.37, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.5.20, 11.8.2, 11.8.8, 11.9.1, 11.9.5, 11.9.6, 11.9.9, 11.9.13, 11.11.14, 11.12.21, 12.8.16, 12.8.23, 12.9-10.6, 12.12.26, 13.3.1, 13.3.4, 13.9.2, 13.11.2, 13.11.3, 13.11.4, 13.11.8, 13.12.8, 13.12.9 | None                         | 6.4.2, 11.3.1, 11.3.2, 11.3.3, 11.3.15, 11.3.16, 11.3.21, 11.3.23, 11.3.24, 11.3.26, 11.3.28, 11.3.27, 11.3.37, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.5.20, 11.8.2, 11.8.8, 11.9.1, 11.9.5, 11.9.6, 11.9.9, 11.9.13, 11.11.14, 11.12.21, 12.8.16, 12.8.23, 12.9-10.6, 12.12.26, 13.3.1, 13.3.4, 13.9.2, 13.11.2, 13.11.3, 13.11.4, 13.11.8, 13.12.8, 13.12.9 |
|                        | Grey snake               | 11.3.1, 11.3.21, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2                                                                                                                                                                                                                          | 11.4.3, 11.4.10              | 11.3.1, 11.3.21, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2                                                                                                                                                                                                                          |
| Individual species     | Condamine earless dragon | Condamine floodplain, 11.3.21, 11.3.24                                                                                                                                                                                                                                                                                                                                      | Non-remnant cropping land    | Condamine floodplain, 11.3.21, 11.3.24                                                                                                                                                                                                                                                                                                                                      |
| Individual species     | Brigalow woodland snail  | 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2<br><br>11.3.2, 11.3.25, 11.3.17, 11.9.5 (Eddie, 2022)                                                                                                                                                                             | None                         | Condamine floodplain, 11.3.1, 11.3.2, 11.3.17, 11.3.25, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26, 6.4.2                                                                                                                                                                                   |
| Individual species     | Murray cod               | NA                                                                                                                                                                                                                                                                                                                                                                          | NA                           | Waterways identified by species expert (Berghuis, 2024).                                                                                                                                                                                                                                                                                                                    |

# APPENDIX P

Fauna Connectivity Strategy

## Appendix D Target species assessment

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

# Appendix D

## Target species assessment

### D1.1 Birds

#### Woodland bird guild

Several threatened bird species identified within the Study Area are small and woodland dependent. Movement capabilities vary from those that travel short-distances between habitat elements (tree canopy or suitable habitat) and can be considered gap sensitive, to species which are able to travel longer distances such as the swift parrot. The grouping of this guild takes into consideration the requirement for woodland habitat and that these species tend to occur in larger patches of vegetation than areas with isolated trees or degraded ground cover. Given the differences in movement abilities, brown treecreeper has been chosen as the model species for this guild due to its gap sensitivity compared with other species in this guild.



Brown treecreeper © Michael Daley  
sourced from eBird

This guild includes the following species:

- Regent honeyeater
- Southern whiteface
- Brown treecreeper
- Squatter pigeon
- Painted honeyeater
- Hooded robin (south-eastern)
- Diamond firetail

#### *Habitat and distribution in the Study Area*

The regent honeyeater is dependent on eucalypt woodland and dry sclerophyll forest to forage on mistletoe and nectar of select eucalypt species (DOE 2015a). The southern whiteface occurs in a wide range of open woodlands and shrublands and is associated with an understorey of grasses or shrubs (DCCEEW 2023a). The brown treecreeper inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, and is associated with an open grassy understorey (DCCEEW 2023c). The squatter pigeon habitat includes remnant and high value regrowth open forest and woodland dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species with a tussock grassy understorey within three kilometres of water sources (TSSC 2015a). The painted honeyeater inhabits mistletoes in eucalypt forests/woodlands and is more common in wider blocks of woodland than in narrower strips (DOE 2015b). The hooded robin (south-eastern) occurs in dry eucalypt and acacia woodlands and shrublands with an open understorey, some grassy areas and a complex ground layer (DCCEEW 2023d). The diamond firetail occurs in eucalypt, *Acacia* or *Casuarina* woodlands, open forests and other lightly timbered habitats (DCCEEW 2023e).

### *Home range and movement*

The regent honeyeater is highly mobile and capable of travelling large distances following the flowering of select eucalypt species but is restricted to areas where nectar resources are available (DOE 2015a). The southern whiteface is considered sedentary, with localised movement occurring during drought years (DCCEEW 2023a). Brown treecreeper is described as sedentary which occupy permanent territories (DCCEEW 2023a). Observations of dispersing females being reluctant to cross large tracts of open land have been noted (DCCEEW 2023c). Brown treecreepers rarely cross gaps of >100m between trees (Doerr et al. 2011). Breeding pairs occupy territories between 1.1 – 10.7 ha (New South Wales Department of Environment and Heritage 2024). Movement patterns for the squatter pigeon are unknown but it is considered sedentary and locally nomadic, with dispersal likely to occur along vegetated corridors (TSSC 2015a). The painted honeyeater has seasonal north-south movements across Australia, governed principally by the fruiting of mistletoe (DOE 2015b). Breeding pairs establish a territory between 3.6 -25 ha (Queensland Government 2024). Its movements are based around food resources in remnant patches of woodland with small patches down to 10 ha important resources (SWIFFT 2024). The hooded robin (south-eastern) has been observed in patches as small as 2.9 ha but in agricultural landscapes they display a preference for larger patches greater than 10 ha (DCCEEW 2023d). The diamond firetail is considered to be sedentary, though some populations move locally (DCCEEW 2023e).

### *Assessment decision*

The species within the woodland bird guild are dependent on woodland patches and some of these bird species display sensitivity to small patch sizes or habitat fragmentation. The Project will potentially impact the gap-sensitive woodland birds due to the shorter distances they move between habitat features, <100 m in some cases. A formal connectivity assessment is needed to ensure that the proposed Project footprint will not potentially impact gap-sensitive woodland bird species.

Reliable data exists for movement parameters of brown treecreepers (Doerr et al. 2011, Doerr et al. 2014), so quantitative modelling will be used to assess impact to this guild. The parameters for the brown treecreeper were used to represent woodland birds because it is likely the most gap-sensitive of all the woodland birds in this guild.



## Migratory birds

Several bird species identified within the Study Area are highly mobile, migratory species listed under international conservation agreements and can be grouped into a migratory bird guild. This guild includes the following species:

- Fork-tailed swift
- Oriental cuckoo
- White-throated needletail
- Satin flycatcher
- Rufous fantail
- Swift parrot



Satin flycatcher © David Tytherleigh sourced from eBird

### *Habitat and distribution in the Study Area*

The fork-tailed swift is an aerial forager, loafing in the air with rare observations of resting on bare, exposed emergent branches (DOE 2024a). The oriental cuckoo occurs across a range of vegetated habitats, feeding arboreally as it forages for insects (DOE 2015c). The white-throated needletail is found across a range of habitats, from inland open plains to wooded areas, where it is exclusively aerial (DOE 2024b). The satin flycatcher mainly inhabits eucalypt forests, often near wetlands or watercourses (DOE 2024c). The rufous fantail occurs across a range of habitats, including dry eucalypt forests and woodlands and Brigalow shrublands (DOE 2024e). The swift parrot forages in forests and woodlands, foraging on flowers and psyllid lerps in *Eucalyptus* species (TSSC 2016a).

### *Home range and movement*

The fork-tailed swift departs breeding grounds in Siberia from August and passes through Korea through to the Malay Peninsula from September, arriving in Australia in September/October and departing by April (DOE 2024a). The oriental cuckoo is a regular migrant to Australia, spending the non-breeding season (September to May) across northern and eastern Australia, returning to Europe to breed (DOE 2015c). The white-throated needletail leaves breeding grounds in eastern Siberia, north-eastern China and Japan in late August, reaching Australia in September and departing in February (DOE 2024b). The satin flycatcher spends spring in south-eastern Australia and moves north in autumn to spend winter in northern Australia and New Guinea (DOE 2024c). The rufous fantail is considered migratory and may winter from Cape York Peninsula north to Torres Strait and southern Papua New Guinea (DOE 2024e). The swift parrot breeds in Tasmania during the summer and the entire population migrates north to mainland Australia for the winter, demonstrating its ability to cross a wide range of clearings and other land uses (TSSC 2016a). Local movements are influenced by seasonal flowering of eucalypts, and the availability of lerps and psyllids.

### *Assessment decision*

Migratory birds are highly mobile, and capable of long-distance movements, which includes traversing large areas of unsuitable habitat to reach areas of suitable habitat with gaps > 100 m between habitat elements. These species are also likely to fly over project infrastructure (i.e. fences) and demonstrate a high capacity for movement, thus the narrow Project footprint is unlikely to impact on the movement of migratory birds. Therefore, a formal assessment of impacts to connectivity for the migratory species is not required.

## Wetland birds

Several bird species identified within the Study Area are highly mobile, migratory species listed under international conservation agreements and wetland habitat specialists which can be grouped into a wetland bird guild. This guild includes the following species:

- Australasian bittern
- Sharp-tailed sandpiper
- Curlew sandpiper
- Latham's snipe
- Glossy ibis
- Australian painted snipe
- Common greenshank



Australian painted snipe  
© Rohan Clarke sourced from eBird

### *Habitat and distribution in the Study Area*

The Australasian bittern occurs primarily in permanent and seasonal freshwater habitats, particularly wetlands dominated by sedges, rushes and reeds (TSSC 2019). The sharp-tailed sandpiper occurs in fresh and hypersaline environments, feeding along the edge of water on mudflats, coastal and inland wetlands (DCCEEW 2024b). The curlew sandpiper occurs on mudflats and occasionally flooded paddocks where they forage at the edges of shallow pools (DCCEEW 2023b). The Latham's snipe inhabits freshwater wetlands with low, dense vegetation such as swamps and flooded grasslands (DCCEEW 2024c). The glossy ibis occurs in freshwater vegetation at the edges of lakes and rivers, lagoons, floodplains, swamps and cultivated areas under irrigation (DOE 2024d). The Australian painted snipe inhabits shallow terrestrial freshwater wetlands that have rank emergent vegetation (DSEWPAC 2013). The common greenshank uses both permanent and ephemeral terrestrial wetlands that are native and artificial (DCCEEW 2024d).

Wetland habitat which may provide suitable foraging and roosting habitat for these species within the Study Area is highly ephemeral (draft EIS; Appendix O).

### *Home range and movement*

Tracking studies of the Australasian bittern have shown the species moves hundreds of kilometres between wetlands in southeast Australia, following the availability of resources as floodwaters move through river systems (TSSC 2019). The sharp-tailed sandpiper breeds in northern Siberia and spends the non-breeding season in Australia and New Zealand (DCCEEW 2024b). The curlew sandpiper breeds in the Arctic, northern of Siberia and migrates to Australasia during the non-breeding period (DCCEEW 2023b). The Latham's snipe is a non-breeding visitor to south-eastern Australia and is a passage migrant through northern Australia (DCCEEW 2024c). It is highly mobile while in Australia and moves with rainfall and food availability (DCCEEW 2024c). Latham's snipe roosts on sheltered ground and forages within a short distance (DCCEEW 2024c). The glossy ibis occurs on most continents and undergoes a long-distance, post-breeding dispersal of 1142 km on average from breeding sites (DOE 2024d). It moves with rainfall when in Australia, roosts in trees generally nearby water but not always (DOE 2024d). Movement patterns for the Australian painted snipe are poorly known however evidence of seasonal movement suggests the species is dispersive or migratory (DSEWPAC 2013). The common greenshank spends the non-breeding season in Australia where it roosts near wetlands (DCCEEW 2024d). Movements during non-breeding are shorter but can be dispersive (DCCEEW 2024d).

### *Assessment decision*

While some wetland birds only move short distances between roost sites and foraging habitat, generally they are capable of moving long-distances which includes traversing large areas of unsuitable habitat. This demonstrates a high capacity for movement, and it is likely that they will fly over the Project footprint and not be impeded by the short gap distance between habitat elements.

Therefore, the Project is unlikely to impact on the movement of wetland birds and a formal assessment of impacts to connectivity for the wetland bird species within this guild is not required due to the negligible impacts from the Project to landscape connectivity for these species.

## Large hollow-dependent bird guild

Two large-sized bird species identified within the Study Area are broadly similar in their reliance on forest cover, undertake large movements and require large hollow bearing trees for breeding, so can be grouped into a hollow-dependent bird guild. This guild includes the following species:

- Glossy black-cockatoo (south-eastern)
- Powerful owl



Glossy black-cockatoo © Stuart Ling sourced from eBird

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The south-eastern glossy black-cockatoo feeds almost exclusively on the seeds of sheoaks (<i>Allocasuarina</i> spp. and <i>Casuarina</i> spp.) (DCCEEW 2022a) and are therefore largely restricted to areas supporting this habitat. Alongside the already narrow dietary requirement, the species are obligate hollow nesters, utilising large hollows in both living and dead eucalypt trees for breeding (DCCEEW 2022a). The powerful owl occurs in forests and woodlands, sheltered gullies and along watercourses (Soderquist and Gibbons 2007). Powerful owls mate for life and pairs defend a territory year-round. The nest is usually a vertical hollow in a large old tree (Soderquist and Gibbons 2007).</p>                                                                                                                                                                                                                                                                                                                     |
| <i>Home range and movement</i>                    | <p>The movement patterns of the south-eastern glossy black cockatoo are poorly understood but it has been suggested that they are seasonal migrants in south-east Queensland, likely as a response to changes in resource availability or breeding requirements (DCCEEW 2022a). Glossy black-cockatoo are able to cover large distances, flying up to 14 km between feeding and nesting sites and between 44 km to 78 km during dispersal events (ACT Government 2013).</p> <p>Powerful owl home ranges of between 1382 – 4774 ha have been recorded (Soderquist and Gibbons 2007). Powerful owls move an average of 4.43 km per night (Carter et al. 2019). Powerful owls use a combination of long-transitory movements and shorter movements when handling prey (Carter et al. 2019). Shorter movements occurred in closer proximity to riparian vegetation, where accessing prey occurs, while longer transitory movements were associated with connecting to habitat patches across areas of unsuitable habitat (Carter et al. 2019).</p> |
| <i>Assessment decision</i>                        | <p>The two species in this guild have long-distance movements and large home ranges that traverse a wide variety of habitats and land uses, including cleared areas. Project infrastructure is unlikely to pose a barrier to movement for these species as they can fly over and are not limited by gap-thresholds (&lt;100 m). The Project is therefore unlikely to impact on the movement of large hollow-dependent birds and a formal assessment of impacts to connectivity for the species within the large hollow-dependent bird guild is not required.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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## D1.2 Mammals

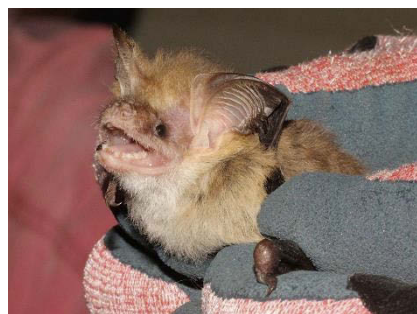
### Spotted-tailed quoll



Spotted-tail quoll © Vincent Watego sourced from iNaturalist

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The spotted-tailed quoll is primarily a forest, woodland and shrubland species, but also occurs in a variety of habitats including treeless areas such as grasslands and pastoral areas, especially where these occur adjacent to or in between areas of forest (TSSC 2020). A large proportion of the Study Area overlaps with modelled habitat and the species was recorded in Bringalily State Forest during ecology surveys.</p>                                                                                                                                                                                                                                                                                    |
| <i>Home range and movement</i>                    | <p>Males have home ranges of up to approximately 5000 ha in size, while females have smaller ranges of several hundred to 1,500 ha (TSSC 2020). They have multiple dens, sometimes up to 20 and move between them every 1-4 days (Department of Environment 2016). Within fragmented landscapes, spotted-tailed quoll have flexibility in habitat use, which is likely related to prey availability and can traverse open grassland to access forest and woodland patches, particularly where vegetation is present to provide stepping-stones (i.e. scattered trees and shrubs) (Henderson et al. 2023). This species is moderately arboreal, with approximately 10% of travelling done in trees (Jones et al. 2001).</p> |
| <i>Assessment decision</i>                        | <p>While the spotted-tailed quoll has large home ranges, movement is potentially impacted by fencing within the Project footprint and a formal assessment of impacts to connectivity for this species is required. The spotted-tailed quoll was selected as a proxy or representative of medium-sized terrestrial mammals because it has a large home range and movement scale, uses a diversity of habitat types and thus encompasses other terrestrial mammal species.</p> <p>A quantitative model using the parameters for an individual species was used because sufficient information about habitat, patch size thresholds and movement parameters are known to inform the models.</p>                               |

## South-eastern long-eared bat



South-eastern long-eared bat © Nyoni Pete sourced from iNaturalist

### *Habitat and distribution in the Study Area*

The south-eastern long-eared bat is forest/woodland- dependant and occurs in a wide range of forest and woodland habitats, including box, ironbark and cypress in southern Queensland (TSSC 2015b).

The species occurs across the Murray Darling basin and a large proportion of the Study Area overlaps with modelled habitat and the species was recorded in Bringalily State Forest during ecology surveys.

### *Home range and movement*

Tracking conducted in Bringalily State Forest recorded a GPS-tagged bat commute 12 km from the site of capture (BAAM 2023) while tracking in the Piliga forest in north-west NSW found tagged bats roosted relatively close to where they were trapped (<1.5 km) and were tracked foraging up to 4 km from their roost, and the largest recorded home range was 747 ha (Law et al. 2016). Other studies indicate typical distances between roosts and capture sites of 1 – 2 km, with one up to 7 km (Lumsden et al 2008, 2011, cited in (Law et al. 2016).

Large intact patches of remnant and mature forest appear to be important to support large and high-density populations of this species.

### *Assessment decision*

The south-eastern long-eared bat may be sensitive to habitat fragmentation due to its dependence or preference for flying and foraging in cluttered habitat (Law et al. 2016) but they are also capable of long-distance flight, including across cleared areas and linear infrastructure (Law et al. 2016). Therefore, a formal assessment of connectivity is not required for this species. We note that the habitat requirements, patch size and movement needs of this species are likely encompassed by those for small woodland birds and therefore any recommendations for mitigation will likely benefit this species also.



## Platypus



Platypus © Steve McBride sourced from iNaturalist

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The platypus occurs in eastern Australia, from near Cooktown in Queensland to the Victorian-South Australian border and Tasmania (Bino et al. 2019). It occupies freshwater habitats including rivers, dams, lakes and utilises waterways with pool-riffle sequences where they forage for small aquatic macroinvertebrates (Bino et al. 2019). Platypus prefer slow moving, shallow waterways filled with complex habitats, including submerged logs, rocks and gravel (Bino et al. 2019).</p> <p>Platypus nest in burrows on the banks of waterways for shelter, resting and breeding (Bino et al. 2019).</p> <p>Platypus occur in western-flowing streams in Queensland and are known to occur in the Study Area.</p>                                                                                                     |
| <i>Home range and movement</i>                    | <p>Platypus are typically solitary however a male home range may overlap with multiple females (Serena et al. 1998). Platypus live permanently in waterways and have linear home ranges that reflect the structure of the waterway. Home ranges are typically less than 15 km long (Bino et al. 2019), with male movement distances larger than those of females (Serena et al. 1998, Bino et al. 2018).</p> <p>Platypus have been observed passing and foraging under road and rail bridges where the waterway continues uninterrupted (TMR 2024i). The Australian Platypus Conservancy have also found the species regularly using a 1.3 m diameter X 45 m long concrete culvert and they recommend that culverts should be at least 250 mm diameter, are set below bed-level, and where possible have natural substrate.</p> |
| <i>Assessment decision</i>                        | <p>The platypus undertakes long movements (multiple kilometres) and readily use a range of underpass types (i.e. culverts and bridges) where the waterway continues uninterrupted. The Project is unlikely to impact on the movement of platypus because all waterways potentially utilised by platypus and dissected by the Project will be fitted with culverts and bridges that exceed the minimum dimensions recommended by the Australian Platypus Conservancy. Therefore, a formal assessment of connectivity is not required due to the negligible impacts from the Project to landscape connectivity for this species.</p>                                                                                                                                                                                              |

## Gliding mammal guild

Gliders in the Study Area range in size from the 10 – 20 gram broad-toed feather-tailed glider (*Acrobates frontalis*) to the 1 – 1.5 kg greater glider. Other gliders include the yellow-bellied glider, squirrel glider and Krefft's glider. The two threatened species in the Study Area are the greater glider and yellow-bellied glider, and they form the gliding mammal guild.



Greater glider © Jordan Aquilina sourced from iNaturalist

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The greater glider (southern and central) is largely restricted to eucalypt forest and woodland across eastern Australia from southern Victoria to near Townsville in Queensland (Australian Government 2022). While typically preferring tall and moist montane forest, they also occur on the inland side of the Greater Dividing Range in the Study Area (Australian Government 2022).</p> <p>The yellow-bellied glider (south-eastern) occurs in eucalypt dominated wet and dry sclerophyll forest and woodland, from south-east Queensland to south-east South Australia, including on the inland side of the Great Dividing Range in the Study Area (DAWEH 2022).</p> <p>Modelled habitat for both the greater glider and yellow-bellied gliders occurs in the Study Area, however no greater gliders or yellow-bellied gliders were detected during surveys for the impact assessment.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <i>Home range and movement</i>                    | <p>Greater gliders have relatively small home ranges, that are typically less than five ha in size (Kavanagh and Lambert 1990, Comport et al. 1996, Pope et al. 2004, Youngentob et al. 2012), but are occasionally large (up to ~20 ha) for males in occurring in logged forest (Smith et al. 2007). Greater gliders are also quite sedentary, with little movement within the home range (Cunningham et al. 2004), and estimated dispersal distances of 1 – 7 km. Greater Gliders glide between trees, are strictly arboreal, rarely come to the ground and are reliant on tree canopy cover (Taylor and Goldingay 2009). Greater gliders use 4 – 20 dens in large hollow-bearing trees within their home range (Smith et al. 2007).</p> <p>In contrast, yellow-bellied gliders have larger home ranges, which average about 30 – 60 ha across their distribution, and may traverse over two km per night (Goldingay 2023). Glide distances vary among species and are related to tree/launch height, body weight and size of the gliding membrane. The maximum observed glide lengths of greater gliders is 70 – 80 m in forest that was 40 – 45 m tall (Rod Kavanagh, pers. comm., Kita Ashman, pers. com.), and 27 m in forest that was 20 – 25 m tall (Ben Nottidge pers. comm.). These observations in the shorter forest equate to a glide angle of approximately 40 degrees, compared to squirrel gliders at approximately 31 degrees. Yellow-bellied gliders have been reported gliding in excess of 100 m in tall forest.</p> |
| <i>Assessment decision</i>                        | <p>Gliders are susceptible to habitat fragmentation and gaps that exceed their glide capability are barriers to movement and therefore a formal assessment of connectivity is required due to the likely impacts from the Project to landscape connectivity for these species (Soanes and van der Ree 2015).</p> <p>There is sufficient detailed information on the habitat requirements and glide capabilities of gliders to undertake the assessment using a quantitative approach.</p> <p>As greater gliders are the most sensitive of all the medium- to large-sized gliders, they were used to represent this guild of large-sized gliders. In addition, this guild also encompasses the needs of squirrel gliders and Krefft's gliders.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Koala



Koala © Talia Lovelinay sourced from iNaturalist

*Habitat and distribution in the Study Area* The koala is distributed from the base of Cape York in Queensland to Kangaroo Island in South Australia. Koalas typically occur at higher densities in coastal areas, within riparian habitats and in forest on soils with higher nutrient and moisture levels.

Koala habitat in the Study Area is eucalypt woodland to open forest with mature box, ironbark and red gum species. The entire Study Area has been classified as one of three categories for koala habitat, namely ‘foraging and breeding habitat’, ‘dispersal habitat’ or ‘not suitable habitat’.

Foraging and breeding habitat is any forest or woodland containing tree species that are known koala food trees, or shrubland with emergent food trees, and is used for foraging, breeding, dispersal and home range movements.

Dispersal habitat contains isolated or scattered foraging or shelter trees and occurs adjacent to foraging and breeding habitat and includes grassland/bare ground, rural land-uses, dwellings, buildings, farm dams, sealed or unsealed roads and existing rail infrastructure. Dispersal habitat is used by koalas for long-distance movements.

*Home range and movement* The home range and movement patterns of koalas varies according to the spatial extent and quality of the habitat, including soil nutrient and moisture levels. The size of koala home ranges varies from a few ha in high quality habitat in coastal areas, to > 100 ha in semi-arid environments (White 1999, Ellis et al. 2002). Individuals can also travel long distances, including two studies reporting movements > 16 and > 30 km over 4 months (White 1999, Rus et al. 2021). Koala within the Study Area are moving on average (males: mean  $173 \pm 220$  m/day, median 95 m/day; females: mean  $106 \pm 185$  m/day, median 52 m/day, with the highest travel distances occurring between July and December (UniSQ 2024). Daily movement rates were recorded nearly three times higher during the dispersal phase ( $341 \pm 498$  m/day) compared with the non-dispersal phase ( $107 \pm 188$  m/day (UniSQ 2024). Home ranges for dispersing koala was also higher (mean =  $2.45 \pm 2.4$  km<sup>2</sup>) compared with non-dispersing (mean =  $0.57 \pm 0.5$  km<sup>2</sup>) and variable among sexes, with males moving greater distances compared with females (UniSQ 2024).

While koalas spend the majority of their time within trees, they usually come to the ground when moving among trees (White 1999, Rus et al. 2021).

The ARTC Inland Rail koala genetics study identified high levels of gene flow across the broader landscape, indicating that despite high levels of habitat loss and habitat fragmentation across the area, koalas are still successfully dispersing (ERM, 2023).

*Assessment decision* The Project may have an impact on the movement of koalas and a formal assessment of impacts to connectivity is required.

There is extensive knowledge and understanding of the habitat requirements and movement patterns of koala around transport infrastructure (refer to TMR 2024e). A habitat proximity assessment approach was adopted for the koala because they use scattered trees and regrowth forest and woodland which may not be accurately assessed at the spatial scale of this study. In addition, the habitat proximity assessment method enabled incorporation of the results of ongoing GPS tracking in the Study Area, ensuring the Strategy could include the most current and up to date assessment of movement of the species.

## Grey-headed flying-fox



Grey-headed flying-fox © Graham Armstrong sourced from iNaturalist

*Habitat and distribution in the Study Area* The grey-headed flying-fox is distributed in a broad geographic band along the east coast of Australia from Bundaberg in central Queensland to Adelaide in South Australia (DAWE 2021).

The species feeds on flowers and fruit from a wide diversity of tree and shrub species in rainforests, forests, woodlands, *Melaleuca* swamps and *Banksia* woodlands. Grey-headed flying-foxes are becoming increasingly abundant in urban areas across their range, often roosting in bushland reserves, botanic gardens and other parks and reserves in cities and towns (DAWE 2021).

The Study Area contains modelled habitat for the species, and the species is known to occur in the Study Area.

*Home range and movement* Flying-foxes are active at night and during the day they roost communally in groups numbering up to tens of thousands of individuals. The movement of grey-headed flying-foxes amongst camps varies seasonally, with a southwards direction in summer and autumn and contraction northwards towards north-eastern NSW and SE Queensland during winter. Food availability is the main driver of flying-fox movements across Australia.

Flying-foxes are capable of moving large distances, with grey-headed flying-foxes typically flying up to 30–50 km each night from their camp to feed and flying a few hundred kilometres per night when moving between camps. Grey-headed flying-foxes travelled up to 2268–2564 km per year between roosts, with a single individual travelling 12,337 km over 1,629 tracking days, while using 123 roosts (Welbergen et al. 2020). When foraging and moving between camps, they traverse a wide variety of ecosystems and habitats, including agricultural landscapes and urban areas.

*Assessment decision* This species can move long-distances across fragmented landscapes with large gaps in the tree canopy, enabling movement over the Project footprint and has a large home range. An assessment of impacts to connectivity is not required due to the negligible impacts from the Project to landscape connectivity for this species.

## Short-beaked echidna



Short-beaked echidna © Dawn Borchardt sourced from iNaturalist

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | The short-beaked echidna is widespread across Australia and inhabits a wide diversity of habitat types and ecosystems, including alpine, rainforest, agricultural, urban-rural fringe, forest and heathland. They are often found amongst rocks, in hollow logs, and holes within tree roots and leaf litter (Wilkinson et al. 1998). The echidna was detected in the Study Area.                                                                                                                                                                                                                                                                                     |
| <i>Home range and movement</i>                    | The echidna has relatively large home ranges, up to approximately 100 ha in size, and can move through cleared and disturbed areas, along roadsides and tracks. The echidna has been observed using numerous concrete box culverts of varying size across many roads in eastern Australia (Taylor and Goldingay 2003, Goldingay et al. 2022).                                                                                                                                                                                                                                                                                                                         |
| <i>Assessment decision</i>                        | The Project is not expected to have a significant impact on the movement of the echidna because it undertakes long-distance movements, has relatively large home ranges, is capable of traversing cleared areas and likely able to climb and traverse many sections of the railway itself. It also readily uses culverts, and thus the large number and frequent distribution of culverts and bridges in the Project reference design within areas of habitat will enable the movement of the echidna. Therefore, an assessment of impacts to connectivity is not required due to the negligible impacts from the Project to landscape connectivity for this species. |



## D1.3 Reptiles

### Woodland reptile guild

Several reptile species identified within the Study Area are woodland dependent species and can be grouped into a woodland reptile guild. This guild includes the following species;

- Death adder
- Dunmall's snake
- Collared delma
- Yakka skink



Collared delma © Glenda Walter sourced from iNaturalist

#### *Habitat and distribution in the Study Area*

The common death adder inhabits forests, woodlands, shrublands and grasslands on well-draining soils with undisturbed leaf litter. The Dunmall's snake inhabits open forests and woodlands on black alluvial cracking clay and clay loams dominated by brigalow (*Acacia harpophylla*), other wattles (*A. burowii*, *A. deanii*, *A. leioclyx*), native cypress (*Callitris* spp.) or bull-oak (*Allocasuarina luehmannii*). The collared delma inhabits eucalypt-dominated woodlands and open-forests in Queensland RE Land Zones that are dominated by poplar box (*Eucalyptus populnea*) on alluvial plains, lemon-scented gum (*Corymbia citriodora*) open forest on coarse-grained sedimentary rocks and poplar box/brigalow (*Acacia harpophylla*) open forests on fine-grained sedimentary rocks. The yakka skink inhabits open dry sclerophyll forests or woodlands, with microhabitats including dense ground vegetation, large hollow logs, fallen trees, and burrows for refuge.

The common death adder is known to live in fragmented populations in the Mitchell Grass Downs of western Queensland and Barkley Tablelands within QLD / NT and east of Darwin, however exact distribution is unknown. The Dunmall's snake occurs from Yeppoon, QLD south to south-central New South Wales. Within QLD, the Dunmall's snake is found from Yeppoon to Oakey, Glenmorgan and Inglewood, with most records occurring between 200-500 m above sea level. The collared delma is found in the western suburbs of Brisbane, Bunya Mountains, Blackdown Tableland National Park (NP), Bullyard Conservation Park, D'Aguilar Range NP, Expedition NP, Naumgna and Lockyer Forest Reserves, Western Creek near Millmerran and the Toowoomba Range. Yakka skinks are located from St George and north to Coen and Cape York with the majority of individuals found in the Mulga Land and Brigalow Belt South Bioregions.

Collared delma and yakka skink were not detected during surveys while the Dunmall's snake and common death adder were detected in the Study Area. Dunmall's snake was recently detected incidentally in the Project footprint.

#### *Home range and movement patterns*

There is limited information on the dispersal habits of common death adder, Dunmall's snake and the yakka skink, however, they are unlikely to have a high dispersal ability. Collared delma are a sedentary species with many individuals living in a 10 x 10 m area (DCCEE 2024a). Yakka skinks have high site fidelity and limited capacity for dispersal from their colony (DCCEE 2024a).

#### *Assessment decision*

These species in the woodland reptile guild are likely to have small home ranges and low dispersal ability, and a formal assessment of impacts to connectivity is required due to the potential impacts from the Project footprint to landscape connectivity for these species.

A habitat proximity assessment was adopted because there is little quantitative data on the movement capabilities of these species.

## Cracking clay reptile guild

Several reptile species identified within the Study Area are woodland dependent species and can be grouped into a woodland reptile guild. This guild includes the following species;

- Five-clawed worm-skink
- Grey snake



Five-clawed worm-skink © Darren Fielder sourced from iNaturalist

**Habitat and distribution in the Study Area** The five-clawed worm skink inhabits areas containing bluegrass (*Dichanthium sericeum*) and/or Mitchell grass dominated grasslands or mixed grasslands that are established on cracking clay soils or self-mulching, friable basalt soils. In the south-east of QLD, this species may occur in river red gum–Queensland blue gum–coolabah–bimble/poplar box grassy woodland/open forests (Department of the Environment 2008).

Grey snakes inhabit brigalow and belah woodlands, Queensland bluegrass and Mitchell grass grasslands on alluvial plains with cracking clay soils and red sodosols, and adjacent ephemeral wetlands and other waterbodies (DCCEEW 2022b).

The five-clawed worm-skink occurs in the Darling Downs bordering the lower western slopes of the Great Dividing Range, in both north-eastern New South Wales and south-eastern Queensland and the Condamine River floodplain in QLD (Department of the Environment 2008). The grey snake is widely distributed, but most records are near the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt region (DCCEEW 2022b).

The five-clawed work skink is known to occur in the Study Area. The grey snake was detected during surveys and is known to occur in the Study Area.

**Home range and movement** The five-clawed worm skink’s movement patterns and dispersal ability is unknown. The grey snake distribution includes several isolated subpopulations, and their distribution is not continuous across its full range, however, no information regarding the home range size or dispersal ability of this species is available. Both the grey snake and five-clawed worm skink are expected to have limited dispersal ability.

**Assessment decision** These species in the cracking clay reptile guild are likely to have small home ranges and low dispersal ability, and a formal assessment of impacts to connectivity is required due to the potential impacts from the Project footprint to landscape connectivity for these species.

A habitat proximity assessment was adopted because there is little quantitative data on the movement capabilities of these species.

## Condamine earless dragon



Condamine earless dragon © Dollery, C, QPWS

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The Condamine earless dragon prefers shorter grassland with an open structure or open areas, particularly where soil cracks, tussock grasses, mats of dead vegetation, and to a lesser extent, where scattered surface rocks and burrows exist (TSSC 2016b). They primarily inhabit intensively cropped black-cracking clays with almost all records occurring along narrow road reserves, in cropland (i.e., cotton, sorghum, maize and sunflower crops), remnant native grassland and exotic grassland, and in headlands of private properties (TSSC 2016b).</p> <p>The Condamine earless dragon is endemic to the eastern Darling Downs, particularly occurring on the Condamine River floodplain, bounded by the Pirrinuan/Jimbour area in the northwest, Millmerran in the southwest, Clifton in the southeast and Toowoomba in the northeast (TSSC 2016b).</p> <p>The Condamine earless dragon was identified during ecology surveys and is known to occur in the Study Area. However, dispersal habitat and breeding and foraging habitat have not been defined for this species, as little is known about their diet or reproductive biology.</p> |
| <i>Home range and movement</i>                    | <p>The extent occurrence of this species is estimated at less than 2000 km<sup>2</sup> and its area of occupancy is 76 km<sup>2</sup> (TSSC 2016b). The geographic distribution of this species is uncertain and also whether there is more than one population of Condamine earless dragons (TSSC 2016b).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Assessment decision</i>                        | <p>Condamine earless dragons are likely to have small home ranges and low movement ability. A formal assessment of impacts to connectivity is required due to the potential impacts from the Project footprint to landscape connectivity for this species.</p> <p>A habitat proximity assessment was adopted because there is little quantitative data on the movement capabilities of this species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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## D1.4 Fish

### Murray cod



Murray cod © Vincent Watego sourced from iNaturalist

**Habitat and distribution in the Study Area** The Murray cod is a large predatory fish endemic and widespread within the Murray-Darling Basin (National Murray Cod Recovery Team 2010). Murray cod live in various habitats ranging from clear, stony streams to slow flowing turbid rivers, lakes and billabongs (National Murray Cod Recovery Team 2010). Murray cod are more common in waterways with large rocks, snags and undercut banks with overhanging vegetation (National Murray Cod Recovery Team 2010). The most common habitat is the main river channel; however, Murray cod will disperse onto floodplains during high flow events (Lintermans 2023).

Habitat includes main river channels featuring complex microhabitat features such as, large rocks, large snags, woody debris, undercut banks and over-hanging vegetation, particularly where riparian habitat with river red gums are present (National Murray Cod Recovery Team 2010). These features are required for foraging, habitat, navigation, and spawning. Generally unsuitable habitat includes de-snagged stretches of river that have had microhabitat features removed, areas of cleared bank without riparian habitat, and ephemeral streams that seasonally dry out (National Murray Cod Recovery Team 2010).

**Home range and movement** Murray cod exhibit a range of movements, including seasonal migrations, daily movements in search of food and suitable habitat, and movements related to reproductive behaviours (Lintermans 2023). These movements are influenced by a variety of factors, including water temperature, food availability and habitat characteristics.

Seasonal migrations are an important aspect of Murray cod biology. During the warmer months, Murray cod move upstream in search of cooler water temperatures and suitable breeding grounds (National Murray Cod Recovery Team 2010). In cooler months they typically move downstream to take advantage of warmer water temperatures and increased food availability (Allen-Ankins et al. 2012).

The daily shorter-range movements of Murray cod are also important because they are often related to searching for food and suitable shelter habitat (National Murray Cod Recovery Team 2010). Murray cod are opportunistic feeders, preying on a large variety of aquatic species such as small fish, crustaceans, and insects (National Murray Cod Recovery Team 2010). Their movements in search of prey can be influenced by environmental conditions, such as temperature, turbidity as well as the availability of suitable habitat structure (Lintermans 2023).

Reproductive behaviours play a key role in the longer-range movement patterns of Murray cod (National Murray Cod Recovery Team 2010). Mating typically occurs during the warmer months, with adults migrating to shallow areas with suitable nesting sites (National Murray Cod Recovery Team 2010). After spawning, the adults may disperse to different areas, with females often guarding the eggs and fry until they are able to fend for themselves (Allen et al. 2002).

**Assessment decision** The Project footprint may have an impact on the movement of Murray cod and a formal assessment of impacts to connectivity is required.

As the definition of Murray cod habitat is simple (i.e. waterways), a habitat proximity assessment is adequate to identify key linkages and habitat connectivity mitigation measures.

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## D1.5 Invertebrates

### Brigalow woodland snail



Brigalow woodland snail © C. Eddie, Boobook Ecological Consulting

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Habitat and distribution in the Study Area</i> | <p>The brigalow woodland snail (BWS) occurs in brigalow and/or eucalypt dominated woodlands associated with waterways and floodplains of the Condamine River and MacIntyre Brook (Threatened Species Scientific Committee 2016). The BWS shelters beneath logs, under rocks, among leaf litter and in loose bark piles at the base of trees (Eddie. C and Hardwick. L 2022). The species can occur in non-remnant habitats (e.g. regrowth and grassland) providing there are suitable shelter sites (Threatened Species Scientific Committee 2016). (Eddie. C and Hardwick. L 2022) identifies habitat as remnant and regrowth vegetation patches regardless of size including fringing/riparian woodlands dominated by river red gum on clay soils along watercourses and other streams, woodlands dominated by poplar box (<i>E. populnea</i>) and/or belah (<i>Casuarina cristata</i>) and/or brigalow (<i>Acacia harpophylla</i>) on alluvial plains with clay soils or woodlands dominated by belah (<i>Casuarina cristata</i>) and/or brigalow (<i>Acacia harpophylla</i>) on undulating low hills with clay soils.</p> |
| <i>Home range and movement</i>                    | <p>Nothing is known of the movements of BWS however, the species is considered to be of very limited mobility (Threatened Species Scientific Committee 2016). A study of snails of similar size recorded short distances during any one observation (often &lt;1m) and the longest recorded movement was 3.5 m out of 50 survey-animal nights (Ridgeway et al. 2014). It is assumed that, like other land snails, eggs are laid in depressions in soil under logs and other ground debris with multiple egg laying events per season depending on the frequency and timing of weather events (Threatened Species Scientific Committee 2016) (Eddie. C and Hardwick. L 2022). During rain events, BWS can move between patches of suitable microhabitat (Threatened Species Scientific Committee 2016). This movement is limited spatially by the arrangement of habitat patches and water flow (Threatened Species Scientific Committee 2016). The association between BWS and predominantly alluvial land suggests dispersal occurs during flooding events.</p>                                                              |
| <i>Assessment decision</i>                        | <p>BWS has low dispersal ability and is likely dependent on flood events to maintain landscape connectivity. The Project may have an impact on BWS movements and a formal assessment of impacts to connectivity for this species is required. Due to the limited information on this species, a habitat proximity assessment was used.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



# APPENDIX P

Fauna Connectivity Strategy

## **Appendix E** Revised reference design assessment maps

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

# APPENDIX

# P

## Fauna Connectivity Strategy

### **Appendix E1** Woodland Reptiles, Cracking Clay Reptiles, and Brigalow Woodland Snail

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- Brigalow woodland snail potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

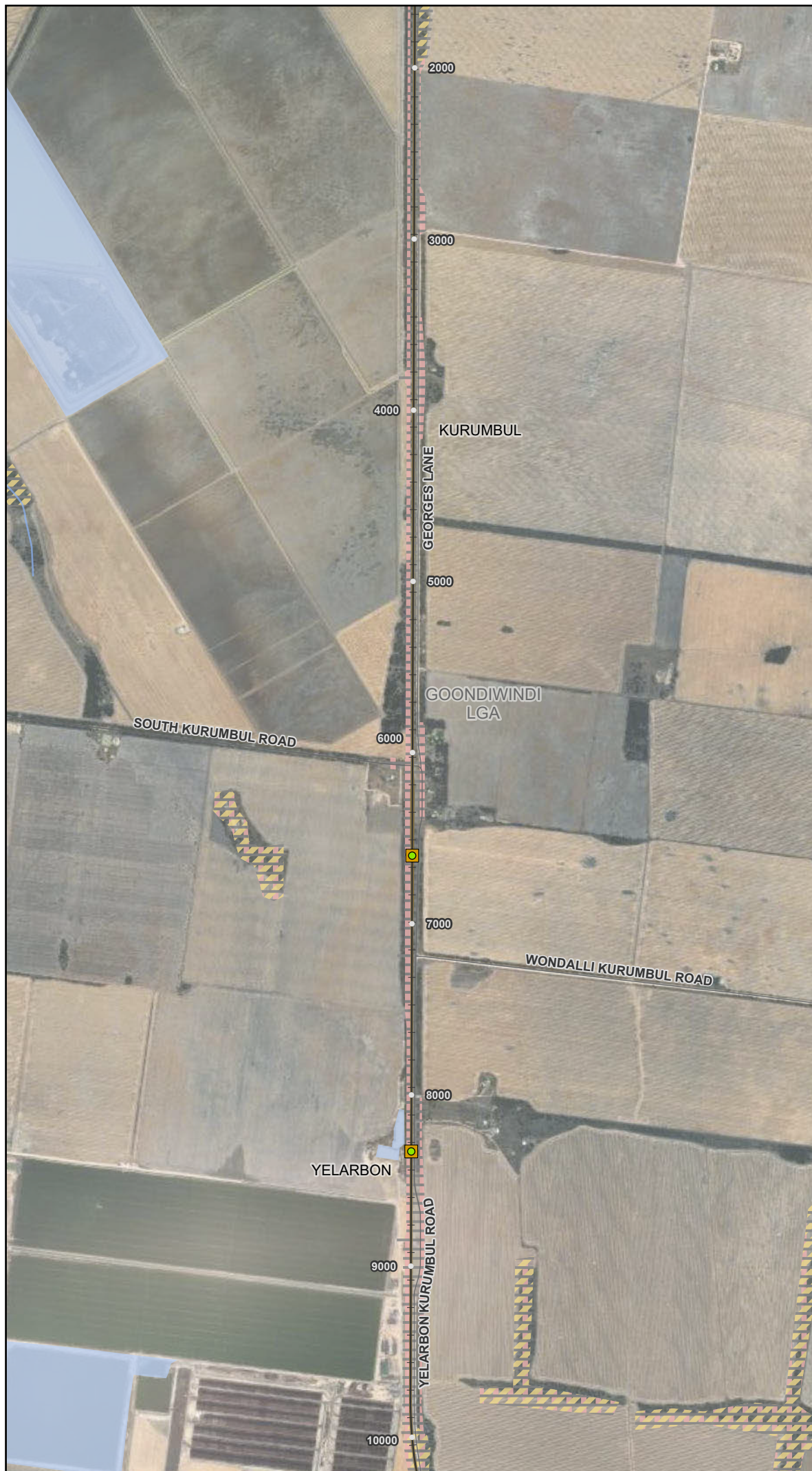
- Existing design structure is satisfactory

### Species habitat

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)

- Culvert

- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is unsatisfactory, or required structure is absent

- Proposed new structure location

**Species habitat**

- Brigalow woodland snail potential habitat

- Cracking clay reptiles potential habitat

- Woodland reptile potential habitat

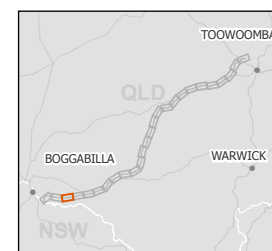
**Topographic**

- Existing operational railway

- Road

- Watercourse

- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

**Species records**

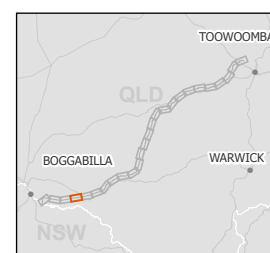
- ▲ Grey snake record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers

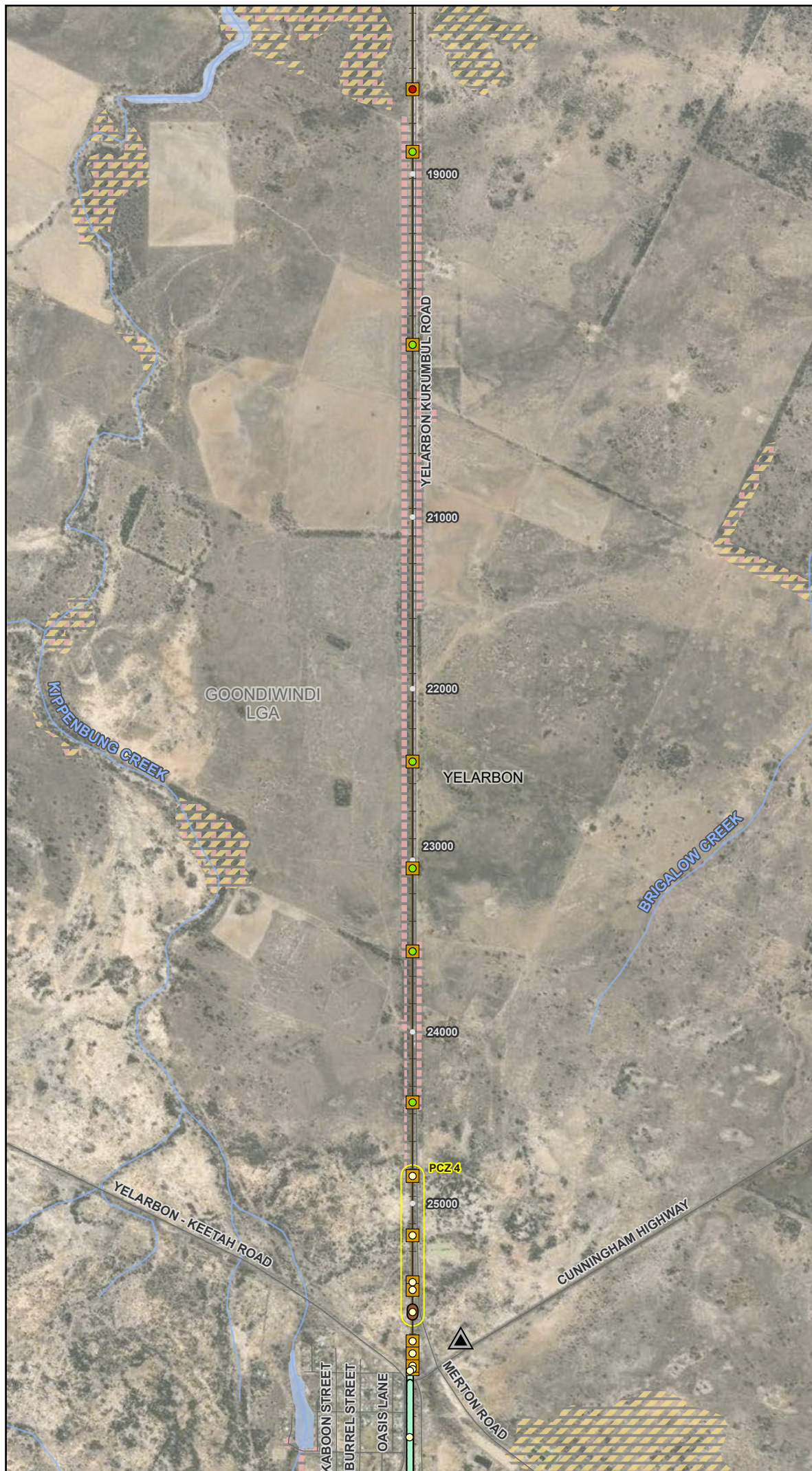
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Concept noise wall location

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

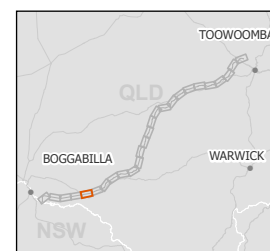
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers

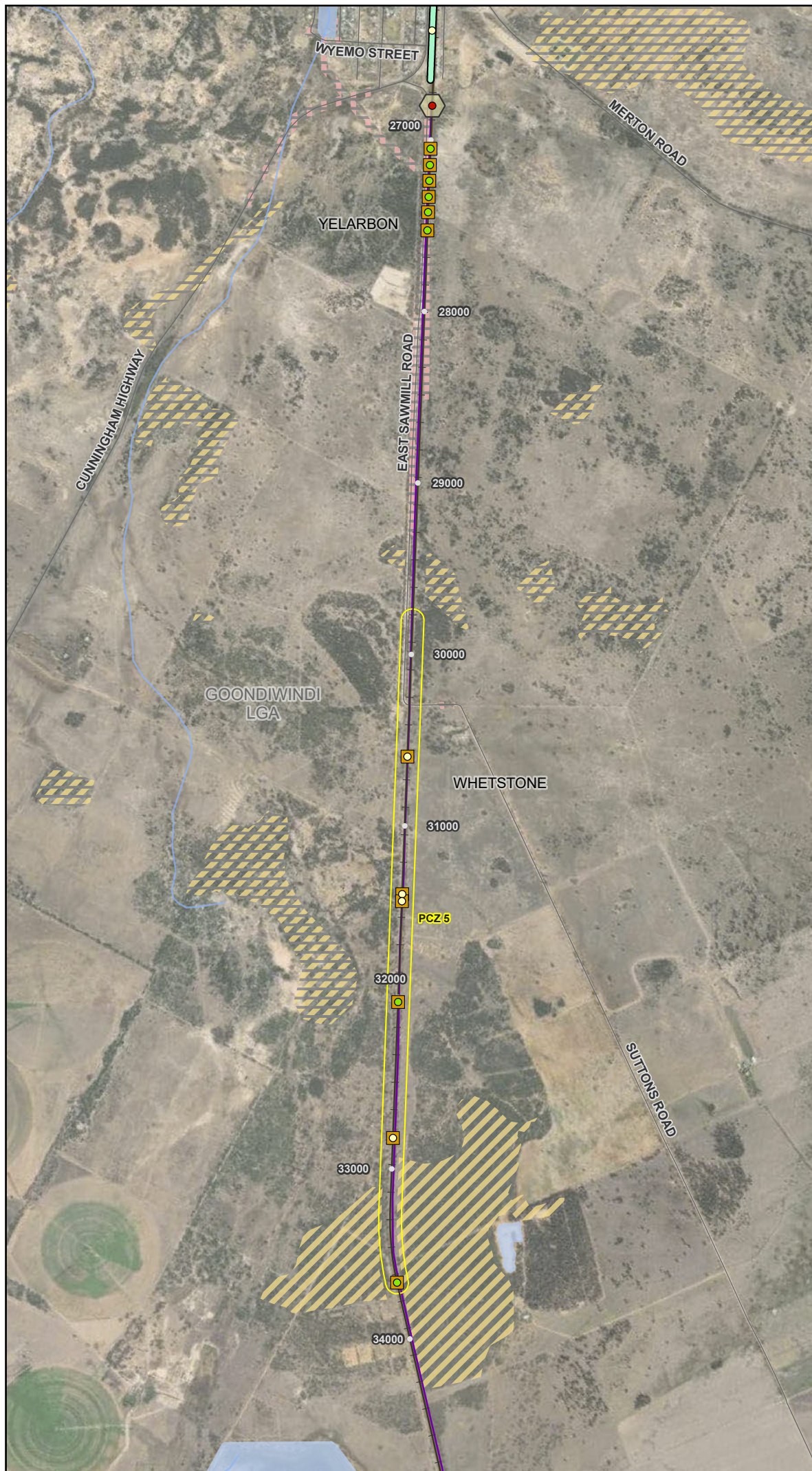
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)

- Culvert

- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory

- Existing design structure is unsatisfactory, or required structure is absent

- Proposed new structure location

**Species habitat**

- Brigalow woodland snail potential habitat

- Cracking clay reptiles potential habitat

- Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence

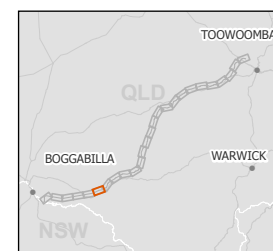
- Existing operational railway

- Road

- Watercourse

- Waterbody

- Protected areas



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

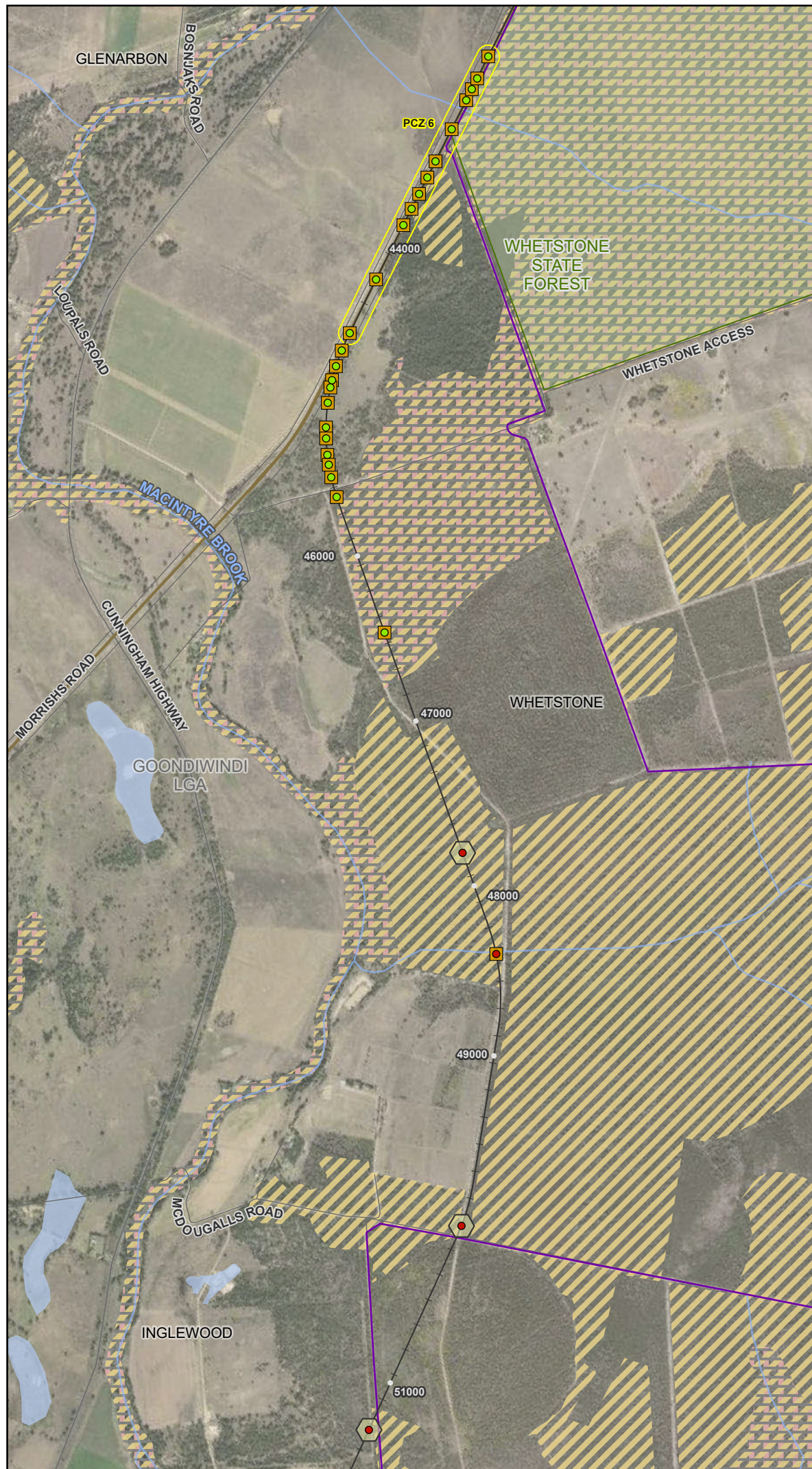
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigidlow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- Brigidlow woodland snail potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

### Topographic

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

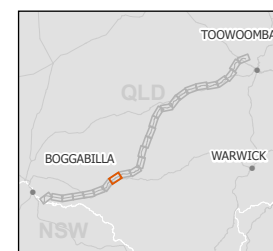
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- ⬡ Proposed new structure location

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- ▬ Wild Dog Check Fence
- ▬ Road
- ▬ Watercourse
- ▬ Waterbody



0 0.5 1  
Kilometers

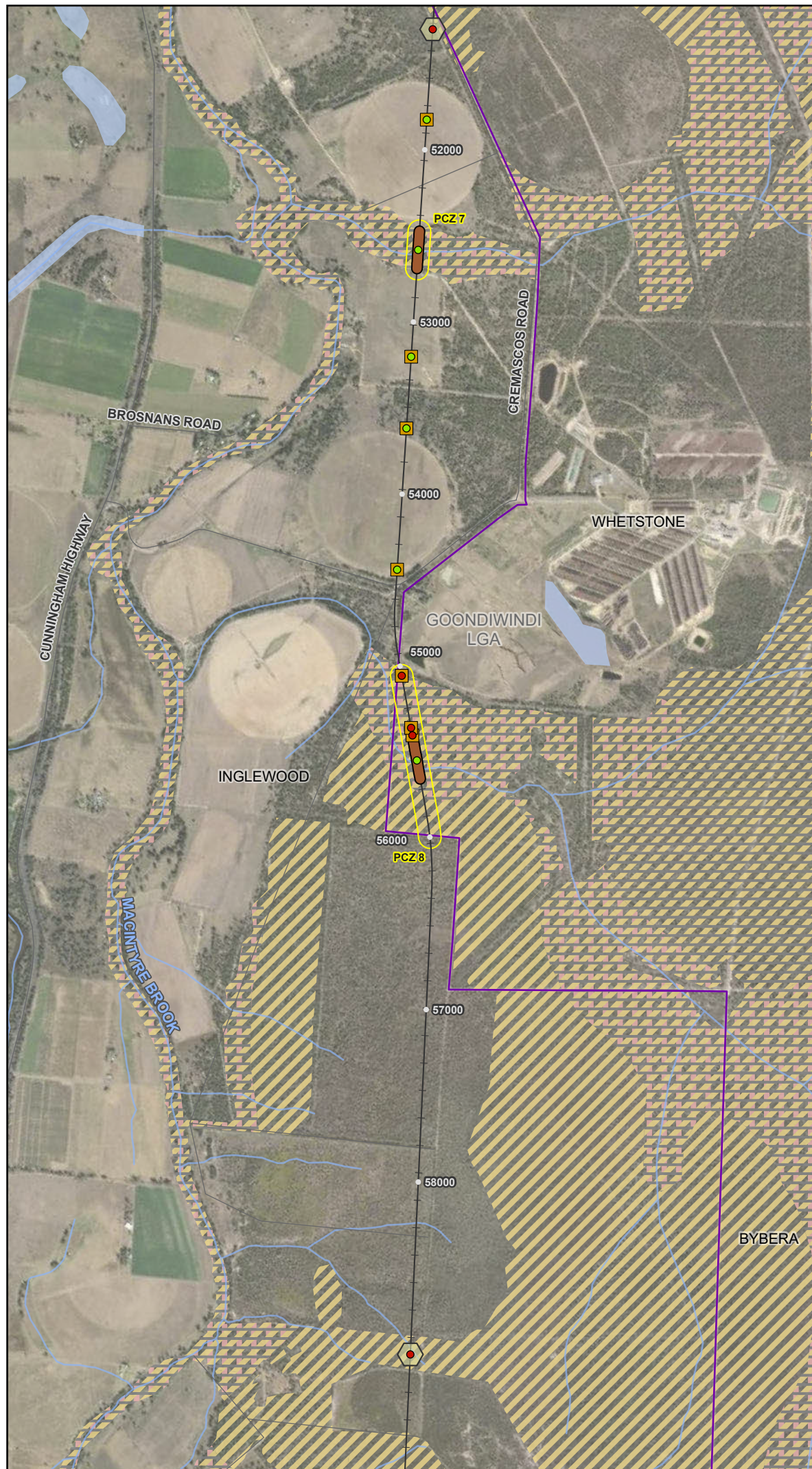
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

**Species records**

Grey snake record

**Species habitat**

Brigalow woodland snail potential habitat



Cracking clay reptiles potential habitat



Woodland reptile potential habitat

**Topographic**

Wild Dog Check Fence



Road



Watercourse



Waterbody



Protected areas



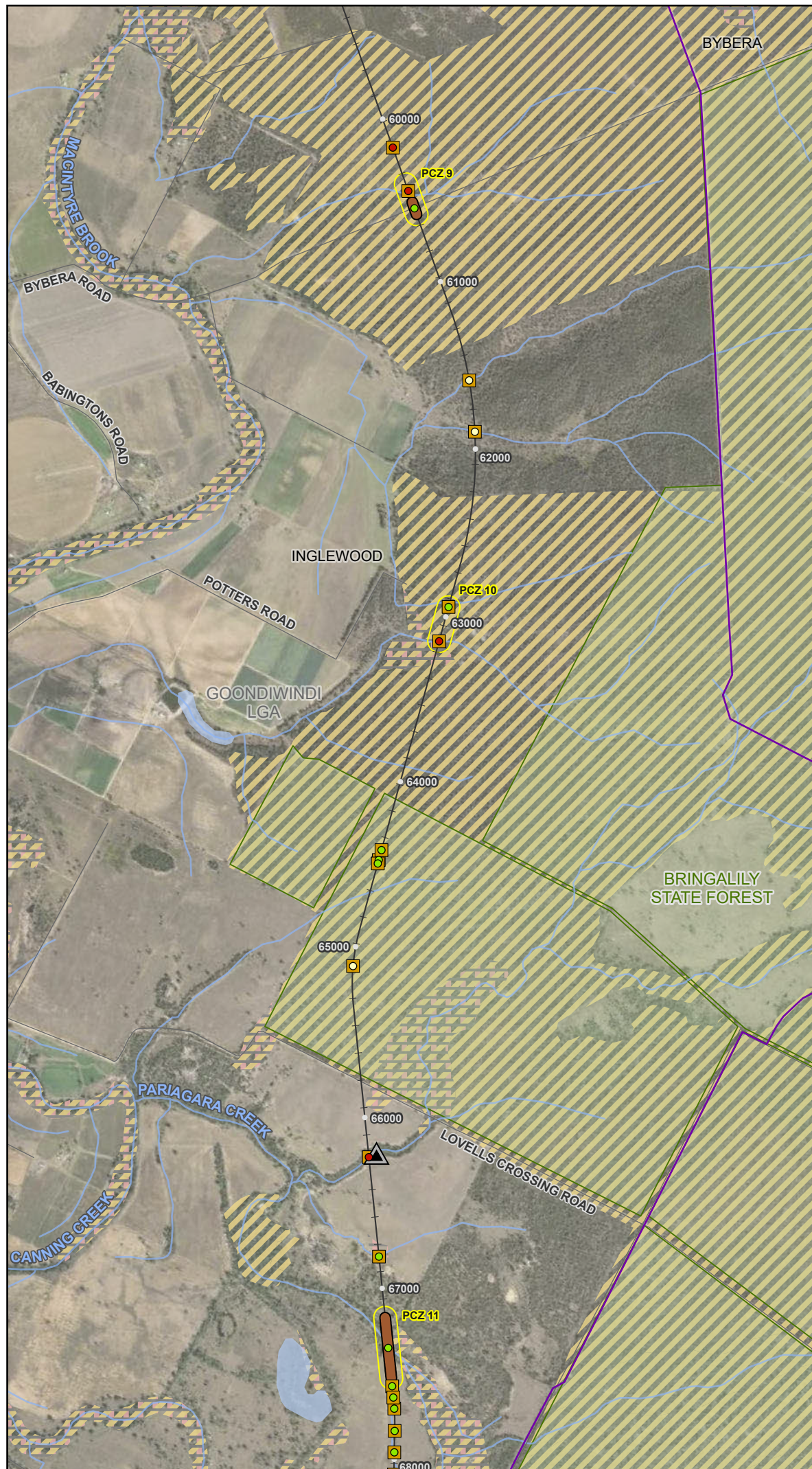
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Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

**Species records**

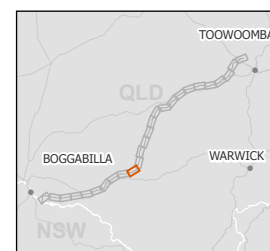
- ▲ Death adder record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



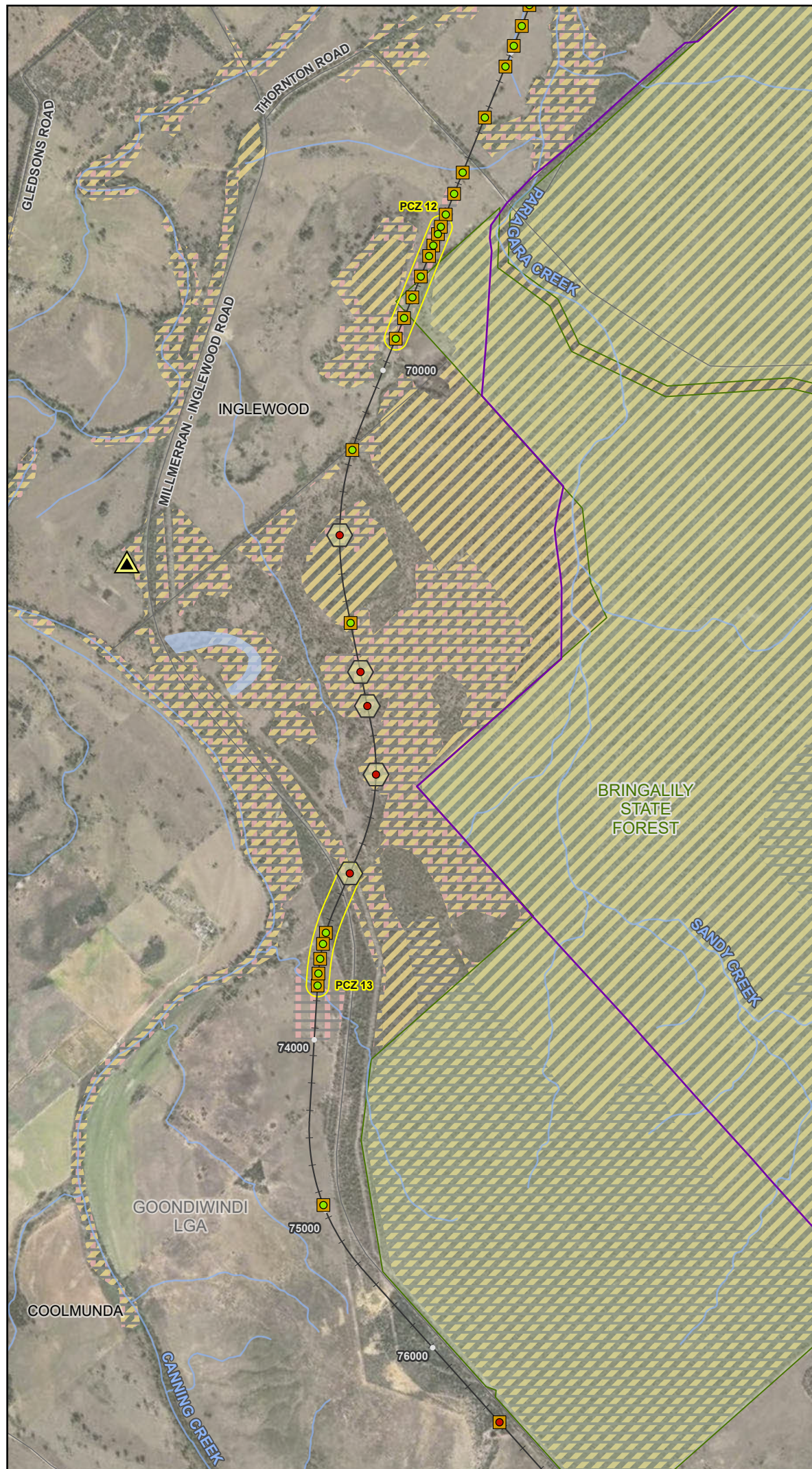
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

**Species records**

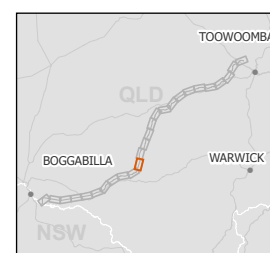
- ▲ Death adder record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



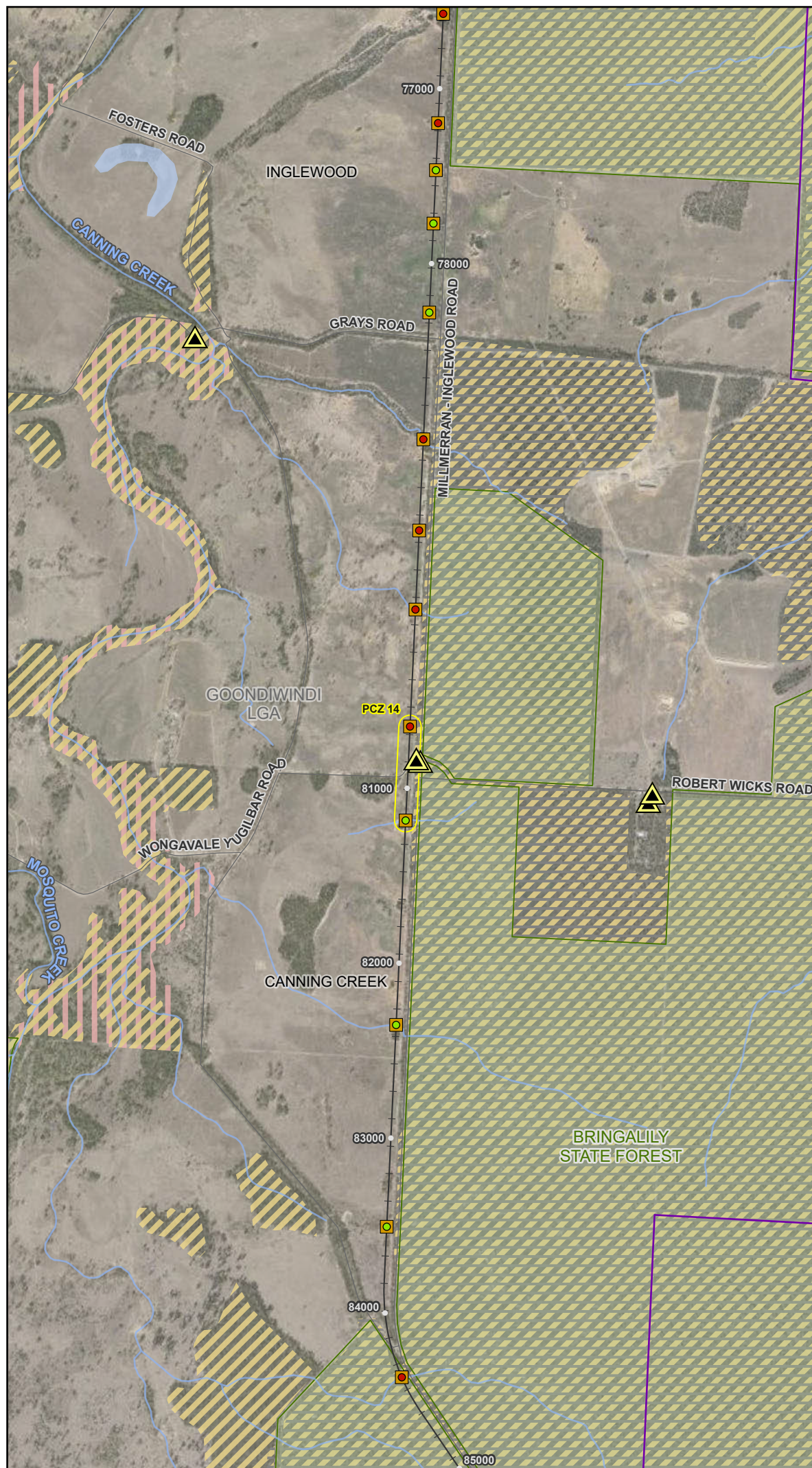
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

**Species records**

- ▲ Brigalow woodland snail record
- ▲ Death adder record
- ▲ Dunmall's snake record

**Species habitat**

- Brigalow woodland snail potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



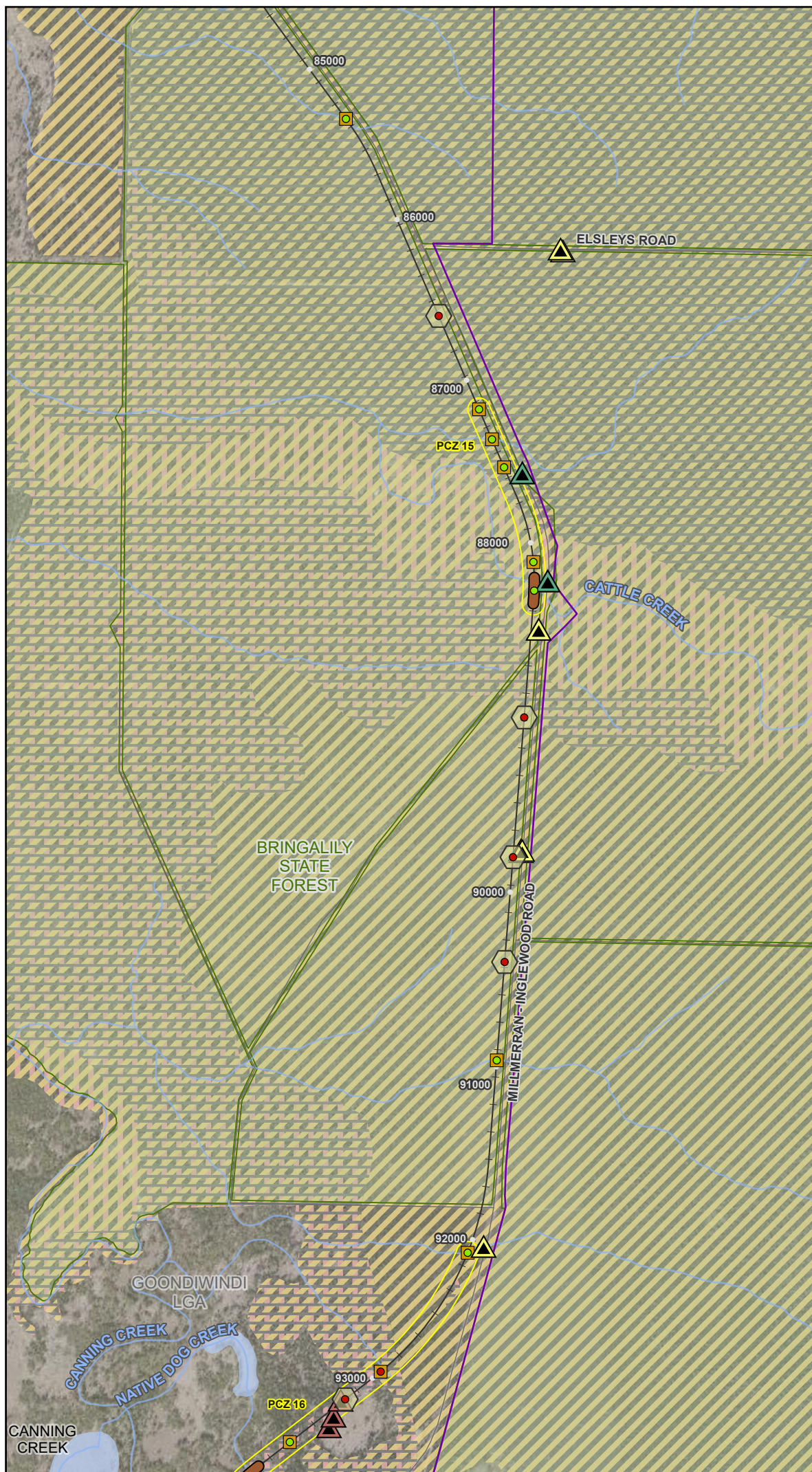
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Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- ⬡ Proposed new structure location

**Species records**

- ▲ Brigalow woodland snail record
- ▲ Death adder record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



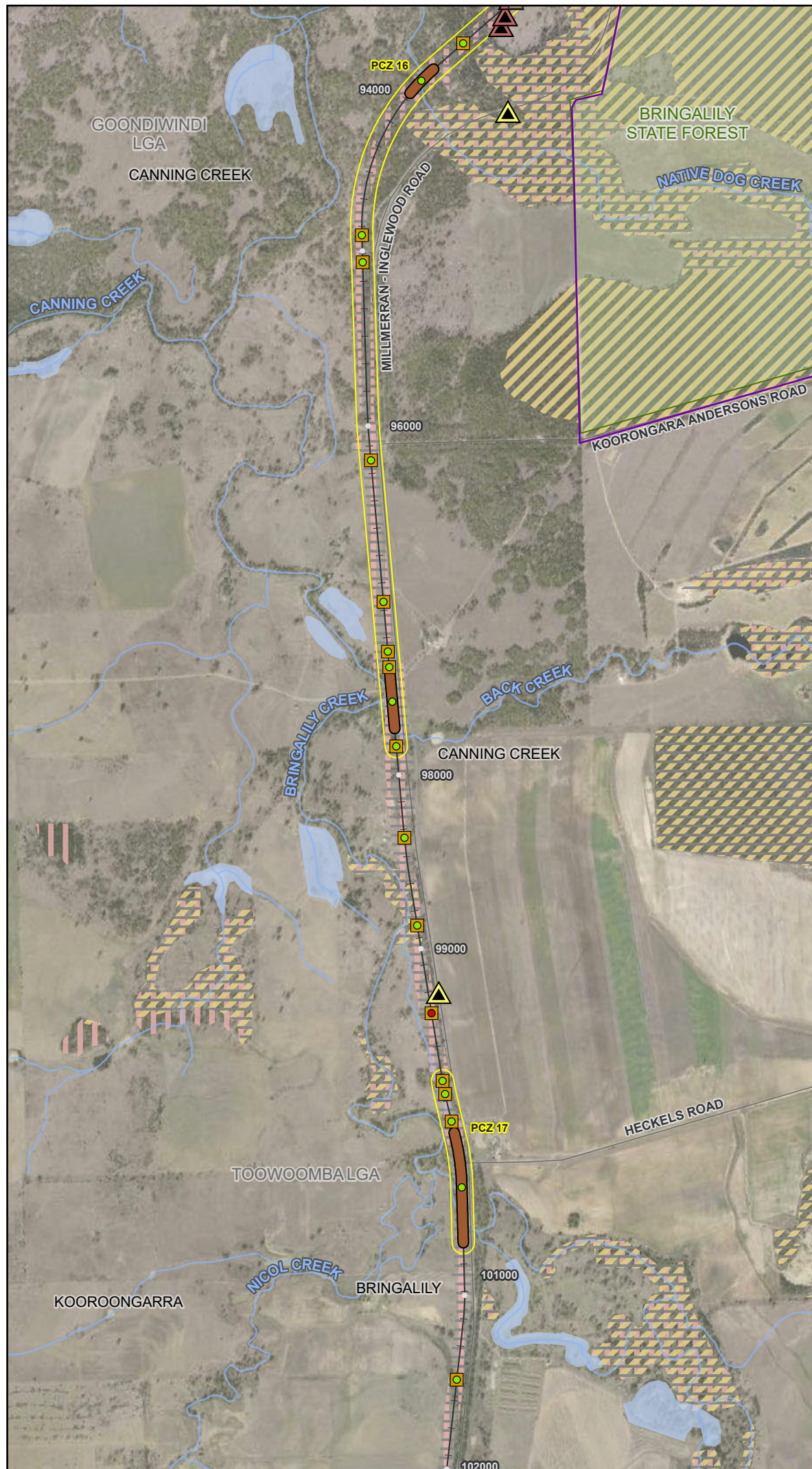
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory

**Species records**

- ▲ Brigalow woodland snail record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



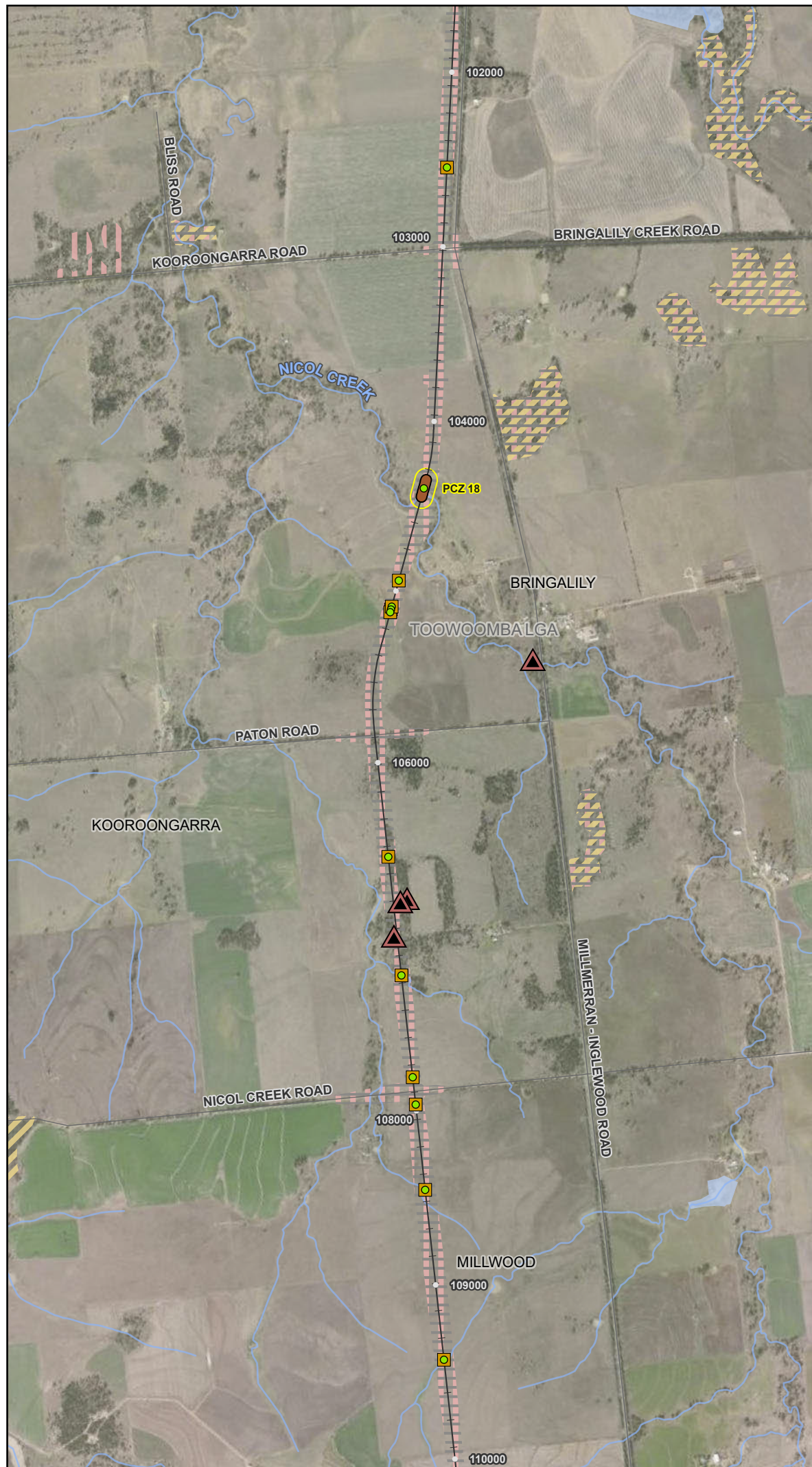
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

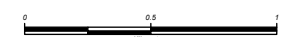
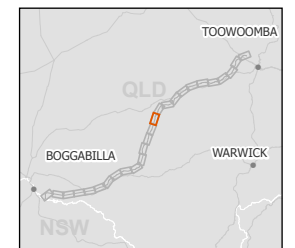
- Brigalow woodland snail record

### Species habitat

- Brigalow woodland snail potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

### Topographic

- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

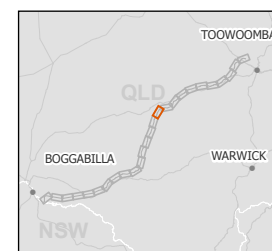
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- ⬡ Proposed new structure location

**Species records**

- ▲ Brigalow woodland snail record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- ⬡ Proposed new structure location

**Species records**

- ⚠ Brigalow woodland snail record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory

**Species records**

- ▲ Brigalow woodland snail record
- ▲ Condamine earless dragon record

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

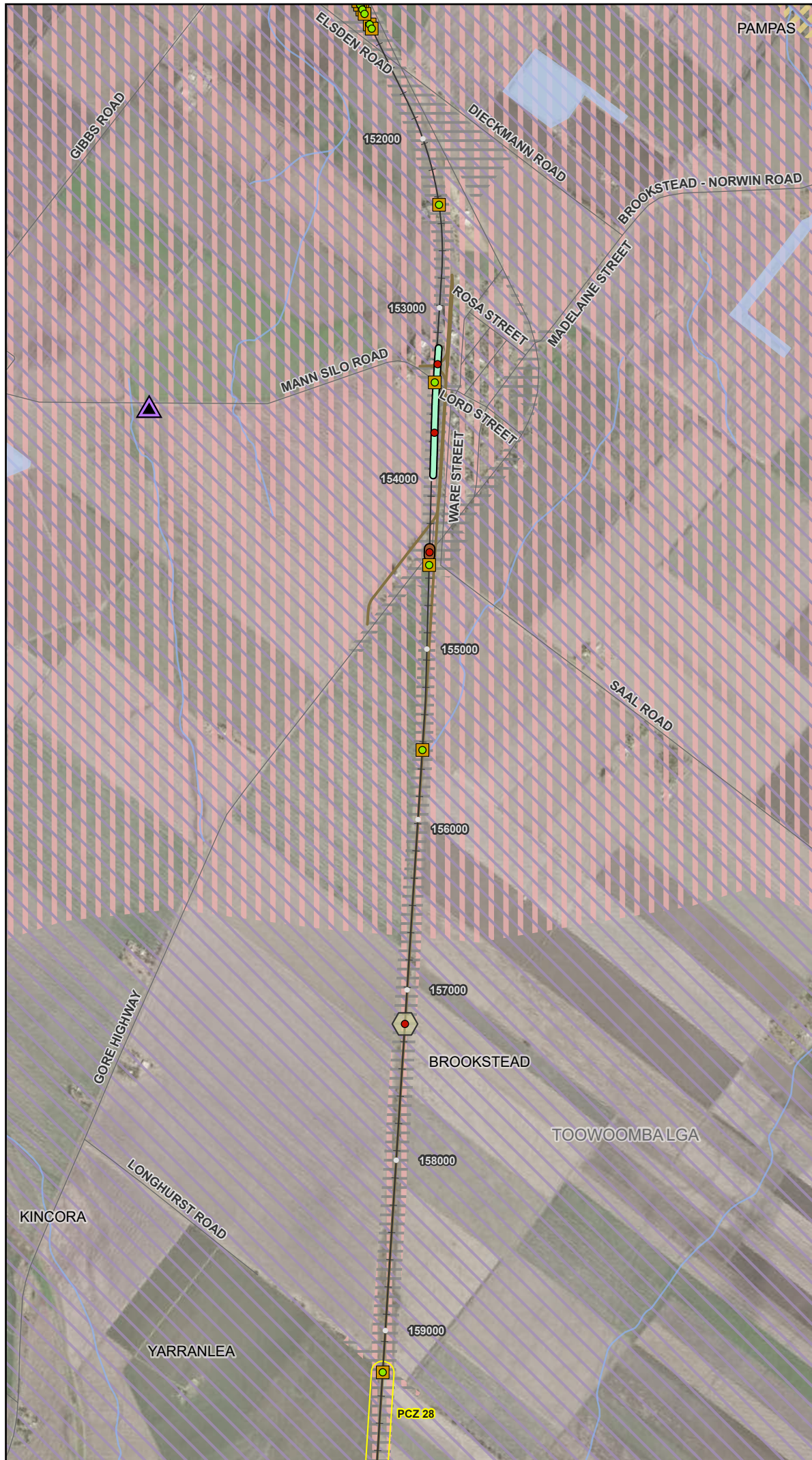
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

### Priority Connectivity Zones (PCZs)

- 

### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

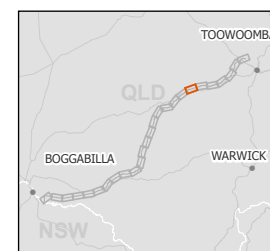
- Condamine earless dragon record

### Species habitat

- Brigalow woodland snail potential habitat
- Condamine earless dragon potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 5 10  
Kilometers

Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4  
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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

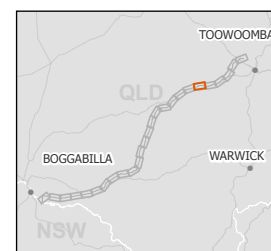
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat
- ▨ Woodland reptile potential habitat

**Topographic**

- ▬ Existing operational railway
- ▬ Road
- ▬ Watercourse
- ▬ Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

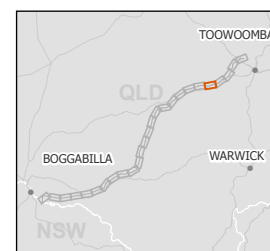
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Cracking clay reptiles potential habitat

**Topographic**

- Existing operational railway
- Road
- Watercourse
- Waterbody
- ▨ Protected areas



0 0.5 1  
Kilometers

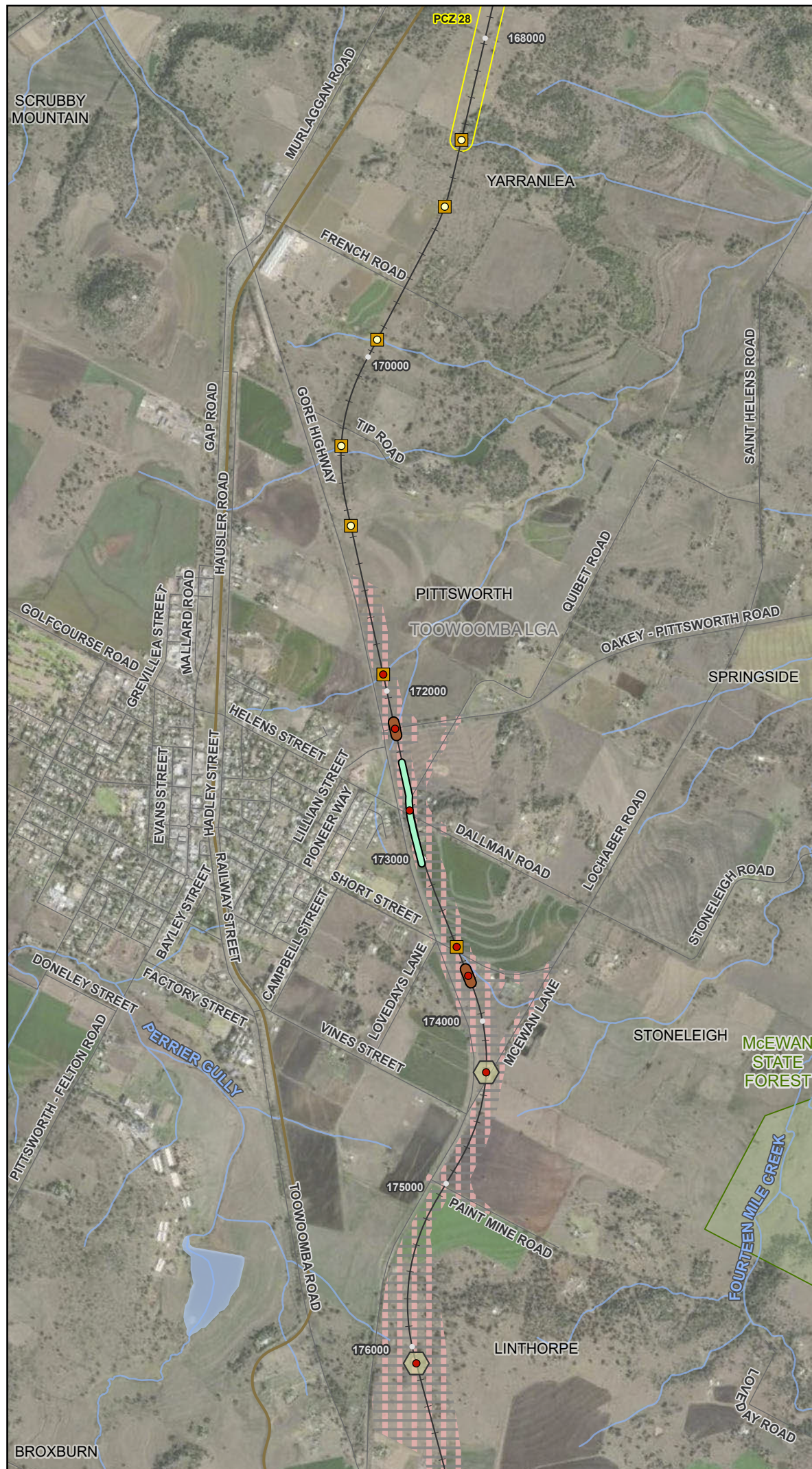
Coordinate system: GDA 1984 Australia Albers

Scale ratio correct when printed at A4

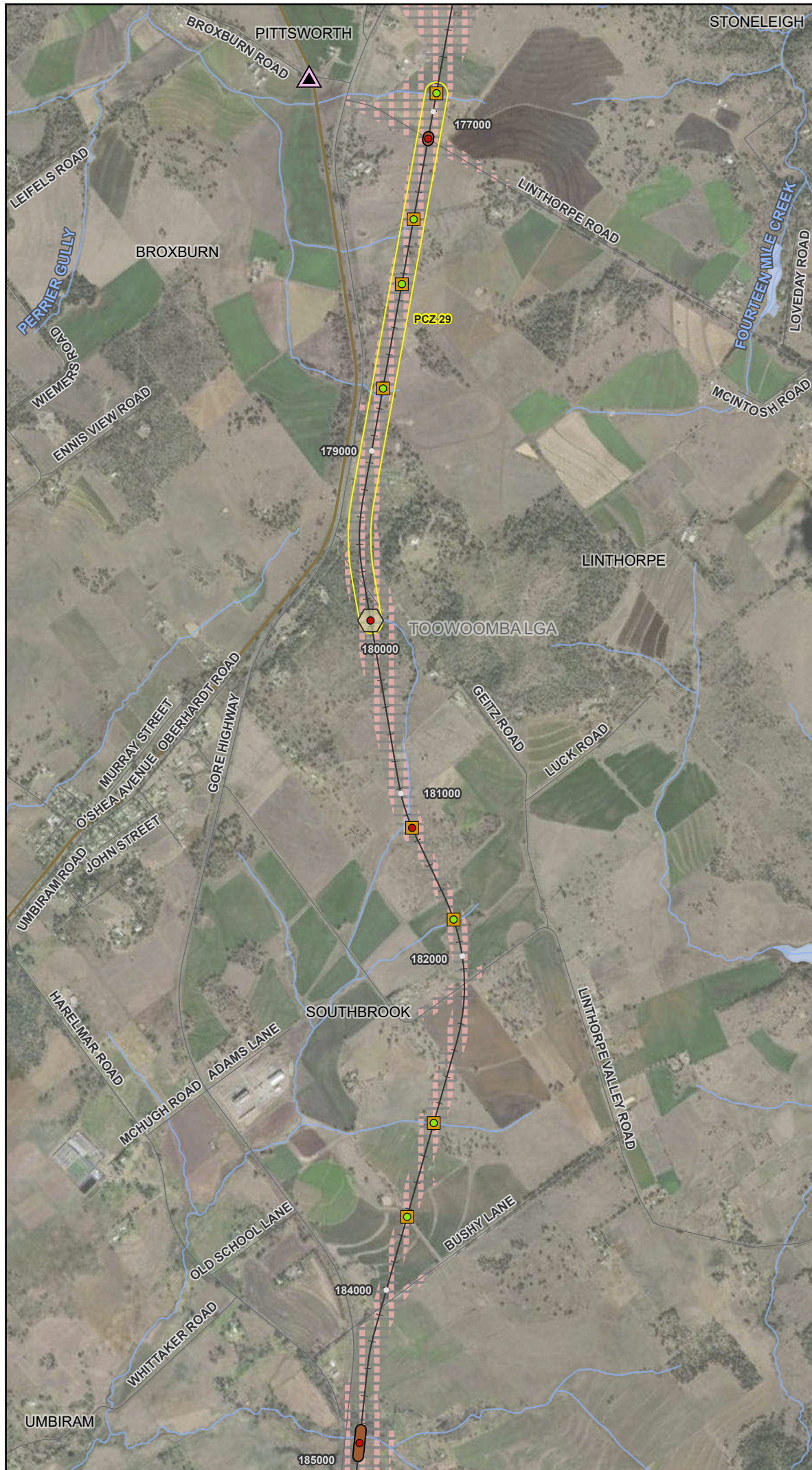
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

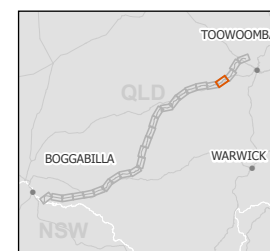
- Five-clawed worm-skink record

### Species habitat

- Brigalow woodland snail potential habitat
- Cracking clay reptiles potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

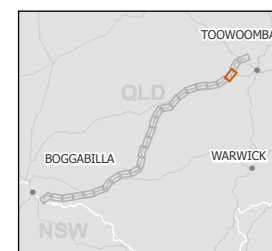
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

**Species habitat**

- ▬▬▬ Brigalow woodland snail potential habitat
- ▬▬▬ Cracking clay reptiles potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



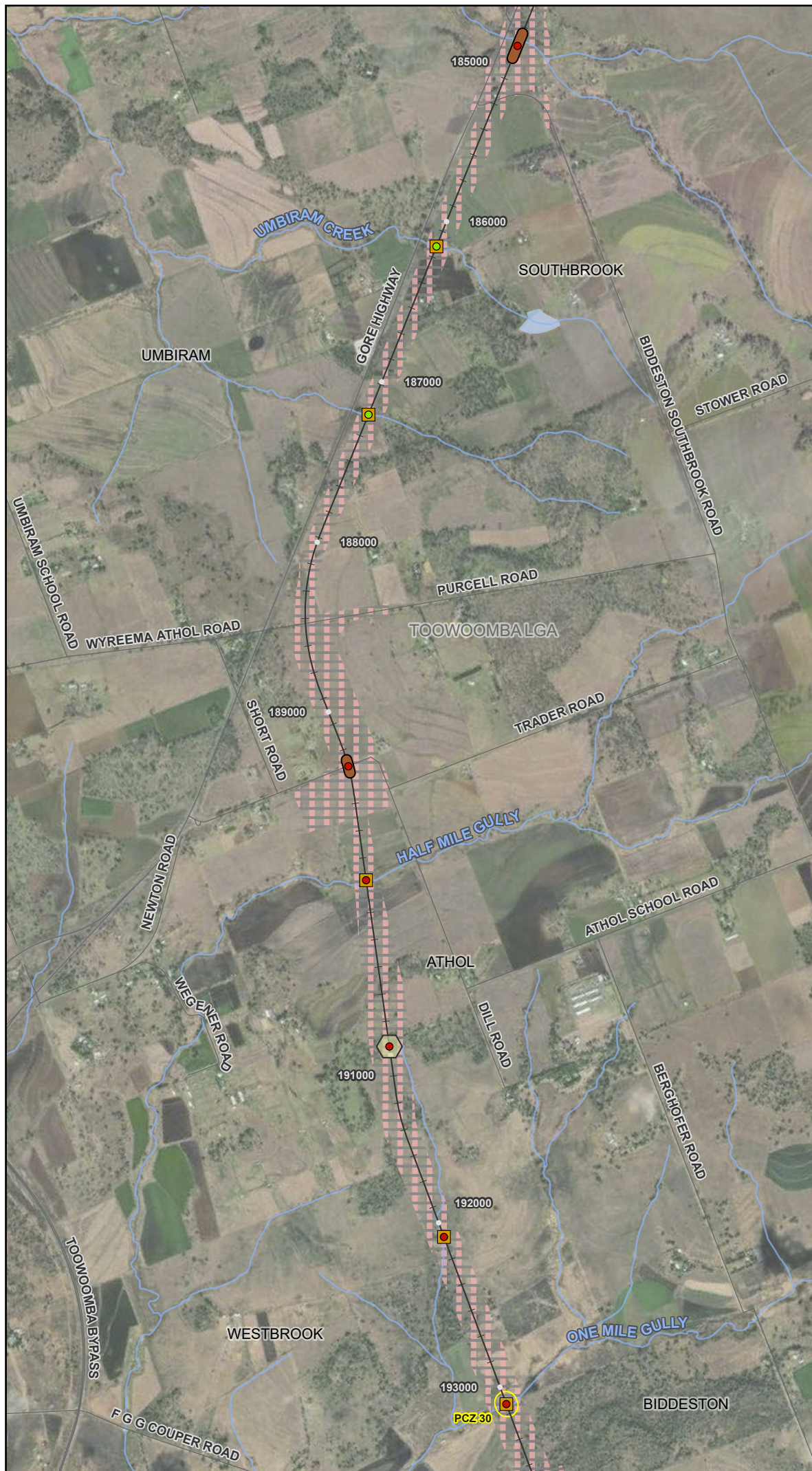
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

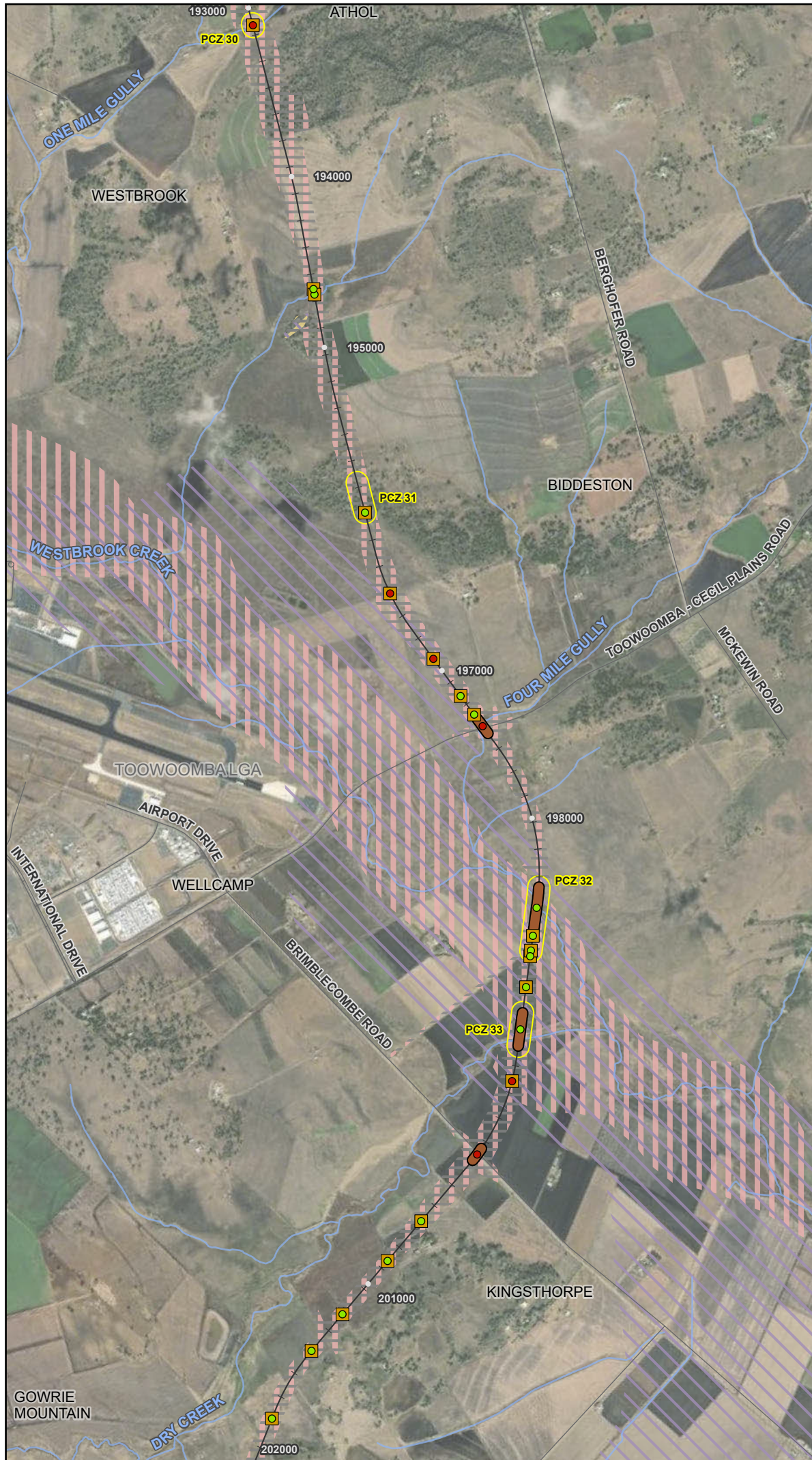
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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Legend

Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

Priority Connectivity Zones (PCZs)



Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

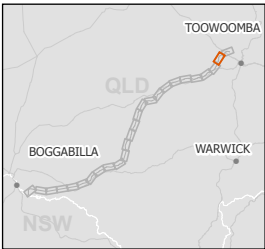
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

Species habitat

- Brigalow woodland snail potential habitat
- Condamine earless dragon potential habitat
- Cracking clay reptiles potential habitat
- Woodland reptile potential habitat

Topographic

- Road
- Watercourse



Coordinate system: GDA 1994 Australia Albers  
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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Suitability of revised reference design to mitigate impacts to connectivity for woodland reptiles, cracking clay reptiles, Condamine earless dragon or Brigalow woodland snail at this location:

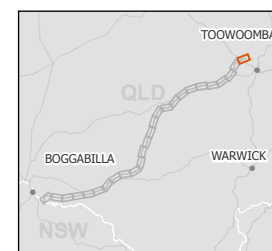
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

**Species habitat**

- ▨ Brigalow woodland snail potential habitat
- ▨ Condamine earless dragon potential habitat
- ▨ Cracking clay reptiles potential habitat

**Topographic**

- ▬ Existing operational railway
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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# APPENDIX P

Fauna Connectivity Strategy

## Appendix E2 Murray Cod

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



Legend

Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge (NS2B)

Priority Connectivity Zones (PCZs)



Assessment

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

- Existing design structure is satisfactory
- Location is not relevant for this species

Species habitat

- Murray cod potential habitat

Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

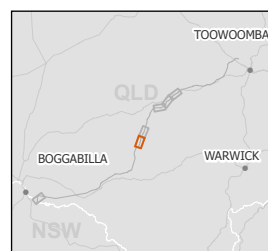
- Existing design structure is satisfactory
- Location is not relevant for this species

### Species habitat

- Murray cod potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment**

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

- Existing design structure is satisfactory
- Location is not relevant for this species

**Species habitat**

- ▬ Murray cod potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

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Data sources: DNRME, TMR, Translink, NSW DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment**

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

- Existing design structure is satisfactory
- Location is not relevant for this species

**Species habitat**

- ▬ Murray cod potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment**

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

- Existing design structure is satisfactory
- Location is not relevant for this species

**Species habitat**

- ▬ Murray cod potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRM, TMR, Translink, NSW DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

**Priority Connectivity Zones (PCZs)****Assessment**

Suitability of revised reference design to mitigate impacts to connectivity for Murray cod at this location:

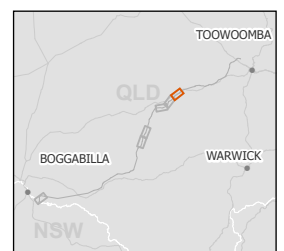
- Existing design structure is satisfactory
- Location is not relevant for this species

**Species habitat**

- Murray cod potential habitat

**Topographic**

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

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Data sources: DNRME, TMR, Translink, NSW DCS,  
Geoscience Australia, Esri

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# P

Fauna Connectivity Strategy

## Appendix E3 Spotted-Tailed Quoll and Koala

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT





Legend

Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

Priority Connectivity Zones (PCZs)



Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

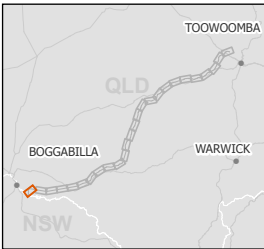
- Proposed new structure location

Species habitat

- Koala and spotted-tailed quoll potential habitat

Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers  
Scale ratio correct when printed at A4  
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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

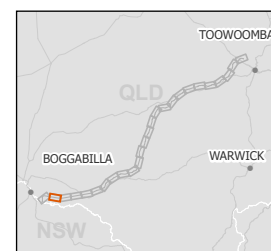
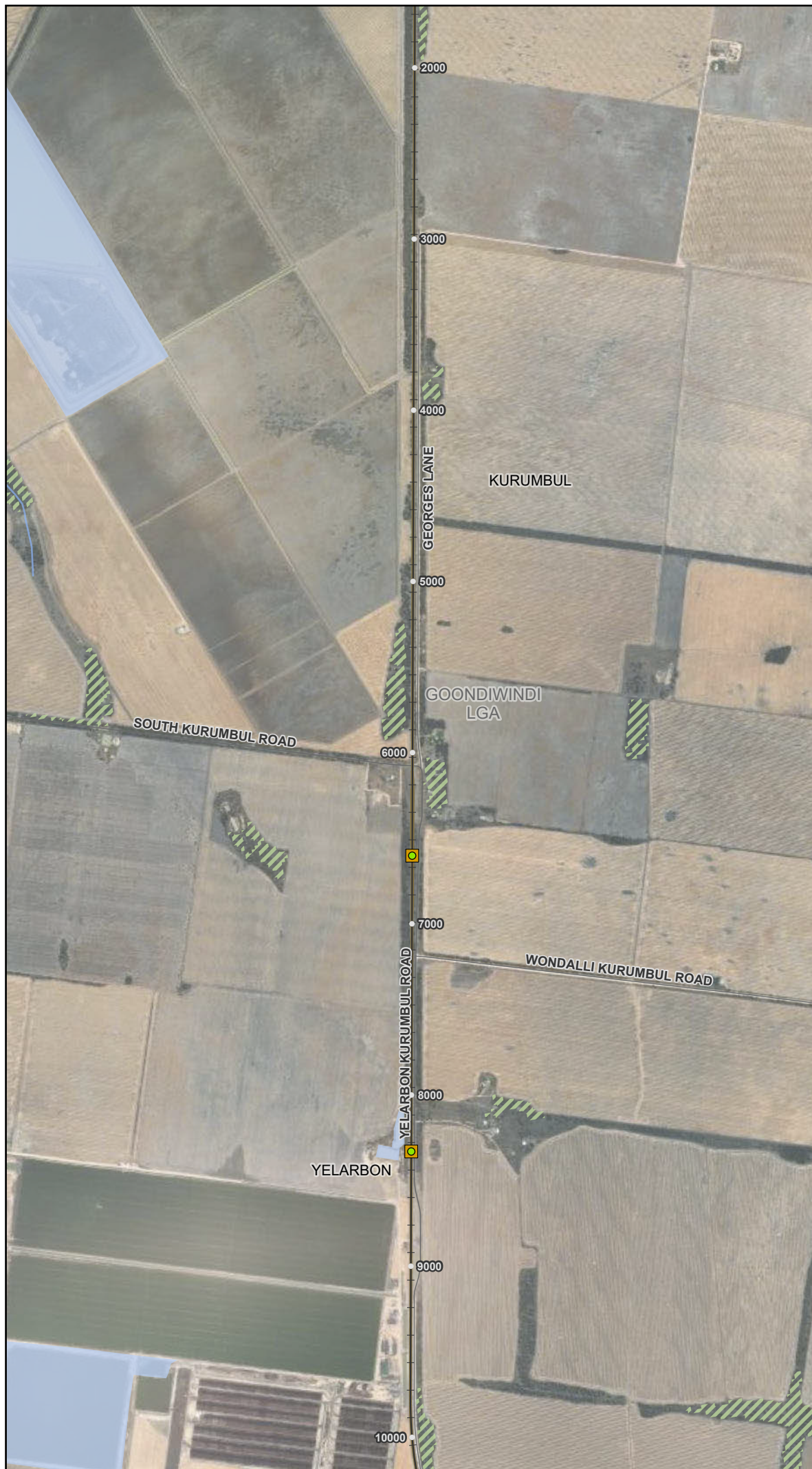
- Existing design structure is satisfactory

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers  
Scale ratio correct when printed at A4  
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

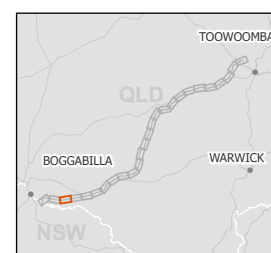
- Existing design structure is unsatisfactory, or required structure is absent

### Species habitat

- Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

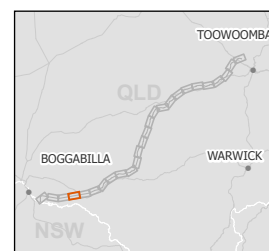
- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

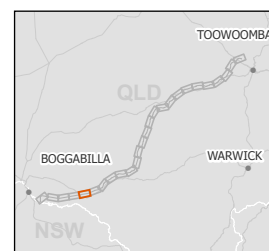
- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody

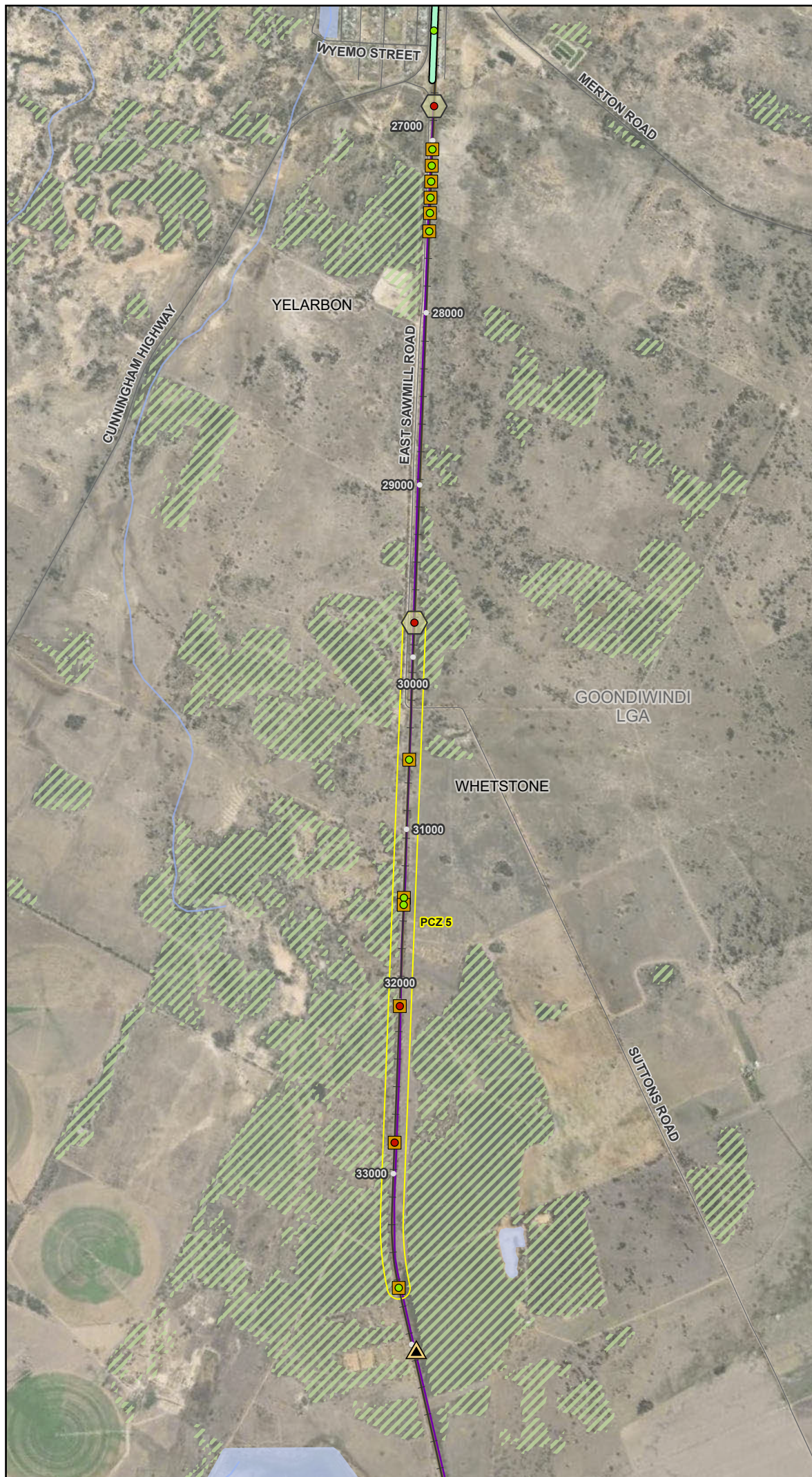


Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

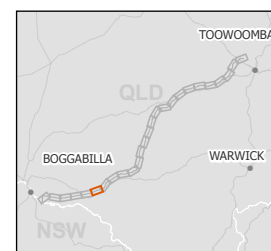
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4  
1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

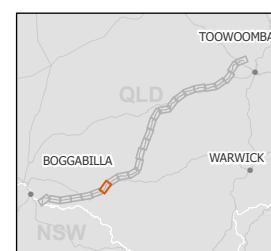
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

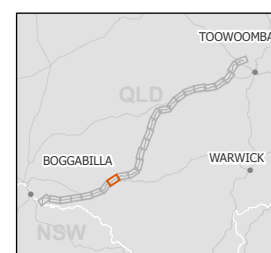
- Existing design structure is unsatisfactory, or required structure is absent
- ⬡ Proposed new structure location

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody

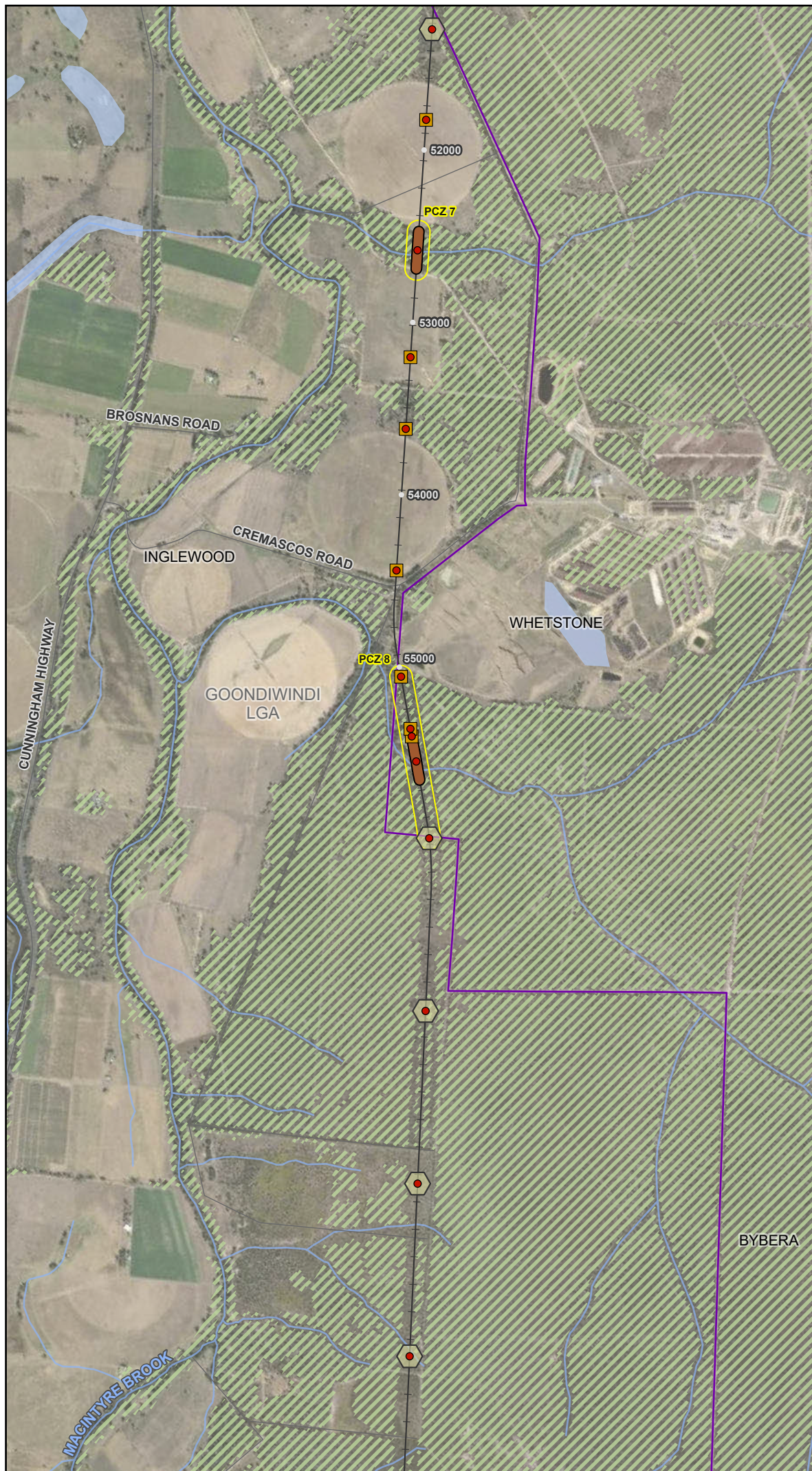


Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4  
1:30,000 Date: 12/11/2024

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

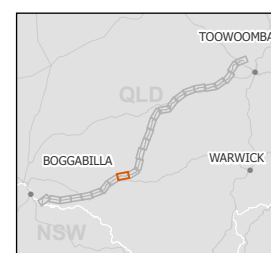
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- ▨ Protected areas



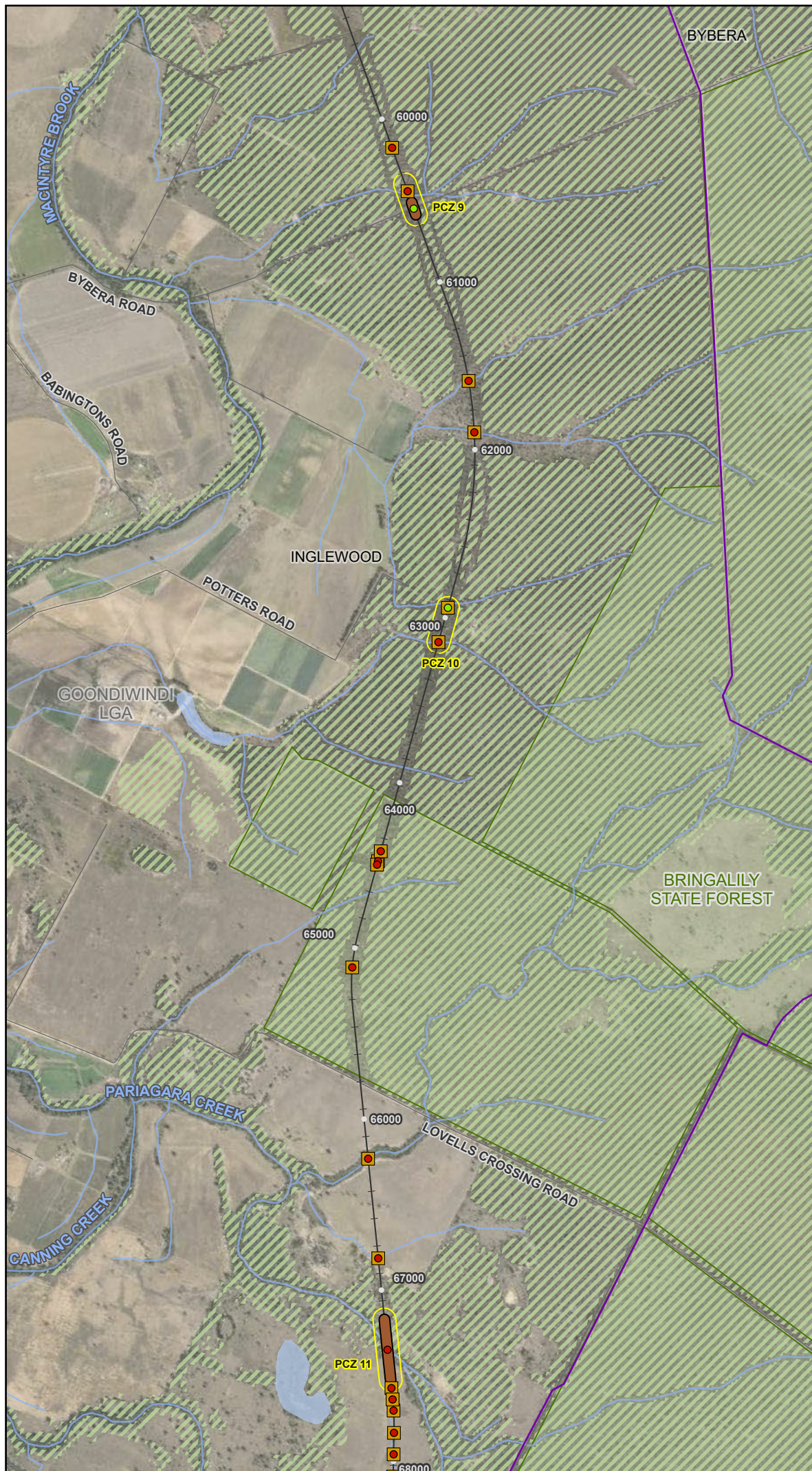
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

### Species records

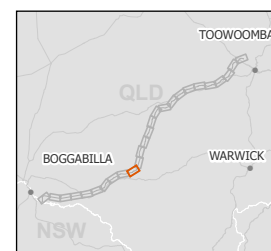
- ⚠ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



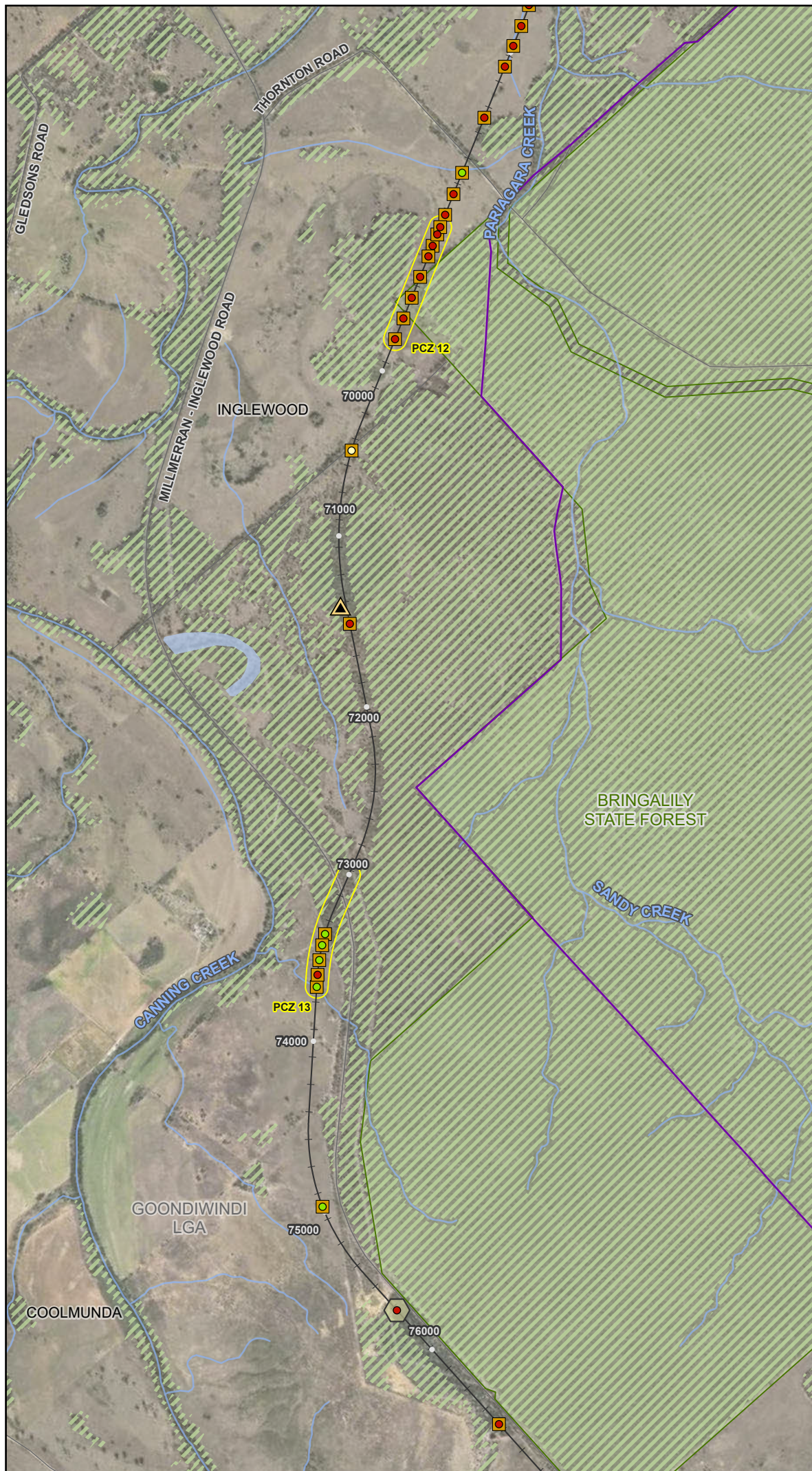
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Scale ratio correct when printed at A4

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Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

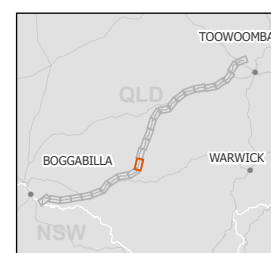
- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas

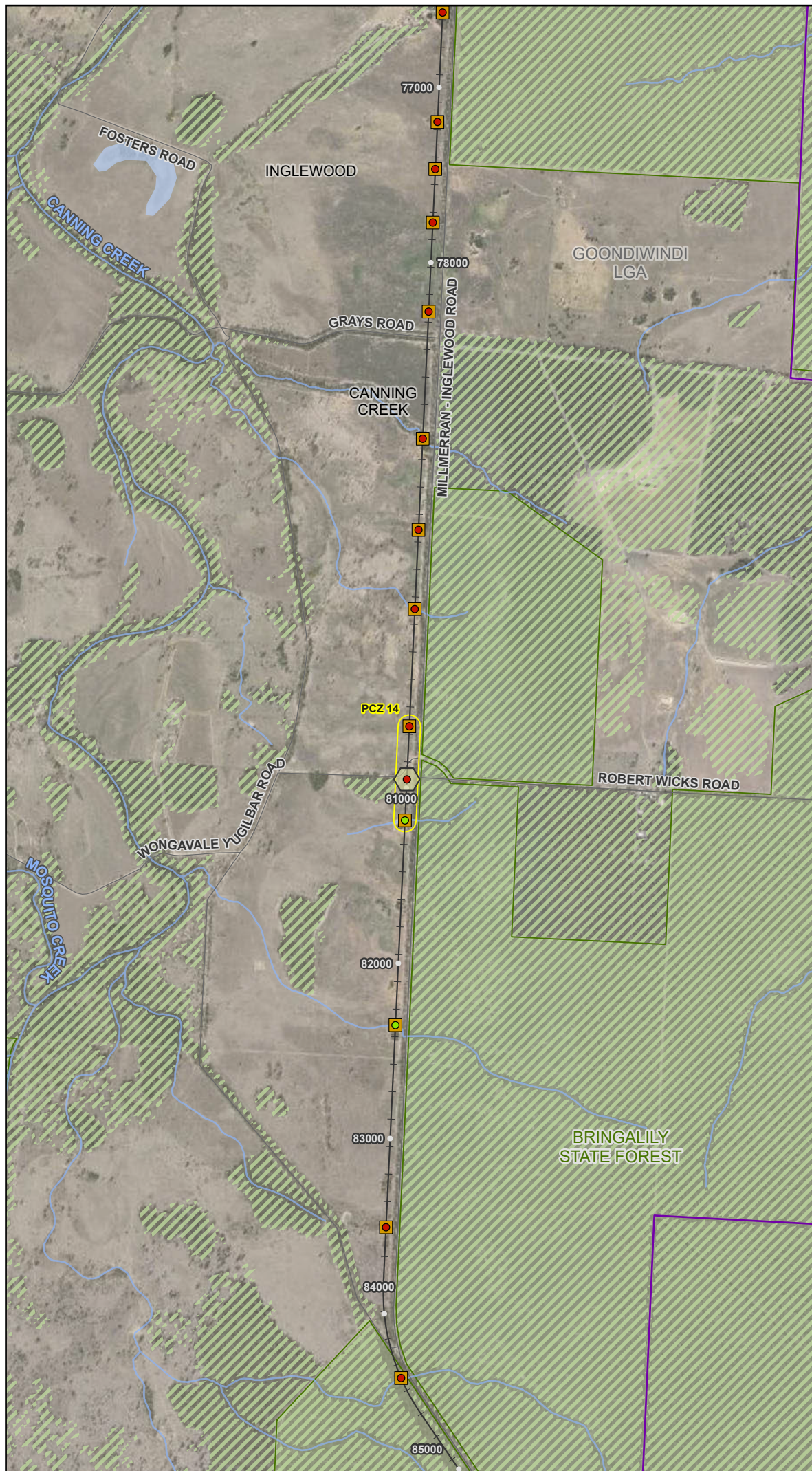


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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

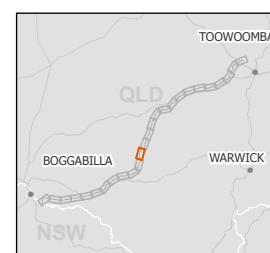
- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



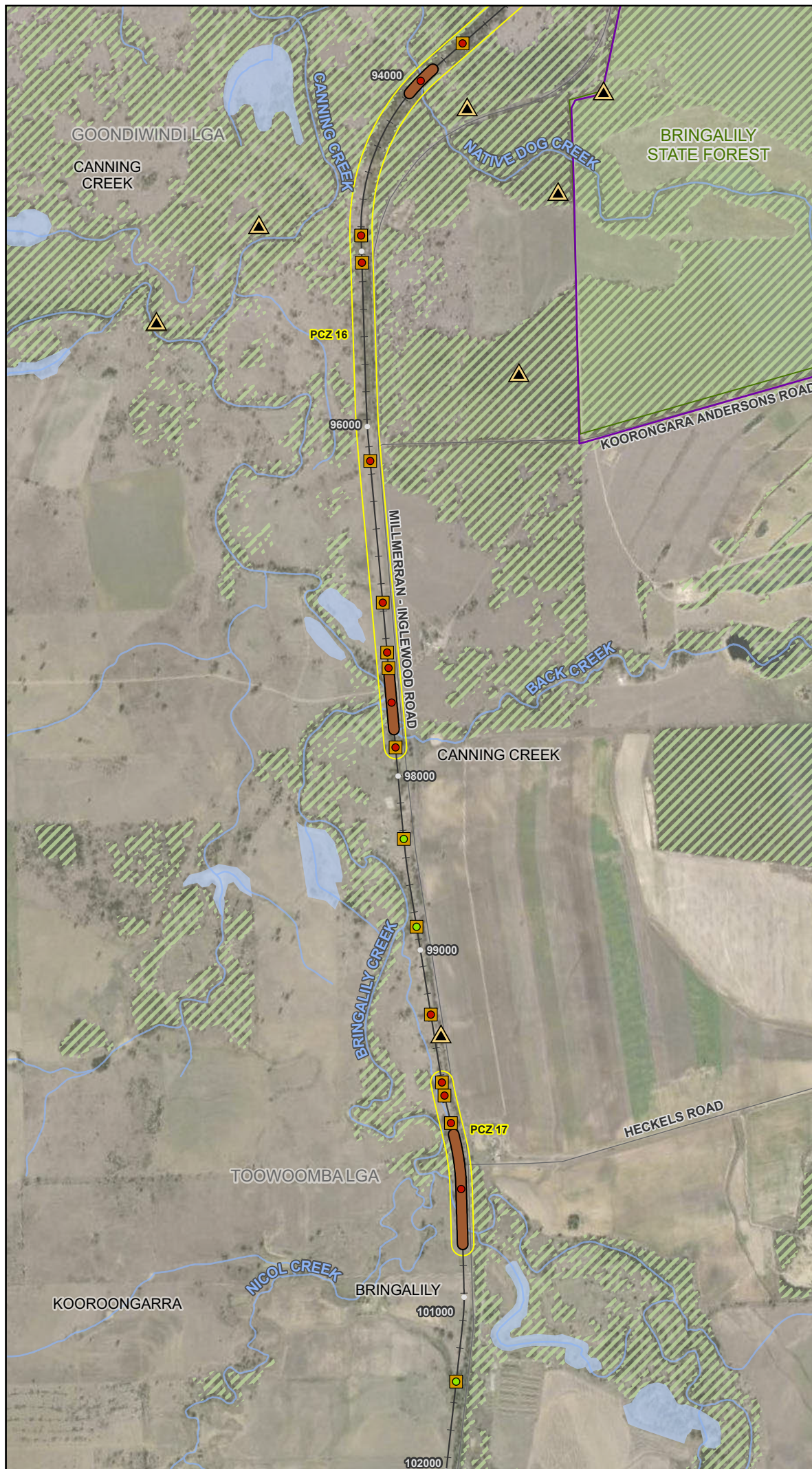
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



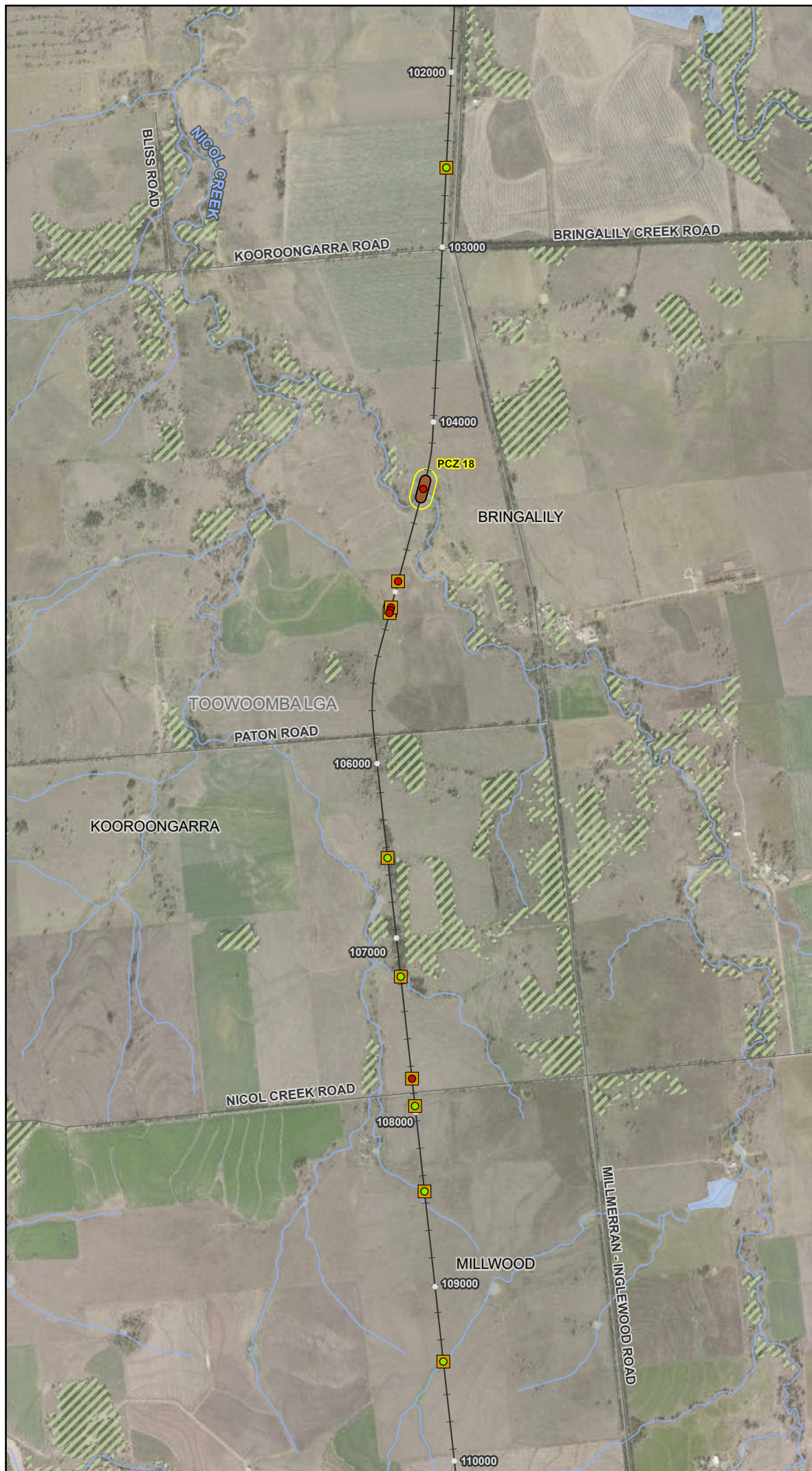
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



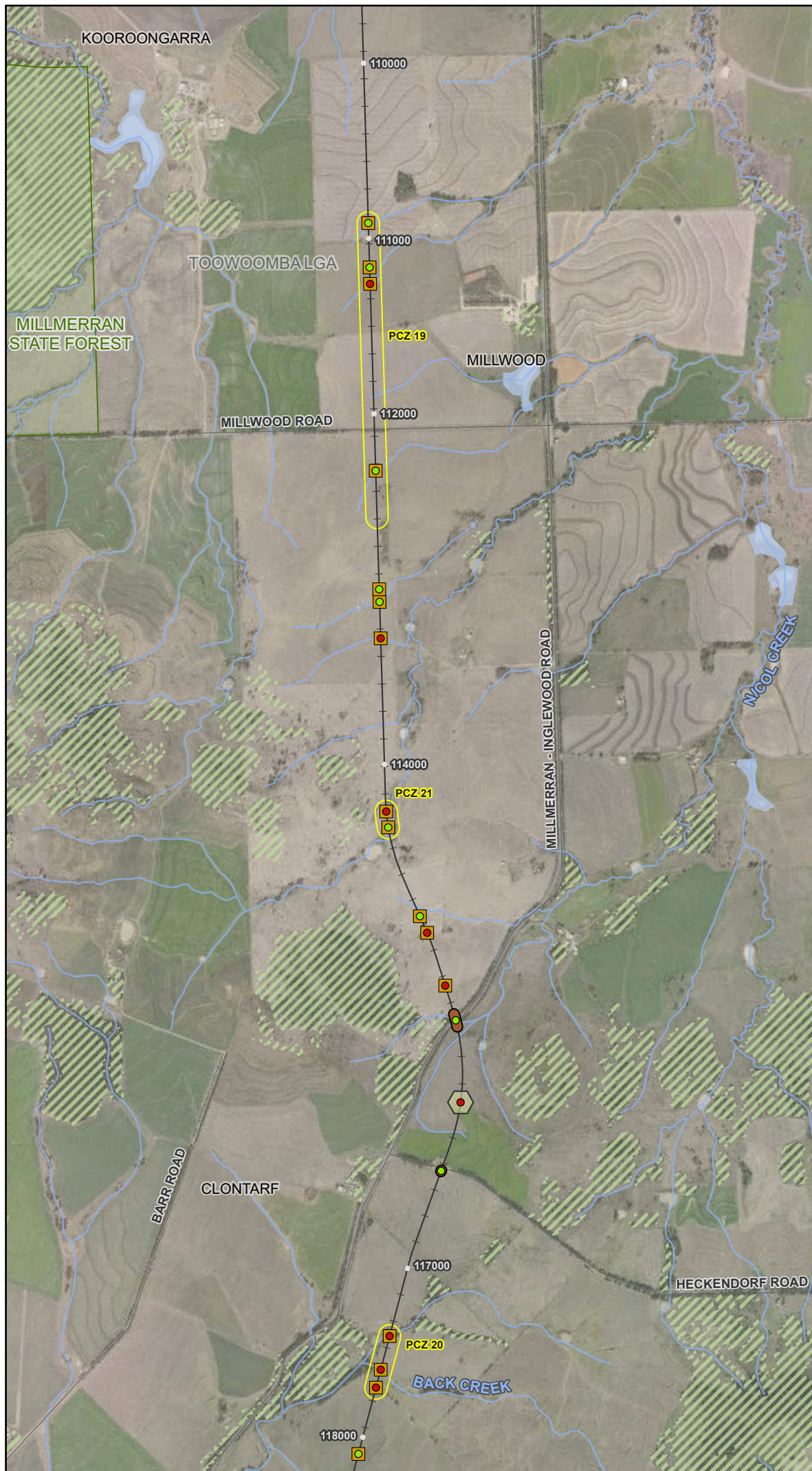
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody
- ▨ Protected areas



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

### Species records

- ⚠ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge
- ▬ Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

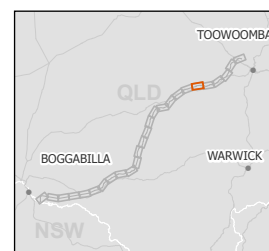
- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

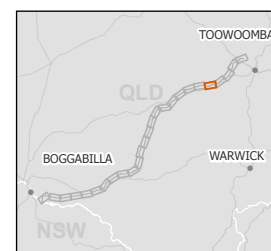
- ▲ Koala record

### Species habitat

- Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



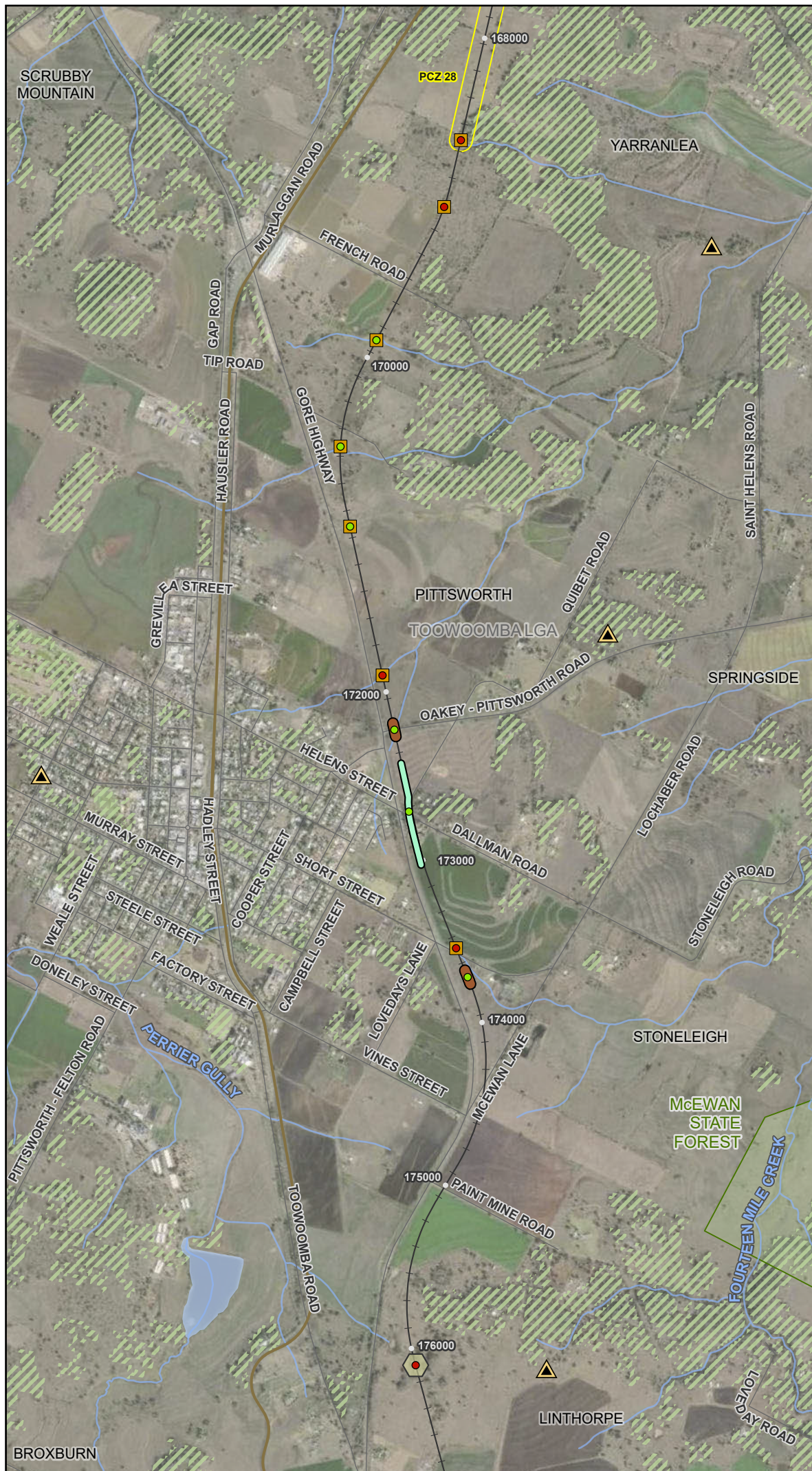
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

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- Existing design structure is unsatisfactory, or required structure is absent
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### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody
- ▨ Protected areas



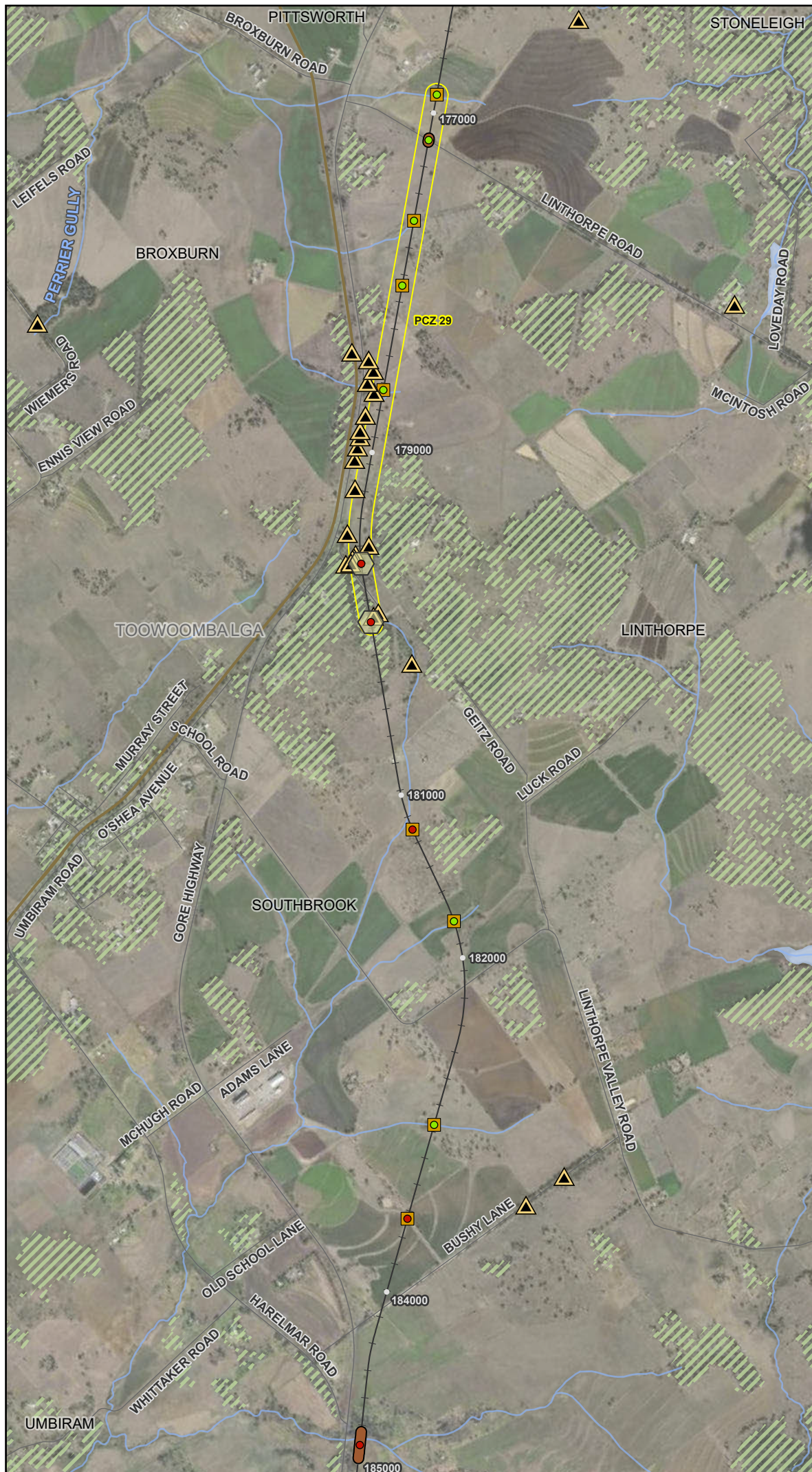
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1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Proposed new structure location

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



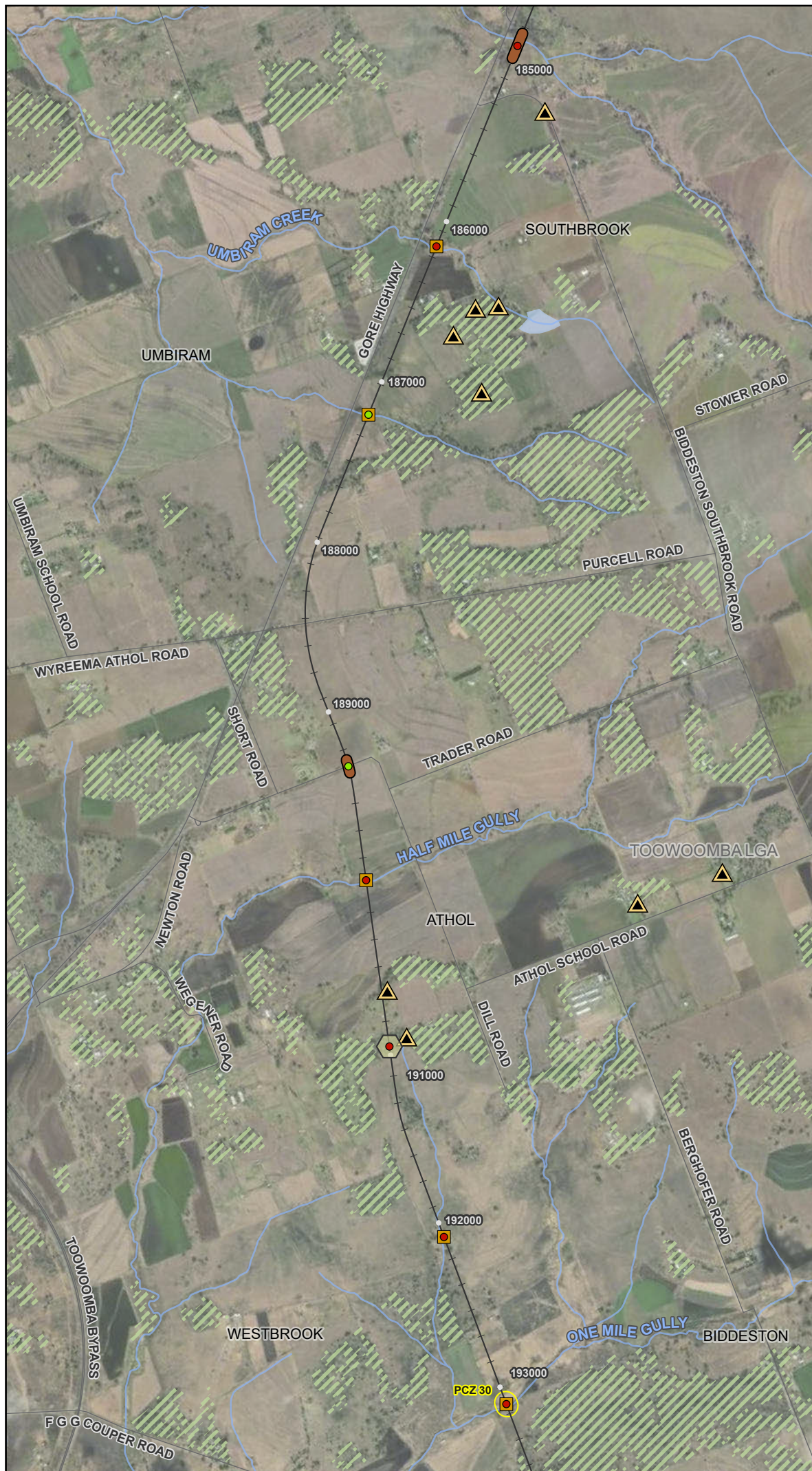
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Road
- Watercourse



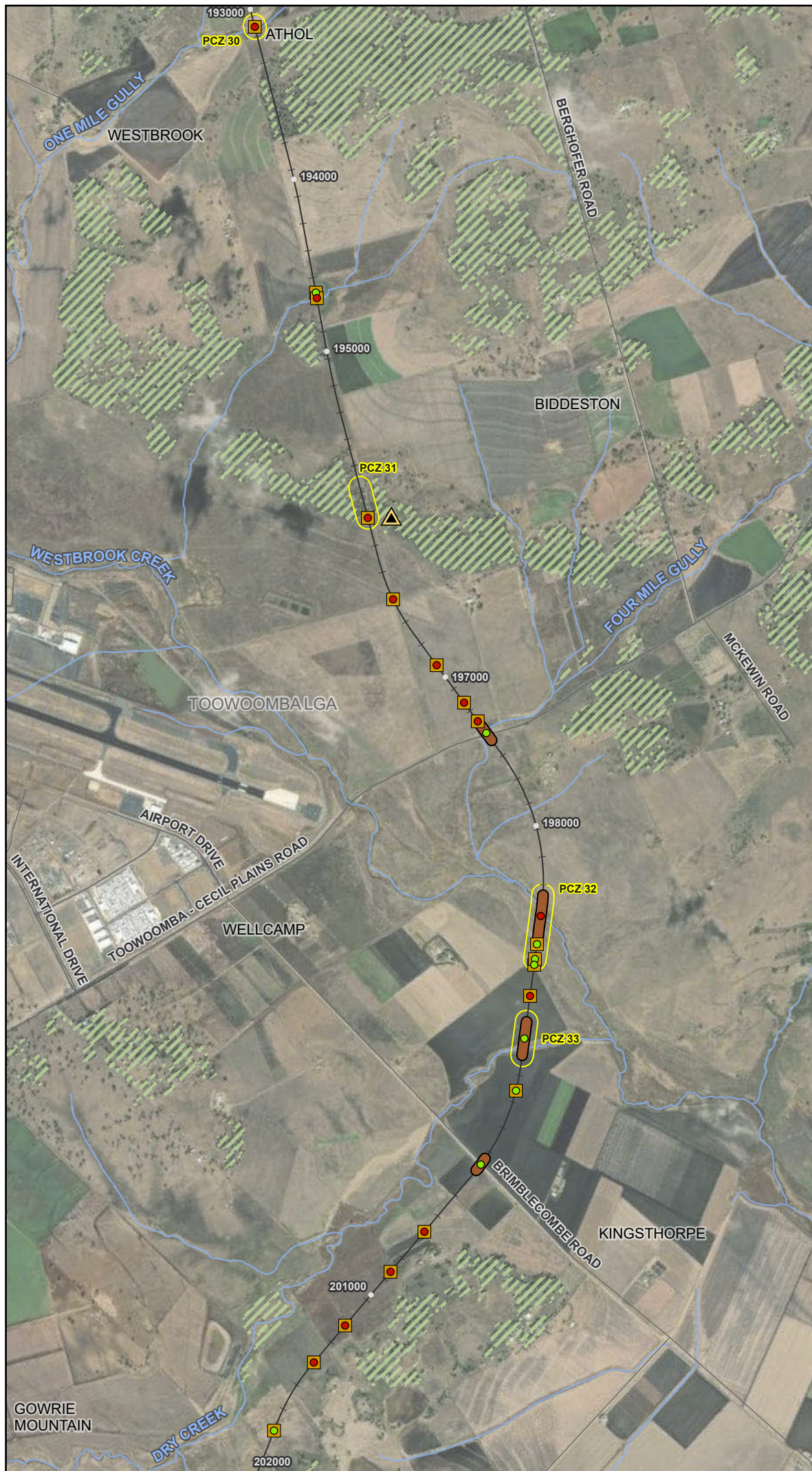
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Suitability of revised reference design to mitigate impacts to connectivity for koalas and spotted-tailed quolls at this location:

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent

### Species records

- ▲ Koala record

### Species habitat

- ▨ Koala and spotted-tailed quoll potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1984 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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Fauna Connectivity Strategy

## **Appendix E4** Gliding Mammals and Woodland Birds

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Assessment and recommendations

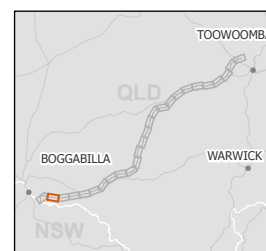
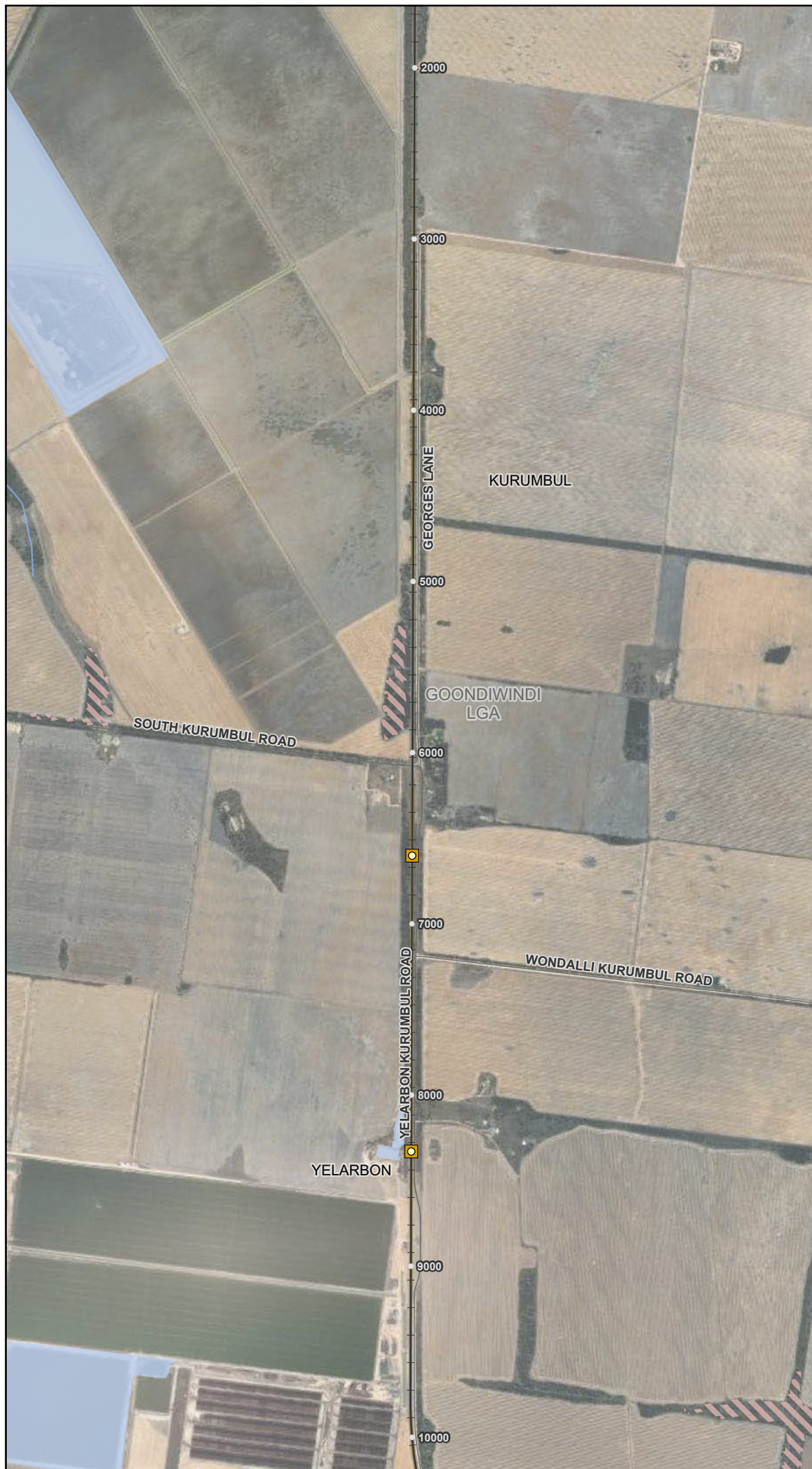
- Location is not relevant for these species

### Species habitat

- ▨ Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Location is not relevant for these species

### Species records

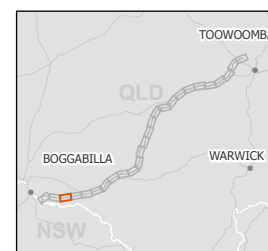
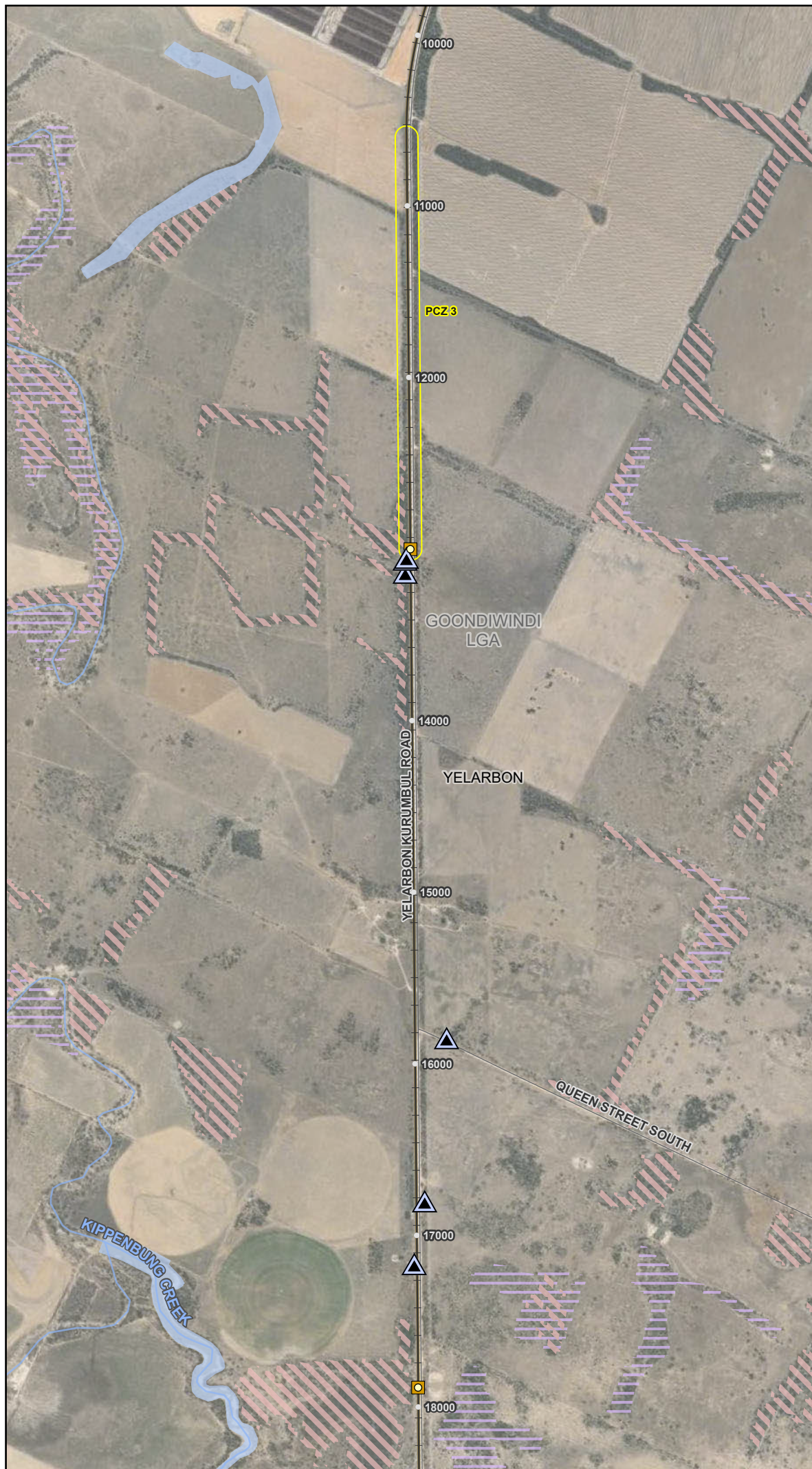
- ▲ Painted honeyeater record

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Location is not relevant for these species

### Species records

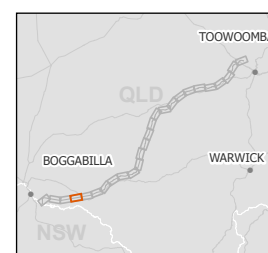
- ▲ Brown tree creeper record
- ▲ Southern whiteface record

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



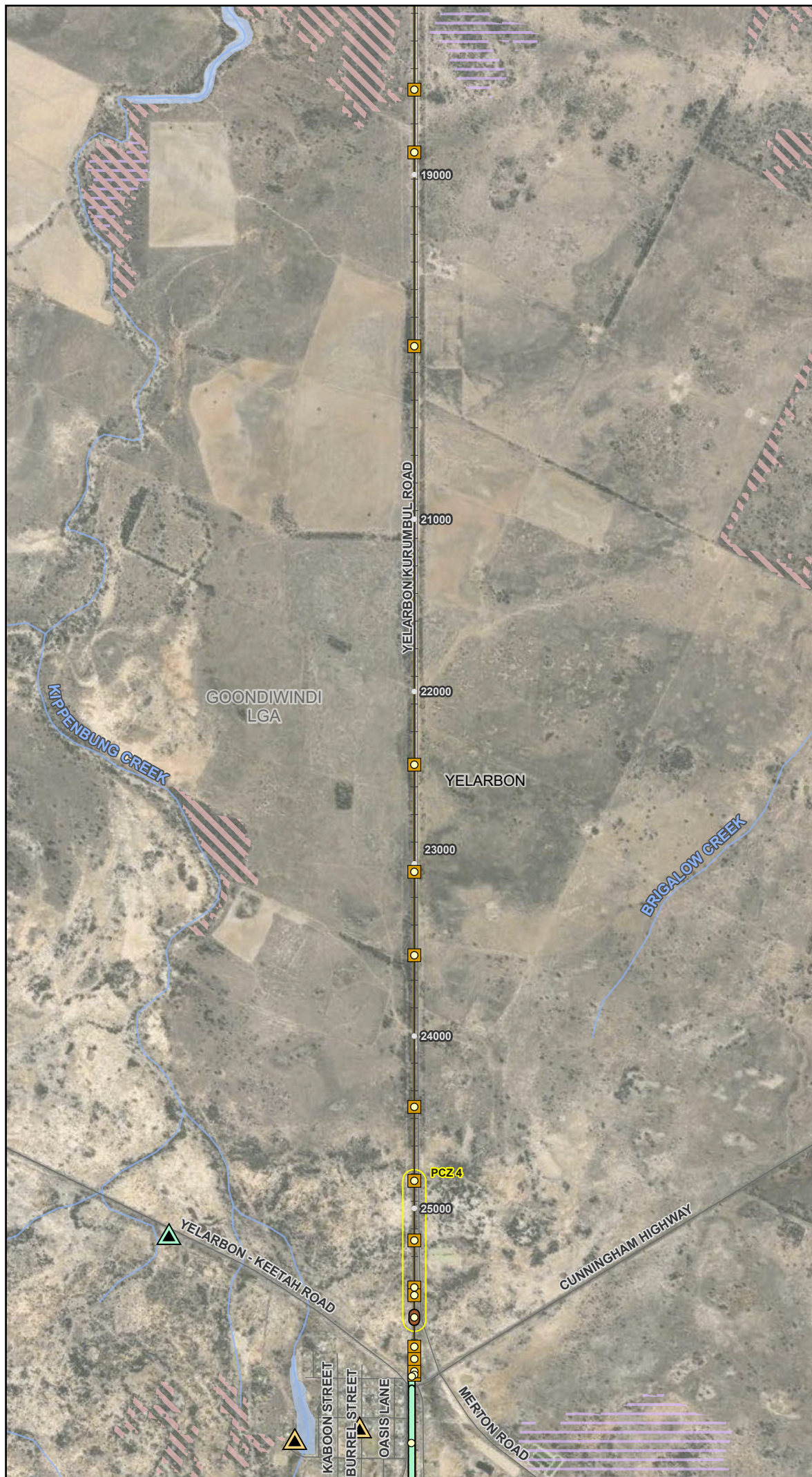
Coordinate system: GDA 1994 Australia Albers

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1:30,000 Date: 12/11/2024

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Concept noise wall location

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species records**

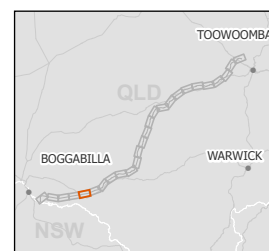
- ▲ Brown tree creeper record
- ▲ Painted honeyeater record
- ▲ Southern whiteface record

**Species habitat**

- Gliding mammals potential habitat
- Woodland birds potential habitat

**Topographic**

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers

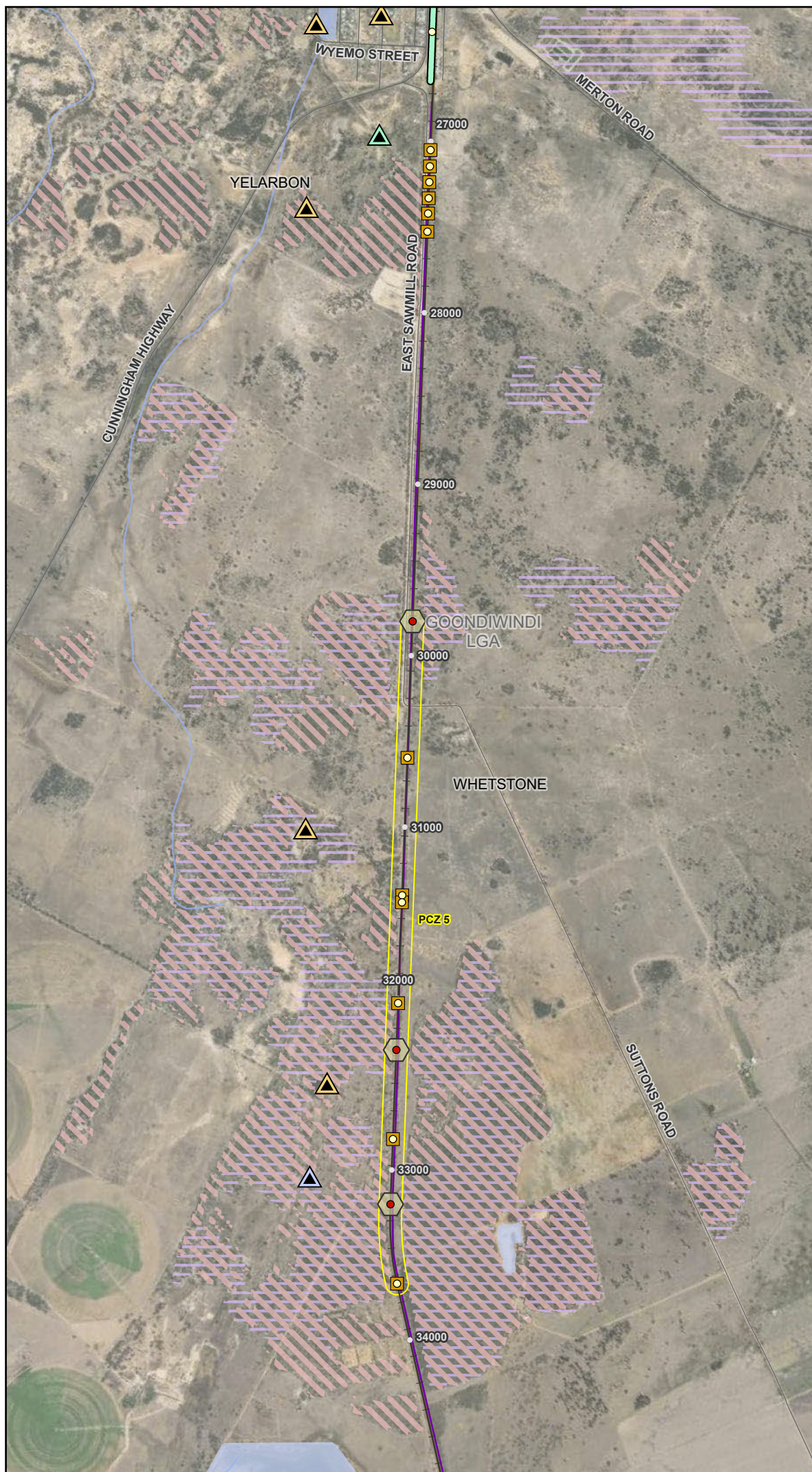
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Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species records**

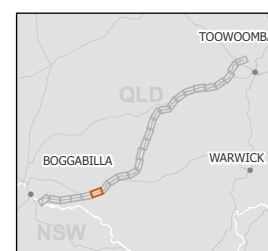
- ▲ Painted honeyeater record

**Species habitat**

- Gliding mammals potential habitat
- Woodland birds potential habitat

**Topographic**

- Wild Dog Check Fence
- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

● Chainage (1000m)

■ Culvert

— Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**● Existing design structure  
is unsatisfactory, or  
required structure is  
absent○ Location is not relevant  
for these species⬡ Proposed new structure  
location**Species records**▲ Brown tree creeper  
record▲ Painted honeyeater  
record**Species habitat**▨ Gliding mammals  
potential habitat▨ Woodland birds  
potential habitat**Topographic**

— Wild Dog Check Fence

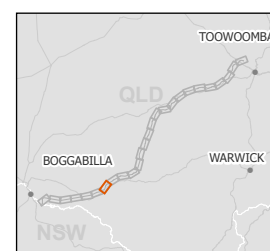
— Existing operational  
railway

— Road

— Watercourse

■ Waterbody

■ Protected areas

0 0.5 1  
Kilometers

Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS,  
Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

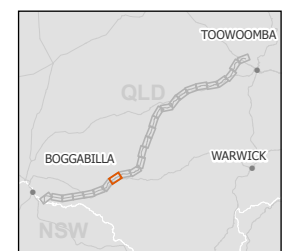
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species habitat**

- ▨ Gliding mammals potential habitat
- ▨ Woodland birds potential habitat

**Topographic**

- ▬ Wild Dog Check Fence
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

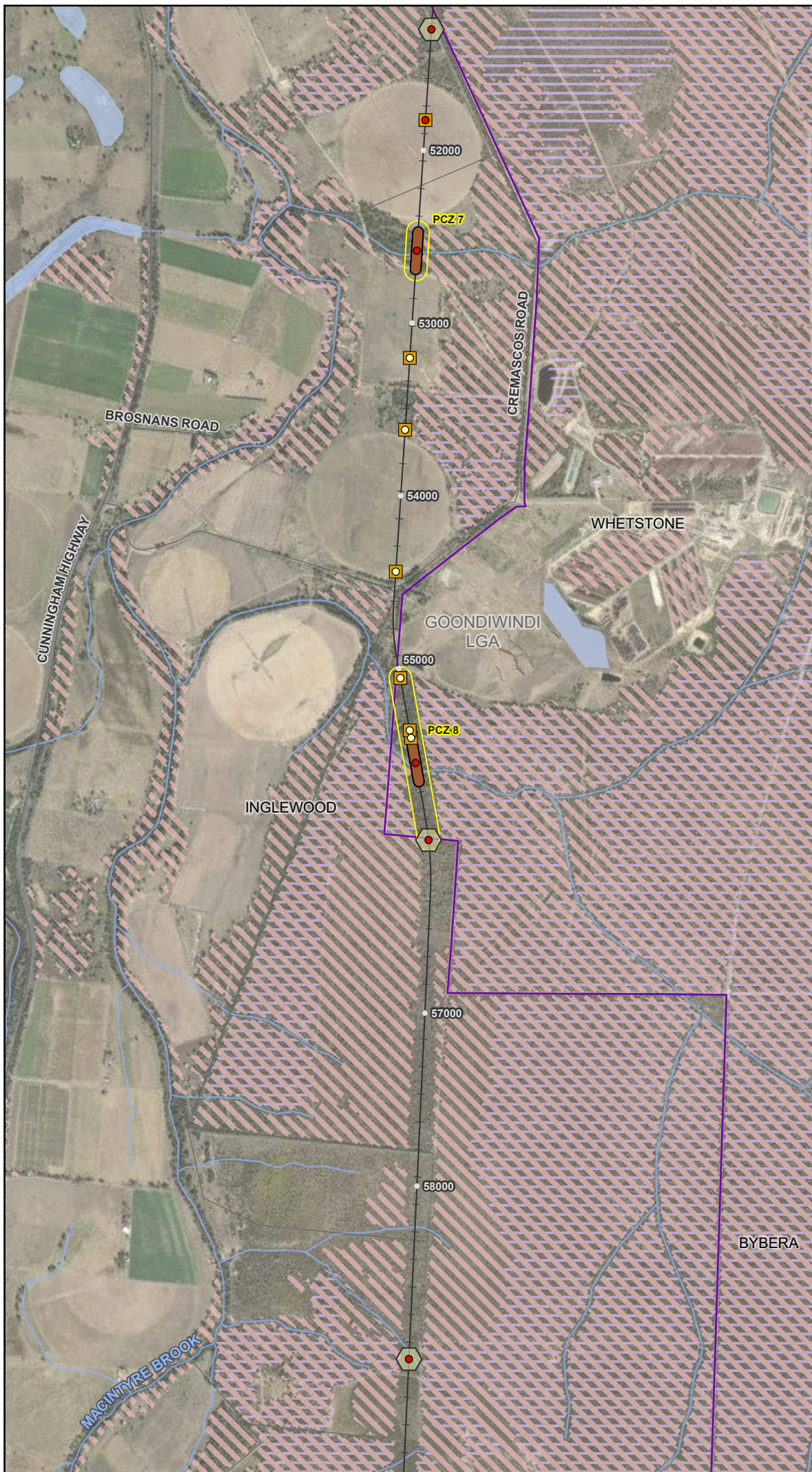
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Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

**Species records**

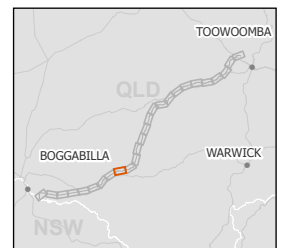
Painted honeyeater record

**Species habitat**

- ▬ Gliding mammals potential habitat
- ▬ Woodland birds potential habitat

**Topographic**

- ▬ Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas

0 0.5 1  
Kilometers

Coordinate system: GDA 1994 Australia Albers

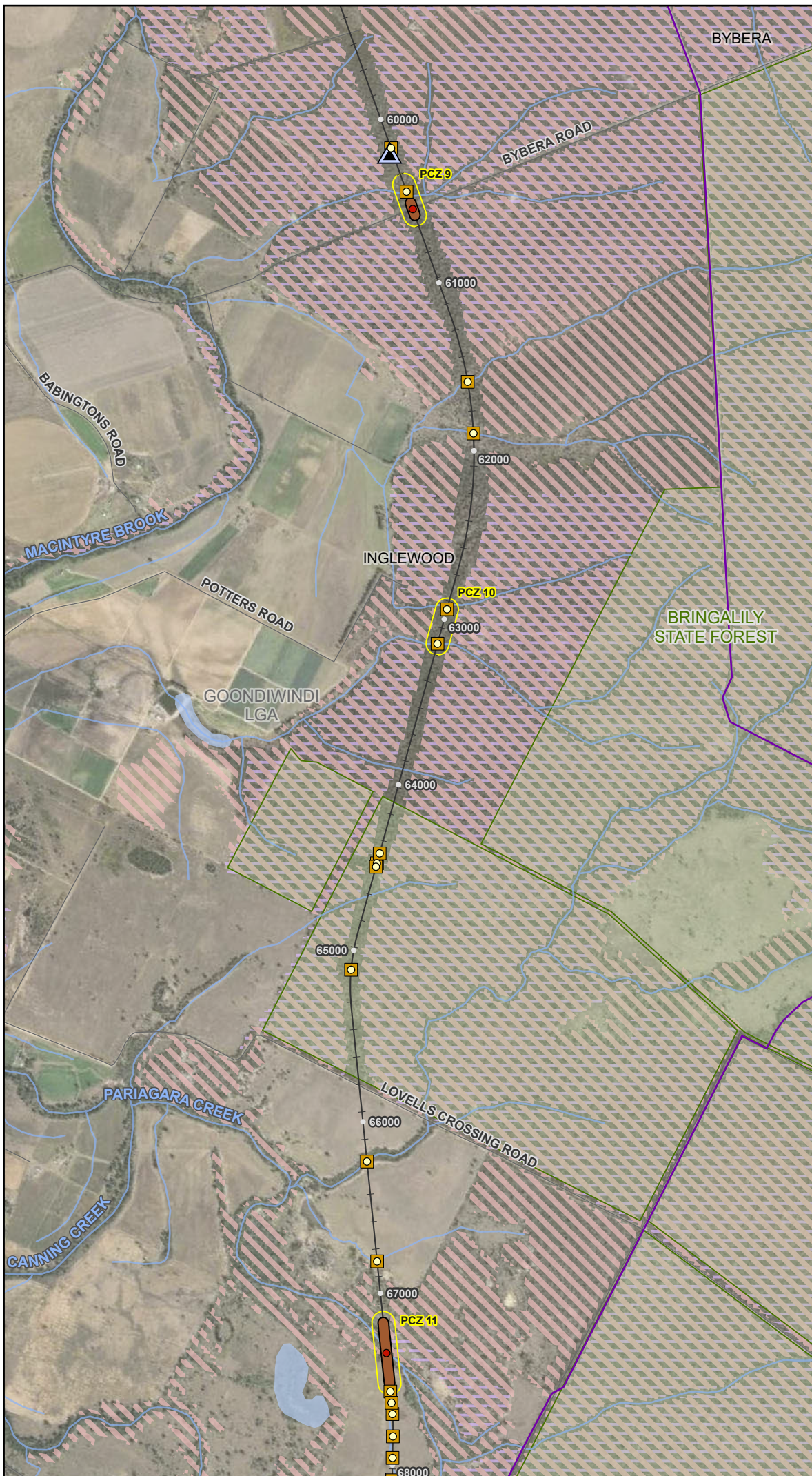
Scale ratio correct when printed at A4

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Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

● Chainage (1000m)

■ Culvert

— Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**● Existing design structure  
is unsatisfactory, or  
required structure is  
absent○ Location is not relevant  
for these species⬡ Proposed new structure  
location**Species habitat**— Gliding mammals  
potential habitat— Woodland birds  
potential habitat**Topographic**

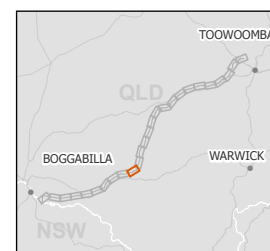
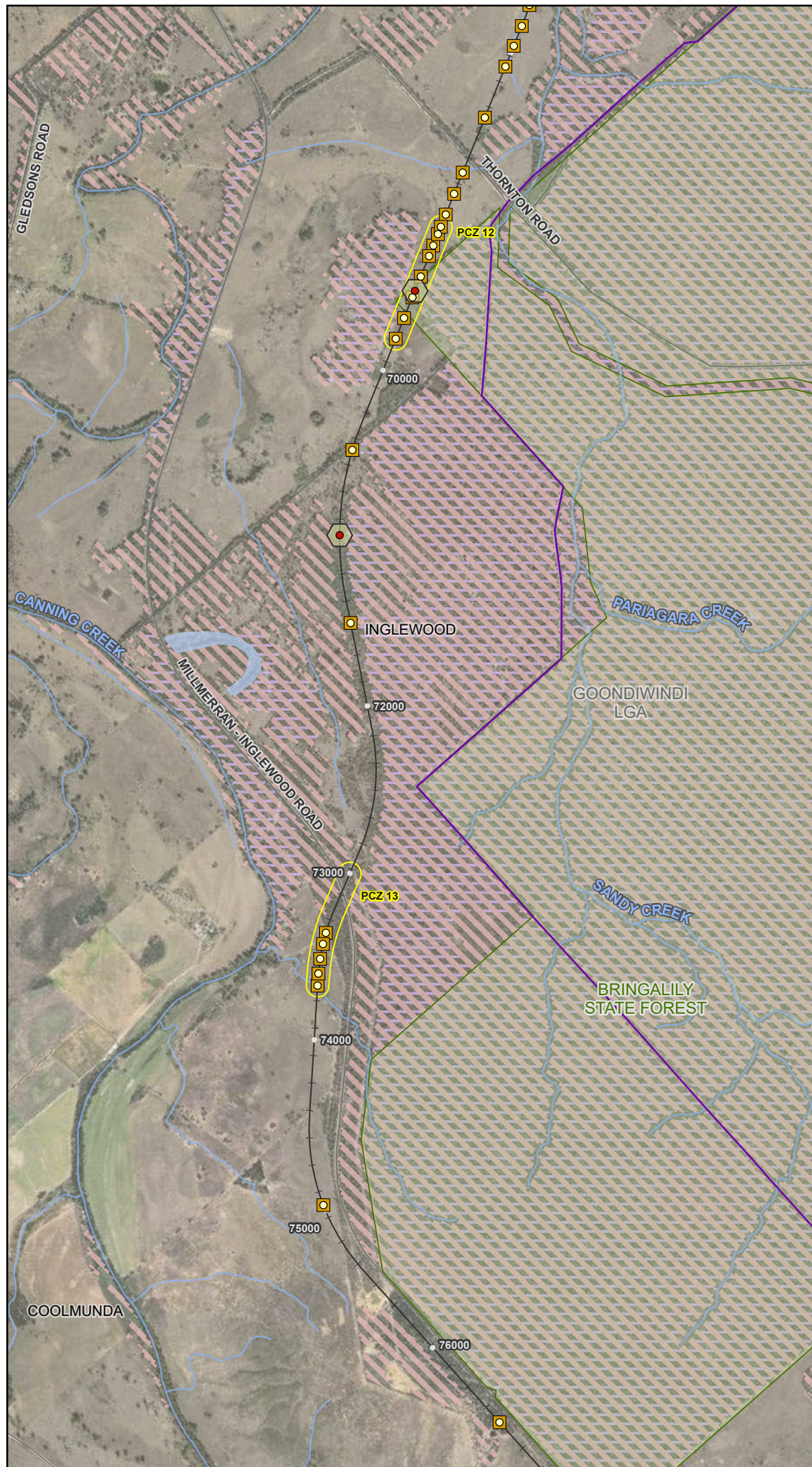
— Wild Dog Check Fence

— Road

— Watercourse

— Waterbody

— Protected areas

0 0.5 1  
Kilometers

Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000

Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS,  
Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species
- ⬡ Proposed new structure location

**Species records**

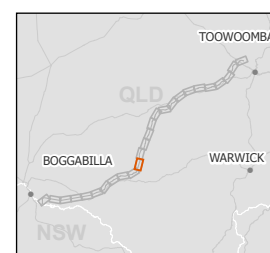
- ▲ Brown tree creeper record
- ▲ Squatter pigeon record

**Species habitat**

- ▨ Gliding mammals potential habitat
- ▨ Woodland birds potential habitat

**Topographic**

- Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



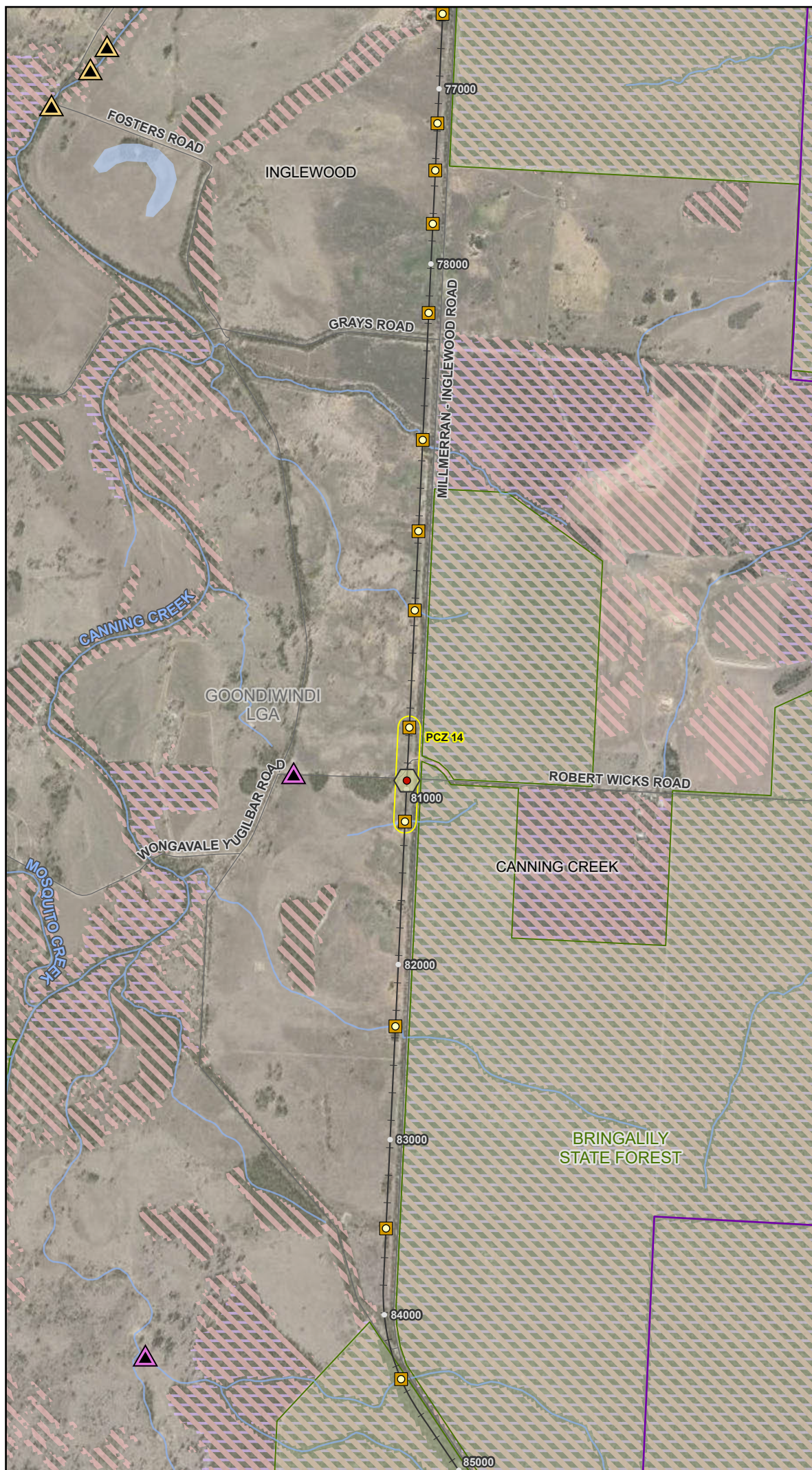
Coordinate system: GDA 1994 Australia Albers

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

Existing design structure is unsatisfactory, or required structure is absent

○ Location is not relevant for these species

⬡ Proposed new structure location

**Species records**

▲ Brown treecreeper record

▲ Painted honeyeater record

▲ Squatter pigeon record

**Species habitat**

▬ Gliding mammals potential habitat

▬ Woodland birds potential habitat

**Topographic**

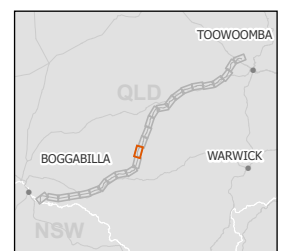
▬ Wild Dog Check Fence

— Road

— Watercourse

■ Waterbody

■ Protected areas



Coordinate system: GDA 1994 Australia Albers

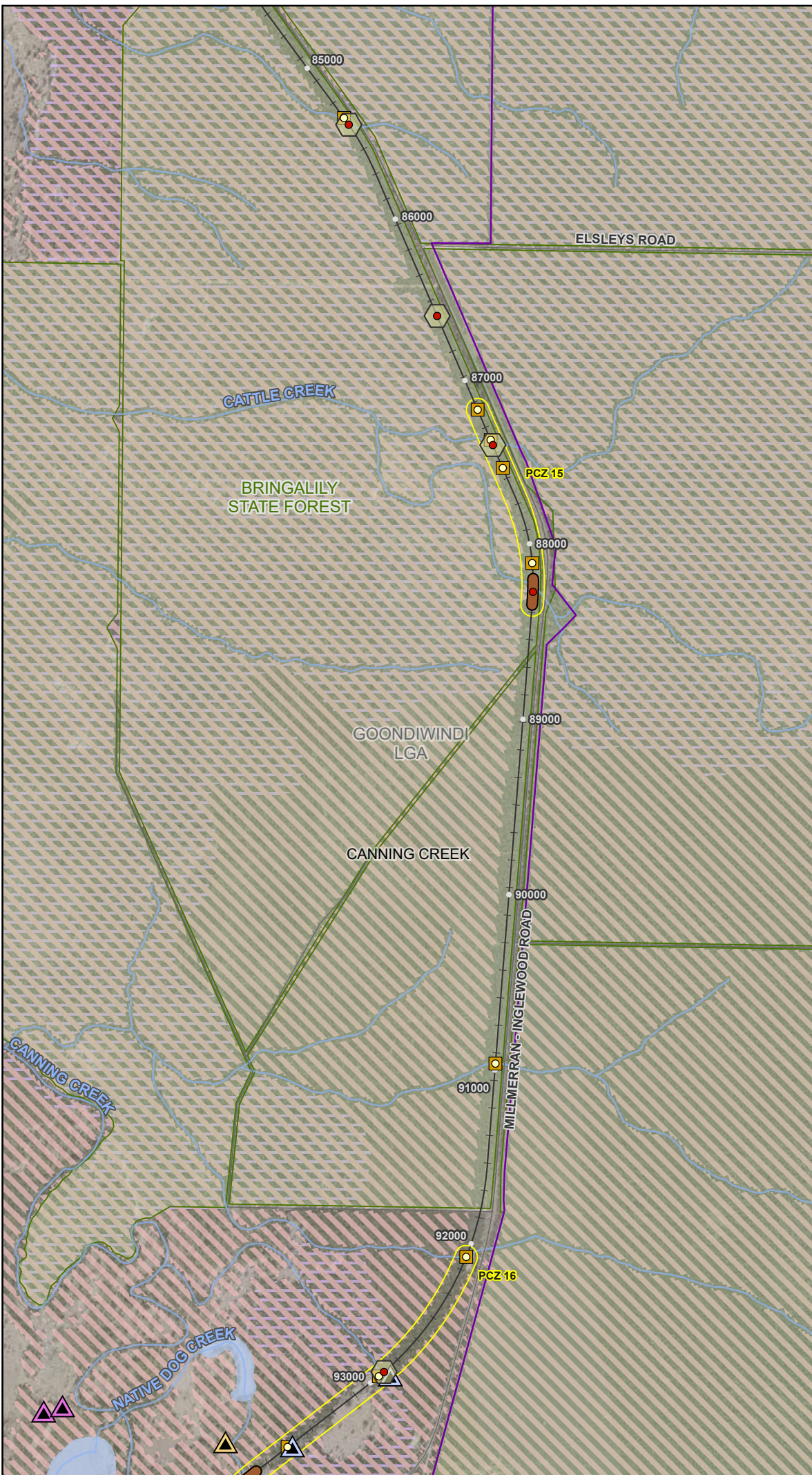
Scale ratio correct when printed at A4

1:30,000

Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

- Existing design structure is satisfactory
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

**Species records**

- ▲ Brown treecreeper record
- ▲ Painted honeyeater record
- ▲ Squatter pigeon record

**Species habitat**

- ▨ Gliding mammals potential habitat
- ▨ Woodland birds potential habitat

**Topographic**

- ▬ Wild Dog Check Fence
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

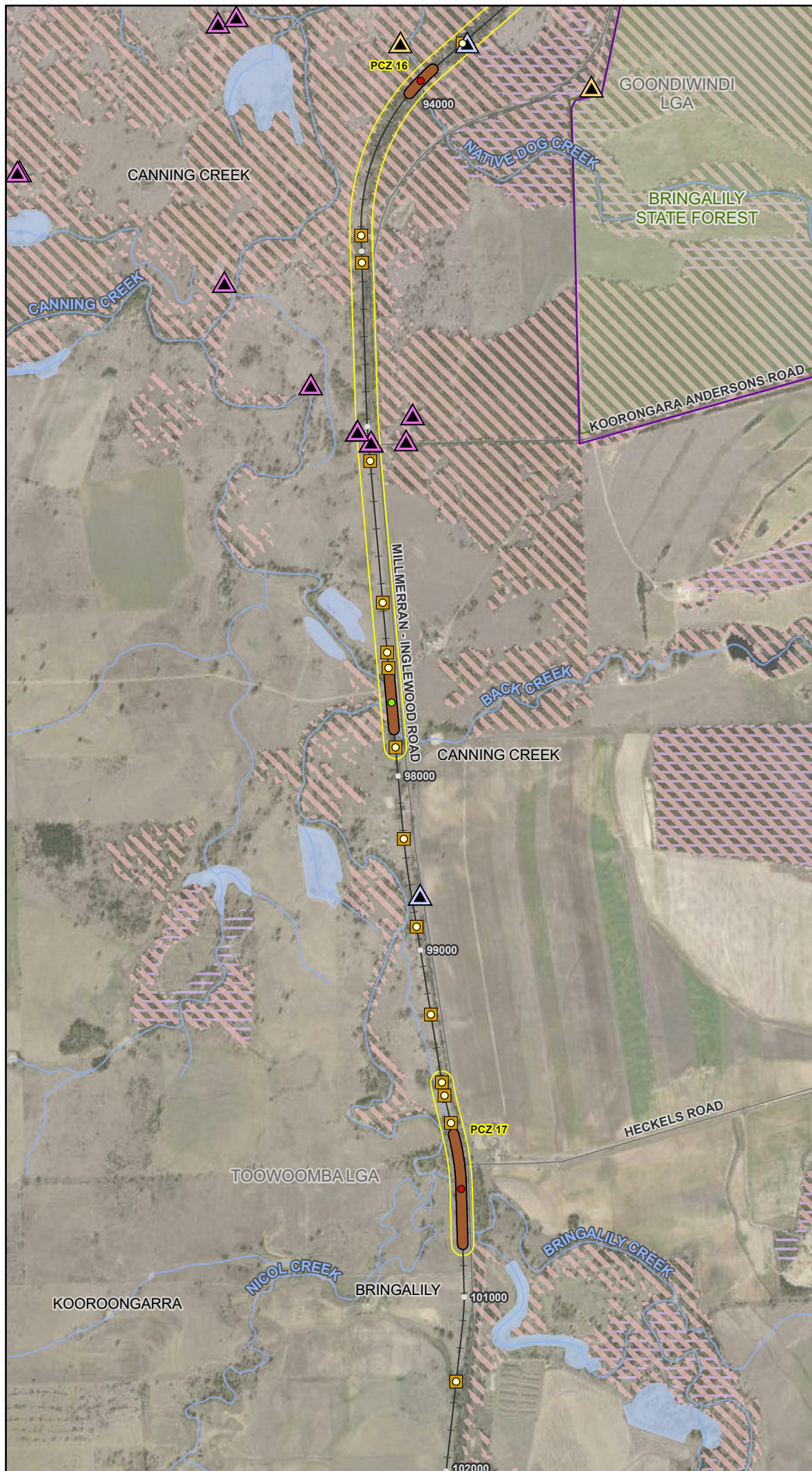
Scale ratio correct when printed at A4

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Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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### Legend

#### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

#### Priority Connectivity Zones (PCZs)



#### Assessment and recommendations

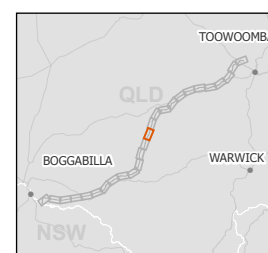
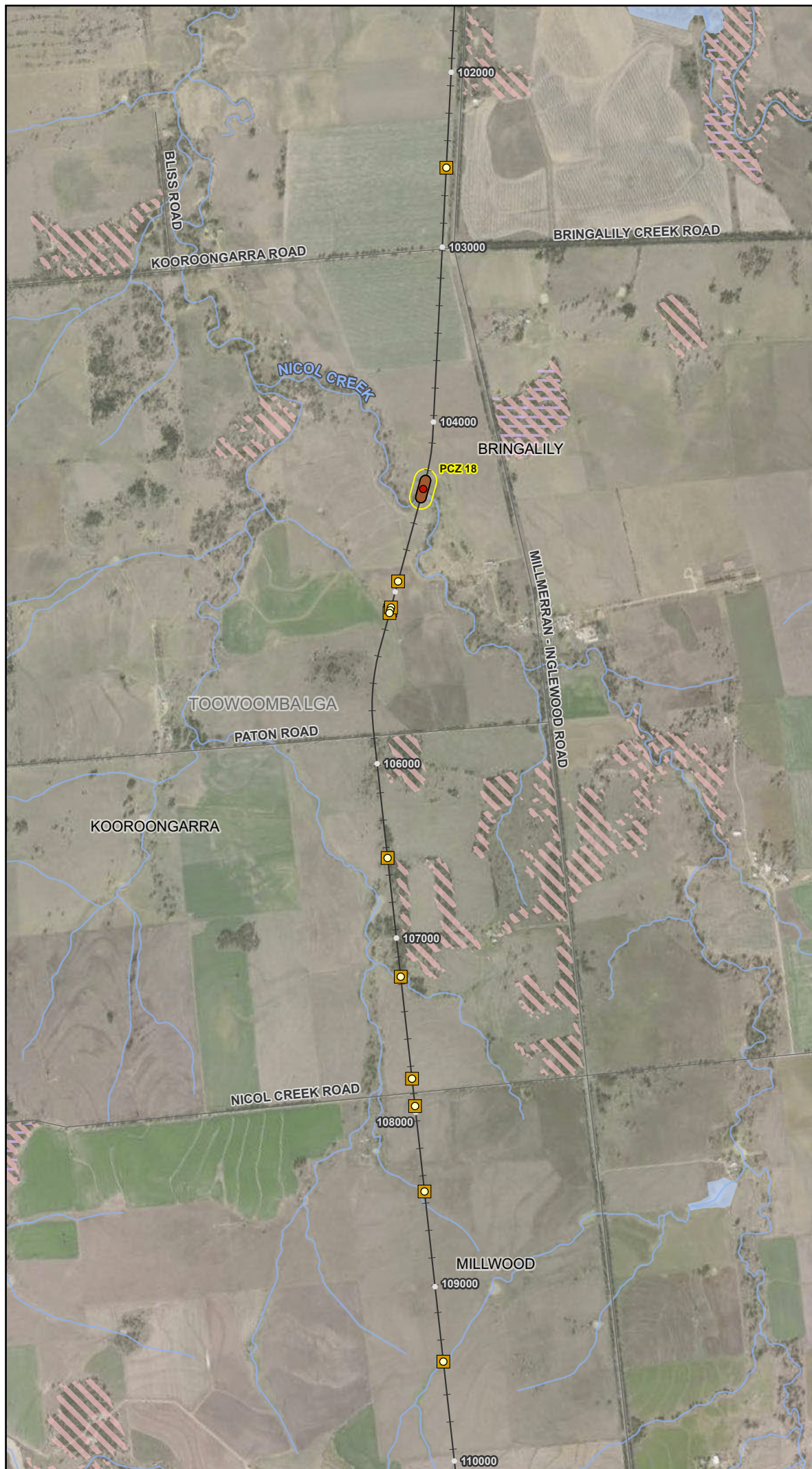
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

#### Species habitat

- ▬ Gliding mammals potential habitat
- ▬ Woodland birds potential habitat

#### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Location is not relevant for these species

### Species records

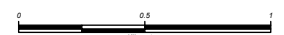
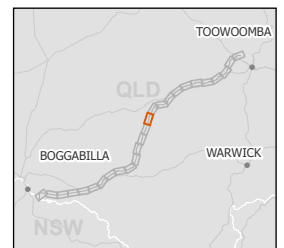
- Painted honeyeater record

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody
- Protected areas



Coordinate system: GDA 1994 Australia Albers

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1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Location is not relevant for these species

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers  
Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

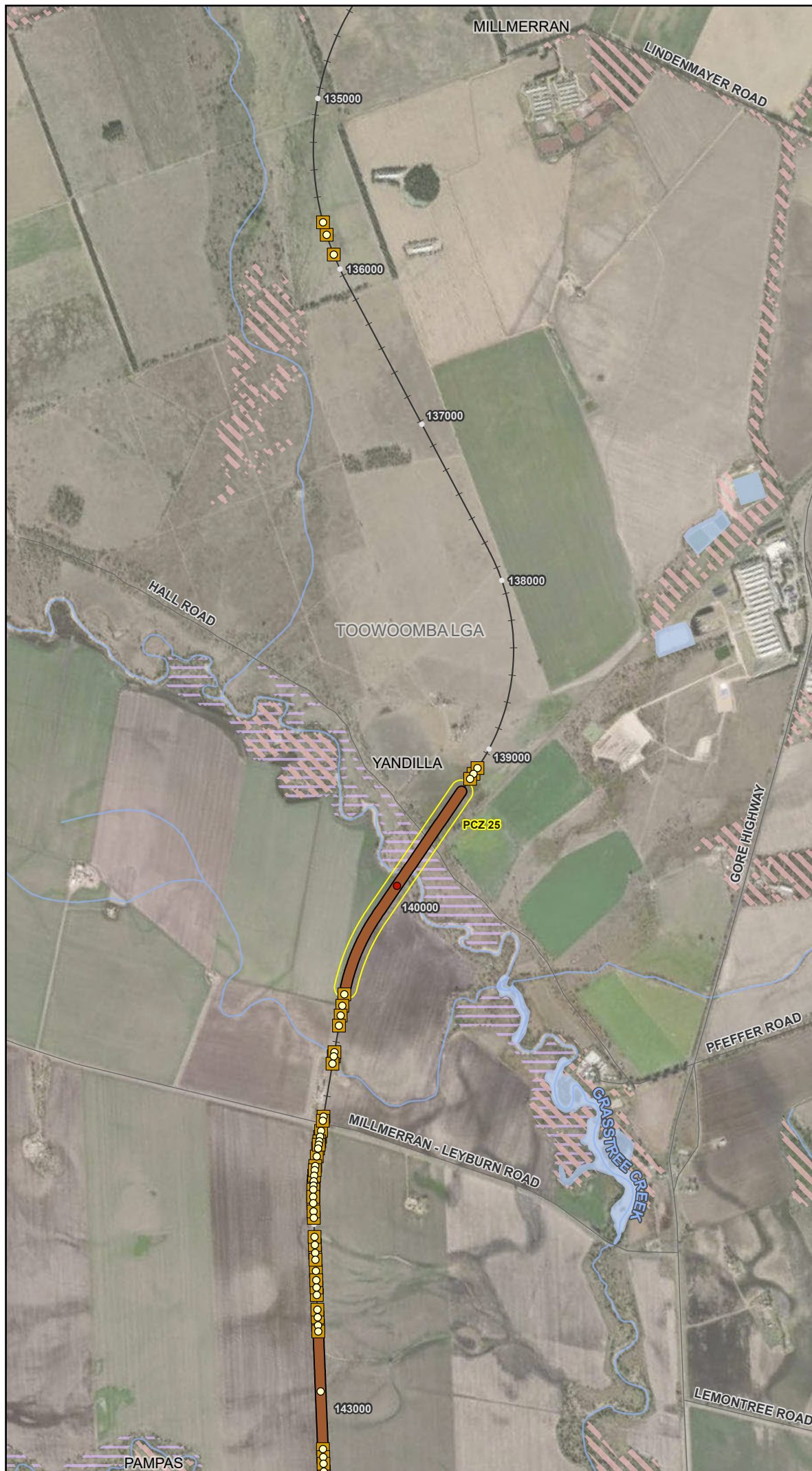
- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species habitat

- ▨ Gliding mammals potential habitat
- ▨ Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS, Geoscience Australia, Esri

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

### Species habitat

- ▬ Gliding mammals potential habitat
- ▬ Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Location is not relevant for these species

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Existing design structure  
is unsatisfactory, or  
required structure is  
absent

○ Location is not relevant  
for these species

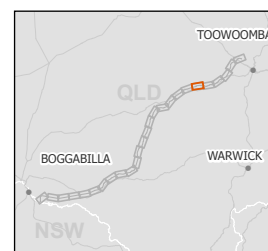
⬡ Proposed new structure  
location

### Species habitat

- ▨ Gliding mammals  
potential habitat
- ▨ Woodland birds  
potential habitat

### Topographic

- Existing operational  
railway
- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

Data sources: DNRME, TMR, Translink, NSW Gov DCS,  
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**Legend****Revised reference design**

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge
- Concept noise wall location

**Priority Connectivity Zones (PCZs)****Assessment and recommendations**

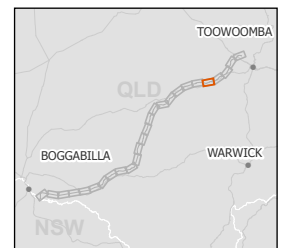
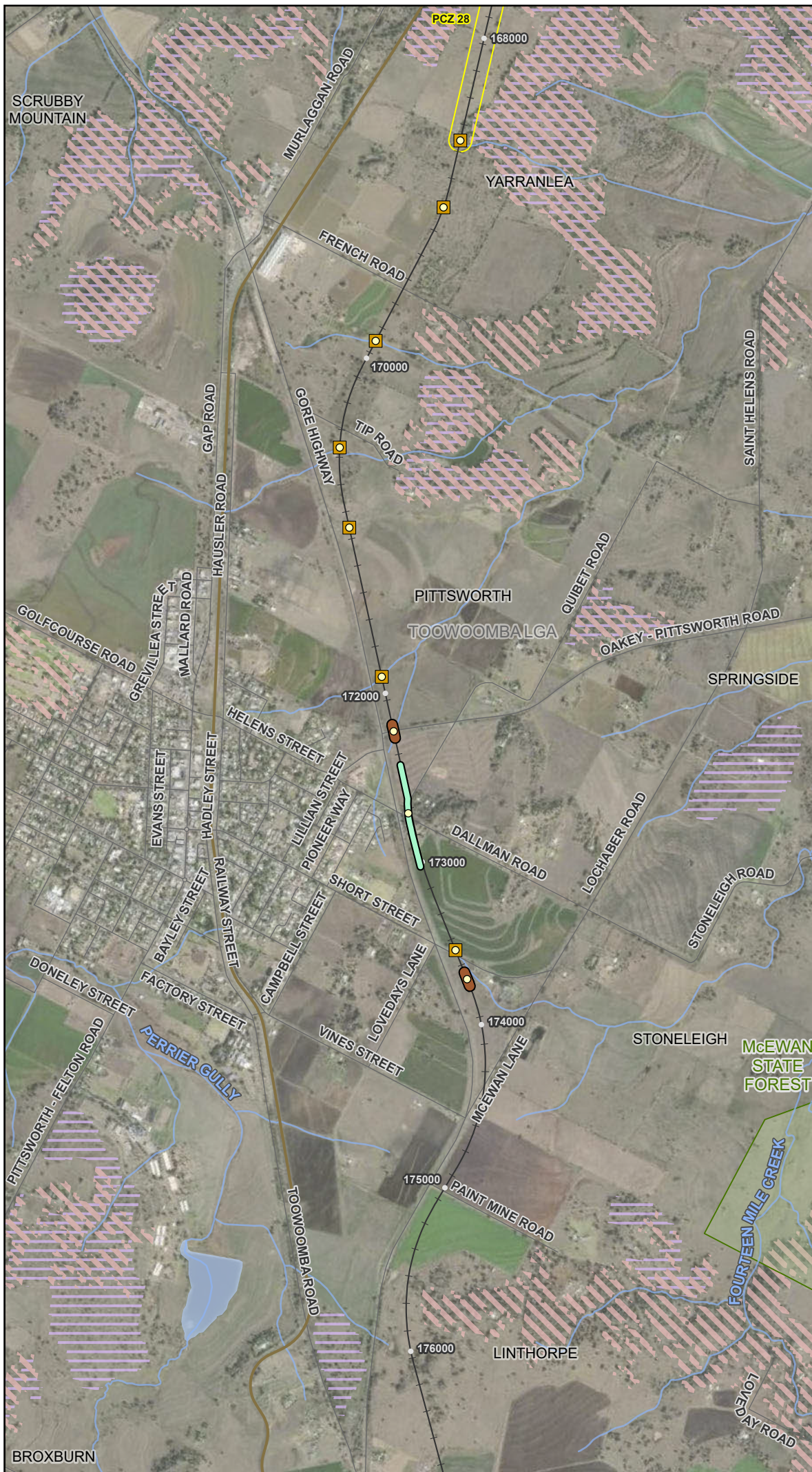
- Location is not relevant for these species

**Species habitat**

- Gliding mammals potential habitat
- Woodland birds potential habitat

**Topographic**

- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



Coordinate system: GDA 1984 Australia Albers

Scale ratio correct when printed at A4

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

- Existing design structure is unsatisfactory, or required structure is absent
- Location is not relevant for these species

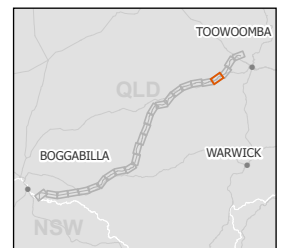
- Proposed new structure location

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody
- Protected areas



0 0.5 1  
Kilometers



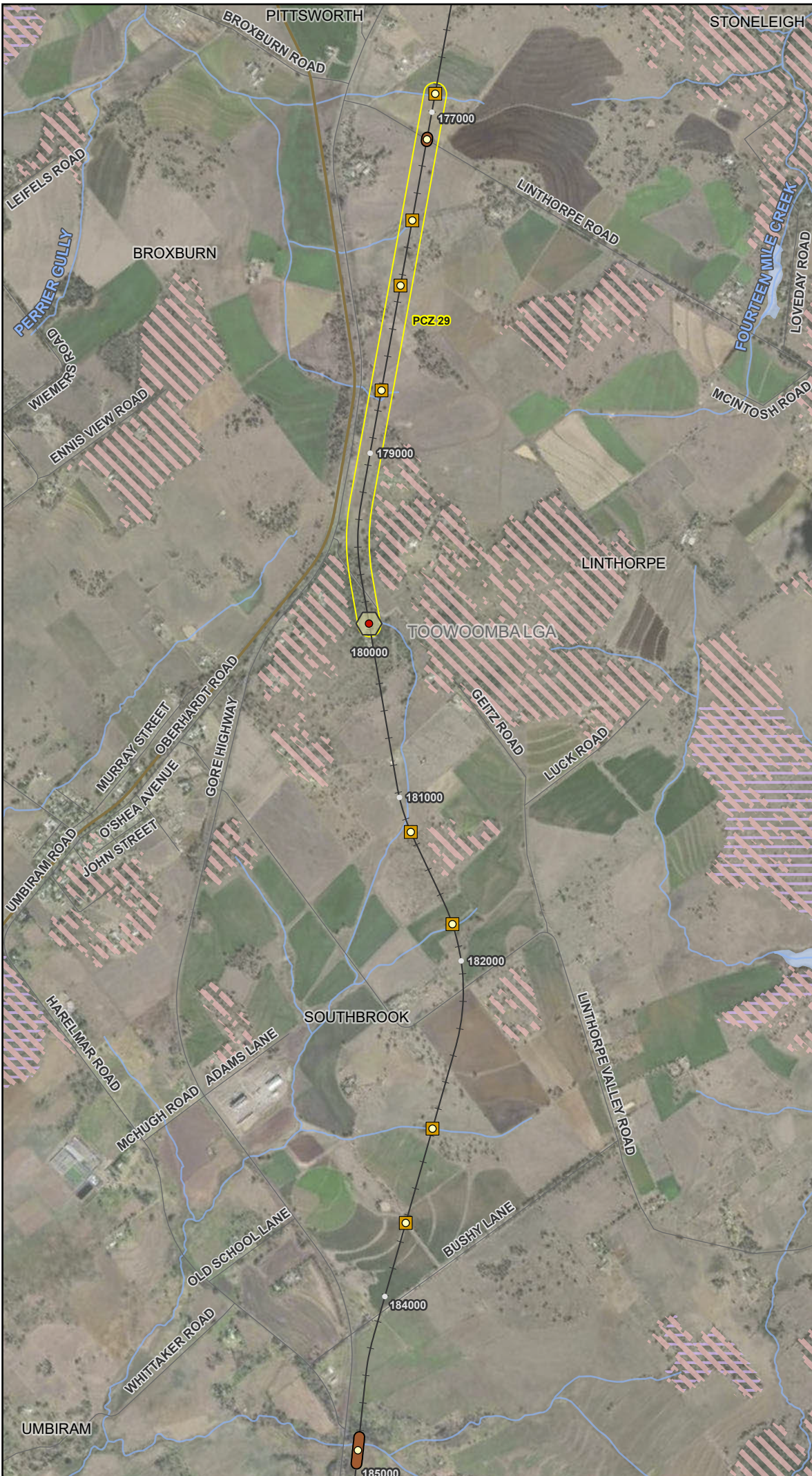
Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

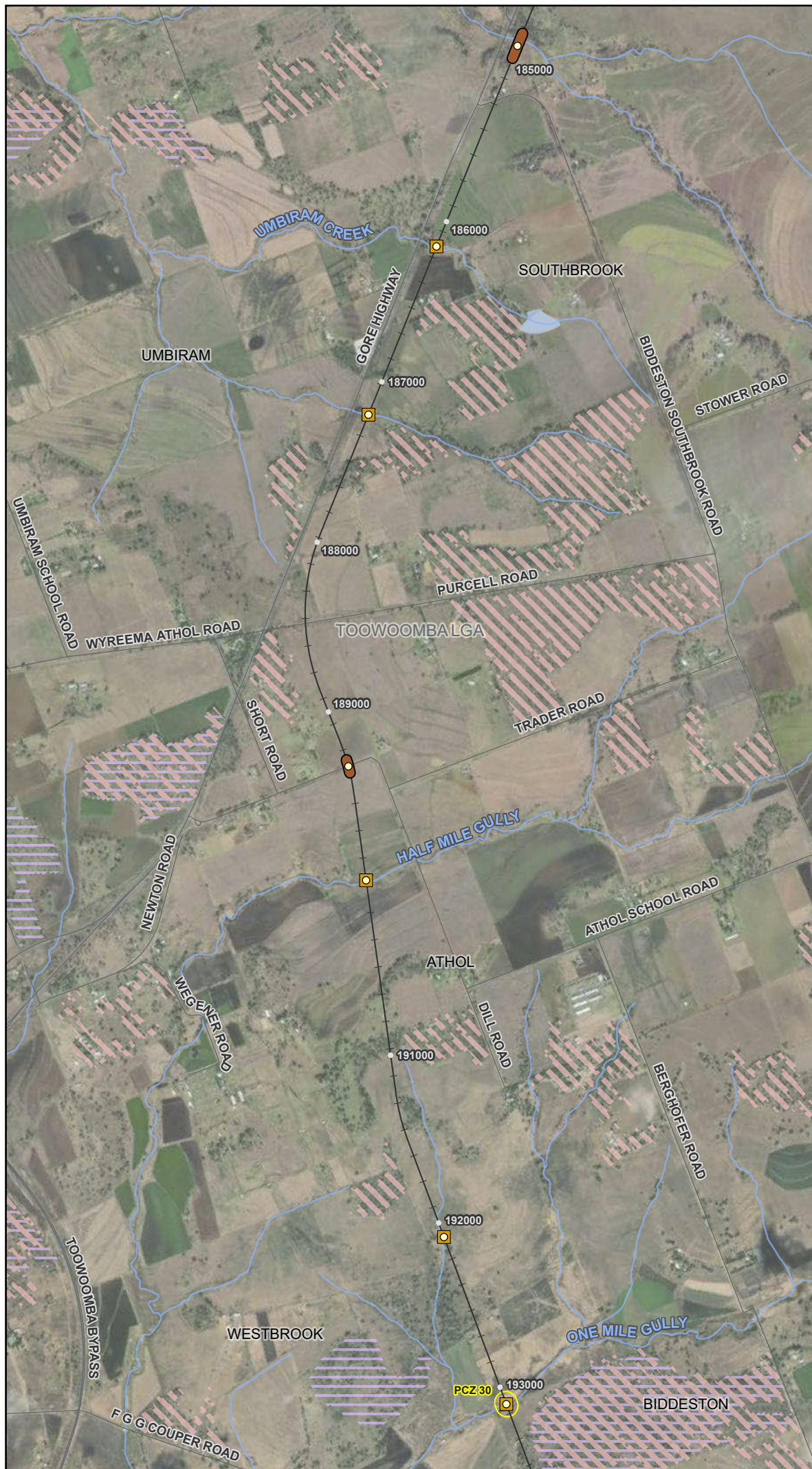
- Location is not relevant for these species

### Species habitat

- Gliding mammals potential habitat
- Woodland birds potential habitat

### Topographic

- Road
- Watercourse
- Waterbody



0 0.5 1  
Kilometers



Coordinate system: GDA 1994 Australia Albers

Scale ratio correct when printed at A4

1:30,000 Date: 12/11/2024

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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

Existing design structure  
is unsatisfactory, or  
required structure is  
absent

○ Location is not relevant  
for these species

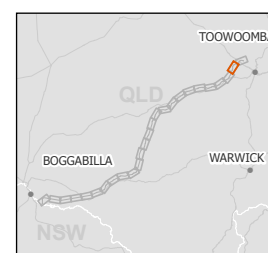
⬡ Proposed new structure  
location

### Species habitat

- ▨ Gliding mammals  
potential habitat
- ▨ Woodland birds  
potential habitat

### Topographic

- Road
- Watercourse



0 0.5 1  
Kilometers

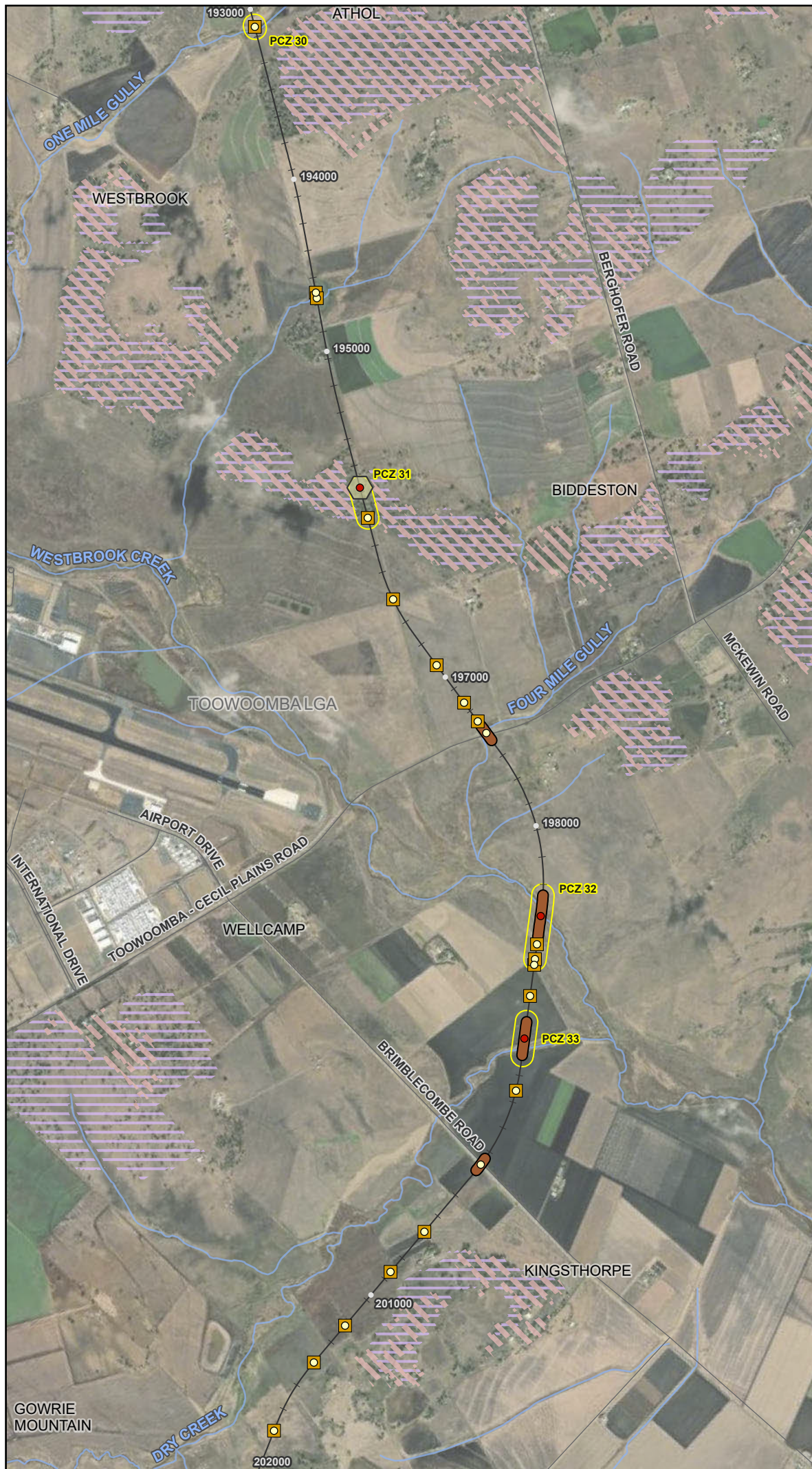


Coordinate system: GDA 1994 Australia Albers  
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## Legend

### Revised reference design

- Chainage (1000m)
- Culvert
- Inland Rail centreline
- ▬ Bridge

### Priority Connectivity Zones (PCZs)



### Assessment and recommendations

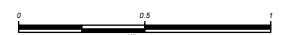
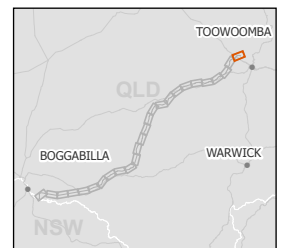
- Location is not relevant for these species

### Species habitat

- ▨ Gliding mammals potential habitat
- ▨ Woodland birds potential habitat

### Topographic

- Existing operational railway
- Road
- Watercourse
- Waterbody



Coordinate system: GDA 1994 Australia Albers  
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# P

Fauna Connectivity Strategy

## **Appendix F** Crossing structure assessment

**BORDER TO GOWRIE** REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT



# Terms

| Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Culvert types                                                                       | Species acronyms                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Y (yes) - indicates revised reference design mitigates impacts to connectivity to a satisfactory level (as defined in Table 3.6).</p> <p>N (no) - indicates structure is currently unsatisfactory (as defined in Table 3.6), or absent at a location (new structures only) and a high-level action is required to mitigate connectivity to a satisfactory level.</p> <p>Blank cell - the location is not applicable for that target species (i.e., no suitable habitat is present to require a crossing structure).</p> | <p>RCP - Reinforced concrete pipe</p> <p>RCBC - Reinforced concrete box culvert</p> | <p>WR - woodland reptiles</p> <p>CCR - cracking clay reptiles</p> <p>BWS - brigalow woodland snail</p> <p>CED - Condamine earless dragon</p> <p>MC - Murray cod</p> <p>WB - woodland birds</p> <p>GM - gliding mammals</p> <p>K - koala</p> |

See Appendix E for map series for each target species of the below structure suitability assessment and associated chainage location. Chainage Inland Rail B2G revised draft EIS Appendix T1 - Hydrology and Flooding Technical Report Volume 1 (Appendix B - Cross Drainage Register).

| Section | Chainage   | Structure |          |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)             |
|---------|------------|-----------|----------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------------------|
|         |            | Type      | Shape    | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                       |
| B2G     | NS2B_30590 | Bridge    | PCB slab | 165    | 3.97  | 1.4    | Y  | Y   | Y                               |     | Y  | N   | N  | N  | N | Maintain vegetation connectivity or raise bridge and add crossing opportunities for gliders and birds |

| Section | Chainage   | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|------------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |            | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | NS2B_31256 | Culvert                | Pipe (RCP) | 32.09  | 1.8   | 1.8    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_31324 | Culvert                | Pipe (RCP) | 30.02  | 1.8   | 1.8    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_31873 | Culvert                | Pipe (RCP) | 14.29  | 0.9   | 0.9    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_31970 | Culvert                | Pipe (RCP) | 15.13  | 0.9   | 0.9    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_32800 | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity and strategic revegetation                                       |
| B2G     | NS2B_33000 | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    | N | Add crossing opportunity and strategic revegetation                                       |
| B2G     | NS2B_34700 | Culvert                | Box (RCBC) | 18.12  | 3     | 1.5    | Y  | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | NS2B_35026 | Culvert                | Pipe (RCP) | 16.44  | 0.9   | 0.9    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_35077 | Culvert                | Pipe (RCP) | 16.72  | 0.9   | 0.9    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage   | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|------------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |            | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | NS2B_35207 | Culvert                | Pipe (RCP) | 17.79  | 0.9   | 0.9    |    | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | NS2B_35882 | Culvert                | Pipe (RCP) | 15.34  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | NS2B_35906 | Culvert                | Pipe (RCP) | 14.50  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | NS2B_36038 | Culvert                | Pipe (RCP) | 13.70  | 0.9   | 0.9    | N  | Y   | Y                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 6602       | Culvert                | Box (RCBC) | 8.50   | 1.8   | 0.9    |    |     | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 8330       | Culvert                | Box (RCBC) | 9.66   | 1.2   | 1.2    |    |     | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 10600      | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 11400      | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 12400      | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 13001    | Culvert                | Box (RCBC) | 10.24  | 2.4   | 0.9    | N  |     | Y                               |     |    | Y   |    |    | N | Strategic revegetation and reduce length                                                  |
| B2G     | 14200    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 17887    | Culvert                | Pipe (RCP) | 22.21  | 1.05  | 1.05   | N  |     |                                 |     |    | Y   |    |    | N | Add crossing opportunity and strategic revegetation                                       |
| B2G     | 18507    | Culvert                | Pipe (RCP) | 20.33  | 1.2   | 1.2    | N  |     |                                 |     |    | Y   |    |    | Y | Add crossing opportunity and strategic revegetation                                       |
| B2G     | 18871    | Culvert                | Pipe (RCP) | 20.34  | 1.05  | 1.05   |    |     | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 19996    | Culvert                | Box (RCBC) | 11.11  | 2.1   | 0.9    |    |     | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 22425    | Culvert                | Box (RCBC) | 9.09   | 1.2   | 0.9    |    |     | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 23047    | Culvert                | Box (RCBC) | 9.58   | 1.2   | 0.9    |    |     | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure  |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type       | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 23531    | Culvert    | Box (RCBC) | 8.79   | 1.2   | 0.9    |    |     | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 24411    | Culvert    | Box (RCBC) | 8.92   | 1.2   | 0.9    |    |     | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 24840    | Culvert    | Box (RCBC) | 10.39  | 1.2   | 0.9    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 25186    | Culvert    | Box (RCBC) | 12.17  | 1.2   | 0.6    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 25459    | Culvert    | Pipe (RCP) | 10.75  | 0.9   | 0.9    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 25500    | Noise wall | NA         | 11.33  | NA    | NA     |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 25504    | Culvert    | Box (RCBC) | 11.33  | 2.4   | 0.9    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 25633    | Bridge     | NA         | 104.00 | 16    | 7.1    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 25803    | Culvert    | Box (RCBC) | 9.26   | 2.4   | 0.9    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 25874    | Culvert    | Box (RCBC) | 9.13   | 2.4   | 0.9    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 25946    | Culvert    | Box (RCBC) | 12.48  | 3     | 0.5    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 25966    | Culvert                | Box (RCBC) | 11.85  | 3     | 0.5    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 26400    | Noise wall             | NA         | 605.00 | NA    | NA     |    |     |                                 |     |    | Y   | Y  |    | Y |                                                                                           |
| B2G     | 26800    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | Y   |    |    | N | Add crossing opportunity and strategic revegetation                                       |
| B2G     | 27051    | Culvert                | Box (RCBC) | 8.52   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 27146    | Culvert                | Box (RCBC) | 8.58   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 27238    | Culvert                | Box (RCBC) | 9.33   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 27332    | Culvert                | Box (RCBC) | 9.43   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 27421    | Culvert                | Box (RCBC) | 9.76   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 27527    | Culvert                | Box (RCBC) | 8.80   | 1.5   | 1.2    |    |     | Y                               |     |    | Y   |    |    | Y |                                                                                           |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 29800    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  | N | Add crossing opportunity, including for gliders                                           |
| B2G     | 30596    | Culvert                | Box (RCBC) | 12.18  | 3     | 1.2    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 31398    | Culvert                | Pipe (RCP) | 11.44  | 1.2   | 1.2    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 31439    | Culvert                | Pipe (RCP) | 11.27  | 1.35  | 1.35   |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 32027    | Culvert                | Pipe (RCP) | 10.59  | 0.9   | 0.9    | Y  |     |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 32300    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 32820    | Culvert                | Pipe (RCP) | 10.65  | 0.9   | 0.9    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 33200    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 33665    | Culvert                | Pipe (RCP) | 13.07  | 1.5   | 1.5    | Y  |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 35176    | Culvert                | Pipe (RCP) | 13.20  | 1.8   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 36900    | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    |     |    |    |   | Strategic revegetation                                                                    |
| B2G     | 37600    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    | N  | N | Add crossing opportunity at fence end                                                     |
| B2G     | 38600    | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures, including for gliders                     |
| B2G     | 39400    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures, including for gliders                     |
| B2G     | 40400    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures,                                           |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |                        |            |        |       |        |    |     |                                 |     |    |     |    |    |   | including for gliders                                                                     |
| B2G     | 41000    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Remove barbed wire and add crossing structures, including for gliders                     |
| B2G     | 41009    | Culvert                | Pipe (RCP) | 13.05  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire and increase dimensions                                                |
| B2G     | 41112    | Culvert                | Pipe (RCP) | 12.30  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire and increase dimensions                                                |
| B2G     | 41197    | Culvert                | Pipe (RCP) | 10.03  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire and increase dimensions                                                |
| B2G     | 41318    | Culvert                | Pipe (RCP) | 11.14  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire and increase dimensions                                                |
| B2G     | 42000    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   | N                               |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures, including for gliders                     |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 42873    | Culvert   | Pipe (RCP) | 11.97  | 0.9   | 0.9    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire and increase dimensions                                                |
| B2G     | 43016    | Culvert   | Box (RCBC) | 15.66  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Remove barbed wire, strategic revegetation, and increase dimensions                       |
| B2G     | 43086    | Culvert   | Pipe (RCP) | 16.20  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Remove barbed wire, strategic revegetation, and increase dimensions                       |
| B2G     | 43158    | Culvert   | Box (RCBC) | 15.34  | 3     | 1.8    | Y  | Y   |                                 |     |    | N   |    |    | N | Remove barbed wire, strategic revegetation and increase dimensions                        |
| B2G     | 43346    | Culvert   | Pipe (RCP) | 14.96  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Remove barbed wire, strategic revegetation and increase dimensions                        |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 43555    | Culvert   | Pipe (RCP) | 15.06  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 43660    | Culvert   | Pipe (RCP) | 14.97  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 43767    | Culvert   | Pipe (RCP) | 15.28  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 43864    | Culvert   | Pipe (RCP) | 15.39  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 43970    | Culvert   | Pipe (RCP) | 14.80  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 44323    | Culvert   | Pipe (RCP) | 15.60  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 44670    | Culvert   | Pipe (RCP) | 25.72  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 44781    | Culvert   | Pipe (RCP) | 17.29  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 44878    | Culvert   | Pipe (RCP) | 17.62  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 44962    | Culvert   | Pipe (RCP) | 16.62  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 45005    | Culvert   | Pipe (RCP) | 16.42  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and                                                                |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |           |            |        |       |        |    |     |                                 |     |    |     |    |    |   | increase dimensions                                                                       |
| B2G     | 45095    | Culvert   | Pipe (RCP) | 16.75  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 45237    | Culvert   | Pipe (RCP) | 15.48  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 45300    | Culvert   | Pipe (RCP) | 16.00  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 45395    | Culvert   | Pipe (RCP) | 16.37  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 45452    | Culvert   | Pipe (RCP) | 16.50  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 45525    | Culvert   | Pipe (RCP) | 16.13  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 45642    | Culvert   | Pipe (RCP) | 15.30  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 46464    | Culvert   | Pipe (RCP) | 20.00  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 47800    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 48400    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 48410    | Culvert                | Pipe (RCP) | 104.19 | 2.7   | 2.7    | N  | N   |                                 |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 50000    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures, including for gliders                     |
| B2G     | 51300    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    | N  | N | Remove barbed wire and add crossing structures, including for gliders                     |
| B2G     | 51825    | Culvert                | Box (RCBC) | 15.85  | 2.7   | 0.9    |    | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 52582    | Bridge                 | NA         | 207.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | Y   | N  | N  | N | Maintain vegetation connectivity or raise bridge and                                      |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |           |            |        |       |        |    |     |                                 |     |    |     |    |    |   | add crossing opportunities for gliders and birds                                          |
| B2G     | 53202    | Culvert   | Pipe (RCP) | 15.23  | 1.2   | 1.2    |    | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 53618    | Culvert   | Box (RCBC) | 10.00  | 1.2   | 0.9    |    | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 54439    | Culvert   | Box (RCBC) | 8.50   | 1.2   | 0.9    |    | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 55056    | Culvert   | Pipe (RCP) | 50.26  | 1.05  | 1.05   | N  | N   | Y                               |     |    | N   |    |    | N | Remove barbed wire, reduce length, and increase dimensions                                |
| B2G     | 55361    | Culvert   | Pipe (RCP) | 61.50  | 1.5   | 1.5    | N  | N   | Y                               |     |    | N   |    |    | N | Remove barbed wire, reduce length and increase dimensions                                 |
| B2G     | 55405    | Culvert   | Pipe (RCP) | 62.08  | 2.1   | 2.1    | N  | N   | Y                               |     |    | N   |    |    | N | Remove barbed wire, reduce length, and increase dimensions                                |



| Section | Chainage | Structure              |       |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)               |
|---------|----------|------------------------|-------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|---------------------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                         |
| B2G     | 55552    | Bridge                 | NA    | 207.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | N   | N  | Y  | N | Remove barbed wire, raise bridge, and add crossing opportunities, including for gliders and birds       |
| B2G     | 56000    | Proposed new structure | TBD   |        | NA    | NA     |    |     |                                 |     |    | N   |    | N  | N | Remove barbed wire from adjacent fence or add crossing opportunity, including for gliders, at fence end |
| B2G     | 57000    | Proposed new structure | TBD   |        | NA    | NA     |    |     |                                 |     |    | N   |    | Y  | N | Add crossing opportunity                                                                                |
| B2G     | 58000    | Proposed new structure | TBD   |        | NA    | NA     |    |     |                                 |     |    | N   |    |    | N | Add crossing opportunity                                                                                |
| B2G     | 59000    | Proposed new structure | TBD   |        | NA    | NA     | N  |     |                                 |     |    |     |    | N  | N | Add crossing opportunity, including for gliders                                                         |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)             |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                       |
| B2G     | 60176    | Culvert   | Pipe (RCP) | 52.65  | 1.2   | 1.2    | N  |     |                                 |     |    | N   |    |    | N | Increase dimensions and reduce length                                                                 |
| B2G     | 60443    | Culvert   | Pipe (RCP) | 89.38  | 2.7   | 2.7    | N  |     |                                 |     |    | N   |    |    | N | Reduce length                                                                                         |
| B2G     | 60550    | Bridge    | NA         | 75.00  | 3.97  | 6.5    | Y  |     |                                 |     |    | Y   | N  | N  | Y | Maintain vegetation connectivity or raise bridge and add crossing opportunities for gliders and birds |
| B2G     | 61598    | Culvert   | Pipe (RCP) | 78.17  | 2.7   | 2.7    |    |     |                                 |     |    | N   |    |    | N | Reduce length                                                                                         |
| B2G     | 61899    | Culvert   | Pipe (RCP) | 61.98  | 2.7   | 2.7    |    |     |                                 |     |    | N   |    |    | N | Reduce length                                                                                         |
| B2G     | 62940    | Culvert   | Box (RCBC) | 20.00  | 2.4   | 2.1    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                                       |
| B2G     | 63148    | Culvert   | Pipe (RCP) | 51.00  | 2.1   | 2.1    | N  | N   |                                 |     |    | N   |    |    | N | Increase dimensions and reduce length                                                                 |
| B2G     | 64415    | Culvert   | Pipe (RCP) | 10.78  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                                   |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 64475    | Culvert   | Pipe (RCP) | 12.61  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 64496    | Culvert   | Pipe (RCP) | 13.20  | 0.9   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 65114    | Culvert   | Box (RCBC) | 9.34   | 2.1   | 0.9    | Y  | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 66232    | Culvert   | Box (RCBC) | 59.54  | 2.4   | 1.8    |    | N   |                                 |     |    | N   |    |    | N | Increase dimensions and reduce length                                                     |
| B2G     | 66814    | Culvert   | Box (RCBC) | 8.71   | 2.7   | 1.2    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 67349    | Bridge    | NA         | 345.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | N   | N  | N  | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 67573    | Culvert   | Pipe (RCP) | 19.40  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 67639    | Culvert   | Pipe (RCP) | 19.55  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and                                                                |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |           |            |        |       |        |    |     |                                 |     |    |     |    |    |   | increase dimensions                                                                       |
| B2G     | 67704    | Culvert   | Pipe (RCP) | 18.81  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 67834    | Culvert   | Pipe (RCP) | 17.14  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 67959    | Culvert   | Pipe (RCP) | 16.97  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 68089    | Culvert   | Pipe (RCP) | 16.78  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 68410    | Culvert   | Pipe (RCP) | 13.51  | 1.2   | 1.2    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 68756    | Culvert   | Pipe (RCP) | 11.80  | 2.1   | 2.1    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 68890    | Culvert   | Pipe (RCP) | 11.90  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69020    | Culvert   | Pipe (RCP) | 12.96  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69097    | Culvert   | Pipe (RCP) | 15.01  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69143    | Culvert   | Pipe (RCP) | 14.04  | 1.5   | 1.5    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69215    | Culvert   | Pipe (RCP) | 12.26  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69281    | Culvert   | Pipe (RCP) | 12.71  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 69410    | Culvert                | Pipe (RCP) | 13.53  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69500    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 69541    | Culvert                | Pipe (RCP) | 14.80  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69671    | Culvert                | Pipe (RCP) | 15.36  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 69801    | Culvert                | Pipe (RCP) | 15.41  | 1.8   | 1.8    | Y  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 70498    | Culvert                | Box (RCBC) | 9.75   | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 71000    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    | N  |   | Add crossing opportunity,                                                                 |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |                        |            |        |       |        |    |     |                                 |     |    |     |    |    |   | including for gliders                                                                     |
| B2G     | 71512    | Culvert                | Box (RCBC) | 8.99   | 2.4   | 0.9    | Y  | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 71800    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 72000    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 72400    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 73000    | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 73374    | Culvert                | Pipe (RCP) | 15.54  | 1.2   | 1.2    |    | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 73441    | Culvert                | Pipe (RCP) | 17.51  | 1.2   | 1.2    |    | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 73529    | Culvert                | Pipe (RCP) | 24.63  | 1.35  | 1.35   |    | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 73615    | Culvert                | Pipe (RCP) | 22.50  | 0.9   | 0.9    |    | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 73685    | Culvert                | Box (RCBC) | 29.89  | 3     | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 74967    | Culvert                | Pipe (RCP) | 27.00  | 1.2   | 1.2    |    | Y   |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 75700    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    | N   |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 76572    | Culvert                | Box (RCBC) | 10.10  | 1.2   | 0.9    | N  | Y   |                                 |     |    | N   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 77197    | Culvert                | Pipe (RCP) | 13.66  | 1.5   | 1.5    | N  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 77466    | Culvert                | Pipe (RCP) | 10.80  | 0.9   | 0.9    |    | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 77771    | Culvert                | Box (RCBC) | 9.20   | 1.5   | 1.5    |    | Y   |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 78280    | Culvert                | Box (RCBC) | 10.06  | 2.1   | 0.9    |    | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 78400    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    | N   |    |    | N | Add crossing opportunity or strategic revegetation to connect with nearby culvert         |
| B2G     | 79005    | Culvert                | Box (RCBC) | 27.86  | 2.4   | 1.8    | N  | Y   |                                 |     |    | N   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 79526    | Culvert                | Pipe (RCP) | 19.27  | 1.35  | 1.35   | N  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 79978    | Culvert                | Box (RCBC) | 7.79   | 0.9   | 0.9    | N  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 80647    | Culvert                | Box (RCBC) | 10.55  | 1.8   | 1.8    | N  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)                                               |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-----------------------------------------------------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                                                         |
| B2G     | 80950    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    | N   |    | N  |   | Add crossing opportunity, including for gliders, or strategic revegetation to connect with nearby culvert and add glider crossing there |
| B2G     | 81184    | Culvert                | Box (RCBC) | 17.67  | 2.4   | 2.4    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                                                                         |
| B2G     | 82353    | Culvert                | Box (RCBC) | 16.45  | 2.4   | 2.4    | Y  | Y   |                                 |     |    | Y   |    |    | Y |                                                                                                                                         |
| B2G     | 83507    | Culvert                | Box (RCBC) | 8.44   | 2.4   | 1.8    | Y  | Y   |                                 |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                                                                          |
| B2G     | 84381    | Culvert                | Box (RCBC) | 17.00  | 3     | 2.7    | N  | N   |                                 |     |    | N   |    |    | N | Reduce length                                                                                                                           |
| B2G     | 85353    | Culvert                | Box (RCBC) | 9.13   | 2.4   | 1.2    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                                                                     |
| B2G     | 85400    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                                                                    |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)             |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                       |
| B2G     | 86600    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    | N  | N | Add crossing opportunity                                                                              |
| B2G     | 87181    | Culvert                | Pipe (RCP) | 27.18  | 2.1   | 2.1    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 87368    | Culvert                | Box (RCBC) | 23.13  | 2.4   | 1.8    | Y  | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 87400    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                                  |
| B2G     | 87542    | Culvert                | Box (RCBC) | 11.00  | 1.8   | 1.8    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 88111    | Culvert                | Pipe (RCP) | 17.50  | 1.2   | 1.2    | Y  | Y   | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 88274    | Bridge                 | NA         | 138.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | N   | N  | N  | N | Maintain vegetation connectivity or raise bridge and add crossing opportunities for gliders and birds |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 89000    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 89800    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 90400    | Proposed new structure | TBD        |        | NA    | NA     | N  |     |                                 |     |    | N   |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 90963    | Culvert                | Box (RCBC) | 36.36  | 2.4   | 2.4    | Y  |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 92080    | Culvert                | Box (RCBC) | 9.20   | 2.4   | 1.5    | Y  | Y   |                                 |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 92900    | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 92939    | Culvert                | Pipe (RCP) | 12.45  | 1.5   | 1.5    | N  |     | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |
| B2G     | 93200    | Proposed new structure | TBD        |        | NA    | NA     |    |     | N                               |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 93606    | Culvert                | Box (RCBC) | 11.80  | 3     | 2.1    | Y  |     | Y                               |     |    | N   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)             |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                       |
| B2G     | 93932    | Bridge    | NA         | 184.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | N   | N  | N  | N | Maintain vegetation connectivity or raise bridge and add crossing opportunities for gliders and birds |
| B2G     | 94910    | Culvert   | Box (RCBC) | 9.14   | 2.1   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 95065    | Culvert   | Box (RCBC) | 10.30  | 2.4   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 96197    | Culvert   | Box (RCBC) | 9.82   | 2.4   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 97008    | Culvert   | Box (RCBC) | 21.11  | 1.5   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 97293    | Culvert   | Pipe (RCP) | 36.19  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 97382    | Culvert   | Pipe (RCP) | 41.86  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |
| B2G     | 97580    | Bridge    | NA         | 299.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     | Y  | N   | N  | Y  | N | Increase dimensions                                                                                   |
| B2G     | 97836    | Culvert   | Pipe (RCP) | 34.10  | 1.5   | 1.5    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                   |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)                                            |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|--------------------------------------------------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                                                      |
| B2G     | 98360    | Culvert   | Pipe (RCP) | 31.18  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                                                                      |
| B2G     | 98866    | Culvert   | Pipe (RCP) | 17.50  | 1.5   | 1.5    | Y  | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                                                                      |
| B2G     | 99373    | Culvert   | Pipe (RCP) | 24.03  | 0.9   | 0.9    | N  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                                                                       |
| B2G     | 99765    | Culvert   | Pipe (RCP) | 18.21  | 1.5   | 1.5    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                                                  |
| B2G     | 99841    | Culvert   | Pipe (RCP) | 20.76  | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                                                  |
| B2G     | 100002   | Culvert   | Pipe (RCP) | 18.02  | 1.5   | 1.5    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                                                                  |
| B2G     | 100383   | Bridge    | NA         | 621.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     | Y  | N   | N  | N  | N | Raise bridge and strategic revegetation and/or add crossing opportunity, including for gliders and birds, and strategic revegetation |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)                      |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|----------------------------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                                |
| B2G     | 101485   | Culvert   | Box (RCBC) | 9.60   | 1.5   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                                                |
| B2G     | 102546   | Culvert   | Box (RCBC) | 8.34   | 1.5   | 0.9    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                                                |
| B2G     | 104389   | Bridge    | NA         | 92.00  | 3.97  | 1.4    | Y  | Y   | Y                               |     | Y  | Y   |    | N  | N | Raise bridge and strategic revegetation and/or add crossing opportunity for gliders and strategic revegetation |
| B2G     | 104938   | Culvert   | Pipe (RCP) | 10.00  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                                            |
| B2G     | 105093   | Culvert   | Pipe (RCP) | 15.51  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                                            |
| B2G     | 105110   | Culvert   | Pipe (RCP) | 16.33  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                                            |
| B2G     | 105126   | Culvert   | Pipe (RCP) | 16.60  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                                            |
| B2G     | 106541   | Culvert   | Box (RCBC) |        | 1.2   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                                                |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 107222   | Culvert   | Box (RCBC) | 8.09   | 2.4   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 107807   | Culvert   | Box (RCBC) | 16.50  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 107964   | Culvert   | Pipe (RCP) | 8.50   | 1.2   | 1.2    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 108454   | Culvert   | Pipe (RCP) | 14.34  | 1.5   | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 109430   | Culvert   | Box (RCBC) | 37.42  | 1.8   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 110912   | Culvert   | Box (RCBC) | 16.18  | 1.8   | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 111165   | Culvert   | Box (RCBC) | 9.46   | 1.2   | 1.2    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 111259   | Culvert   | Box (RCBC) | 8.10   | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 112325   | Culvert   | Box (RCBC) | 8.39   | 1.8   | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 113001   | Culvert   | Box (RCBC) | 11.10  | 1.2   | 1.2    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 113073   | Culvert   | Box (RCBC) | 14.80  | 2.4   | 2.4    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 113281   | Culvert                | Box (RCBC) | 13.14  | 2.1   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 114269   | Culvert                | Pipe (RCP) | 8.92   | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 114360   | Culvert                | Box (RCBC) | 12.79  | 2.1   | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 114900   | Culvert                | Box (RCBC) | 10.50  | 1.8   | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 115003   | Culvert                | Pipe (RCP) | 15.26  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 115322   | Culvert                | Pipe (RCP) | 22.00  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 115529   | Bridge                 | NA         | 29.50  | 3.97  | 6.5    |    | N   | N                               |     |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |
| B2G     | 116000   | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    | N   |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 116409   | Bridge                 | NA         | 59.00  | 10.5  | 7.1    |    | N   | N                               |     |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |
| B2G     | 117401   | Culvert                | Box (RCBC) | 16.32  | 3     | 1.8    | N  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and                                                                |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |           |            |        |       |        |    |     |                                 |     |    |     |    |    |   | increase dimensions                                                                       |
| B2G     | 117600   | Culvert   | Box (RCBC) | 11.95  | 2.7   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 117706   | Culvert   | Box (RCBC) | 10.52  | 1.5   | 1.5    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 118099   | Culvert   | Box (RCBC) | 8.00   | 2.1   | 0.9    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 118430   | Culvert   | Box (RCBC) | 8.68   | 3     | 1.5    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 118606   | Culvert   | Box (RCBC) | 9.56   | 1.2   | 1.2    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 118903   | Culvert   | Pipe (RCP) | 17.50  | 0.9   | 0.9    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 119036   | Culvert   | Box (RCBC) | 17.00  | 2.4   | 1.8    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 119298   | Culvert   | Box (RCBC) | 19.00  | 1.2   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 119378   | Culvert   | Box (RCBC) | 19.00  | 3     | 1.5    | N  | Y   | Y                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 119751   | Culvert   | Box (RCBC) | 10.60  | 2.4   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 119875   | Culvert                | Box (RCBC) | 8.90   | 1.5   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 120080   | Culvert                | Box (RCBC) | 10.10  | 1.5   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 120252   | Culvert                | Box (RCBC) | 8.80   | 2.4   | 1.5    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 120310   | Culvert                | Box (RCBC) | 12.13  | 2.4   | 1.8    | N  | Y   | Y                               |     |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 120765   | Culvert                | Box (RCBC) | 11.54  | 2.4   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 122300   | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 123945   | Bridge                 | NA         | 75.00  | 3.97  | 6.5    | N  | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 124442   | Culvert                | Pipe (RCP) | 53.00  | 1.8   | 1.8    |    | N   | N                               |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 125483   | Culvert                | Pipe (RCP) | 72.00  | 1.8   | 1.8    |    | N   | N                               | N   |    | N   |    |    | N | Reduce length                                                                             |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)                                              |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|----------------------------------------------------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                                                        |
| B2G     | 125716   | Culvert                | Pipe (RCP) | 50.26  | 0.9   | 0.9    |    | N   | N                               | N   |    | N   |    |    | N | Increase dimensions and reduce length                                                                                                  |
| B2G     | 125824   | Culvert                | Pipe (RCP) | 30.50  | 1.8   | 1.8    |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                                                                        |
| B2G     | 126767   | Culvert                | Pipe (RCP) | 45.81  | 0.9   | 0.9    |    | Y   |                                 | Y   | Y  | Y   |    |    | N | Increase dimensions                                                                                                                    |
| B2G     | 126807   | Culvert                | Pipe (RCP) | 46.82  | 0.9   | 0.9    |    | Y   |                                 | Y   | Y  | Y   |    |    | N | Increase dimensions                                                                                                                    |
| B2G     | 126972   | Bridge                 | NA         | 167.00 | 3.97  | 6.5    | N  | N   | N                               | N   |    | Y   | N  | N  | Y | Raise bridge and strategic revegetation and/or add crossing opportunities, including for gliders and birds, and strategic revegetation |
| B2G     | 127600   | Proposed new structure | TBD        |        | NA    | NA     | N  | N   |                                 | N   |    |     |    |    |   | Add crossing opportunity and strategic revegetation                                                                                    |
| B2G     | 128066   | Bridge                 | NA         | 230.00 | 3.97  | 1.4    | Y  | Y   | Y                               | Y   | Y  | N   | N  | N  | N | Raise bridge and/or add crossing                                                                                                       |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |                        |            |        |       |        |    |     |                                 |     |    |     |    |    |   | opportunity, including for gliders                                                        |
| B2G     | 128893   | Culvert                | Box (RCBC) | 10.60  | 1.2   | 0.9    |    | Y   |                                 | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 129849   | Bridge                 | NA         | 72.00  | 14    | 7.1    | N  |     | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 133020   | Culvert                | Box (RCBC) | 15.80  | 1.2   | 0.9    | Y  | Y   |                                 | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 133400   | Proposed new structure | TBD        |        | NA    | NA     | N  |     | N                               |     |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 134850   | Proposed new structure | TBD        |        | NA    | NA     |    | Y   |                                 | N   |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 135716   | Culvert                | Box (RCBC) | 12.66  | 1.8   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 135790   | Culvert                | Box (RCBC) | 11.57  | 1.8   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 135910   | Culvert                | Box (RCBC) | 9.24   | 1.8   | 0.9    |    | N   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions and reduce length                                                     |

| Section | Chainage | Structure              |            |         |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|---------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length  | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 137400   | Proposed new structure | TBD        |         | NA    | NA     |    | N   |                                 | N   |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 139129   | Culvert                | Pipe (RCP) | 23.78   | 1.35  | 1.35   |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |
| B2G     | 139170   | Culvert                | Pipe (RCP) | 20.56   | 1.65  | 1.65   |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |
| B2G     | 139205   | Culvert                | Pipe (RCP) | 19.27   | 1.8   | 1.8    |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |
| B2G     | 139958   | Bridge                 | NA         | 1330.00 | 3.97  | 1.4    | Y  | Y   | Y                               | Y   | Y  | N   |    | N  | N | Raise bridge and/or add crossing opportunity, including for gliders                       |
| B2G     | 140663   | Culvert                | Pipe (RCP) | 12.58   | 1.8   | 1.8    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 140730   | Culvert                | Pipe (RCP) | 13.69   | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 140787   | Culvert                | Pipe (RCP) | 13.46   | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 140846   | Culvert                | Pipe (RCP) | 10.98   | 1.8   | 1.8    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 141001   | Culvert   | Pipe (RCP) | 16.49  | 1.65  | 1.65   |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 141025   | Culvert   | Box (RCBC) | 24.23  | 2.4   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141068   | Culvert   | Pipe (RCP) | 19.23  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141377   | Culvert   | Pipe (RCP) | 16.34  | 1.8   | 1.8    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141401   | Culvert   | Pipe (RCP) | 17.19  | 1.8   | 1.8    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141460   | Culvert   | Pipe (RCP) | 12.73  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141494   | Culvert   | Pipe (RCP) | 12.59  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141521   | Culvert   | Pipe (RCP) | 12.64  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141541   | Culvert   | Pipe (RCP) | 12.73  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141563   | Culvert   | Pipe (RCP) | 12.81  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141609   | Culvert   | Pipe (RCP) | 11.31  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 141665   | Culvert   | Pipe (RCP) | 11.71  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141689   | Culvert   | Pipe (RCP) | 12.94  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141721   | Culvert   | Pipe (RCP) | 12.67  | 1.8   | 1.8    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141753   | Culvert   | Pipe (RCP) | 12.96  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141778   | Culvert   | Pipe (RCP) | 13.25  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141801   | Culvert   | Pipe (RCP) | 13.21  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141842   | Culvert   | Pipe (RCP) | 13.39  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141879   | Culvert   | Pipe (RCP) | 13.71  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141926   | Culvert   | Pipe (RCP) | 13.30  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 141963   | Culvert   | Pipe (RCP) | 13.94  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142072   | Culvert   | Pipe (RCP) | 14.06  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 142118   | Culvert   | Pipe (RCP) | 14.16  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142164   | Culvert   | Pipe (RCP) | 13.84  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142203   | Culvert   | Pipe (RCP) | 14.28  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142267   | Culvert   | Pipe (RCP) | 14.27  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142320   | Culvert   | Pipe (RCP) | 14.63  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142362   | Culvert   | Pipe (RCP) | 14.66  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142405   | Culvert   | Pipe (RCP) | 14.87  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142489   | Culvert   | Pipe (RCP) | 14.48  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142533   | Culvert   | Pipe (RCP) | 14.38  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142579   | Culvert   | Pipe (RCP) | 14.53  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 142614   | Culvert   | Pipe (RCP) | 15.29  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 142958   | Bridge    | NA         | 658.00 | 3.97  | 1.4    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143288   | Culvert   | Pipe (RCP) | 14.17  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143334   | Culvert   | Pipe (RCP) | 14.30  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143372   | Culvert   | Pipe (RCP) | 14.37  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143417   | Culvert   | Pipe (RCP) | 13.35  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143445   | Culvert   | Pipe (RCP) | 13.36  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143478   | Culvert   | Pipe (RCP) | 13.26  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143509   | Culvert   | Pipe (RCP) | 13.82  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143538   | Culvert   | Pipe (RCP) | 12.93  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143574   | Culvert   | Pipe (RCP) | 12.65  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143654   | Culvert   | Pipe (RCP) | 12.72  | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |



| Section | Chainage | Structure |            |         |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|---------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length  | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 143701   | Culvert   | Pipe (RCP) | 12.75   | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143734   | Culvert   | Pipe (RCP) | 12.58   | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143768   | Culvert   | Pipe (RCP) | 12.59   | 2.1   | 2.1    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 143792   | Culvert   | Pipe (RCP) | 12.77   | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 143832   | Culvert   | Pipe (RCP) | 13.07   | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 143875   | Culvert   | Pipe (RCP) | 13.84   | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 145170   | Bridge    | NA         | 2577.00 | 3.97  | 1.4    | Y  | Y   | Y                               |     |    | N   | N  | N  | N | Raise bridge and/or add crossing opportunity, including for gliders and birds             |
| B2G     | 146452   | Culvert   | Box (RCBC) | 15.39   | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 146497   | Culvert   | Box (RCBC) | 14.39   | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 146536   | Culvert   | Box (RCBC) | 13.52  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 146610   | Culvert   | Box (RCBC) | 10.17  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 146686   | Culvert   | Box (RCBC) | 10.53  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 147013   | Culvert   | Box (RCBC) | 11.06  | 1.5   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 147116   | Culvert   | Box (RCBC) | 11.73  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 147178   | Culvert   | Box (RCBC) | 11.69  | 1.5   | 0.9    |    | Y   | Y                               |     |    |     |    |    |   |                                                                                           |
| B2G     | 147213   | Culvert   | Box (RCBC) | 11.72  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 147265   | Culvert   | Box (RCBC) | 11.54  | 1.2   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 147315   | Culvert   | Box (RCBC) | 11.01  | 1.5   | 0.9    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 147851   | Culvert   | Box (RCBC) | 8.97   | 1.2   | 0.6    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 147914   | Culvert   | Box (RCBC) | 10.24  | 1.2   | 0.6    |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure |            |         |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details)         |
|---------|----------|-----------|------------|---------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|---------------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length  | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                                   |
| B2G     | 148874   | Culvert   | Pipe (RCP) | 12.19   | 1.05  | 1.05   |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                               |
| B2G     | 148915   | Culvert   | Pipe (RCP) | 13.13   | 1.05  | 1.05   |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                               |
| B2G     | 148956   | Culvert   | Pipe (RCP) | 14.37   | 1.05  | 1.05   |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                               |
| B2G     | 149016   | Culvert   | Pipe (RCP) | 15.55   | 1.05  | 1.05   |    | Y   | Y                               |     |    |     |    |    | N | Increase dimensions                                                                               |
| B2G     | 149834   | Bridge    | NA         | 1568.00 | 3.97  | 1.4    | Y  | Y   | Y                               | Y   | Y  | N   | N  | N  | N | Raise bridge, strategic revegetation or add crossing opportunity, including for gliders and birds |
| B2G     | 150677   | Culvert   | Pipe (RCP) | 10.82   | 1.35  | 1.35   |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                                   |
| B2G     | 150708   | Culvert   | Pipe (RCP) | 10.76   | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                                   |
| B2G     | 150744   | Culvert   | Pipe (RCP) | 11.84   | 1.35  | 1.35   |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                                   |
| B2G     | 151077   | Culvert   | Pipe (RCP) | 10.93   | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                                   |

| Section | Chainage | Structure  |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type       | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 151119   | Culvert    | Pipe (RCP) | 12.51  | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 151142   | Culvert    | Pipe (RCP) | 12.44  | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 151173   | Culvert    | Pipe (RCP) | 12.64  | 1.35  | 1.35   |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 151201   | Culvert    | Pipe (RCP) | 12.21  | 1.35  | 1.35   |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 151269   | Culvert    | Pipe (RCP) | 11.20  | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 151296   | Culvert    | Pipe (RCP) | 11.49  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 152396   | Culvert    | Box (RCBC) | 9.00   | 0.9   | 0.9    |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 153300   | Noise wall | NA         | 210.00 | NA    | NA     |    |     | N                               | N   |    | Y   |    |    | Y | Add crossing for reptiles at noise wall – e.g. small gaps underneath                      |
| B2G     | 153438   | Culvert    | Box (RCBC) | 10.80  | 0.9   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 153700   | Noise wall | NA         | 507.59 | NA    | NA     |    | N   | N                               | N   |    | Y   |    |    | Y | Add crossing for reptiles at noise                                                        |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
|         |          |                        |            |        |       |        |    |     |                                 |     |    |     |    |    |   | wall – e.g. small gaps underneath                                                         |
| B2G     | 154433   | Bridge                 | NA         | 108.00 | 14    | 7.1    |    | N   | N                               | N   |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 154508   | Culvert                | Box (RCBC) | 8.22   | 2.1   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |
| B2G     | 155592   | Culvert                | Box (RCBC) | 9.30   | 2.1   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    |   |                                                                                           |
| B2G     | 157200   | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 | N   |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 159245   | Culvert                | Box (RCBC) | 7.44   | 2.4   | 1.2    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 160414   | Culvert                | Pipe (RCP) | 16.00  | 1.8   | 1.8    | N  | Y   | Y                               | Y   |    | Y   |    |    | N | Strategic revegetation and increase dimensions                                            |
| B2G     | 161152   | Culvert                | Pipe (RCP) | 32.00  | 1.2   | 1.2    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 162301   | Culvert                | Pipe (RCP) | 31.00  | 1.5   | 1.5    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 162533   | Bridge                 | NA         | 69.00  | 3.97  | 5.4    |    | N   | N                               | N   |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |
| B2G     | 162824   | Culvert                | Pipe (RCP) | 33.00  | 1.8   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 164160   | Culvert                | Pipe (RCP) | 86.51  | 0.9   | 0.9    |    | N   | N                               |     |    | N   |    |    | N | Increase dimensions and reduce length                                                     |
| B2G     | 164288   | Culvert                | Pipe (RCP) | 70.21  | 1.2   | 1.2    |    | N   | N                               |     |    | N   |    |    | N | Increase dimensions and reduce length                                                     |
| B2G     | 164571   | Bridge                 | NA         | 121.00 | 3.97  | 5.4    |    | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 165063   | Culvert                | Pipe (RCP) | 61.23  | 1.8   | 1.8    |    | N   | N                               |     |    | N   |    |    | N | Increase dimensions and reduce length                                                     |
| B2G     | 166104   | Culvert                | Box (RCBC) | 8.45   | 2.4   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 166200   | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 167082   | Culvert                | Box (RCBC) | 9.77   | 1.2   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 167700   | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 168611   | Culvert                | Box (RCBC) | 17.40  | 2.4   | 0.9    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 169013   | Culvert                | Box (RCBC) | 14.55  | 1.2   | 1.2    |    |     |                                 |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 169886   | Culvert                | Pipe (RCP) | 37.35  | 2.7   | 2.7    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 170548   | Culvert                | Box (RCBC) | 25.20  | 2.4   | 2.4    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 171018   | Culvert                | Pipe (RCP) | 27.04  | 1.8   | 1.8    |    |     |                                 |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 171902   | Culvert                | Pipe (RCP) | 70.72  | 1.8   | 1.8    |    | N   | N                               |     |    |     |    |    | N | Strategic revegetation and reduce length                                                  |
| B2G     | 172225   | Bridge                 | NA         | 69.00  | 3.97  | 7      |    | N   | N                               |     |    |     |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 172800   | Noise wall             | NA         | 601.85 | NA    | NA     |    | N   | N                               |     |    | Y   |    |    | Y | Add crossing for reptiles at noise wall – e.g. small gaps underneath                      |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 173544   | Culvert                | Pipe (RCP) | 61.12  | 1.35  | 1.35   |    | N   | N                               |     |    | N   |    |    | N | Strategic revegetation, increase dimensions, reduce length                                |
| B2G     | 173724   | Bridge                 | NA         | 75.00  | 3.97  | 5.4    |    | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 174300   | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    |     |    |    |   | Add crossing opportunity                                                                  |
| B2G     | 176100   | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 176892   | Culvert                | Box (RCBC) | 32.58  | 2.4   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 177160   | Bridge                 | NA         | 66.00  | 10.5  | 7.1    |    | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 177635   | Culvert                | Pipe (RCP) | 25.27  | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 178017   | Culvert                | Pipe (RCP) | 41.00  | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 178632   | Culvert                | Pipe (RCP) | 12.50  | 1.8   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |



| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 179650   | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 180000   | Proposed new structure | TBD        |        | NA    | NA     |    | N   |                                 |     |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 181208   | Culvert                | Pipe (RCP) | 66.79  | 2.1   | 2.1    |    | N   | N                               |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 181784   | Culvert                | Pipe (RCP) | 48.01  | 1.8   | 1.8    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 182991   | Culvert                | Pipe (RCP) | 31.17  | 2.4   | 2.4    |    | Y   | Y                               |     |    |     |    |    | Y |                                                                                           |
| B2G     | 183558   | Culvert                | Pipe (RCP) | 31.00  | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 184903   | Bridge                 | NA         | 144.00 | 3.97  | 5.4    |    | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 186155   | Culvert                | Box (RCBC) | 14.08  | 2.4   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 187205   | Culvert                | Pipe (RCP) | 47.00  | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 189331   | Bridge                 | NA         | 75.00  | 3.97  | 6.5    |    | N   | N                               |     |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |

| Section | Chainage | Structure              |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|------------------------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type                   | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 189990   | Culvert                | Box (RCBC) | 74.00  | 1.8   | 1.5    |    | N   | N                               |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 190950   | Proposed new structure | TBD        |        | NA    | NA     |    | N   | N                               |     |    |     |    |    | N | Add crossing opportunity                                                                  |
| B2G     | 192086   | Culvert                | Pipe (RCP) | 60.00  | 1.8   | 1.8    |    | N   | N                               |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 193103   | Culvert                | Pipe (RCP) | 109.86 | 3     | 3      |    | N   | N                               |     |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 194659   | Culvert                | Box (RCBC) | 18.84  | 1.5   | 1.2    |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |
| B2G     | 194691   | Culvert                | Pipe (RCP) | 23.60  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 195800   | Proposed new structure | TBD        |        | NA    | NA     |    |     |                                 |     |    |     |    | N  |   | Add crossing opportunity for gliders                                                      |
| B2G     | 195978   | Culvert                | Box (RCBC) | 9.83   | 1.5   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 196465   | Culvert                | Pipe (RCP) | 53.00  | 1.2   | 1.2    |    | N   | N                               | N   |    | N   |    |    | N | Reduce length                                                                             |
| B2G     | 196916   | Culvert                | Pipe (RCP) | 59.73  | 1.35  | 1.35   |    | N   | N                               | N   |    | N   |    |    | N | Reduce length                                                                             |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 197181   | Culvert   | Pipe (RCP) | 47.22  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 197313   | Culvert   | Pipe (RCP) | 44.11  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 197396   | Bridge    | NA         | 92.00  | 3.97  | 6.1    |    | N   | N                               | N   |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |
| B2G     | 198521   | Bridge    | NA         | 230.00 | 3.97  | 1.4    |    | Y   | Y                               | Y   |    | N   | N  | N  | N | Raise bridge and/or add crossing opportunity, including for gliders and birds             |
| B2G     | 198684   | Culvert   | Pipe (RCP) | 14.88  | 2.4   | 2.4    |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 198770   | Culvert   | Pipe (RCP) | 12.53  | 1.5   | 1.5    |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 198803   | Culvert   | Pipe (RCP) | 12.15  | 1.2   | 1.2    |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 198983   | Culvert   | Pipe (RCP) | 23.47  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 199230   | Bridge    | NA         | 184.00 | 3.97  | 1.4    |    | Y   | Y                               | Y   |    | Y   |    | N  | Y | Add crossing opportunity for gliders                                                      |

| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 199533   | Culvert   | Pipe (RCP) | 65.53  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 200009   | Bridge    | NA         | 75.00  | 3.97  | 5.4    |    | N   | N                               | N   |    | Y   | Y  |    | Y | Strategic revegetation                                                                    |
| B2G     | 200519   | Culvert   | Pipe (RCP) | 15.02  | 0.9   | 0.9    |    | Y   | Y                               | Y   |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 200824   | Culvert   | Box (RCBC) | 7.75   | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 201233   | Culvert   | Box (RCBC) | 9.56   | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 201514   | Culvert   | Box (RCBC) | 8.23   | 0.9   | 0.9    |    | Y   | Y                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |
| B2G     | 201974   | Culvert   | Pipe (RCP) | 24.77  | 1.2   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 202524   | Culvert   | Pipe (RCP) | 26.62  | 1.2   | 1.2    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 202802   | Culvert   | Box (RCBC) | 33.52  | 2.1   | 2.1    |    | Y   | Y                               |     |    | Y   |    |    | Y |                                                                                           |
| B2G     | 204337   | Bridge    | NA         | 132.00 | 3.97  | 6.9    |    | N   | N                               |     |    | Y   |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 204447   | Culvert   | Pipe (RCP) | 60.61  | 1.05  | 1.05   |    | N   | N                               |     |    | Y   |    |    | N | Increase dimensions                                                                       |



| Section | Chainage | Structure |            |        |       |        |    |     | Satisfactory for target species |     |    |     |    |    |   | High-level action to mitigate impacts to connectivity (refer to Section 5.17 for details) |
|---------|----------|-----------|------------|--------|-------|--------|----|-----|---------------------------------|-----|----|-----|----|----|---|-------------------------------------------------------------------------------------------|
|         |          | Type      | Shape      | Length | Width | Height | WR | CCR | BWS                             | CED | MC | STQ | WB | GM | K |                                                                                           |
| B2G     | 205834   | Bridge    | NA         | 299.00 | 3.97  | 5.4    |    | N   | N                               | N   |    |     |    |    | Y | Strategic revegetation                                                                    |
| B2G     | 206167   | Culvert   | Pipe (RCP) | 98.63  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 206359   | Culvert   | Pipe (RCP) | 89.11  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 206421   | Culvert   | Pipe (RCP) | 88.91  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 206574   | Culvert   | Pipe (RCP) | 78.24  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 206651   | Culvert   | Pipe (RCP) | 68.62  | 1.05  | 1.05   |    | N   | N                               | N   |    |     |    |    | Y | Reduce length                                                                             |
| B2G     | 206746   | Culvert   | Pipe (RCP) | 46.97  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 206876   | Culvert   | Pipe (RCP) | 35.61  | 1.05  | 1.05   |    | Y   | Y                               | Y   |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 207146   | Culvert   | Pipe (RCP) | 14.73  | 1.35  | 1.35   |    | Y   | Y                               | Y   |    |     |    |    | Y |                                                                                           |
| B2G     | 207705   | Culvert   | Box (RCBC) | 11.45  | 1.8   | 0.9    |    | Y   | Y                               | Y   |    |     |    |    | N | Increase dimensions                                                                       |
| B2G     | 208208   | Culvert   | Box (RCBC) | 21.38  | 2.4   | 1.5    |    | Y   | Y                               | Y   |    | Y   |    |    | Y |                                                                                           |